Wetlands Management II – Compensatory Mitigation

Author contact information

Wynn W. Cudmore, Ph.D., Principal Investigator
Northwest Center for Sustainable Resources
Chemeketa Community College
P.O. Box 14007
Salem, OR 97309
E-mail: wynn.cudmore@chemeketa.edu
Phone: 503-399-6514

Published 2011
DUE # 0757239

NCSR curriculum modules are designed as comprehensive instructions for students and supporting materials for faculty. The student instructions are designed to facilitate adaptation in a variety of settings. In addition to the instructional materials for students, the modules contain separate supporting information in the "Notes to Instructors" section, and when appropriate, *PowerPoint* slides. The modules also contain other sections which contain additional supporting information such as assessment strategies and suggested resources.

Acknowledgements

We thank Tom Robertson of Portland Community College and Anna VanDeWalle of Chemeketa Community College for their thoughtful reviews. Their comments and suggestions greatly improved the quality of this module. We thank NCSR administrative assistant, Liz Traver, for the review, graphic design and layout of this module. Carla Cudmore located appropriate photographs and figures for this module and obtained permission for their use.

Table of Contents

NCSR *Wetland Ecology and Management Series*
Introduction

Wetlands are among the most productive ecosystems on earth, and as such, provide countless ecological and economic benefits to humans. Management of this valuable resource is complex and represents an opportunity to approach the nature and management of a natural resource from several different perspectives in natural resource or environmental science programs. The NCSR *Wetland Ecology and Management Series* is designed to support the instruction of wetlands topics at the undergraduate level. It is modular in nature and instructors can pick and choose some topics for coverage and de-emphasize or ignore others. Thus, these curriculum materials are designed to meet a variety of instructional needs and strategies. The NCSR *Wetland Ecology and Management Series* is comprised of the following modules:

- ***Wetlands – An Introduction***

This module characterizes the wetlands resource and introduces students to wetlands as ecosystems and to the rationale for wetlands management. Wetland functions and values are also described.

- ***Wetlands – Then and Now***

This module describes the current status of wetlands and compares that to their place in history. Wetland types, classification schemes and causes for wetland loss and degradation are also discussed.

- ***Wetlands Management I – Determination and Delineation***

This module introduces wetlands management and describes wetland determination and delineation as first steps in wetland management projects. A field activity is included that engages students in the essential elements of wetland determination and delineation.

- ***Wetlands Management II – Compensatory Mitigation***

This module introduces the concept of compensatory mitigation and evaluates its effectiveness as a strategy for managing the wetland resource. A wetland mitigation field activity is included that describes how instructors can identify appropriate local wetland mitigation sites and how to organize a mitigation tour.

- ***Wetlands and Climate Change***

This module describes the complex relationship between wetlands and climate change.

- ***Wetlands and Hurricanes***

This module examines the impact of hurricanes on wetlands as well as the role of wetlands in the protection of coastal areas.

- ***Wetland Restoration in the Everglades***

This module uses restoration efforts in south Florida as a case study of wetland restoration.

Each module includes a lecture outline, *PowerPoint* presentation and detailed instructor notes. Modules with field-based activities also include student handouts, detailed procedures, data sheets and notes to instructors. In addition to the presentations and field activities described above, complete citations and brief summaries of relevant web, print and video resources are provided that can be used to:

- Enhance existing lecture topics
- Develop lectures on new topics
- Develop geographically relevant case studies
- Update wetlands statistics
- Select articles for student reading
- Access video and photos for presentation purposes

Intended audience

The NCSR *Wetland Ecology and Management Series* is intended to provide instructional support for undergraduate education at the freshman/sophomore level. Technical programs that include wetlands topics such as Wetlands Management, Civil Engineering and Biological Technician programs will find the modules to be a useful introduction to wetlands science and management. The materials are not designed to provide the training that is required by individuals to become certified wetland delineators or other types of wetlands technicians, as these curriculum materials and mechanisms for their delivery are available elsewhere. Also, NCSR wetlands materials are not designed for K-12 as a number of efforts have addressed wetlands for this level. In addition to providing background for those who will work with wetlands in their profession, NCSR materials also provide the background and context for students in other undergraduate programs. The materials may generate interest in some to pursue wetlands management as a career, but more importantly will result in an informed citizenry on wetlands issues. It is hoped that a more informed public will gather support for wetland conservation efforts as they occur in their local communities and help build a greater understanding of their importance.

The need for an undergraduate wetlands curriculum

Recent interest in wetlands as a valuable and dwindling resource has resulted in a large and growing volume of wetlands-related curriculum. However, the vast majority of these wetlands education resources target audiences other than first- and second-year college students. The K-12 audience, for example, has been well-served by efforts such as Project WET (Slattery and Kesselheim, 2003). The demand for training of wetlands delineators and those with expertise in wetland mitigation has driven the development of a number of continuing education classes that teach this material. The intended audience is those who are in the wetlands profession who seek the proper certification to conduct these activities. Examples include:

The Ohio State University
Olentangy River Wetland Research Park
www.swamp.osu.edu

North Carolina State University
Forestry and Environmental Outreach Program (FEOP)
http://www.ces.ncsu.edu/nreos/forest/feop/

Portland State University
Environmental Professional Program
http://epp.esr.pdx.edu/

The Swamp School
www.swampschool.org

Some degree programs at 4-year colleges and universities include courses in wetland ecology and management. However, the majority are taught at the graduate level and curriculum materials are not widely available for use outside of those institutions.

Thus, there appears to be a lack of classroom-ready materials and resources available for **undergraduate courses** that include some coverage of wetlands topics and form a bridge between the various wetlands curriculum materials described above. The NCSR *Wetland Ecology and Management Series* is designed to fill that void.

Guidelines for use

The manner in which instructors use the modules in this series will depend upon:

- The course in which the module will be used

The wetland mitigation modules are most appropriate for inclusion in undergraduate courses such as *Environmental Science, Introduction to Natural Resources, Wetlands Ecology* and *Introduction to Wetlands Management*. Parts of the modules may also have application in courses with a broader scope such as *General Ecology* and *General Biology*.

- The background of the students

The wetland mitigation modules assume some basic understanding of basic ecology including populations, communities and ecosystem structure and function. The treatment of ecology in either a college- or high school-level general biology course should be sufficient. Instructors may need to provide additional background to students who are not familiar with this material.

- The time that will be dedicated to the study of wetlands

There is sufficient information and resources in the wetlands mitigation modules to present anything from a single one-hour lecture to a significant portion of a full semester-long or quarter-long course. Instructors may select from the various components depending on course objectives and the amount of time allocated for wetlands topics.

A note on wetland field and laboratory experiences

The NCSR *Wetland Ecology and Management Series* emphasizes lecture support for instructors who are looking for wetlands material to insert into their courses. Although classroom lectures and discussions are a necessary element of a course that deals with wetlands issues, field and laboratory experiences enhance the learning experience and allow the instructor to explore topic areas that are not easily covered in the classroom. Additionally, students are more likely to become engaged in the topic when they can experience it firsthand.

Field activities may include a wide variety of experiences ranging from "tours" of various wetland types and restoration or mitigation projects to investigative experiences where students are actively engaged in the "scientific process."

Types of field activities (adapted from Baldwin, 2001):

- Field identification of wetland plants
- Preparation of plant collections using standard herbarium techniques
- Field identification of wetland animals
- Estimates of animal diversity and abundance (e.g., collection of invertebrates in soil litter samples, mammal livetrapping, amphibian surveys)
- Vegetation sampling methods (e.g., qualitative, line-intercept, transect, quadrat sampling)
- Analysis of wetland plant diversity and abundance
- Determination of hydric soils indicators
- Determination of site hydrology

Details of these methods are beyond the scope of this series and have been well-documented elsewhere in field and laboratory manuals designed for college-level courses. See resources below for some examples.

RESOURCES

Baldwin, A.H. 2001. Got mud? Field-based learning in wetland ecology. Journal of College Science Teaching 31:94-100.

O'Neal, L.H. 1995. Using wetlands to teach ecology and environmental awareness in general biology. American Biology Teacher 57:135-139.

Slattery, B.E. and A.S. Kesselheim. 2003. WOW! The wonders of wetlands: An educator's guide. Environmental Concern, Inc., St. Michaels, MD and The Project WET International Foundation, Bozeman, MT. 348 pp.

Wetlands Management II – Compensatory Mitigation

Module Description

This instructional guide is designed to provide instructors with lecture and laboratory materials that introduce the concept of compensatory mitigation as it is applied to wetlands. Student objectives, a general lecture outline and a more detailed *PowerPoint* presentation with instructor notes are provided. The concept of compensatory mitigation is defined and the various mitigation options that are used to replace wetlands lost to development are described. Examples of successful and unsuccessful mitigation projects are also provided. Wetland mitigation banking is introduced including trends and an overview of the regulatory process. A field-based laboratory is described that provides instructors with the resources to develop a "wetland mitigation tour" in their own community. Students are required to develop their own evaluation of the wetland mitigation process.

Instructors who are looking for videos or additional print and web-based resources on the topics covered here should consult the resources list provided at the end of this module where these resources are summarized and cited.

Objectives

Upon successful completion of this module students should be able to:

1. Describe the concept of wetland compensatory mitigation and the mechanisms for its implementation
2. Evaluate the costs and benefits of wetland mitigation
3. Identify the measures of success that are used to evaluate the effectiveness of wetland mitigation projects
4. Describe the concept of wetland mitigation banking

Wetlands Management II – Compensatory Mitigation

General Lecture Outline

I. Introduction to Compensatory Mitigation
- A. Definition
- B. The Clean Water Act
- C. Activities that require mitigation
- D. Initial shortcomings of mitigation projects
- E. Mitigation options
    1. Restoration
    2. Creation
    3. Enhancement
    4. Preservation
- F. Status and trends

II. The Challenge of Compensatory Mitigation
- A. Ecosystem replacements?
- B. To plant or not to plant
- C. Measures of success
    1. Performance standards
    2. Monitoring
    3. Reference sites
    4. Performance bonds
    5. Federal conservation programs
    6. Conservation easements
- D. Case studies
    1. Sweetwater National Wildlife Refuge
    2. Evergreen Wetland Mitigation Bank
- E. Mitigation ratios

III. Wetland Mitigation Banking
- A. The concept of mitigation banking
- B. Components
    1. Bank site
    2. Bank instrument
    3. Interagency Review Team
    4. Service area
- C. Regulation of mitigation banking
- D. Benefits
- E. Costs
- F. Trends and distribution

IV. Wetland Regulation in the United States
- A. Federal agencies
- B. Non-governmental organizations
- C. Supreme Court decisions
- D. Different viewpoints

PowerPoint Presentation with Instructor Notes

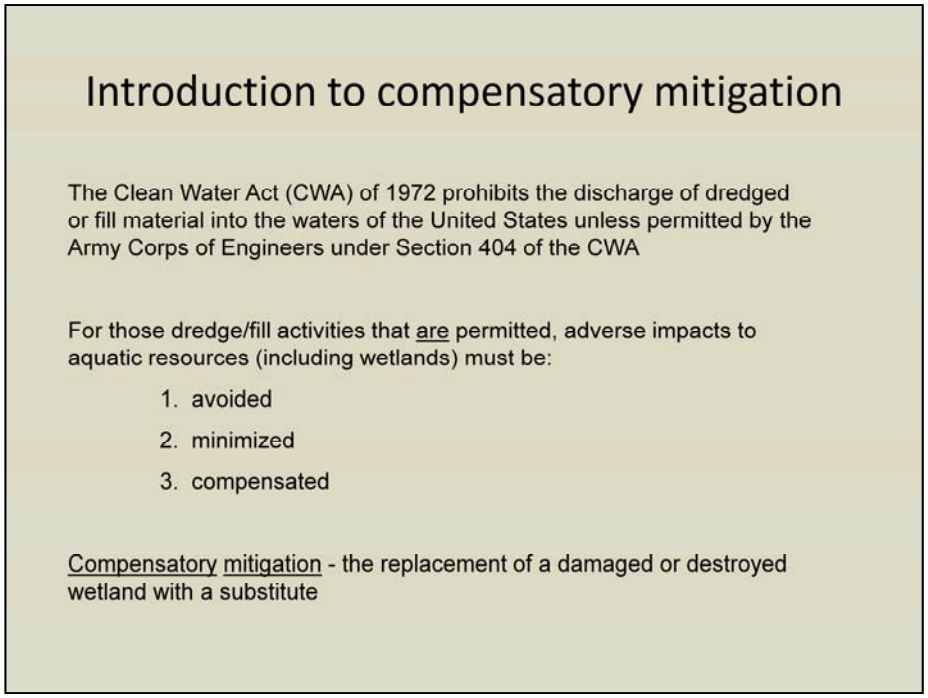
Wetlands Management II - Compensatory Mitigation

By Wynn W. Cudmore, Ph.D.

Northwest **C**enter for **S**ustainable **R**esources

DUE # 0757239

This project supported in part by the National Science Foundation. Opinions expressed are those of the authors and not necessarily those of the Foundation.



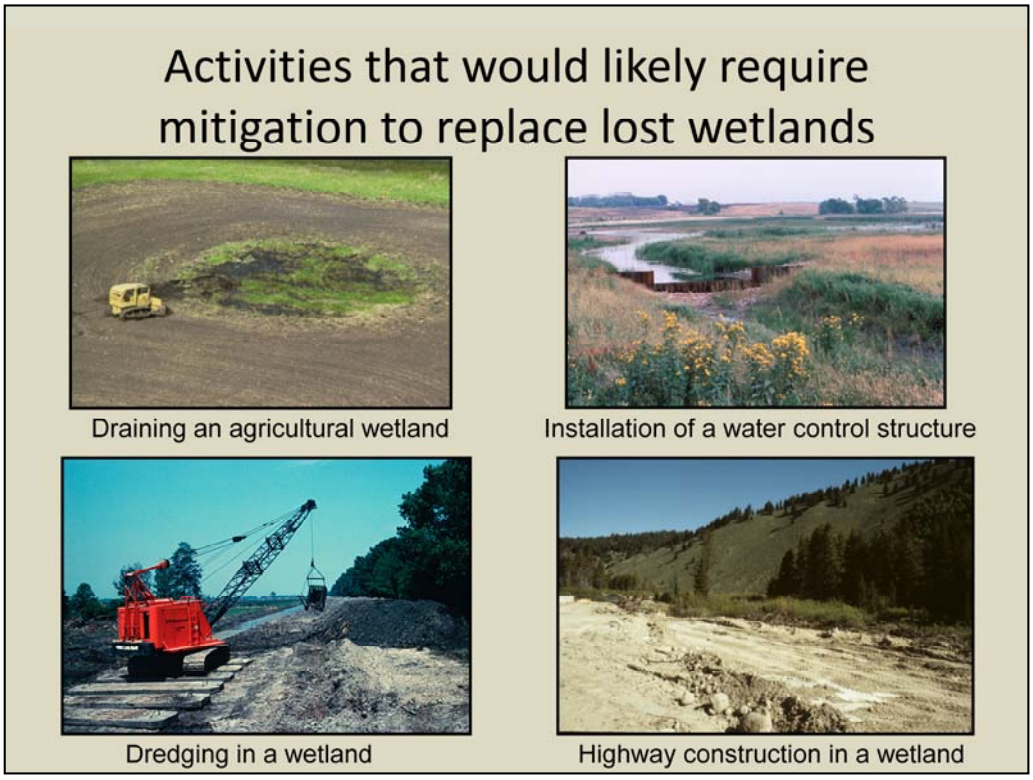
The Clean Water Act (1972) attempts to restore and maintain the chemical, physical and biological integrity of U.S. waters. To achieve this goal the CWA prohibits the discharge of dredged or fill material into waters of the U.S. unless a permit is issued to do so by the U.S. Army Corps of Engineers (ACOE) under Section 404 of the CWA. For those discharges that are authorized, adverse impacts to aquatic resources (including wetlands) must be avoided and minimized to the greatest extent possible. For those impacts that are unavoidable, compensatory mitigation is required to replace the loss of wetland functions in the watershed.

Simply stated, compensatory mitigation is the replacement of a damaged or destroyed wetland with a substitute (ideally, an equivalent wetland ecosystem). The nature of compensatory mitigation as a wetland management tool is the focus of this module.

It is important to note that compensatory mitigation is actually the third step in a sequence of actions that must be followed to offset impacts to wetland functions:

1. Adverse impacts to wetlands should be avoided if there is a practicable alternative with less adverse impacts
2. If impacts cannot be avoided, they should be minimized
3. Appropriate compensatory mitigation (as determined by the ACOE) is required for those adverse impacts that cannot be avoided or minimized

NOTE: Although the Clean Water Act is federal legislation, each state interprets the law somewhat differently and there is usually state legislation that also regulates the filling of wetlands. In Oregon, for example, if a wetland has been farmed since 1985, it is not subject to any of the normal restrictions and can continue to be used for agricultural purposes. However, if the landowner wants to take the property out of agricultural production, it immediately falls under current wetland laws. Also, up to 50 cubic yards (approximately 5 dump truck loads) of fill may be placed in a jurisdictional wetland without requiring a permit.



With laws that were passed in the 1970s to protect wetlands, it became necessary to compensate for wetlands lost to development. These activities, for example, would likely require compensatory mitigation if conducted in a wetland – placement of fill material, ditching activities, levee and dike construction, land leveling, road construction, and dam construction.

Photo credits:
Top left (draining) - Division of Public Affairs/U.S. Fish and Wildlife Service
Top right (water control structure) - U.S. Fish and Wildlife Service
Bottom left (dredging in wetland) - Gary Heet, U.S. Fish and Wildlife Service, Division of Public Affairs
Bottom right (highway construction) - NMFS/Northwest Fisheries Science Center; Pacific Northwest Collection, National Oceanic and Atmospheric Administration/Department of Commerce

In the early 1980s, in an effort to reconcile developers need for land with demands for environmental protection, a number of conservation groups and government regulators, saw wetland mitigation as a solution. In the first wave of development, many wetlands were overlooked as development sites due to the difficulty of building. However, as land became scarce, developers began to view these lands as potential sites for new housing developments and commercial and industrial development. Developers were restrained by Section 404 of the CWA, which prevented the filling of wetlands without a permit. Based on a growing body of knowledge developed by the new science of ecological restoration, compensatory mitigation was seen as a way that we could have both development and conservation. The idea was that if all efforts to prevent wetlands development failed, we could allow the development to proceed and compensate by building the wetlands elsewhere.

In an effort to satisfy the “no net loss” policy and other wetlands regulations, it has become common for regulatory agencies to require the creation, restoration or enhancement of wetlands to compensate for those that have been lost to development. These wetlands are often referred to as “mitigation wetlands.”

Photo credits:
Left – Construction - www.free-pictures-photos.com/construction/index.htm
Right - Sunset – Steve Hillebrand, USFWS

Initial shortcomings of wetland mitigation

Wetland mitigation site in Salem, Oregon

See notes slide 5 (page 15)

Photo credit: Google Earth

Notes slide 5 (page 15)

Particularly in its early years, however, wetland mitigation projects often fell far short of providing ecological equivalents (i.e., similar functions and values) of the original wetlands development had destroyed. A 1991 analysis of wetland mitigation in South Florida, for example, found that only half of the wetland mitigation projects had actually been constructed. For those that had been constructed, 24 of 40 (60%) projects were incomplete or had failed. Some dried up and no longer resembled wetlands; others looked like wetlands but failed to support the endangered birds or plants they were designed to replace. Many resembled swimming pools with steep sloping sides since that is what the construction crews who built them knew what to build. A typical early mitigation project would have a mechanical fountain, mowed grass, bark dust and landscaped plants. These early mitigation projects also promoted invasive species such as bullfrogs, snapping turtles and reed canarygrass (in Oregon). The most common type of wetland found in early mitigation projects was open water ponds with a fringe of wetland vegetation. However, in a 5-year study of the effectiveness of wetland mitigation, no development had destroyed this wetland type. They were built simply because they were easy to build. Monitoring after construction was a rarity. Even if adequate planning was conducted, often the projects were not built according to those plans.

Historically, species composition and ecological services provided by a created wetland often fell far short of those provided by the original natural wetland. The most common scenario was a shallow pond with an island ("duck donut") built to replace a freshwater marsh.

Since the 1980s various state and federal regulations have improved the mitigation process. Mitigation projects are now expected to be as close as possible to the affected wetland and they should attempt to re-create the type of wetland that is being lost.

Under current regulations, a mitigation plan must be in place before development of a wetland can begin. Given the high failure rate of mitigation historically, some regulatory agencies are attempting to require that mitigation be complete or in some advanced stage of completion before construction activities begin. Regulations concerning the mitigation process continue to evolve.

This *Google Earth* satellite image shows an on-site wetland mitigation project that was built in the mid-1990s to mitigate for commercial and light industrial development in Salem, Oregon. The project is typical of early mitigation sites as described above:

1. Site is almost entirely open water, constructed by excavating a regularly shaped depression (vertically-oriented pond at center of image)
2. "Duck islands" (3) were placed in open water
3. Margins are steep-sided, therefore transition from "open water" to "upland" is rapid producing a very thin margin of wetland surrounding the pond
4. Small tree and shrub plantings around the margin
5. Site is isolated from other wetlands (no connectivity)
6. Site is surrounded by urban development – interstate highway at top of images, impervious surfaces (parking lots and roads) – with potential for contaminated runoff

These 2010 photographs of the site shown in the previous image illustrate some of the characteristics of this wetland mitigation project approximately 15 years after its construction. "Duck islands," an in-pond fountain, tree and shrub plantings, site fencing and the wetland margin can be seen. Although the site is certainly "wet," there is very little wetland present. The transition from open water to upland is abrupt and the area of seasonally saturated soils is small.

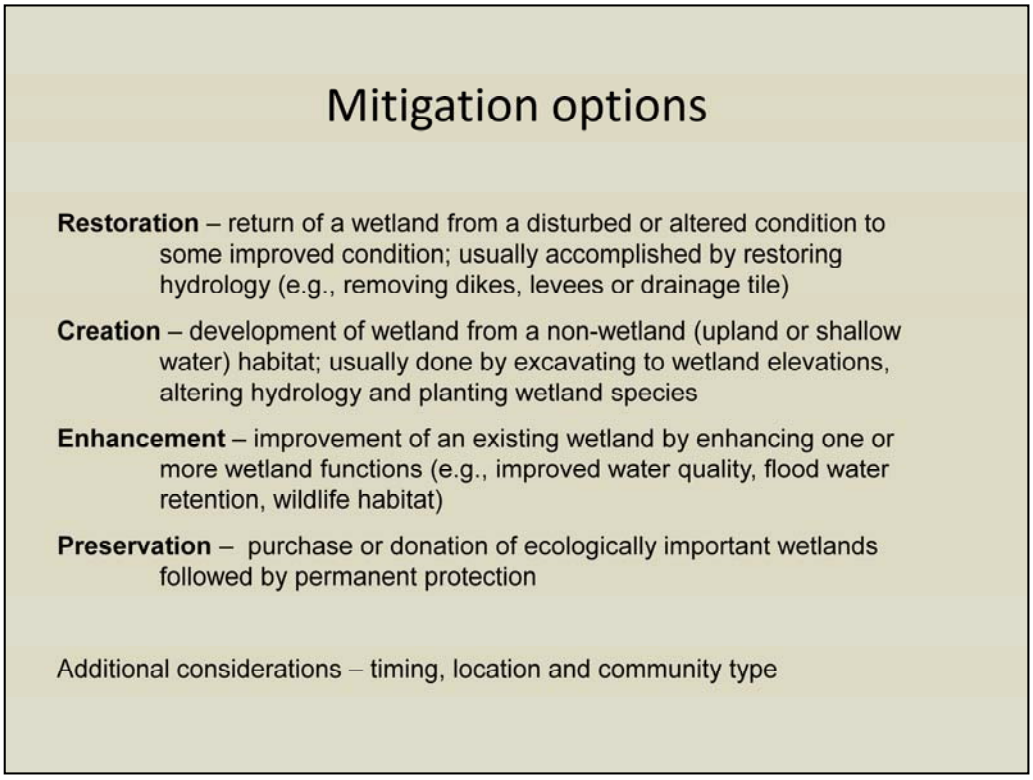
Given your understanding of wetland functions, which are provided by wetland mitigation projects of this type? Which are not provided?

Provided:
- Some stormwater storage (but, little capacity for absorbing additional flow)
- Duck resting
- Esthetics – pond is likely seen as an amenity by surrounding businesses
- Aquifer recharge?

Not provided:
- Water treatment (due to minimal wetland vegetation and associated soils and microbes; some aeration is provided artificially by fountain)
- Wildlife habitat (no nesting or feeding habitat for most wetland-associated species)
- Endangered species habitat
- Flood protection (minimal)

Standards for wetland mitigation sites have become more stringent in recent years and while this wetland mitigation site was declared successful in the mid-1990s, it would not likely be approved today.

Photo credits: Becca Cudmore



See notes slide 7 (page 18)

Notes slide 7 (page 18)

A number of different types of mitigation are now recognized:

Restoration - refers to the return of a wetlands from a disturbed or altered condition due to human activity to a previously existing wetland condition (i.e., return of a former wetland with no or few wetland functions being met to one where they are being met); many of these wetlands have had their hydrology altered and restoration often involves reestablishing hydrological conditions that allow wetland vegetation to return; practices include removing dikes, levees, or tiling systems in agricultural fields designed to drain wetlands; restoration wetlands have a higher probability of success when compared to created wetlands since there are often remnant elements of former wetlands such as hydric soils, hydrology, seed banks, roots and rhizomes. Restoration may result in a gain in wetland function or wetland area, or both.

Creation – (or "establishment") refers to a wetland developed from a non-wetland (i.e., upland or shallow water area) habitat; usually done by excavating uplands to wetland elevations, altering hydrology to mimic that of a natural wetland ecosystem and planting wetland species; created wetlands have a higher probability of failure due to the scientific and technical challenges of creating wetland in non-wetland habitat; however, if they are successful, the result is a net gain in wetland acres and function.

Enhancement – human intervention within an existing wetland that improves one or more wetland functions (e.g., improved water quality, flood water retention, or wildlife habitat); enhancement results in a net gain wetland function, but not a net gain of wetland acreage

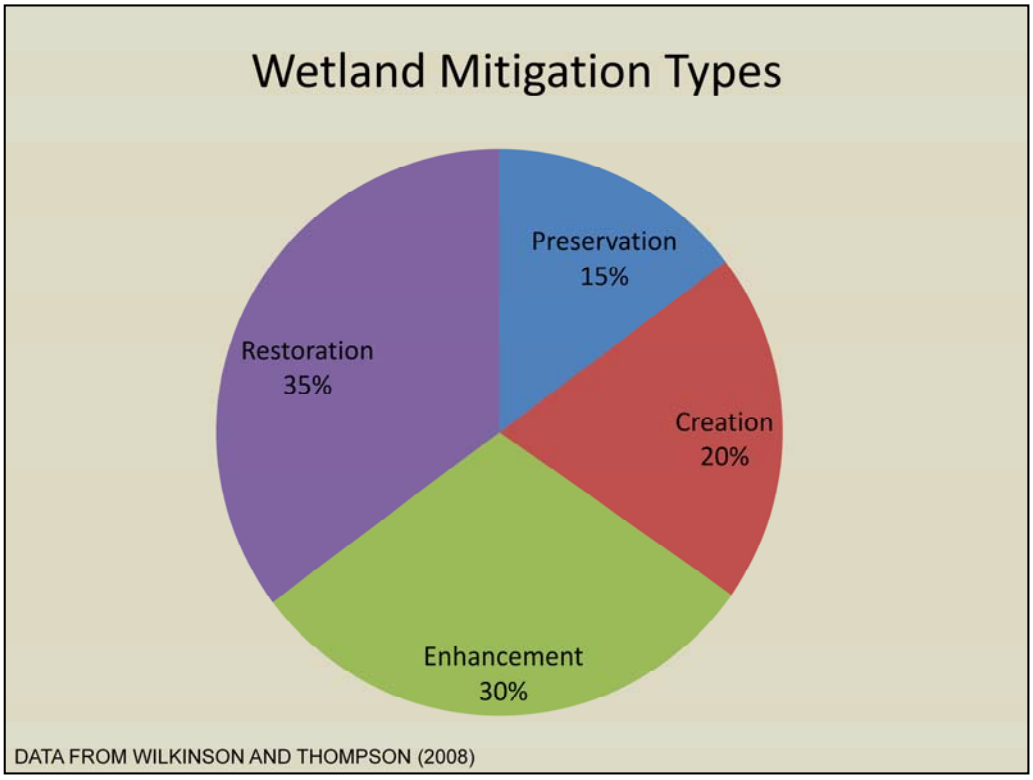
Preservation - purchase or donation of ecologically important wetlands followed by permanent protection; sometimes upland areas adjacent to ecologically important wetlands are protected to provide a protective buffer for a wetland; preservation is used less often for compensatory mitigation and is generally used only when the aquatic resources that are being protected contribute significantly to the ecological sustainability of the watershed.

Additional considerations:

Timing - mitigation may be done before (preferred), during (possible for typical mitigation where system is well-known and there have been other successes) or after (discouraged) the original wetland is destroyed

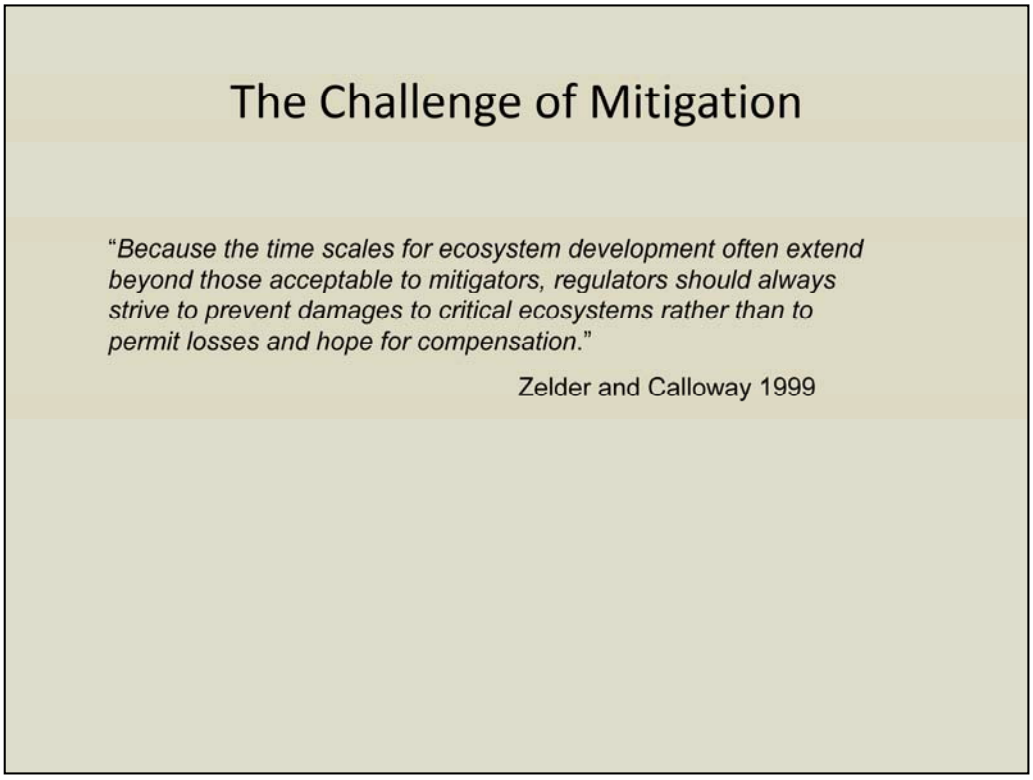
Location – on-site (same locale as a destroyed wetland) or off-site (different locale)

Community type – may be in-kind (same species/wetland type) or out-of-kind (different species/wetland type)



Proportion of wetland mitigation types implemented in the United States in 2003 calculated as a percent of total wetland mitigation that year (43,549 acres). Note that restoration (36%) and enhancement (30%) are more commonly used than either creation or preservation.

Wilkinson, J. and J. Thompson. 2006. 2005 Status report on compensatory mitigation in the United States. Environmental Law Institute. Washington, D.C.



The challenge of mitigation

Compensating for the loss of natural wetlands by restoring, creating or enhancing other wetlands can be tricky business. Humans have a checkered past when it comes to "improving nature," despite the assumption by some that we can create entire ecosystems. Ecosystems are probably more complex than we have the ability to understand and it is easy to make mistakes. As a result, those with experience in wetland mitigation often suggest that interventions remain simple and that they conform to the degree possible with the limitations established by the natural landscape.

Stressed wetlands in urban areas where many mitigation projects are implemented, and forested wetlands in particular, may take very long time frames to re-establish. Freshwater marsh systems in low stress environments are often at the other end of the scale and reach targets in a relatively short period of time. For those wetland types that have been particularly difficult to restore, create or enhance, some wetland scientists recommend caution in the use of wetland mitigation as a tool:

"Because the time scales for ecosystem development often extend beyond those acceptable to mitigators, regulators should always strive to prevent damages to critical ecosystems rather than to permit losses and hope for compensation." Zelder and Calloway 1999

These authors recommend that mitigation ratios should reflect the reality that recovery times may be much longer than realized. Compensation ratios currently range from 1:1 (for highly degraded wetlands) to 10:1 for mature wetlands in a natural condition (and, therefore, with high functions and values). They recommend that higher ratios should be required for replacing ecosystems that require longer development periods or that have not been effectively replaced in earlier restoration efforts.

Note: Wetland mitigation ratios are described in more detail later in the module. A "10:1 ratio" means that for every acre of wetland destroyed, 10 acres would have to be created or restored.

Should wetland mitigation sites be planted or left to populate with plants on their own?

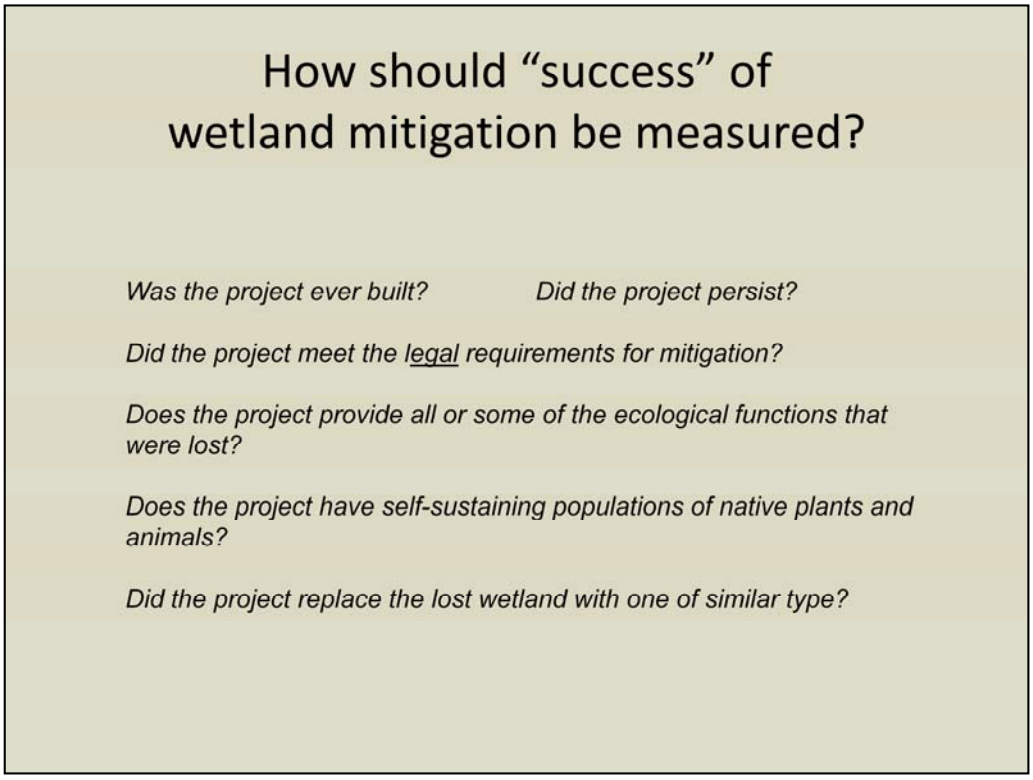
Science informing this question is in flux and there remains some disagreement among experts in the field. Some claim that self-design of ecosystems (humans establish initial conditions of hydrology and disturbance regimes and then let plant communities establish on their own) should be emphasized since we do not have complete understanding of these complex ecosystems. Mitsch, et al. 1999 (BioScience 48:1019-1030), for example, report on an experiment in which the vegetation community of a planted and an unplanted wetland became similar. They concluded from this that planting may not always be necessary to start a wetlands along a trajectory to recovery. Planting on mitigation sites requires an investment of time, money and energy.

Streever and Zelder (2000), however, caution that this should not be universally applied and that planting remains an important element of wetland creation and restoration projects. They suggest that not planting may allow the establishment of invasive species, allow erosion to occur and slow the development of natural wetland vegetation structure. They claim that the question is not whether or not planting should be done, but rather which species should be planted and how different planting methods influence plant community development.

For a detailed discussion of this issue, see:

Streever, B. and J. Zelder. 2000. To plant or not to plant. BioScience 50:188-190.

Mitsch, W.J., et al. 1998. Creating and restoring wetlands. BioScience 48:1019-1030.



Establishing a definition for wetland mitigation success and methods for measuring that success have evolved since the inception of wetland mitigation. What is wetland mitigation "success" and how should it be measured?

"Success" can be interpreted in different ways by different interests and may include answers to the following questions:

Was the project ever built?

Did the project persist?

Particularly in the early days of mitigation, many planned mitigation projects were never completed and those that were did not retain wetland characteristics soon after construction.

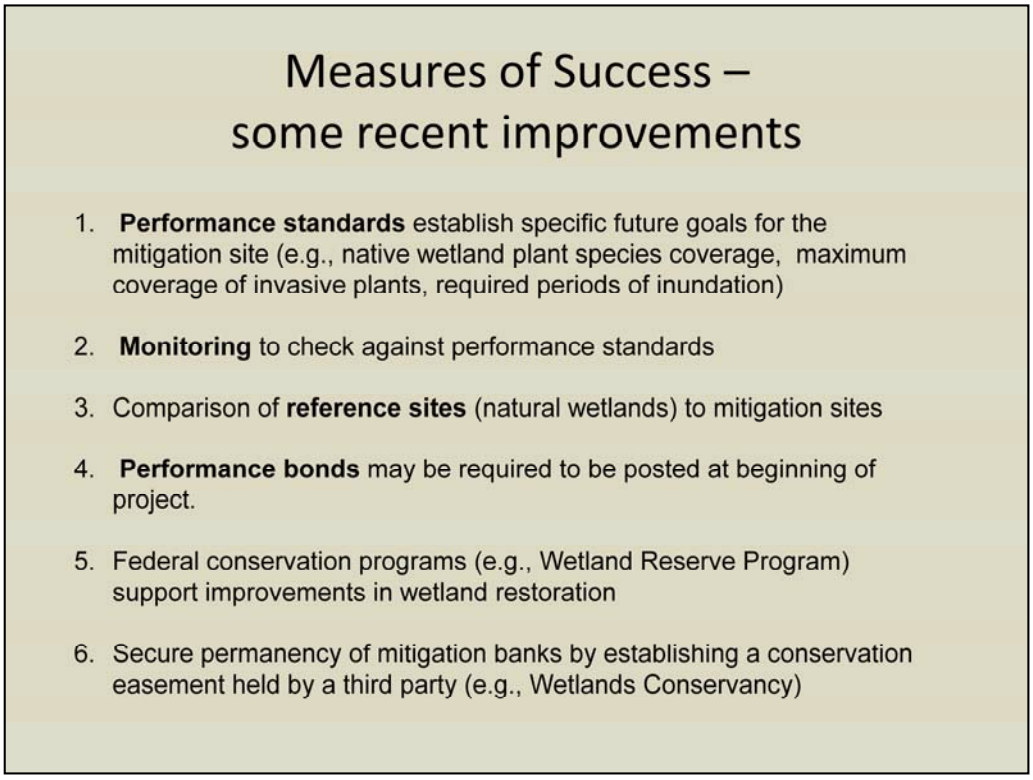
Did the project meet the legal requirements for mitigation?

Does the project provide all or some of the ecological functions that were lost? (i.e., water storage, flood buffering, waterfowl habitat, etc.)

For some wetland types, achieving lost ecological functions can be very difficult.

Does the project have self-sustaining populations of native plants and animals?

Did the project replace the lost wetland with one of similar type?



See notes slide 12 (page 24)

Notes slide 12 (page 24)

In recent years, changes have been made in the mitigation process by the Army Corps of Engineers with the goal of improving the likelihood for successful mitigation:

1. **Performance standards** are now required that establish specific future goals for the mitigation site. These may include, for example, minimum coverage by native wetland species, minimum measures of animal diversity, maximum amount of invasive plants allowed, specific periods of inundation, etc.
2. **Monitoring** for a minimum of 5 years to check against performance standards
3. For mitigation banks, the use of **reference sites** (a "natural" wetland of the same type in the same general area that is used as a benchmark to compare) for comparison with mitigation sites. Both the reference site and the mitigation site must be monitored and compared.
4. **Performance bonds** may be required to be posted at beginning of project. If performance standards are <u>not</u> met, the performance bond is forfeited. Also, for mitigation banks, if performance criteria are not met, the bank owner will not be allowed to sell additional credits.
5. Federal conservation programs also support improvements in wetland restoration. The Wetland Reserve Program (WRP), for example, pays farmers to restore farmland to wetland.
6. In the future, the permanency of mitigation banks will likely be secured by establishing a permanent conservation easement that is held by a third party (e.g., Wetlands Conservancy)

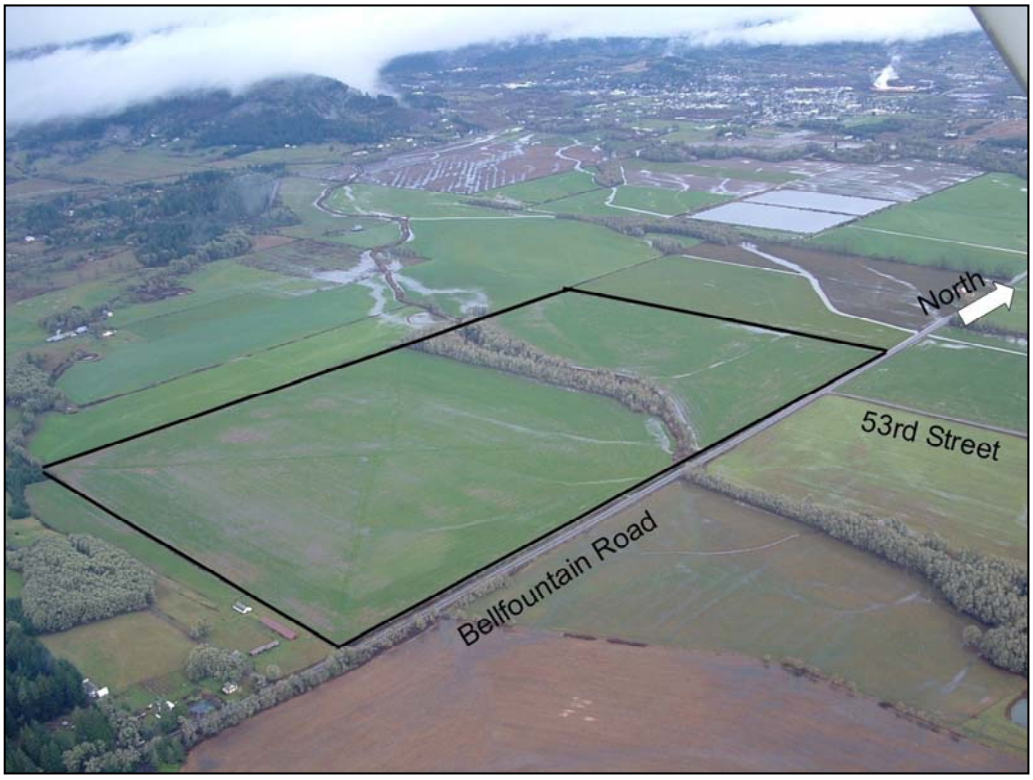
Many wetland scientists now suggest that the overall success of a mitigation wetland should include both:

1. **Legal success** (i.e., Does the mitigation wetland compensate for lost wetland function and area?)

AND

2. **Ecological success** (i.e., Does the mitigation wetland have the same attributes as a reference wetland?)

In practice, the success of a mitigation project is usually determined by a comparison between the size of the wetland lost and the size of the mitigation project. Using this measure, the U.S. has been successful in its attempt to achieve its long-stated policy of "no net loss of wetlands." Since the early 1990s, <u>mitigated</u> (wetland gain) acreage has exceeded <u>permitted</u> (wetland loss) acreage.



The following slides will be used to illustrate the planning, building and monitoring of a large wetland mitigation project in western Oregon. Several of the “recent improvements” of wetland mitigation described on the previous slide have been incorporated into the development of this site.

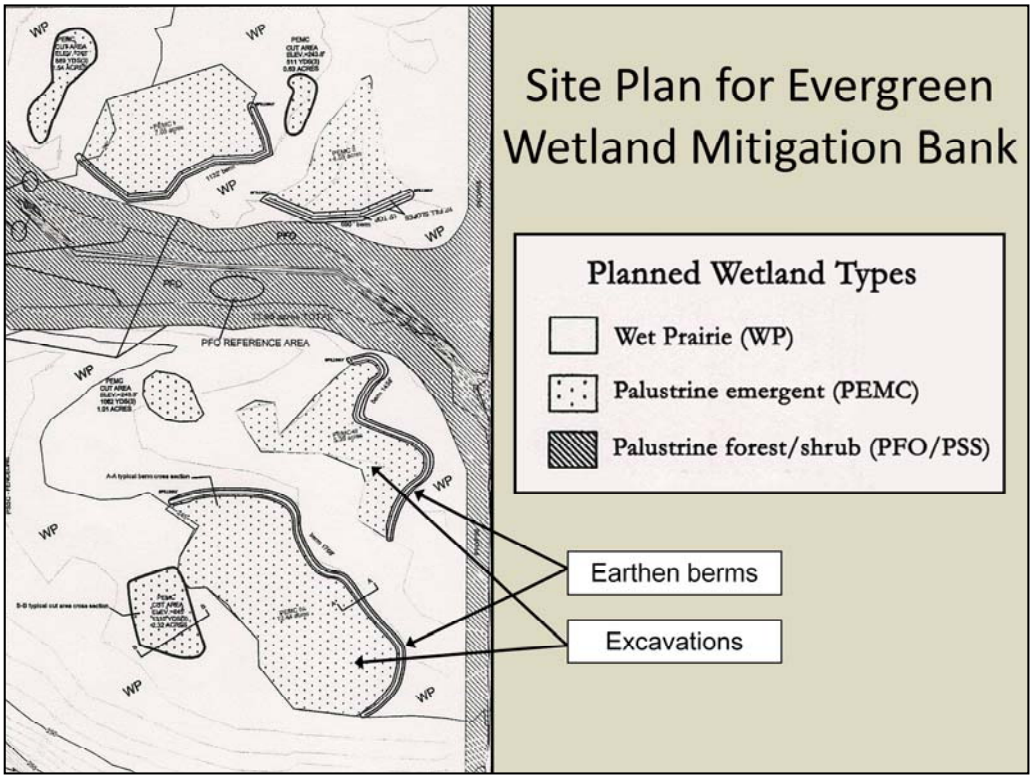
Photo: Evergreen Mitigation Bank before restoration (January 2005)

The site is 174 acres (boundaries in black) located 1.5 mi south of Philomath, Oregon, Benton Co. It was originally a Ryegrass field (grown to produce grass seed) surrounded by other grass seed fields, some native vegetation (riparian and upland forest) and residential areas (to north at top of photo).

Natural drainage can be seen in upper third of site flowing SE (to right) in photo. The associated riparian area is dominated by Oregon ash, hawthorn, cascara and wild cherry.

The owners decided to develop the site as a for-profit wetland mitigation bank in 2005. Wetland mitigation banking is described later in this module.

Photo credit: Ray Fiori, Oregon Wetlands, LLC



The site plan for the Evergreen Wetland Mitigation Bank is shown here prior to any restoration activities. The proposed location of berms (to retain natural runoff and precipitation), excavations and wetland types are indicated.

Three wetland types were planned:

1. Wet prairie (WP) – higher elevation and somewhat drier areas on the site

A wet prairie is similar to a marsh but with water levels that are intermediate between a marsh and a wet meadow, which is a grassland with waterlogged soils but without standing water throughout the year.

2. Palustrine emergent (PEMC) – stippled on map; lower elevation, excavated areas on the site

A palustrine emergent wetland is a non-tidal marsh that is frequently or continually inundated and dominated by emergent herbaceous vegetation.

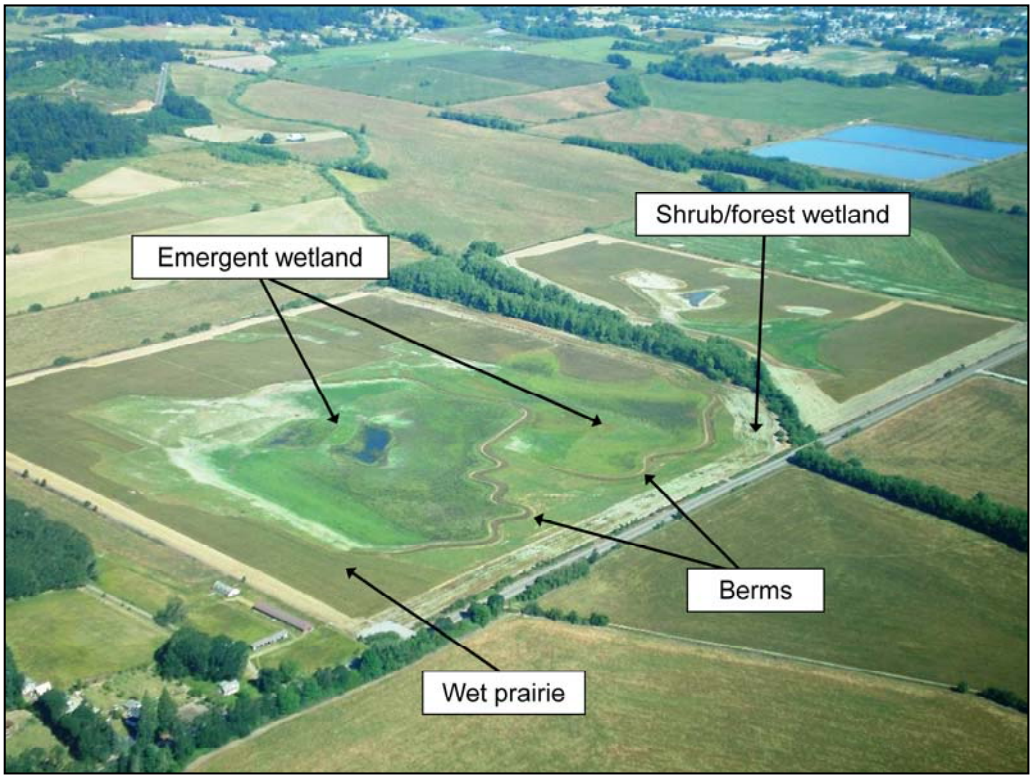
3. Palustrine forest/shrub (PFO/PSS) – cross-hatched on map

A palustrine forest/shrub wetland is similar to above, but dominated by woody vegetation.

Note that the site plan proposes to expand the existing riparian forest along the creek and adjacent to road along right margin of map.

Also, note elliptical reference area for palustrine shrub/forest, which will be used for comparison to developing shrub/forest wetland elsewhere on the site. This will be used as part of ongoing monitoring, as discussed later in “Performance Standards.”

Image Credit: Ray Fiori, Oregon Wetlands, LLC



Evergreen Wetland Mitigation Bank 1 year after restoration activities began (Summer 2007)

Restoration began in July 2006:

1. Removal of straw and stubble after harvest of grass seed.
2. Surface grading began in July 2006 – Ponded areas were scooped out and this fill was used to create berms (irregular brown lines in photo), which serve to retain water on the site. Also, transitional areas (from ponded areas to wet prairie) were gently graded.
3. Emergent wetlands (ponded areas behind berms; blue and light green in photo) were seeded in September 2006.
4. Herbicide was applied to wet prairie areas (3 times) to control invasive plants.
5. Trees and shrubs (bare root) were planted in February 2007.
6. Wet prairie areas were seeded in April 2007.

Note that for this mitigation project, implementation is very close to the site plan.

Photo credit: Ray Fiori, Oregon Wetlands, LLC

Permanently located photo points are commonly used on mitigation sites to monitor changes in vegetation over time. This photo shows the Evergreen Wetland Mitigation Bank shortly after initial tree and shrub planting (February 2007).

Trees planted - Pacific dogwood, Douglas hawthorn, cottonwood, flowering crabapple, Oregon ash, Ponderosa pine, white alder

Shrubs planted - Indian plum, Nootka rose, Pacific ninebark, red flowering currant, red osier dogwood, Sitka willow, Pacific willow

At this site, trees and shrubs were planted in widely separated rows to allow for mechanical mowing and mechanical herbicide applications. The site was then over-seeded in April 2007 with herbaceous species (grasses and herbaceous wetland plants).

Photo – Evergreen Wetland Mitigation Bank - year 1 - Photo Point #7

Photo credit: Ray Fiori, Oregon Wetlands, LLC

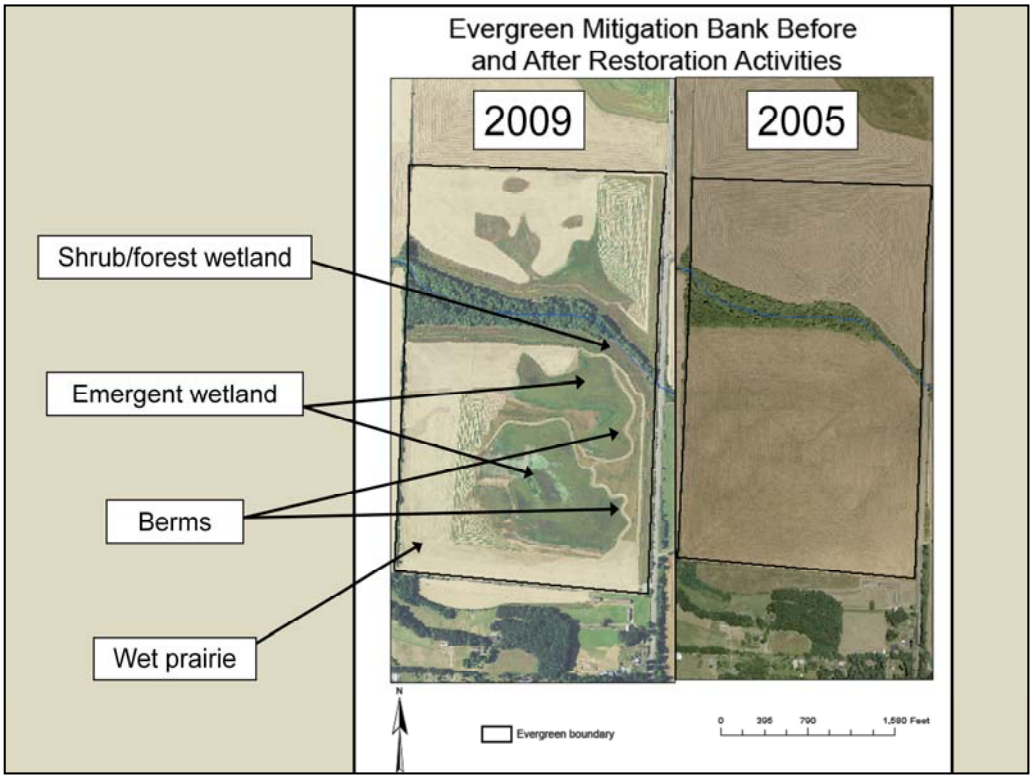
This photo shows the same photo point in the third growing season (Summer 2009).

Emergent wetland (right and center in photo) and wet prairie (lower left in photo) are well-established. Herbaceous species, shrubs and trees are growing well throughout the site.

When a site has reached this stage of development, mechanical spraying is abandoned in favor of spot spraying to control invasives.

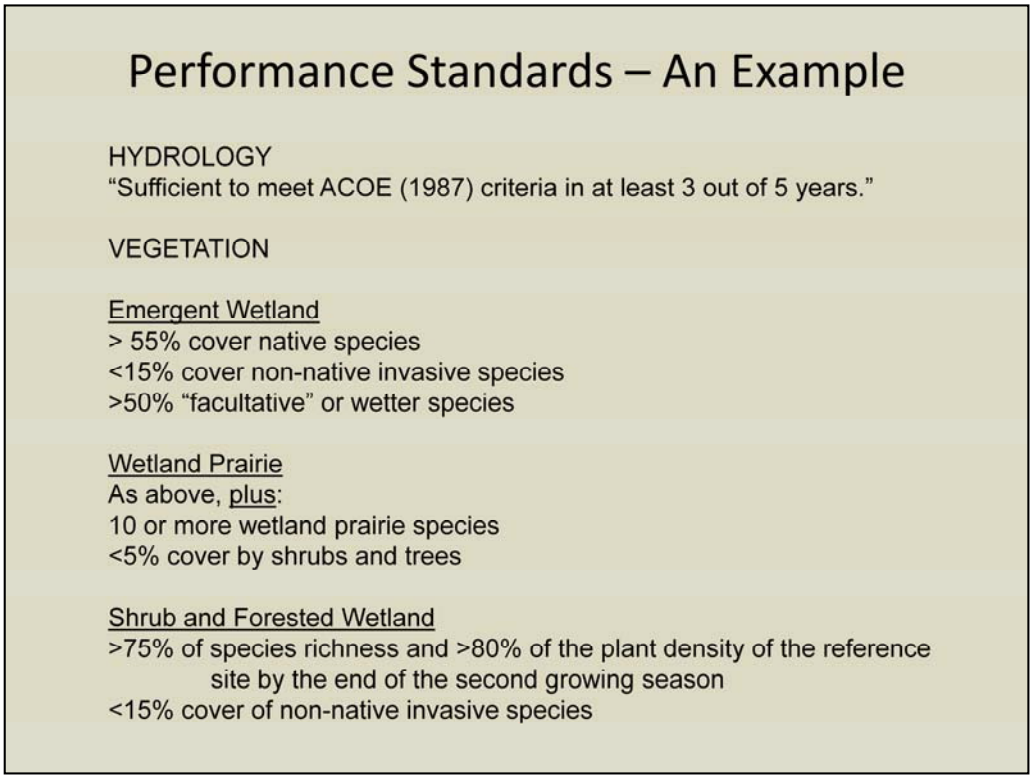
Photo - Evergreen Mitigation Bank year 3 - Photo Point #7

Photo credit: Ray Fiori, Oregon Wetlands, LLC



This side by side comparison illustrates the changes that have occurred on this mitigation site before (2005) and four years after (2009) restoration activities.

Photo credit: Ray Fiori, Oregon Wetlands, LLC



See notes slide 19 (page 32)

Notes slide 19 (page 32)

Monitoring is often required after the site is built to determine whether or not the site meets wetland criteria. Performance standards are established and the site is monitored to evaluate its development as a wetland. The length of time monitoring is required (and, in fact, whether or not monitoring is even required) varies from state to state. In Oregon, for example, wetland monitoring for an approved mitigation bank must be conducted for at least 5 years after the last credit is sold. Other (non-bank) mitigation sites must be monitored for at least 3 years after being built.

The example shown here is for Evergreen Wetland Mitigation Bank in Benton Co., Oregon, shown in the previous slides. It is presented for illustration purposes, only to show what performance standards might look like and how they are measured.

Hydrology and vegetation, but not soils, are evaluated during monitoring. Hydric soil characteristics develop only after long periods of time and are disturbed by any grading or excavation done on the site. Thus, they are not very useful as indicators that a wetland is developing.

These performance standards were evaluated during monitoring using the following methods:

Hydrology – Methodology

1. Water monitoring tubes (approx. 3" dia.) called piezometers were inserted at locations representative of the hydrological variation on-site. Data were collected 3 times between 1 March and 30 May to determine if sufficient saturation was present

2. Evaluation of level of saturation in soil pits or by using soil probes along the wetland boundary

Vegetation – Methodology

A stratified, systematic plot method was used to conduct vegetation sampling. Vegetation data were collected at 100 sample points located along 6 transects. Sample points were used as centers for 10' diameter plots. In the shrub/forest wetland 50' square plots were used. Percent cover was visually estimated and, where required, density was determined by stem counts.

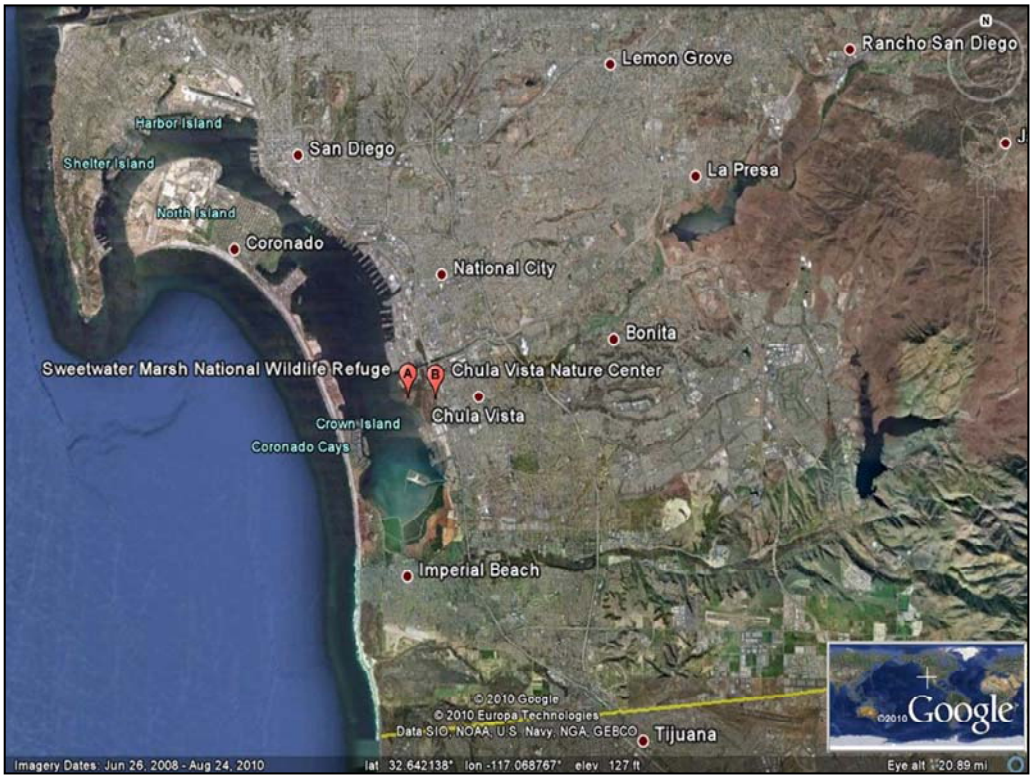
Results of 2008 Monitoring

In a 2008 monitoring report, this mitigation bank met 10 of the 14 performance standards. At this very early stage of development, the vast majority of species that were planted, remain established on-site. As the site matures, it is expected that some planted species will disappear while some new species will appear (i.e., natural propagation).

A case study of the trajectories of a southern California (San Diego Bay) mitigation site serves to illustrate the difficulty in achieving successful wetland mitigation. In the mid-1980s, the California Department of Transportation agreed to restore 12 hectares of coastal wetland as mitigation for a highway project that impacted an area of coastal marsh. This wetland type provides habitat for the Light-footed clapper rail (*Rallus longirostris levipes*), a federally-listed species under the Endangered Species Act. Over the past 150 years, dredging and filling operations to support commercial and port development have resulted in the loss of San Diego Bay's coastal wetlands, including critical habitat for the clapper rail. Over 84% of historic tidal wetlands and 70% of salt marsh habitat in this area have been lost.

A mitigation site was selected in the Sweetwater National Wildlife Refuge, about 8 km south of San Diego. In 1984, the site was excavated to intertidal elevations and, in 1985, it was planted with native cordgrass (*Spartina foliosa*) using seed from a nearby marsh. The goal was to produce self-sustaining stands of *Spartina*, which would provide nesting habitat for clapper rails.

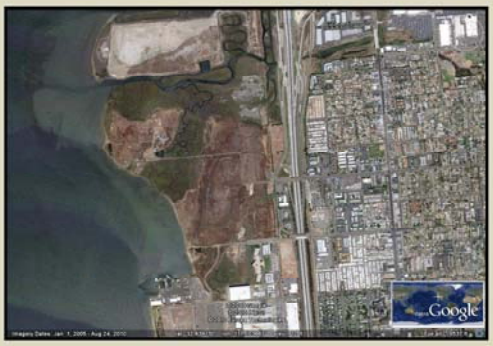
Photo credit: U.S. Geological Survey



The location of Sweetwater Marsh National Wildlife Refuge can be seen in this Google Earth image. The refuge is located about 8 km south of downtown San Diego on San Diego Bay. The refuge is surrounded by heavy urban and port development.

Photo credit: Google Earth

Failed mitigation



Sweetwater Marsh National Wildlife Refuge

Spartina at mitigation site failed to achieve required height due to soil characteristics

Sandy soils could neither supply nor retain sufficient nitrogen to optimize *Spartina* growth

Clapper rail nesting habitat must have vegetation >90 cm to:

- Secure nests on flood tides
- Weave canopy to provide protection from predators

See notes slide 22 (page 36)

Photo credits:
Left – Google Earth
Right – U.S. Geological Survey

Notes slide 22 (page 36)

Closer view of Sweetwater Marsh National Wildlife Refuge where mitigation project was located.

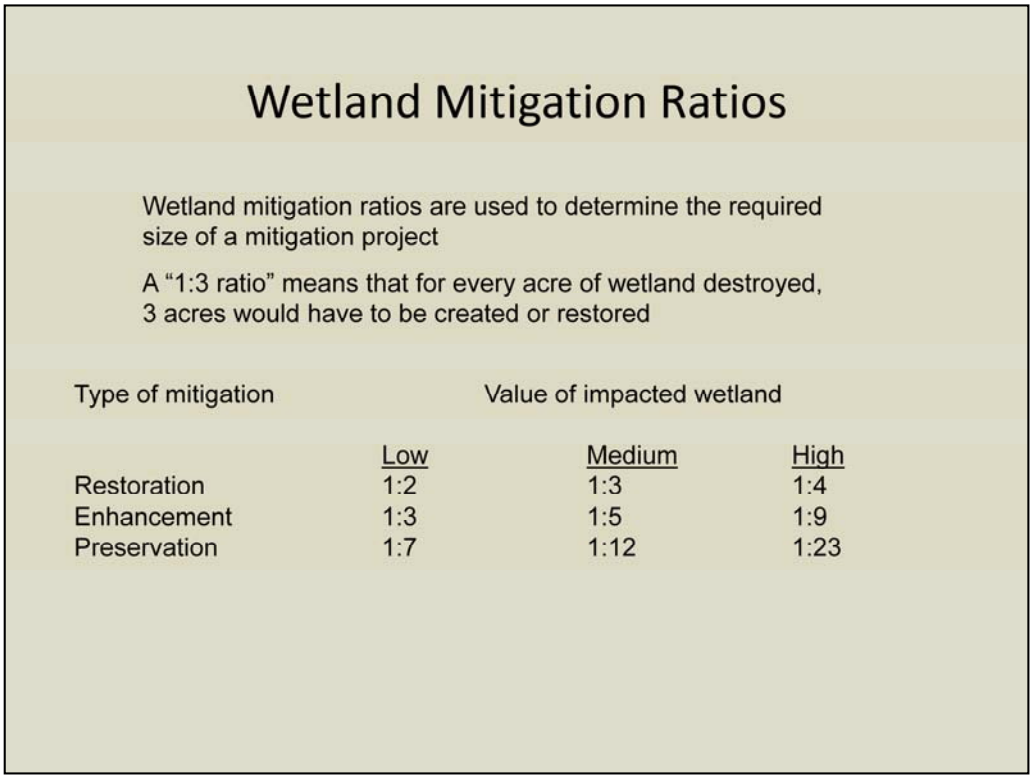
However, after 10 years of monitoring and study, researchers concluded that the mitigation project had failed to achieve that objective. Furthermore, the scientists concluded that the marsh was unlikely to ever provide clapper rail nesting habitat. The problem centered around the height of vegetation on the mitigation site. Clapper rail nesting habitat must have vegetation that is at least 90 cm tall. Grass of this height is needed to secure nests that will float and rise with the tide. Also, cordgrass must be at least 90 cm tall to weave into a canopy over the nest to provide protection from flying predators. Short cordgrass was also found to be more susceptible to insect outbreaks, which reduced vegetation height even further.

The shorter vegetation on the mitigation site can be traced back to soil characteristics. The substrate on the mitigation site is much sandier than natural marshes and the coarser soil neither supplies nor retains sufficient nitrogen to optimize cordgrass growth. Therefore, the cordgrass does not grow tall enough to support clapper rail nesting. The conclusion was that this mitigation project did not meet agency expectations in the short-term (5-10 years) and there was little evidence that over the long term it would. Clapper rails have still not nested on the site.

Artificial enrichment of wetland soils in experimental plots accelerated cordgrass growth, but resulted in a change in species mix that favored annual pickleweed (*Salicornia*) over cordgrass. Additionally, nitrate returned to low levels once the researchers stopped adding fertilizer.

Despite the failure of this mitigation site, light-footed clapper rail populations have increased slowly from an estimated 203 pairs in 1980 to 443 pairs in 2007. The U.S. Fish and Wildlife Service has established the criterion of “800 pairs in at least 20 marsh complexes” for the species to be downlisted from “endangered” to “threatened.” In September 2010, the agency implemented the San Diego Bay Coastal Restoration Project – a plan to preserve, restore and create 4000 ha (10,000 acres) of salt marsh in and around San Diego Bay that would be suitable habitat for the species.

This case study serves to illustrate that functional replacement of many wetland types may be very difficult, particularly when they are designed to provide habitat for endangered species.



Wetland mitigation in practice

Although the details of how wetland mitigation gets implemented vary from state to state, some features are common to all projects. Among these is the determination (by regulators) of a required ratio between the area of the impacted wetland and the area of the mitigation site. The mitigation ratio that is selected is based on how long it might take a restored site to reach wetland structure and function targets and how closely the site is expected to match reference sites.

Requirements for mitigation ratios vary from state to state and for different wetlands types. A mitigation ratio of 1:3, for example means that for every acre of wetland destroyed, 3 acres would have to be created or restored.

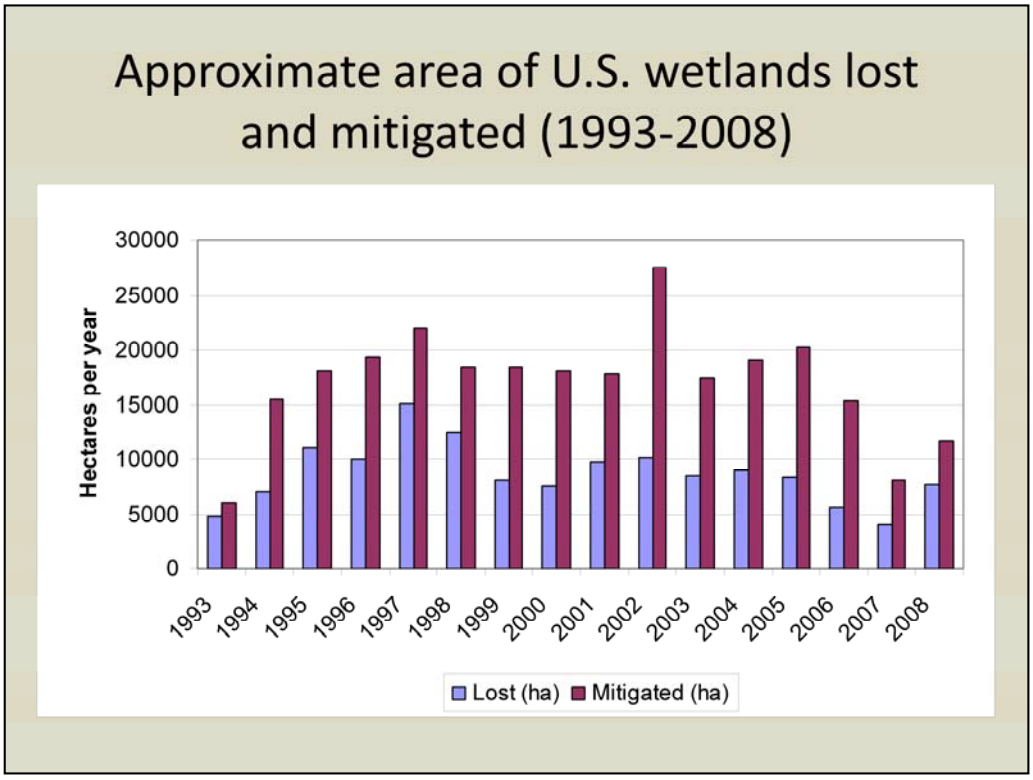
The "ratio method" is usually used to determine the required size of a mitigation project or the number of credits available at a mitigation bank (discussed later). The following ratios are commonly used:

Type of mitigation	Value of impacted wetland		
	Low	Medium	High
Restoration	1:2	1:3	1:4
Enhancement	1:3	1:5	1:9
Preservation	1:7	1:12	1:23

In Oregon, the usual ratio for "created wetlands" is 1:1.5

These ratios are based on:

1. the different levels of improved wetland function of the different mitigation types
2. the time required for the mitigation site to achieve maturity or some target condition
3. the risk of failure (i.e., a mitigation site that does not achieve functional replacement)
4. consideration of the loss of function over time
5. NOTE: For those who would like to see a sample calculation of how the number of credits would be determined for a hypothetical wetland mitigation bank site, see "Ratio Method" on the RIBITS web site (cited in Resources).



Wetland mitigation is the primary mechanism by which the United States attempts to achieve its policy of "no net loss" of wetlands. Using data from the Army Corps of Engineers dredge-and-fill permit program, it appears, on paper at least, that in recent years this goal is being met. The graph above illustrates the approximate area of wetlands lost (permitted) and gained (mitigated by restoration, enhancement or creation) through the Clean Water Act Section 404 ACOE dredge-and-fill program from 1993-2008. A net gain of approximately 134,000 ha has been achieved during this time period through this program.

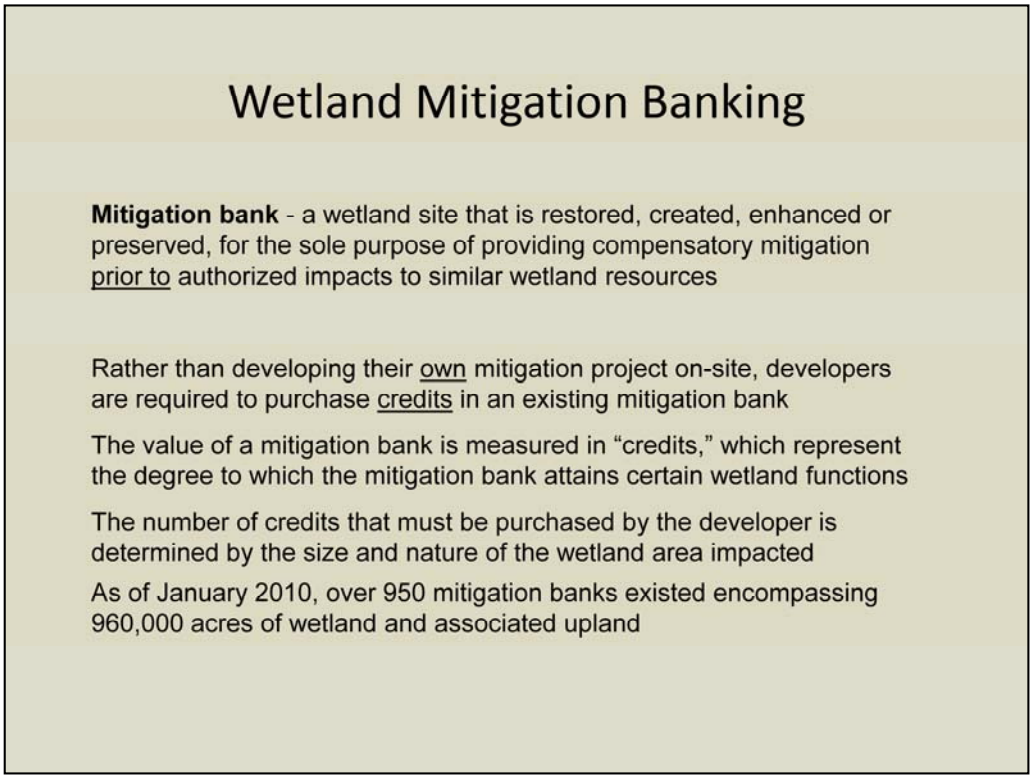
This apparent success, however, should be tempered with the following qualifiers:

1. These numbers reflect a net gain of wetland area, but do not take into account the quality of the restored and created wetlands. Comparisons between what wetlands functions were lost versus those functions that were gained are only now being attempted.

2. The net gain in wetland area indicated by these data from 1993-2008 represent a gain of only 0.3% (134,000 ha) of the loss of the 47 million hectares of U.S. wetlands that occurred from pre-settlement time to the 1980s.

3. Some wetland loss in the United States continues that is never mitigated for. Wetlands continue to be developed without agency approval by unscrupulous developers or by landowners who are simply unaware of the restrictions. These losses, although small and probably declining, are not included in this evaluation of mitigation success.

NOTE: This graph shows the approximate area of wetlands lost (authorized to be filled) and gained (restored, enhanced or created) through U.S. Army Corps of Engineers Section 404 dredge-and-fill program 1993-2008. The values shown here should be considered approximations of wetland areas permitted and mitigated. The Army Corps of Engineers has used somewhat different methods of calculating these values over time and, as a result, precise year-to-year comparisons may not be valid.



See notes slide 25 (page 40)

Notes slide 25 (page 40)

Most wetland mitigation has been done on a project by project basis and is the responsibility of the party that is impacting the wetlands (i.e., "permittee responsible mitigation"). That is, if a developer plans to destroy an acre of wetland, he/she is required to develop a compensatory mitigation project (preferably on-site or nearby) that mitigates for the loss of that acre of wetland. In many cases these compensatory mitigation projects end up being small, isolated projects that provide few of the ecological benefits of the original wetland. In some areas, these mitigation projects become local "dump sites" and places for illicit activity.

The proximity of the mitigation project to the lost wetland is an important consideration. Should mitigation projects be required to occur adjacent to or near the developed site? Is it acceptable to allow mitigation to occur away from the mitigation site, but within the same watershed? How about allowing mitigation to occur outside the watershed? Carried to extremes, repeatedly allowing mitigation to occur outside one watershed could sacrifice the functions and values provided by wetlands in that watershed, in favor of promoting those in another. The ecological function of entire watersheds could be disrupted over time. Additionally, connectivity of wetland habitats could be lost resulting in the loss of biodiversity in the affected watershed. As with many other aspects of the mitigation process, the policies of regulatory agencies regarding proximity are evolving.

Once it is determined that impacts on wetlands can be neither avoided or minimized, mitigation is required. In the past, regulatory agencies preferred that mitigation occur on-site, nearby off-site or at a mitigation bank, in that order. This approach resulted in a large number of small, often isolated mitigation projects that frequently failed or provided wetland functions at a relatively low level. More recently, regulators are promoting mitigation banks as the preferred mitigation method. As discussed later, mitigation banks provide more durable and functional wetlands, reducing the short-comings of smaller, individual projects.

Mitigation banks are required to establish a service area – a geographic area within which permitted impacts can be compensated for by a given wetland mitigation bank. The boundaries of new mitigation bank service areas are frequently defined as the watershed in which the bank resides. Therefore, theoretically at least, wetland losses should be compensated for within the same watershed.

An interesting variation on wetland mitigation on a project by project basis has been the development of what are called "mitigation banks." A **mitigation bank** is a wetland site that is restored, created, enhanced, or rarely preserved, for the sole purpose of providing compensatory mitigation prior to authorized impacts to similar wetland resources. Wetland mitigation banks are built before development activities begin and rather than developing their own mitigation project on-site, developers are required to purchase credits in an existing mitigation bank.

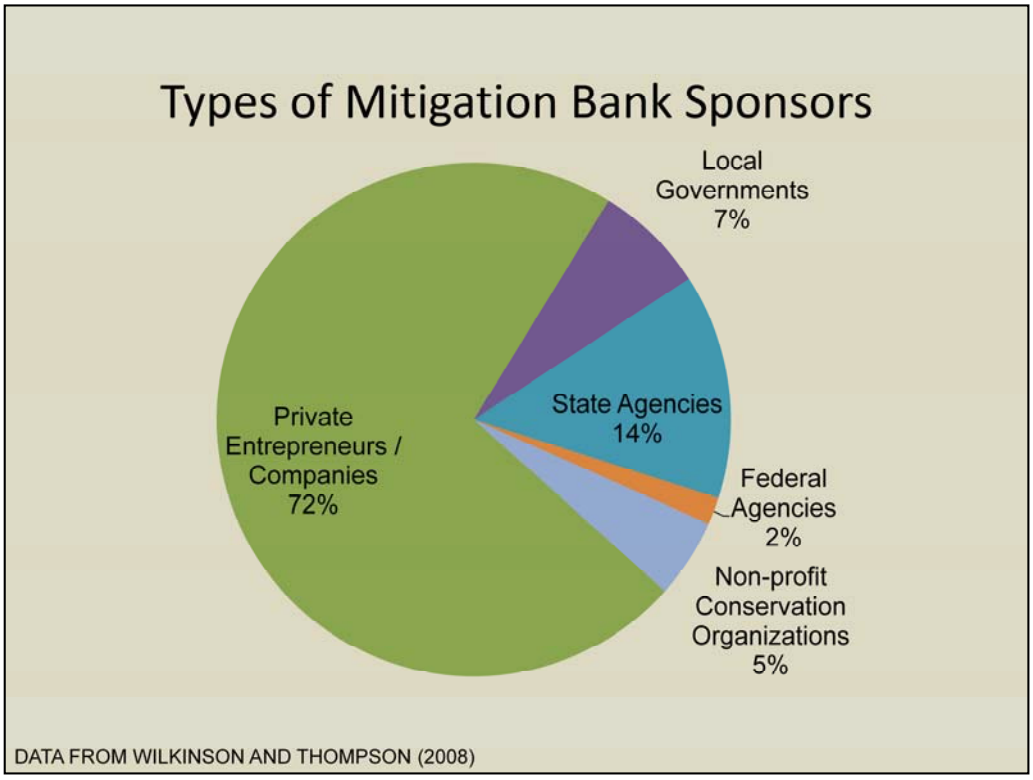
Banking typically results in the consolidation of what would otherwise be several small, fragmented wetland mitigation projects into one large contiguous site. The value of a mitigation bank is measured in "credits," which represent the degree to which the mitigation bank attains certain wetland functions. The number of credits that must be purchased by the developer is determined by the size and nature of the wetland area impacted. The cost per credit is highly variable and determined by local markets, but may exceed $100,000 per credit. Mitigation banks may be either private or public. They are generally supported by the Society of Wetland

Scientists, the primary professional society that provides scientific information in support of mitigation practices.

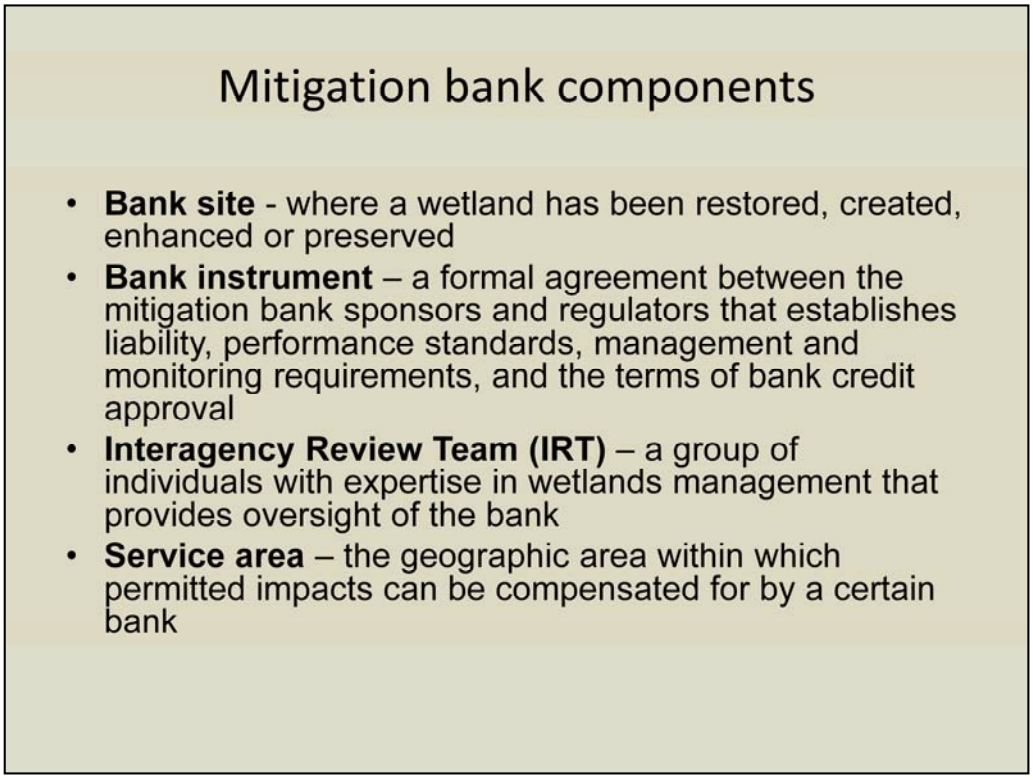
As of January 2010, over 950 mitigation banks had been approved by the U.S. Army Corps of Engineers encompassing 960,000 acres of wetland and associated upland.

Wetland Mitigation Banking – a hypothetical example:

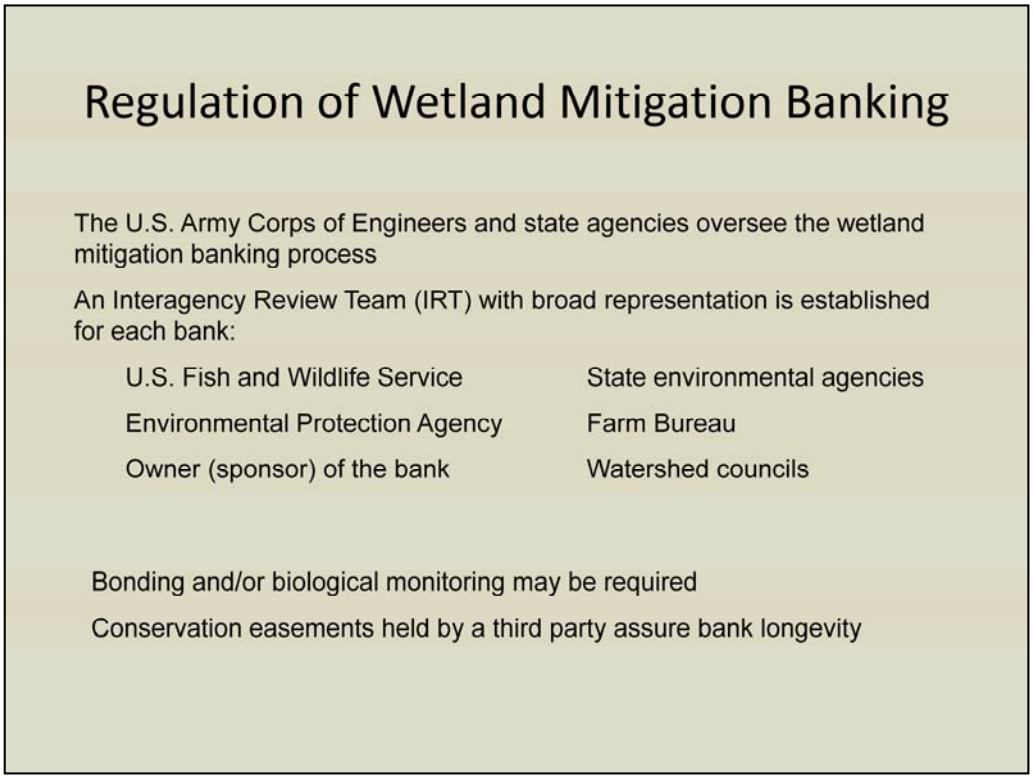
A planned commercial development by a private developer will impact 2 acres of existing wetland. Federal and state regulatory agencies have reviewed the development plan and have agreed that the developer cannot avoid or minimize the effect on those 2 acres. Consequently, the developer must compensate for the lost wetlands by purchasing credits in a mitigation bank or seeking approval from the regulatory agency for some other form of mitigation. After careful evaluation, the developer decides to purchase wetland mitigation bank credits, rather than to construct a mitigation project of his/her own.



The majority of wetland mitigation bank owners ("sponsors") are private individuals or companies (72%). However, local, state and federal governments (23%) and non-profits (5%) also sponsor banks. The sponsor is responsible for creating the bank and conforming to all associated state and federal regulations.



The components of a typical wetland mitigation bank include the site itself, a bank instrument, a review team and a service area.



See notes slide 28 (page 45)

Notes slide 28 (page 45)

The regulatory process for wetland mitigation banks is evolving and varies from state to state. Some general ideas that represent the current state of affairs follow:

The wetland mitigation banking process is regulated by the Army Corps of Engineers in cooperation with the relevant state agency (e.g., Division of State Lands in Oregon), which must sign off on the bank for it to be approved.

Additionally, an Interagency Review Team (IRT) comprised of a broad range of interested parties is established to provide input into the design and management of each wetland mitigation bank. The IRT approves the design and management of the bank and determines the number of credits available for sale by the bank owner. Membership on the IRT is highly variable, but may include representatives of other federal and state agencies (U.S. Fish and Wildlife Service, Environmental Protection Agency, state departments of fish and wildlife, state environmental agencies), the owner (sponsor) of the bank and sometimes the Farm Bureau and watershed councils.

A bonding process may be required by the IRT in which the mitigation bank owner must put up a financial security (bond) on a per acre or per site basis before any credits are released. This financial security is released piecemeal as different parts of the bank are constructed and proven.

Once established, biological/hydrological monitoring of the mitigation bank may be required to assure that the bank is meeting some standard of compliance or serving specific ecological functions (water storage, wildlife habitat, etc.). The length of time that is required for this monitoring is established by the IRT. A common standard is 5 years after the last credit is released.

Since wetland mitigation banks are established to serve long-term wetland functions, there has been a move recently to require that some mechanism be put in place to assure that the banks persist "in perpetuity." Conservation easements, held and funded by some third-party, may be required as part of the bank development process to assure the long-term function of the bank. This third party may be the state or perhaps an environmental group (e.g., The Wetlands Conservancy) that manages a fund that is used to maintain the bank over the long run. The money may be used to pay for fencing, predator control, invasive species removal, periodic burning, herbicide spraying, or any other activity required to maintain the bank.

The Wetlands Conservancy (http://twc.oregonwetlands.net) is an Oregon-based non-profit that promotes partnerships that permanently protect and conserve wetlands in Oregon. The Conservancy works with local communities, land trusts, watershed councils, individual landowners and resource managers to promote stewardship, restoration and acquisition of wetlands. Their goal is to permanently conserve 12,000 acres of wetland in the state. Similar organizations exist in other states.

See notes slide 29 (page 47)

Notes slide 29 (page 47)

Benefits of wetland mitigation banks:

The developer does not have to spend the time and money to design and monitor a wetland mitigation project and risk failure and additional cost. The developer may not be experienced in wetland restoration, which requires expertise and equipment the developer may not possess. Buying credits in a bank can be less costly than on-site mitigation, particularly when an investment in additional land is required for mitigation and the cost of the additional permitting process is added to the construction task. Also, by purchasing credits in a mitigation bank, all legal responsibility for mitigation of wetlands is transferred to the mitigation banker (owner).

Mitigation banks eliminate those losses of wetland functions that typically occur when mitigation is initiated during or after development impacts occur (i.e., no temporal loss of wetlands).

Mitigation banks have a greater likelihood of providing wetland functions over the long run (in perpetuity). On-site (and smaller) wetland mitigation projects have a high rate of failure in part because the landowner does not have sufficient incentive or expertise to maintain them. Mitigation bankers assume responsibility for the mitigation and guarantee perpetual maintenance of the bank's environmental assets.

Bigger is better - Mitigation banks are larger than separate, isolated individual projects and are more likely be a functional part of a watershed and to be connected to other waterways, thus providing greater ecological benefit; they provide habitat for species that do not survive in small, isolated wetlands and also, they have a wider variety of habitat types and larger seed banks that may make them less vulnerable to environmental changes and natural disasters. Larger projects may also be less vulnerable to invasive species.

A large mitigation bank is more likely to have access to the scientific and technical expertise to assure success than a small isolated project.

Mitigation banks provide a revenue stream for landowners on what may otherwise be "unproductive land." The success of mitigation banks has spawned a home-grown industry that contributes hundreds of millions of dollars to the nation's economy.

For governmental agencies that regulate the mitigation process, the consolidation of what might be several small, scattered mitigation projects into a single mitigation bank greatly improves their efficiency. Limited resources can be dedicated to the oversight of a single project rather than several smaller ones.

If properly managed (high standards for design, long-term monitoring, etc.) wetland mitigation banks hold some promise for regaining some of the wetland functions that have been lost due to wetland loss and degradation for the past 200 years.

<u>The costs of wetland mitigation banks:</u>

1. Costs associated with initial establishment can be prohibitive and will likely include:

• Consulting fees (to develop mitigation wetlands, to navigate the regulatory environment, to obtain necessary permits)

• Equipment rental for excavation/grading

• Survey costs

• Plant and seed costs/labor

• Weed control

• Monitoring and reporting

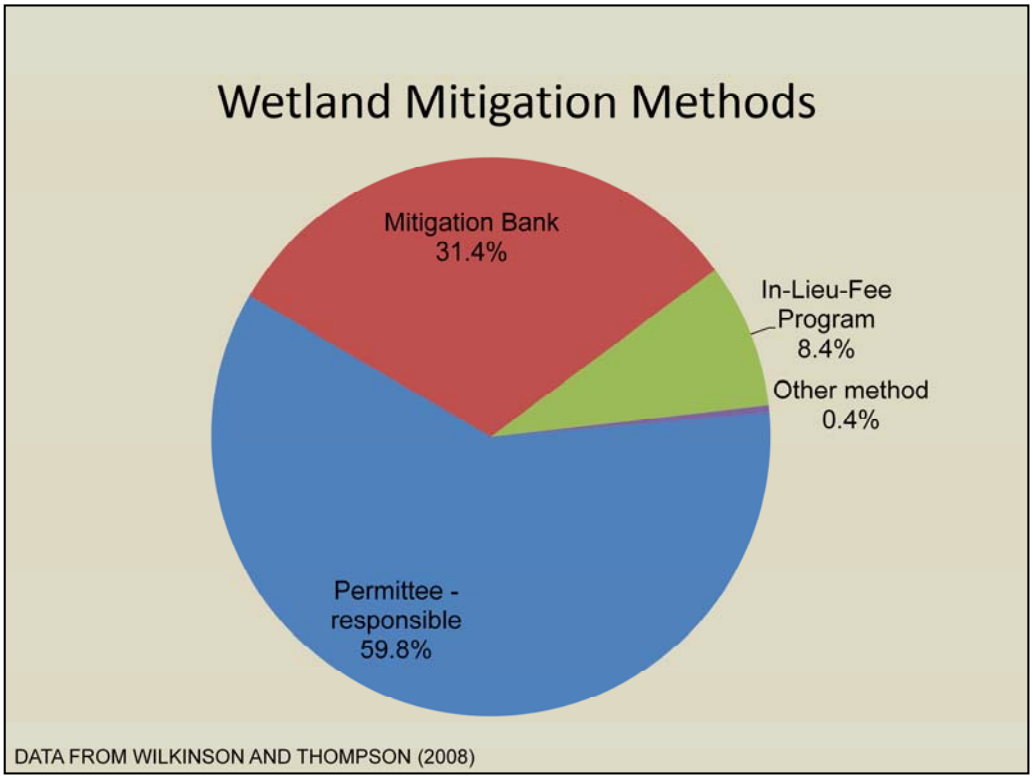
• Bonding

2. Public may see developers as being able to "buy their way out of" inflicting environmental damage
3. Agricultural interests may object on the basis of "farmland loss" – wetland mitigation banks are frequently attacked by property rights advocates
4. Regulatory process can be cumbersome – meeting the requirements of federal, state and local agencies can be difficult and time-consuming; each has their own set of permits and regulations that have to be dealt with
5. Loss of small, local wetlands

• Small, isolated populations of species with limited migrating capacity are lost (e.g., frogs, salamanders, snails)

• Local water storage and filtering functions are lost

• Loss of public awareness as small, neighborhood wetlands disappear and are "moved" further away from people and development where they can be protected



A study of wetland mitigation methods in the U.S. found that the majority (60%) of the 43,549 acres mitigated in 2005, were mitigated by the permittee. In other words, an on-site or off-site mitigation project was used to compensate for lost wetlands rather than some other method. Wetland mitigation banks, accounting for nearly one-third of mitigated acres, and payment into an in-lieu fee program, accounted for the remaining acres. Trends since 2005 have seen an increase in the number of acres mitigated by mitigation banks and a decrease in in-lieu payments.

NOTE: In-lieu payment programs allow direct payment by the developer into some fund maintained by a state or federal agency that is used to support wetland restoration or management activities. The Army Corps of Engineers is now discouraging this type of mitigation. It is usually used only in areas that are not served yet by a wetland mitigation bank or for a site with no on-site or nearby off-site mitigation possibilities.

SOURCE:

Wilkinson, J. and J. Thompson. 2006. 2005 Status report on compensatory mitigation in the United States. Environmental Law Institute. Washington, D.C.

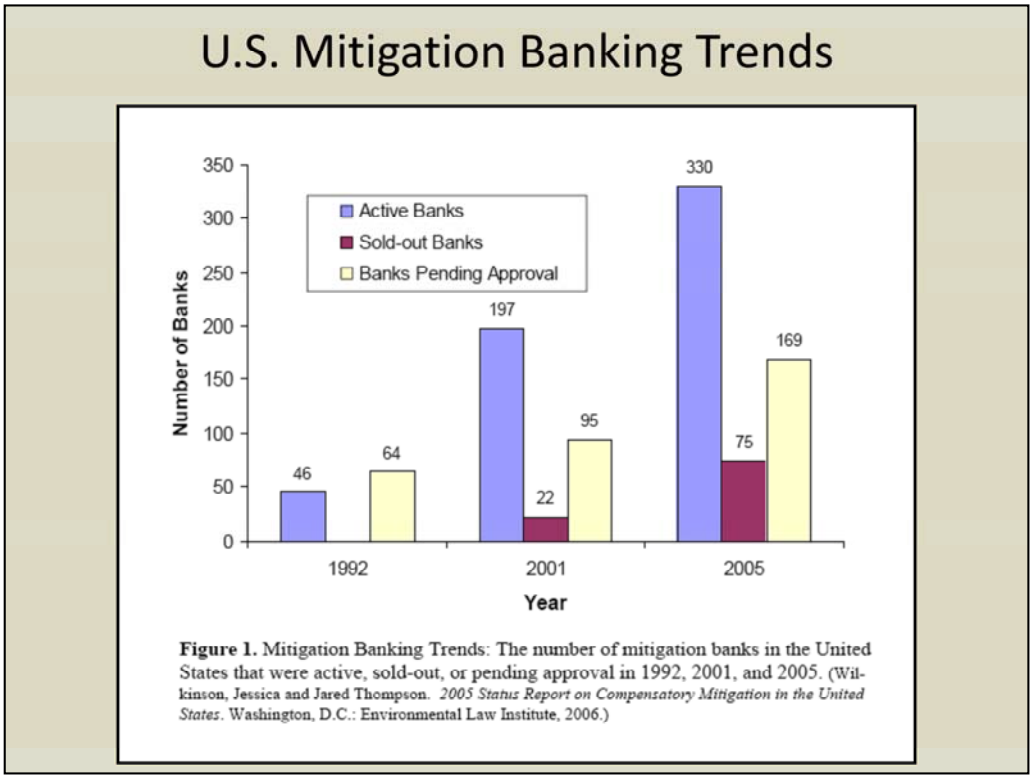


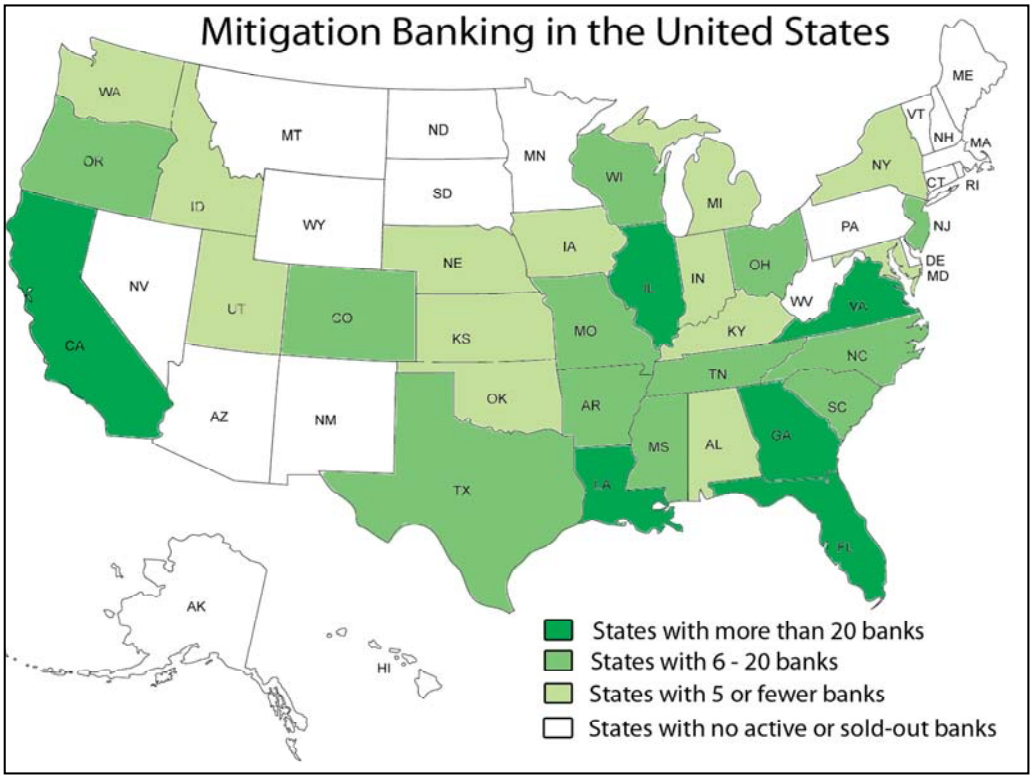
Figure 1. Mitigation Banking Trends: The number of mitigation banks in the United States that were active, sold-out, or pending approval in 1992, 2001, and 2005. (Wilkinson, Jessica and Jared Thompson. *2005 Status Report on Compensatory Mitigation in the United States*. Washington, D.C.: Environmental Law Institute, 2006.)

This figure from the same publication illustrates the increasing popularity of wetland mitigation banking as a method for compensatory mitigation in the United States. "Active Banks" are those that have been approved and are currently selling credits; "Sold Out Banks" are those that are in operation, but have sold all of their credits; "Banks Pending approval" are those that are in some stage of development, but have not received final approval to begin selling credits.

These figures are from the most recent national evaluation of wetland mitigation banks (www.eli.org) – citation below:

Environmental Law Institute. 2006. 2005 Status report on compensatory mitigation in the United States. Environmental Law Institute, Washington, D.C.

Figures may be used in publications and presentations – just include citation.



An analysis of the geographic distribution of approved wetland mitigation banks shows that the majority are located in the southeastern U.S. and in California in 2005.

Image credit: Adapted from Wilkinson, Jessica and Jared Thompson. 2005 Status Report on Compensatory Mitigation in the United States. Washington, D.C.: Environmental Law Institute, 2006

See notes slide 34 (page 53)

Notes Slide 34 (page 53)

A number of federal agencies play a major role in the protection and regulation of wetland resources including the wetland mitigation process. The primary emphasis of each is indicated here; however, there is significant overlap in responsibility and jurisdiction. As a result, decisions on wetlands (particularly as related to wetland mitigation) are typically made by teams of wetland regulators comprised of representatives from several federal agencies (e.g., Interagency Review Teams of wetland mitigation banks). State and local agencies are also involved and may be represented as well.

Key federal wetland protection agencies:

1. USACOE – wetland resources related to navigation and water supply; responsible for authorization of construction projects that affect wetlands (i.e., the federal permitting process for "drain and fill" permits)
2. EPA – wetland resources related to maintaining water quality
3. USFWS – wetlands as fish and wildlife habitat; manages National Wildlife Refuge system

Some examples of USFWS programs:

> "Partners for Fish and Wildlife" program – provides technical and financial assistance to landowners to restore wetlands and other fish and wildlife habitats on their land. The program emphasizes re-establishment of native vegetation and ecological communities that benefit fish and wildlife species.
>
> "Duck Stamp" program - a portion of waterfowl hunting licenses is allocated to wetland protection. From 1934-1984, the sale of duck stamps to waterfowl hunters preserved over 1.4 million hectares (3.5 million acres) of wetlands.
>
> "North American Waterfowl Management Plan" – identifies key waterfowl habitat areas and works with partners to protect and restore them

4. NOAA – management of coastal wetlands

Examples:

> Coastal Zone Management Program
>
> National Marine Estuarine Reserve Program – creates a network of estuarine reserves for research and education

5. NRCS – wetland resources on agricultural lands

Examples:

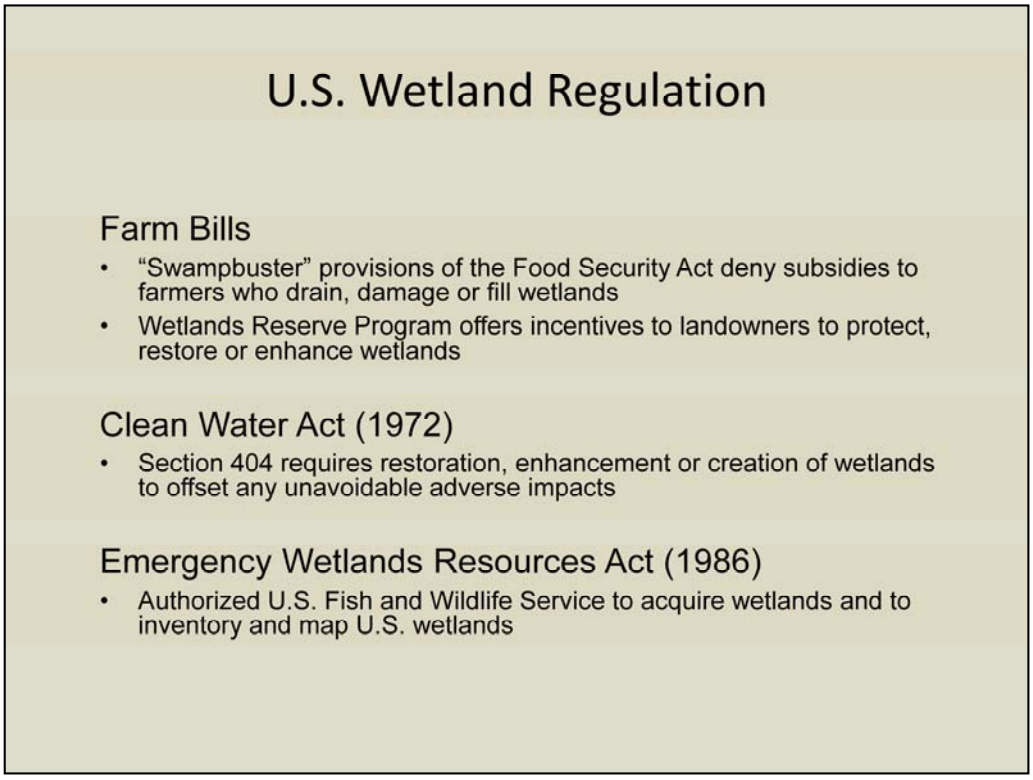
> Wetlands Reserve Program
>
> Wildlife Habitat Incentives Program

6. US BUREC – since its origin by Congress in 1902 BUREC has a long history of facilitating wetland "reclamation" but more recently has supported some wetland conservation (e.g., "Stream Corridor Restoration" program)

NOTE: See Dahl (2006) for a more complete listing of federal agencies and their wetland conservation programs.

A wide variety of state agencies are also involved in wetland protection and regulation. In Oregon, for example, the Department of State Lands (DSL) has primary responsibility. Depending on the specific site and circumstances, other state agencies that might be involved include the Oregon Department of Fish and Wildlife, the Oregon Department of Water Resources and the Oregon Department of Environmental Quality. Of course, this will differ from state to state.

A large number of non-governmental organizations are also involved in wetland conservation, restoration and protection activities. These include professional societies, environmental groups and hunting and fishing organizations. Most work in partnership with federal and state agencies engaged in similar efforts. The list here is but a sample of the many non-governmental organizations that support wetland conservation.



See notes slide 36 (page 57)

Notes slide 36 (page 57)

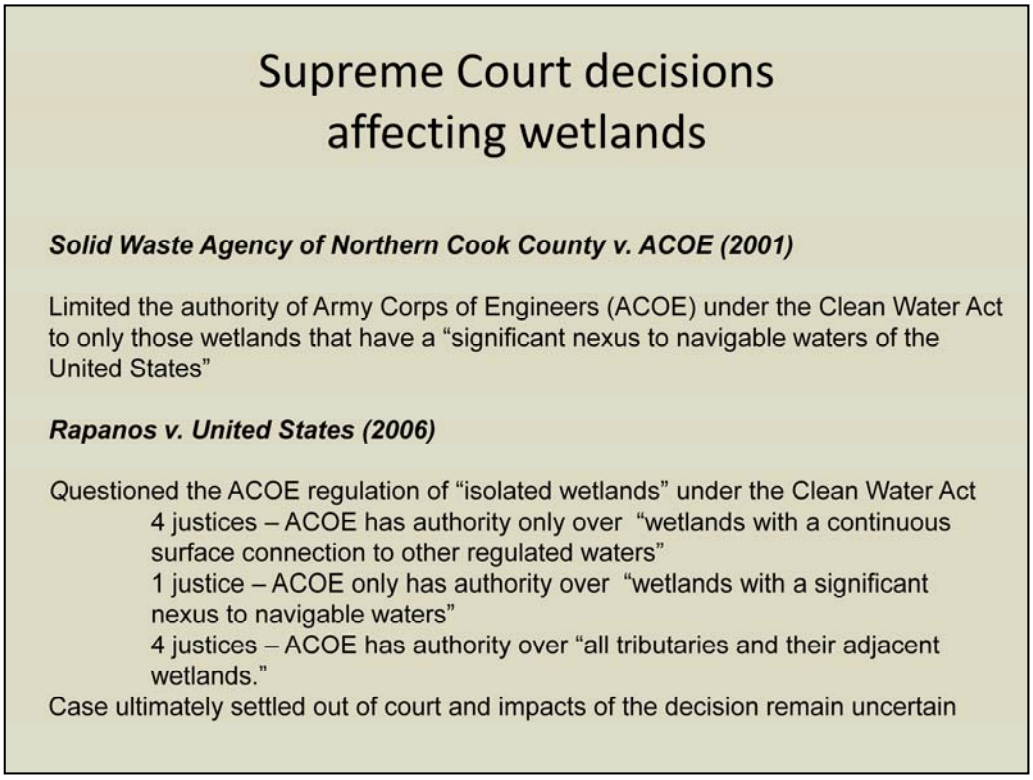
In the U.S., wetlands are managed/regulated by a combination of federal and state laws and often local ordinances. The legislation and court decisions below represent some of the more significant wetland regulatory measures at the federal level:

1. Major legislation affecting agriculture is usually incorporated into the **Farm Bill**, which is renewed and revised on a periodic basis. Since 1985 this piece of legislation has included provisions that promote wetland protection. Amendments to the 1985 and 1996 Farm Bill, for example, called the Food Security Act, included **"Swampbuster"** provisions that protected wetlands by denying USDA programs (farm subsidies) to growers who drain, damage or fill wetlands.

The Wetlands Reserve Program (WRP) was included as part of the Food Security Act of 1985 (with amendments in the 1990, 1996 and 2002 Farm Bill). This program offers landowners incentives to protect, restore and enhance wetlands on their property. Financial incentives are provided in exchange for retiring marginal agricultural land. This is a voluntary program that seeks to restore and protect privately owned, freshwater wetlands that were previously drained for cropland. One common mechanism is the establishment of a permanent conservation easement on the wetland. This program is administered by the Natural Resource Conservation Service. For farmers who frequently lose crops to flooding (e.g., Mississippi River Basin), the WRP offers an incentive for not farming these floodable lands.

2. The **Clean Water Act (1972)** has been most effective in the protection of coastal wetlands. It has not been as effective in protection of inland wetlands. Section 404 of the Act requires restoration, enhancement or creation of wetlands to offset any unavoidable adverse impacts that cannot otherwise be minimized. It requires federal permits before any dredging or filling of wetlands can be done, or any pollutants are dumped in wetlands. However, only partial protection is provided as the primary emphasis is on navigable waterways, not wetlands. Originally in 1972, the Act required discharge permits (sect. 404) for dumping waste into surface waters. In 1977, this was interpreted by the federal courts to prohibit both pollution and filling (but not drainage) of wetlands.

3. The **Emergency Wetlands Resources Act (1986)** authorized USFWS to inventory and map U.S. wetlands and increased funding for wetlands acquisition.



See notes slide 37 (page 59)

Notes slide 37 (page 59)

U.S. Supreme Court decisions affecting wetlands

2001 – In *Solid Waste Agency of Northern Cook County v. ACOE (2001)* the use of isolated wetlands in Michigan by migratory birds was declared insufficient to give the federal government jurisdiction over isolated wetlands under the Clean Water Act. The Supreme Court, in a 5-4 decision, limited the scope of ACOE authority under Section 404 of the Clean Water Act to wetlands that had a "significant nexus" to "navigable waters of the United States." The court decision brought into question the Army Corps of Engineers' authority to have jurisdiction over "isolated wetlands."

2006 – The Rapanos decision (*Rapanos v. United States*)

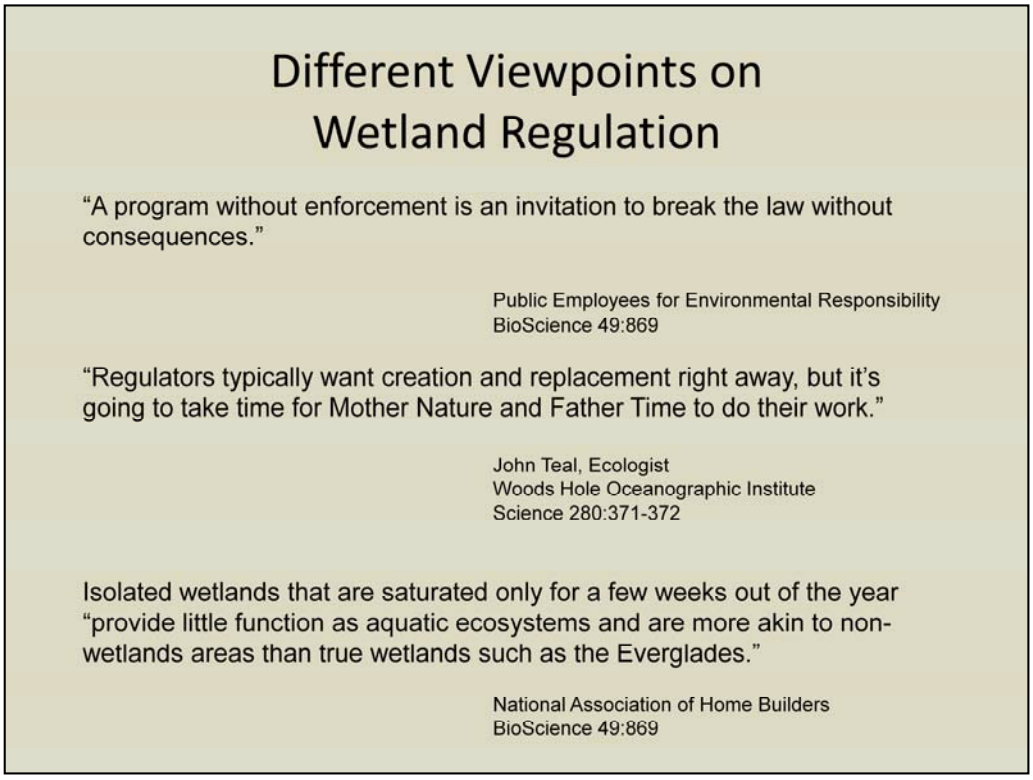
In another Michigan case, John Rapanos wanted to fill in some of his 175 acres to sell to a developer who planned to build a shopping mall on the property. Rapanos was informed by his consultant that since wetlands were present on the property, a federal permit would be required. In response, Rapanos asked the consultant to destroy any paper evidence of wetlands on his property and threatened to fire and sue him if he did not comply. The wetlands are 11 miles from the Kawkawlin River, but connected by a creek and a manmade drainage ditch. Rapanos then proceeded to fill the wetlands and was fined by the federal government. Rapanos brought suit against the federal government and the situation was characterized by private property rights advocates as an infringement of private property rights by overzealous government regulators. The case ultimately made its way to the U.S. Supreme Court.

By a 5-4 vote, the Supreme Court further questioned the ACOE regulation of isolated wetlands under the Clean Water Act. The ruling, however, appears to have created more confusion concerning the authority of ACOE.

The original petition argued that wetlands are not subject to the Clean Water Act because they have only a surface connection to the "waters of the United States."

Four justices interpreted the CWA narrowly, stating that the ACOE should have authority over only "those wetlands with a continuous surface connection to other regulated waters." Four other justices interpreted the CWA more broadly and granted authority to the ACOE to regulate "all tributaries and their adjacent wetlands." An intermediate position was taken by Justice Kennedy, who returned to the "significant nexus" standard stating that regulated wetlands need to have a significant nexus to navigable waters, which should be determined on a case by case basis. The Rapanos case was ultimately settled out of court in 2009 with the plaintiff paying a $150,000 civil fine and an additional $750,000 to mitigate 54 acres of wetlands that were filled without a permit.

Although the original case is now settled, confusion reigns among all three branches of the federal government. The impact of this decision on wetland regulation remains uncertain.



See notes slide 38 (page 61)

Notes slide 38 (page 61)

These Supreme Court cases illustrate some of the different viewpoints on wetland regulation held by different interests. Much like other types of environmental regulation (such as the enforcement of the Endangered Species Act or land use laws or the Clean Air Act), wetland regulation generates a significant amount of controversy. Although there is a wide range of opinion, we could characterize the usual warring factions as follows:

Environmental groups often feel that wetland protection has fallen by the wayside because the pressures to develop land are overwhelming. Agricultural, residential and commercial development is closely tied to the economic growth that this stimulates.

The Public Employees for Environmental Responsibility (www.peer.org), for example, when commenting on the reluctance of the U.S. Army Corps of Engineers to enforce wetlands laws state that:

"A program without enforcement is an invitation to break the law without consequences."

Public Employees for Environmental Responsibility
BioScience 49:869

"Regulators typically want creation and replacement right away, but it's going to take time for Mother Nature and Father Time to do their work."

John Teal, Ecologist
Woods Hole Oceanographic Institute
Falmouth, Massachusetts
Science 280:371-372

Development interests predictably have a different view of wetland regulation. Many believe that government regulatory agencies have been overzealous in the regulation of wetlands and some, for years, have waged an on-going campaign to weaken wetlands regulation. The National Association of Home Builders, for example, when commenting on the status of isolated wetlands that are saturated only for a few weeks out of the year state that they "provide little function as aquatic ecosystems and are more akin to non-wetlands areas than true wetlands such as the Everglades."

National Association of Home Builders
BioScience 49:869

Summary – Compensatory Mitigation

- Compensatory mitigation is the replacement of a damaged or destroyed wetland with a substitute when adverse impacts to wetlands cannot be avoided or minimized
- Early wetland mitigation projects often fell short as replacement ecosystems
- Mitigation options include restoration, creation, enhancement and protection
- Mitigation ratios are established based on how long it might take a restored site to reach wetland structure and function targets
- Wetland mitigation banks are wetlands that are restored, created, or enhanced to provide compensatory mitigation prior to authorized impacts on wetlands
- Wetland mitigation banking is regulated by the Army Corps of Engineers and an Interagency Review Team
- Wetlands are managed in the U.S. by a number of federal agencies and guided by legislation and Supreme Court cases

Photo Credits

- Association of State Wetland Managers
- Becca Cudmore
- Bureau of Reclamation
- Environmental Law Institute
- Environmental Protection Agency
- Google Earth
- National Oceanic and Atmospheric Administration
- Natural Resource Conservation Service
- NMFS/Northwest Fisheries Science Center; Pacific Northwest Collection, National Oceanic and Atmospheric Administration/Department of Commerce
- Partners in Flight
- Ray Fiori, Oregon Wetlands, LLC
- The Nature Conservancy
- Trout Unlimited
- U.S. Army Corps of Engineers
- U.S. Geological Survey
- U.S. Fish and Wildlife Service: Division of Public Affairs, Gary Heet, Steve Hillebrand
- www.free-pictures-photos.com/construction/index.htm

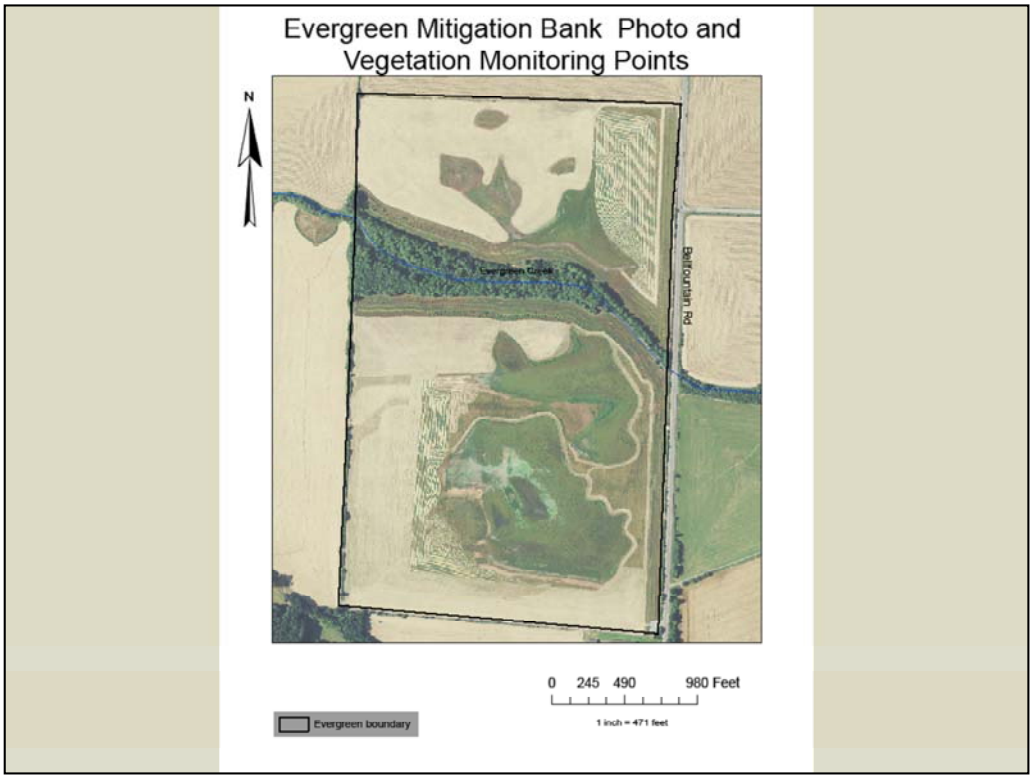


Photo credit: Ray Fiori, Oregon Wetlands, LLC

Extra Slide

Wetland Mitigation Laboratory

INTRODUCTION

Wetlands are defined by three criteria - hydrology, soils and vegetation. Historically, wetlands have been perceived as wastelands and dump sites since they were difficult to develop or farm. As a result, throughout most of our history we have filled or drained wetlands in an effort to make them more suitable for human use as agricultural lands or building sites. Consequently, over half of wetlands in the lower 48 states have been converted into some other land use. Beginning in the 1970s, growing evidence suggested a different role for wetlands. Wetlands remained difficult to farm or develop, but their ecological importance as wildlife habitat, buffers against floods and storms and water purifiers became clear.

Wetland policies gradually evolved to accommodate the new-found understanding of wetlands. Wetlands gained new protections under the Clean Water Act (1972) and soon after a federal policy of "no net loss of wetlands" was declared. Underlying this policy was the assumption that although wetlands could be destroyed by development, new wetlands could be created that would take their place. The new wetlands would be “functional equivalents” of those that had been destroyed, thus – no net loss. This concept of "compensatory mitigation" was supported by the new scientific field of ecological restoration. The goal of ecological restoration is to return a damaged ecosystem to a more natural condition. Knowledge of ecosystem structure and function and ecological succession are used.

Although the loss and degradation of wetlands continues, since the early 1990s the U.S. has been successful in its attempt to achieve its long-stated policy of “no net loss of wetlands.” During this time, more wetland acreage has been added through mitigation than was lost to development.

BACKGROUND

A. How does wetland mitigation work?

A builder wishes to develop an area that has been identified as a wetland. Careful consideration is given to ways that the development can be accomplished without adversely impacting the wetland. If this is not found to be practicable, ways to minimize the adverse impacts must be explored. If after this, it is found that destroying the wetland is the only option, compensation for destroying this wetland is made by restoring, creating or enhancing a wetland either on-site or off-site.

The wetland mitigation process is regulated by both federal and state agencies, which will establish the criteria that must be met for the mitigation project. One consideration is establishing the **mitigation ratio** - the ratio between the size of the wetland that will be impacted and the size of the compensatory mitigation project. Wetland mitigation ratios are rarely 1:1, but rather some ratio larger than this. A ratio of 3:1 for example, would require 3 acres of mitigation project for every acre of impacted wetland. The ratio that is assigned to a project is determined

by the regulating agencies and depends on the specific type of mitigation being done. Some possible types of mitigation include:

Restoration (1:1) An area that used to be a wetland but is no longer (due to being tiled, drained, dammed, etc.) and wetland hydrology, soils and vegetation are restored to a natural state

Creation (1.5:1) Creation of a new wetland from upland

Enhancement (3:1) An area that is still a wetland but has been degraded (e.g., a field that is still wet but vegetation is marginal including many invasives). Enhancement activities may include removal of exotics, changing hydrology, planting native wetland plants, etc.

Different ratios are established because each mitigation type carries with it a different probability of success, potential ecological benefit and expected duration of time to maturity. For example, the restoration of an area that used to be a wetland has high probability of success in a relatively short time period and a relatively low risk of failure, and is therefore designated on an "acre-for-acre" basis. Other types of mitigation are more risky and less effective and are designated higher ratios.

Particularly in the early days of wetland mitigation, it was clear that a majority of wetland mitigation projects were failures and were <u>not</u> functional equivalents of natural wetlands.

B. Wetland Mitigation Banking

Wetland mitigation banking is a relatively new practice that most would characterize as an improvement over traditional wetland mitigation practices. In mitigation banking, a land owner (public or private) develops a wetland of many acres (typically 10-100 acres and usually on farmland that was a wetland in the past and had been drained). Once the wetland is established and has been approved by state and federal agencies, "credits" may be sold to developers who wish to mitigate for wetlands that they have destroyed. Purchase is on an acre-for-acre basis and is restricted by the same mitigation ratios described above. For example, if a 60-acre mitigation bank has been created through enhancement (a 3:1 ratio) the owner gets 20 credits to sell. The value of credits is highly variable and determined by local markets, but may exceed $100,000 per credit.

There are a number of benefits of wetland mitigation banking to all parties involved:

1. The developer is relieved of the responsibility and risk of developing their own mitigation project. All of the challenges of on-site mitigation (finding a site, excavation, gaining hydrology, establishing wetland vegetation, monitoring, long-term maintenance, etc.) are no longer the responsibility of the developer.

2. The owner of the wetland mitigation bank is provided with a source of revenue for land that has been taken out of agricultural production. For some wetland bank owners, the benefits of improved aesthetics and wildlife habitat and more protection from flooding are also important.
3. In general, larger wetlands are more likely to be functionally equivalent to natural wetlands and play a significant role on the watershed as compared to smaller mitigation projects. They are more likely to be closely monitored and have access to a wider range of expertise in their creation and maintenance.

OBJECTIVES

In today's laboratory you will explore the practice of wetland mitigation using a number of different resources including site visits. Upon successful completion of this exercise, you should be able to:

1. Describe the fundamental concept of wetland mitigation
2. Evaluate wetland mitigation projects in the field
3. Identify the risks and benefits of wetland mitigation including wetland mitigation banks
4. Formulate your opinions on wetland mitigation
5. Suggest improvements that would improve the effectiveness of wetland mitigation

PROCEDURE

1. Read the U.S. Environmental Protection Agency document, *Wetlands Compensatory Mitigation*, prior to the laboratory
2. View *Wetland Management II – Compensatory Mitigation* presentation
3. Participate in field tour and related discussions
4. Respond to discussion questions

QUESTIONS FOR DISCUSSION

1. Why do you think that, especially in the early days of compensatory mitigation, wetland mitigation projects were frequently unsuccessful?

2. How should success be defined for a wetland mitigation project?

3. Do you agree or disagree with the following statement? Explain.

"Wetland restoration should not be used to mitigate avoidable destruction of other wetlands until it can be scientifically demonstrated that the replacement ecosystems are of equal or better functioning."

4. Compensatory mitigation is actually the third step in a sequence of actions that must be followed to address adverse impacts to wetlands. The mitigation sequence, as described above, is "avoidance," followed by "minimizing impact" and then only for "unavoidable" impacts, "compensatory mitigation." How would you distinguish between "avoidable" and "unavoidable" impacts on wetlands?

5. Do you agree or disagree with the following statement? Explain.

"The decision of whether to permit the destruction of a wetland should be based on whether we can afford to lose that system, not whether we can replace it. Compensatory mitigation should be the last resort, and must be based on the best available science."

Mary E. Kentula
EPA Wetland Research Program
Corvallis, OR
Quoted from: *Science* 260:1890-1892

6. What, in your view, are the essential elements of effective compensatory mitigation of wetlands? What safeguards should be in place that assure that wetland mitigation results in wetlands that are "functional equivalents" of the impacted wetland?

7. Now that you have evaluated the process, are you generally in support of the concept of compensatory mitigation or not. Explain your view.

LAB PRODUCT

Submit your responses to the questions above. Your answers should be based on background provided by your instructor, the tour of wetland mitigation sites and classroom discussion.

NOTES TO INSTRUCTORS

The wetland mitigation laboratory is designed to be flexible and can be presented in a number of different ways. Here is a suggestion that makes use of all elements:

1. Assign the Environmental Protection Agency document, *Wetlands Compensatory Mitigation*, or a similar resource, prior to this lecture. The EPA document is available at: www.epa.gov/owowwtr1/wetlands/facts/fact16.html http://www.epa.gov/owow/wetlands/pdf/CMitigation.pdf
2. Present the *Wetlands Mitigation PowerPoint* presentation to introduce the concept of wetland mitigation
3. Conduct a field tour of local wetland mitigation site(s)
4. Conduct a classroom discussion of how wetland mitigation is implemented and solicit student views on the process
5. Have students submit written responses to the questions included above

As an alternative, instructors may want to provide students with some background on wetland mitigation and then hold a town meeting in which students represent the various stakeholders in the process and discuss the merits and shortcomings of wetland mitigation. See NCSR module *Town Meeting: An Approach to Exploring Environmental Issues*, for details on the process of setting up a town meeting. The questions above can be used by the moderator to guide the meeting. I would also suggest the following:

1. Identify the stakeholders. Some possibilities include:
   - Environmental groups with an interest in wetlands conservation
   - Developers who wish to build on a wetland
   - Farmers who are interested in building a wetland mitigation bank
   - Farmers who are concerned about farmland "being taken out of production" as mitigation projects
   - Government regulators responsible for overseeing the mitigation process
   - Waterfowl hunting groups
   - Landowners adjacent to mitigation projects
2. What are the likely viewpoints of the various stakeholders listed above?
3. What are the positive aspects of wetland mitigation? Negative aspects?
4. Does wetland mitigation banking have your support? Why or why not?
5. What are the risks? Benefits?
6. Are we overly optimistic that we know how to mitigate for lost wetlands?
7. What drives the need for wetland mitigation?
8. If you do not accept wetland mitigation, what are the alternatives?

QUESTIONS FOR DISCUSSION – SOME SUGGESTED POINTS FOR DISCUSION

Here are some possible responses to the questions posed to students. They can be used to help guide discussion.

1. Why do you think that, especially in the early days of compensatory mitigation, that wetland mitigation projects were frequently unsuccessful?

In the early days of compensatory mitigation, failures were at least as common as successes. Some projects disappeared 2-3 years after implementation, some persisted, but bore no resemblance to natural wetlands and others were close mimics, but for reasons not always understood, failed to support the species they were designed for (see case study below). More specific reasons for mitigation failure include the following:

- *Mitigation is not completed according to plans filed with government agencies*
- *Mimicking natural systems (true mitigation) is complex and very difficult (Can we really expect to be able to construct a functioning ecosystem even when we know all of the components?). This is particularly difficult for endangered species habitat.*
- *Lack of properly-trained personnel. Wetlands restoration consultants with minimal Plans give little attention to the hydrology of the created site - the most crucial factor*
- *Vegetation is often not replaced correctly - poor specifications*
- *Post-construction monitoring is not conducted*
- *Most mitigation projects are open water ponds - the only wetland type that is actually increasing. In Oregon, although no open water ponds were affected by development, 23% of mitigation projects were open ponds because they are easier to build.*
- *Wetland mitigation projects are often land-locked, isolated and small. Even if functional, they are often a tiny island of habitat in a sea of development and often become trash receptacles for the local community.*
- *Some citizens may prefer a "scenic but manicured pond" to a "mucky swamp" even though the latter is likely providing more ecosystem services.*

A Case Study in Wetland Mitigation

A 12-hectare restoration of cordgrass wetland in San Diego Bay began in 1984-85. Although it was designed to create habitat for two endangered birds (the Light-footed clapper rail and Least tern), four years after the start of project, there were still no birds on the site. The cause was traced to the short height of the cordgrass (*Spartina* sp.), which is a critical habitat component for the clapper rail. Cordgrass must reach a certain height before it will be used by the birds as nesting sites. The short growth of cordgrass was caused by a lack of nitrogen due to sandy soils. Soils on this mitigation site are much sandier than natural marshes and they neither produce nor retain sufficient nitrogen. Short, stressed plants are also more susceptible to insects and insect outbreak caused by lack of a predator. The addition of nitrogen fertilizer encouraged cordgrass to grow taller, but also changed the species composition in favor of pickleweed, rather than cordgrass. The constructed wetland still did not support nesting clapper rails 15 years after it was built. Nitrogen levels are not expected to reach those of a reference site for at least 40 years.

This case study emphasizes the difficulty of recreating natural systems. By 1990, the constructed wetland was only 60% similar to reference wetlands as measured by 11 criteria (grass height, invertebrate counts, etc.) It appears that much longer periods of time are required for some constructed wetlands to achieve equivalency with natural systems – perhaps as long as 40 - 100 years.

2. How should success be defined for a wetland mitigation project?

"Success" can be (and has been) defined in many ways:

- *Whatever is in the contract?*
- *Replace exactly what was lost?*
- *Hydrology and vegetation that persist over time?*
- *Restoring an ecosystem to natural or near-natural composition and function?*

In recent years, the mitigation process has improved in the following ways:

- ***Performance standards** that establish specific future goals for mitigation site must be established (e.g., minimum coverage by native wetland species, minimum measures of animal diversity, maximum amount of invasive plants allowed, inundation periods, etc.)*
- *Monitoring for a minimum of 5 years to check against performance standards*
- *For mitigation banks, the use of **reference sites** (with natural wetlands) for comparison with mitigation sites. Both the reference site and the mitigation site must be monitored and compared.*
- ***Performance bonds** are sometimes posted at beginning of project. If performance standards are <u>not</u> met, the performance bond is forfeited. Also, for mitigation banks, if performance criteria are not met, they will not be allowed to sell additional credits.*
- *New federal programs also support improvements in wetland restoration. The Wetland Reserve Program (WRP), for example, pays farmers to restore farmland to wetland.*
- *In the future, permanency of mitigation banks will likely be secured by establishing a permanent conservation easement that is held by a third party (e.g., Wetlands Conservancy)*

3. Do you agree or disagree with the following statement?

"Wetland restoration should not be used to mitigate avoidable destruction of other wetlands until it can be scientifically demonstrated that the replacement ecosystems are of equal or better functioning."

Students should be able to respond to this quote.

4. How would you distinguish between "avoidable" and "unavoidable" destruction of wetlands?

This is a tough question because clearly at some level all wetland destruction is "avoidable." However, the reality is that developers largely make this determination based on their expertise and the specifics of the development that they have planned. Cynics suggest that developers will lean in favor of unavoidable impacts if they can make a profit by developing the land that exceeds the cost of mitigation. Students will have to decide for themselves how confident they feel about the process.

5. Do you agree or disagree with the following statement?

"The decision of whether to permit the destruction of a wetland should be based on whether we can afford to lose that system, not whether we can replace it. Compensatory mitigation should be the last resort, and must be based on the best available science."

Mary E. Kentula
EPA Wetland Research Program
Corvallis, OR
Science 260:1890-1892

*Since we are only beginning to understand how wetland mitigation (and ecological restoration in general) should be done, it seems that **adaptive management** should guide the practice. "I reserve the right to be smarter tomorrow than I am today."*

6. What, in your view, are the essential elements of effective compensatory mitigation of wetlands? What safeguards should be in place that assure that wetland mitigation results in wetlands that are "functional equivalents" of the impacted wetland?

Some thoughts:

1. *Mitigation should be done as a "last resort"; to a great degree compensatory mitigation continues to be the first option*
2. *There should be provisions for mid-course corrections (adaptive management)*
3. *Long-term monitoring should be a requirement*
4. *For wetlands of particularly high ecological value (e.g., endangered species, important corridors, unusually high biological diversity), a developer must prove that the mitigation project is on the desired trajectory before the original wetland is destroyed*
5. *Qualified personnel, including ecologists, botanists, wetland specialists, hydrologists, soil scientists, etc. should be involved in projects. Would you be willing to let a beautician perform gall bladder surgery on you?*
6. *Where endangered species are involved, have they returned and are they breeding?*
7. *Hydrology must resemble original (no more "open ponds")*
8. *Require higher ratios for replacing ecosystems that require longer development times or that have not been restored by previous efforts (i.e., those for which we have no prior track record)*

7. Now that you have evaluated the process, are you generally in support of the concept of compensatory mitigation or not. Explain your view.

At this point in the exercise, students should have enough information to formulate their opinions on compensatory mitigation. A wide range of opinions should be expected.

Field Tour

1. Identify several wetland mitigation projects in your area. A variety of different projects should be identified including small, on-site mitigation projects, private or public mitigation projects, mitigation banks, etc. Locations and descriptions of wetland mitigation banks can be found at the Regional Internet Bank Information Tracking System (RIBITS), National Mitigation Banking Association (NMBA) and Association of State Wetland Managers (ASWM) web sites. The location of individual mitigation projects can be found by contacting your local office of the state agency that regulates wetland mitigation. In Oregon, this is the Division of State Lands. Instructors may be able to get a copy of the permit or mitigation plan from the regulatory agency as these are usually public documents.

2. Contact the wetland mitigation project owner/manager to see if they would be willing to meet with your class on-site and briefly describe the mitigation project to you and your students. If so, arrange for a tour of mitigation sites.

3. The tour should be considered a "fact-finding mission" to help students better understand and visualize the process of wetland mitigation. Students should be encouraged to ask questions to help them gain a more complete understanding of the project. The following is a list of suggested topics/questions that could be asked by students or included in a presentation by the owner/manager of the site:

- Why was the mitigation project conducted? What losses is it mitigating for?
- When was the project initiated? How mature is the project? What changes are expected on the site in the foreseeable future?
- How large is the project and how does it compare to the area of the original impacted wetland? What was the mitigation ratio assigned to the site? How was this ratio determined?
- Was this mitigation project a created, restored, enhanced or protected wetland?
- What (if any) interventions were made to create, restore or enhance the condition of the three primary components of a wetland – hydrology, vegetation and soils?
- How would you characterize the success of the mitigation project to date?
- What type of monitoring (if any) is being done on the site to measure success? If required by the regulating agency, how long will this monitoring be done?
- If a mitigation bank, what (if anything) is being done to assure that the site will be maintained "in perpetuity" after all the credits are sold (i.e., a restrictive covenant or conservation easement)?
- What type of on-going activities will be required to maintain the site?

Other questions will certainly come up in discussion, but this should provide a starting point. In addition to acquiring information from the owner/manager of the mitigation project, students should also make their own observations on the site. Here are some suggestions:

- Evidence for the three primary components of a wetland - hydrology, vegetation and soils
- Observations that indicate "success" or "failure" of the site, or that the project is a "work in progress"
- Diversity and abundance of wetland plants at the site
- Presence/absence and abundance of invasive species
- Diversity and abundance of wildlife
- Evidence of potential impacts on the site from adjacent land use

RESOURCES

Association of State Wetland Managers
www.aswm.org
The Association of State Wetland Managers (ASWM) is a nonprofit membership organization established in 1983 to promote and enhance protection and management of wetland resources, to promote application of sound science to wetland management efforts and to provide training and education for our members and the public.

National Mitigation Banking Association
www.mitigationbanking.org/
The National Mitigation Banking Association (NMBA) is an industry organization that brings together leaders who are committed to restoring and conserving America's wetlands and other natural resources using sound economic and environmental practices. Established in 1998 and based in Orlando, Florida, NMBA promotes federal legislation and regulatory policy that encourages mitigation banking as a means of compensating for adverse impacts to our nation's wetlands. This commitment is fulfilled through a variety of research, education, and outreach programs sponsored by the NMBA and made available to its members. NMBA publishes a quarterly newsletter with updated information on wetland mitigation banking and provides links to other wetland mitigation banking sites.

NMBA provides a list of wetland mitigation banks throughout the U.S. with links to their web sites. This can be used by instructors to identify wetland mitigation banks in their region. See:
www.mitigationbanking.org/mitigationbanks/index.html

Descriptions and photos of wetland mitigation banks throughout the U.S. are provided.
See: www.mitigationbanking.org/pdfs/2010-wetlandconservation.pdf

Regional Internet Bank Information Tracking System (RIBITS)
http://www.lrc.usace.army.mil/co-r/ribits.htm
This web site was developed by the U.S. Army Corps of Engineers (USACE) specifically for those interested in wetland mitigation banking. Although designed primarily for those who wish to develop (sponsor) or buy credits from a mitigation bank, educators with an interest in mitigation banking will also find this site to be useful. General mitigation concepts are described and mitigation banking is defined and its merits described. There is a glossary of terms commonly used in mitigation (see "Basic Definitions"). Links to USACE web sites are provided along with on-going training opportunities for wetland practitioners. RIBITS also provides a list of wetland mitigation banks throughout the U.S. (see "Existing Banks") along with the status of each (size, number of credits approved, available and sold). This can be used by instructors to identify wetland mitigation banks in their region and to prepare a wetlands mitigation tour.

U.S. Environmental Protection Agency
www.epa.gov/wetlandsmitigation

This Environmental Protection Agency (EPA) web site offers useful background information on wetland mitigation banking. The EPA document, *Wetlands Compensatory Compensation*, is available at:
www.epa.gov/owowwtr1/wetlands/facts/fact16.html

Wetlands Management II - Compensatory Mitigation - Resources

Wetland Regulation

Baker, B. 1999. Governmental regulation of wetlands is under siege from all sides. BioScience 49:869.

Sponberg, A.F. 2009. U.S. struggles to clear up confusion left in the wake of Rapanos. BioScience 59:206.

Sponberg, A.F. 2006. Supreme Court ruling leaves future of Clean Water Act murky. BioScience 56:966.

Wetland Mitigation

Environmental Law Institute
www.eli.org

The Environmental Law Institute has a number of publications that have evaluated the status and effectiveness of wetland compensatory mitigation. The ELI National Wetlands Newsletter *is published 6 times a year and emphasizes news and analysis of wetlands issues that center on wetlands regulation, policy, science and management. Updates are also available at National Wetlands on the Web.*

Environmental Law Institute. 2002. Banks and fees: The status of off-site wetland mitigation in the United States. Environmental Law Institute, Washington, D.C.

Environmental Law Institute. 2006. 2005 Status report on compensatory mitigation in the United States. Environmental Law Institute, Washington, D.C.

Malakoff, D. 1998. Restored wetlands flunk real world test. Science 280:371-372.

Marsh, L.L., et al. 1996. Mitigation banking: Theory and practice. Island Press, Covelo, CA. 300 pp.

National Academy of Sciences. 2001. Compensating for wetland losses under the Clean Water Act. National Academy Press, Washington, D.C.
www.nap.edu

National Mitigation Banking Association
www.mitigationbanking.org/

The National Mitigation Banking Association (NMBA) is an industry organization that brings together leaders who are committed to restoring and conserving America's wetlands and other natural resources using sound economic and environmental practices. Established in 1998 and based in Orlando, Florida, NMBA promotes federal legislation and regulatory policy that encourages mitigation banking as a means of compensating for adverse impacts to our nation's wetlands. This commitment is fulfilled through a variety of research, education, and outreach programs sponsored by the NMBA and made available to its members. NMBA publishes a quarterly newsletter with updated information on wetland mitigation banking and provides links to other wetland mitigation banking sites.

NMBA provides a list of wetland mitigation banks throughout the U.S. with links to their web sites. This can be used by instructors to identify wetland mitigation banks in their region.
www.mitigationbanking.org/mitigationbanks/index.html

Descriptions and photos of wetland mitigation banks throughout the U.S. are provided at:
www.mitigationbanking.org/pdfs/2010-wetlandconservation.pdf

National Mitigation Banking Conference
www.mitigationbankingconference.com

U.S. Environmental Protection Agency
www.epa.gov/wetlandsmitigation (see "Mitigation Banking Fact Sheet")

U.S. Fish & Wildlife Service
www.fws.gov

U.S. Army Corps of Engineers
www.usace.army.mil

Regional Internet Bank Information Tracking System (RIBITS)
http://www.lrc.usace.army.mil/co-r/ribits.htm

This web site was developed by the U.S. Army Corps of Engineers specifically for those interested in wetland mitigation banking. Although designed primarily for those who wish to develop (sponsor) or buy credits from a mitigation bank, educators with an interest in mitigation banking will also find this site to be useful. General mitigation concepts are described and mitigation banking is defined and its merits described. There is a glossary of terms commonly used in mitigation (see "Basic Definitions"). Links to USACE web sites are provided along with on-going training opportunities for wetland practitioners. RIBITS also provides a list of wetland mitigation banks throughout the U.S. (see "Existing Banks") along with the status of each (size, number of credits approved, available and sold). This can be used by instructors to identify wetland mitigation banks in their region and to prepare a wetlands mitigation tour.

Roberts, L. 1993. Wetlands trading is a loser's game, say ecologists. Science 260:1890-1892.

Society for Ecological Restoration International Science and Policy Working Group. 2004. The SER international primer on ecological restoration. Society for Ecological Restoration International. 13 pp.
www.ser.org

This publication by the Society for Ecological Restoration is a general description of ecological restoration and, although it is not specifically written for wetlands, much still applies. It includes succinct definitions of terms commonly used in wetland restoration and general descriptions of restoration practices.

Zedler, J.B. and J.C. Callaway. 1999. Tracking wetland restoration: Do mitigation sites follow desired trajectories? Restoration Ecology 7:69-73.

Wetland Management II – Compensatory Mitigation –

Video Resources

"Restoring a Treasure: The Klamath Basin" 2002. VHS. 30 min.
University of California Extension. Center for Media and Independent Learning. Berkeley, California

This 30-minute videotape produced by the University of California Extension Service is used to introduce the issue to students. It describes the history of the region including the role of the Bureau of Reclamation in the draining of extensive areas of wetlands in the Klamath Basin area of Oregon and California. The video also includes some basic wetland ecology and the viewpoints of several stakeholders in the region.

Wetlands Stewardship: A call to action. 28 min.
McDonald and Woodward Publishing Co.
www.mwpubco.com

Designed for a general audience, this video describes the importance of wetlands to the environment and highlights several community-based activities that have conserved local wetlands.

Oregon Field Guide – Wetlands Videos

Oregon Public Broadcasting
7140 Macadam Avenue
Portland, OR 97219
www.opb.org

All of the following Oregon Field Guide *episodes are available on-line. The titles listed and described below are brief segments on specific examples of wetland restoration. They are intended for a general audience, but are of high quality and appropriate to enhance lectures.*

Episode #704 Wetland Restoration. 1996. 15 min.

Seasonally flooded wetlands (tufted hairgrass prairie, forested wetlands) in the Willamette Valley, Oregon are mostly on private lands. Most have been drained for agricultural lands. More species rely on seasonally flooded wetlands than higher elevation habitats in the Cascade Mountains, which are better protected. Steve Smith with the Oregon Department of Fish and Wildlife describes restoration of Willamette Valley wetlands by working with private landowners who have an interest in developing wetlands. One landowner has built a pond on his land and allows flooding of an adjacent field. The regulatory process is long and arduous with three different agencies involved. These newly restored wetlands on private lands provide supplemental habitat for established cores of already-protected wetlands. One landowner has planted wild rice as a cash crop, which also has wildlife value. Improvement comes quickly as nesting ducks and geese and beaver establish. Most restoration of this type is done on land that is difficult to farm anyway due to seasonally saturated soils. The wetlands plant seed sources is already there, so planting of native species may not need to be done. A pond turtle captive rearing program grows turtles to sufficient size for release. This is an effort to try to avoid Endangered Species Act listing, which would place further restrictions on landowners.

Episode #902 – Sycan Marsh. 1998. 15 min.

Sycan Marsh is a showcase wetland restoration project in southern Oregon owned by the Nature Conservancy (TNC) that incorporates habitat for sensitive species with cattle grazing. TNC collects grazing fees for its use and a permit allows grazing through 2020. The wetland site, surrounded by the Freemont National Forest, has a flat topography. Sixty-five species of grasses, sedges and rushes are represented as well as a variety of bird species (nesting and stopover) – willet, sandhill crane, widgeon, ducks, red-winged blackbird, white-faced ibis, white pelicans. In the mid-1800s the site was drained to build pasture, the original hydrology was dammed and drained areas have been taken over by trees. Invasive species (reed canarygrass) have also had an impact. The management goal is to restore this mountain meadow wetland to pre-European settlement conditions. The water control system has been re-engineered to allow flooding over a wide area (possible due to flat topography), extent of grazing is now below historic levels, timing and intensity of grazing is controlled (high intensity for short time periods). Grazing has been shown to have some benefits. Tufted hairgrass did better in grazed area than in protected, un-grazed area. Cattle apparently remove excess dead vegetation allowing for new growth. In the past this function was performed by periodic fires and flooding. However, cattle <u>do</u> compact and dry out soil and <u>over</u>-grazing is destructive.

Native Oysters – Episode #1004. 1999. 15 min.

This video describes efforts to re-introduce native oysters into Netarts Bay, Oregon. Non-native planted oysters are regularly grown and harvested in bays and estuaries along the Oregon Coast. They are raised to thumbnail size on empty oyster shells and then spread on mudflats for further growth and development. In the mid-1800s, native oysters were abundant in Netarts Bay and other similar bodies of water. Larvae of this species are dependent on adult shells to settle and attach. Over harvesting and the removal of harvested shells caused initial declines of native oysters. Declining water quality due to runoff from pulp mills and adjacent logging "finished the job" and native oysters nearly disappeared. Restoration efforts are described and involve the cooperation of the oyster industry, which is considered sustainable. The presence of eelgrass is considered an indicator of a healthy bay. The health of nearby Tillamook Bay is in question due to agricultural runoff. Netarts Bay does not have this as a challenge.

Warner Wetlands – Episode #1005. 1999. 15 min.

The Bureau of Land Management is conducting wetland restoration in the Warner Wetlands at the base of Hart Mountain in southern Oregon. The 25,000-acre wetland is comprised of lakes, sloughs, potholes and previously drained pastures that were used to graze cattle. Natural hydrological regimes are being restored. The emphasis of this video is on developing a greater diversity of nesting habitat for wetland birds.

Willapa Bay Restoration – Episode #1610. 2005. 15 min.

Willapa Bay is described as the "most pristine bay in the lower 48." The mudflats of Willapa Bay National Wildlife Refuge in southwest Washington are an important feeding area for shorebirds. An invasive grass, Spartina alterniflora, introduced from eastern U.S. over 100 years ago, has become established in the bay threatening this wetland ecosystem. Oysters, salmon and shorebirds are all threatened. The mudflats have been transformed into wetlands dominated by grasses, which are unsuitable feeding habitat for mudflat-adapted shorebirds. Eradication of Spartina is the management goal and an aggressive herbicide spraying campaign is being waged using tank-like spraying vehicles, GPS software and chlorophyll-sensing spray heads. Other less intrusive methods for control have failed and the expected outcome of "no action" would be further loss of shorebirds. The eradication program has the support of the local oyster industry. Watershed-level management is being implemented, including converting former cattle pastures back into wetlands and protecting old growth forests adjacent to the estuary.

Episode #1908 Klamath Levee Blast. 2007. 15 min.

In October of 2007, the Nature Conservancy used explosives to breach about 2 miles of levees along Upper Klamath Lake as part of a wetland restoration project on the Williamson River Delta. These wetlands were originally converted into cropland by constructing levees and drainage canals, so the change has been from marsh to agricultural lands and now back to marsh. Loss of wetlands resulted in loss of nutrient processing function of wetlands causing eutrophication and contributed to loss of sucker fish. The marsh will regenerate after water is added back into the system – a similar project resulted in a functional wetland just seven years after restoration. This project has the support of farmers, tribal members and environmental groups. As the lake rises more water will come into the delta and a full wetland community should appear in 5 to 7 years.

Environmental Protection Agency
www.epa.gov/wetlands/education/wetlandsvideo/

This is a short (approx 15 min.) video designed for a general audience that emphasizes the importance of providing outdoor, nearby nature experiences for children – emphasis is on wetlands and includes interviews with wetlands scientists and environmentalists. Web site has directions for saving/downloading video.

General and Comprehensive Resources

The following resources cover a broad range of wetlands-related topics. Several are comprehensive web sites that contain a variety of information on wetlands that may be relevant to instructors. More detailed descriptions of the content of these web sites are provided in a separate section entitled "Detailed Descriptions of Comprehensive Resources" that follows. These resources have been identified with an asterisk (*) in the list below. More specific resources that cover one or few aspects of wetlands are provided in the module that is most relevant to those topics.

Association of State Wetland Managers (*)
www.aswm.org

The Association of State Wetland Managers is a nonprofit membership organization established to promote and enhance protection and management of wetland resources, to promote application of sound science to wetland management and to provide wetland training and education.

Batzer, D.P. and R.R. Sharitz. 2007. Ecology of freshwater and estuarine wetlands. Univ. of Calif. Press. 581 pp.
www.ucpress.edu

This is a comprehensive undergraduate text in wetland ecology. It is appropriate for a course devoted entirely or primarily to wetlands. Otherwise, it would be a useful reference for instructors who incorporate wetlands topics into a broader course in ecology.

Dahl, T.E. 2006. Status and trends of wetlands in the conterminous United States 1998-2004. U.S. Fish and Wildlife Service, Washington, D.C. 112 pp.
http://www.fws.gov/wetlands/StatusAndTrends/

Environmental Protection Agency (*)
www.epa.gov/wetlands

The EPA wetlands site provides some good introductory information on wetlands. Wetlands definitions, types, status and trends, functions and values and wetlands management (including mitigation) and protection are all covered.

Hammer, D.A., ed. 1989. Constructed wetlands for wastewater treatment. Lewis Publishers, Inc., Chelsea, MI . 831 pp.

Kusler, J.A. and T. Opheim. 1996. Our national wetland heritage: A protection guide, 2nd ed. Environmental Law Institute, Washington, D.C. 149 pp.

This is a comprehensive guide to the protection and restoration of wetlands by local governments, private citizens, conservation organizations and landowners.

Maltby, E. and T. Barker (eds.). 2009. The wetlands handbook. Wiley-Blackwell, Inc. San Francisco, CA. 800 pp.
www.wiley.com

At $300 this text is probably only for the most serious wetlands instructors. It is a comprehensive analysis of ecosystem-based approaches to wetlands management. The emphasis is on maintaining/restoring ecological functions in freshwater wetlands.

Marks, R. 2006. Ecologically isolated wetlands. Natural Resources Conservation Service and Wildlife Habitat Council. Fish and Wildlife Habitat Management Leaflet #38. 8 pp.

This brief document is an excellent introduction to wetlands and is suitable to assign for student reading. Wetland processes and functions, ecological and economic benefits and issues associated with wetland loss and degradation are covered. As the title suggests, management issues emphasize what can be done to reduce the effects of wetland isolation.

Millennium Ecosystem Assessment. 2005. Ecosystems and human wellbeing: Wetlands and water – Synthesis. World Resources Institute, Washington, D.C.
www.millenniumassessment.org/documents/document.358.aspx.pdf

http://www.maweb.org/documents/document.358.aspx.pdf

This is a global assessment of wetlands resources with recommendations for future management.

Mitsch, W.J. and J.G. Gosselink. 1986. Wetlands. Van Nostrand Reinhold Co., Inc. New York, NY. 539 pp.

Mitsch, W.J. and J.G. Gosselink. 2007. Wetlands. 4th ed. John Wiley and Sons, Inc., Hoboken, NJ.

A potential choice for a textbook for a course on wetlands, but designed for junior/senior level students and for those with some background in ecology.

Mitsch, W.J., et al. 2009. Wetland ecosystems. John Wiley and Sons, Inc., Hoboken, NJ. 285 pp.

Earlier editions of the Mitsch and Gosselink Wetlands *classic wetlands text (described above) included seven "ecosystem" chapters that described the structure and function of wetland ecosystems found in North America. In the interest of reducing the size of this text, the authors decided in the most recent edition to pull out these chapters and develop a separate text.* Wetland Ecosystems *is the result of that effort.*

National Research Council (NRC). 1995. Wetlands: Characteristics and boundaries. National Academy Press, Washington, D.C. 306 pp.

National Research Council (NRC). 2001. Compensating for wetlands losses under the Clean Water Act. National Academy Press, Washington, D.C. 158 pp.

Oregon Wetlands Explorer (*)
www.oregonexplorer.info/wetlands/

This joint project of Oregon State University, The Wetlands Conservancy and Oregon Division of State Lands is primarily designed for wetlands professionals, but educators (especially those in Oregon) will find some useful information here.

Payne, N.F. 1992. Techniques for wildlife habitat management of wetlands. McGraw-Hill, Inc., New York, NY. 549 pp.

Ramsar Convention on Wetlands
www.ramsar.org

The Ramsar site is most useful for international wetlands information. The Ramsar Convention is an intergovernmental treaty that commits its member countries to maintain the ecological character of "wetlands of international importance." The site provides digital photos and other media for instructor use including a 4-minute introductory You-tube video that introduces Ramsar and describes the value of wetlands.

Society of Wetland Scientists (*)
www.sws.org

The Society of Wetland Scientists (SWS) is the premier professional organization for wetland scientists and other professionals in the field. SWS publishes, Wetlands*, the leading journal on wetlands science and issues. Their web site has a number of resources that educators will find useful.*

Tiner, R.W. 2005. In search of swampland: A wetland sourcebook and field guide. Rutgers University Press, New Brunswick, NJ
http://rutgerspress.rutgers.edu

This resource is an excellent introduction to wetlands issues written for the "average citizen."

U.S. Army Corps of Engineers (*)
www.usace.army.mil/CECW/Pages/techbio.aspx

The Army Corps of Engineers has primary responsibility for waterways in the U.S. and is the primary agency that regulates wetlands at the federal level. As a focal point for federal wetlands management, this site has links to lots of wetlands resources with an emphasis on wetland delineation and classification, wetland functions and values, mitigation banking, and wetland plants and soils.

U.S. Fish and Wildlife Service - National Wetland Inventory (*)
www.fws.gov/wetlands

This site, maintained by the U.S. Fish and Wildlife Service, provides a wealth of useful information and tools including wetland status reports (national and regional), Google Earth with wetlands maps overlay and digitized wetlands maps.

U.S. Geological Survey – National Wetlands Research Center
www.nwrc.usgs.gov

Wetlands International
www.wetlands.org

The mission of this international conservation organization is "to sustain and restore wetlands, their resources and biodiversity for future generations." The organization uses science-based information to promote the protection and restoration of wetlands. Instructors looking for an international perspective on wetlands issues, especially those related to climate change and wetland bird conservation, will find Wetland International publications to be useful resources. The organization also produces a number of short (5-15 min.) videos available for download on their web site. Topics include the impacts of climate change on mangrove forests, wetland restoration and carbon dioxide storage in peatland forests.

Details on Comprehensive Web Sites (*)

Association of State Wetland Managers
www.aswm.org

The Association of State Wetland Managers is a nonprofit membership organization established to promote and enhance protection and management of wetland resources, to promote application of sound science to wetland management and to provide wetland training and education. Their web site has lots of resources related to all wetlands topics including:

A wetlands glossary:
http://www.aswm.org/watersheds/wetlands-and-watershed-protection-toolkit/887-wetlands-and-watershed-protection-toolkit?start=15

An excellent collection of publications that examine the relationship between wetlands and climate change:
www.aswm.org/science/climate_change/climate_change.htm

A collection of publications that examine the Gulf Oil Spill and its impact on wetlands. Includes coverage of wetland legal issues such as the Rapanos decision, "navigability," landmark legal cases,"takings." Instructors may also want to subscribe to "Wetland Breaking News" a newsletter on up-to-date wetlands issues and new publications.
http://aswm.org/wetland-science/2010-gulf-oil-spill

Environmental Protection Agency
www.epa.gov/wetlands
http://water.epa.gov/type/wetlands/index.cfm

The EPA wetlands site provides some good introductory information on wetlands. Wetlands definitions, types, status and trends, functions and values, wetlands management (including mitigation) and protection are all covered. The "Fact Sheets" are concise, 1-2 page summaries of various wetlands topics. Specific EPA sites of interest to instructors include:

This EPA wetlands module outlines the various values assigned to wetlands and describes how they are measured.
www.epa.gov/watertrain/wetlands/index.htm

This is an EPA site dedicated to wetland mitigation.
www.epa.gov/wetlandsmitigation

This EPA fact sheet is an excellent introduction to wetland mitigation banking.
www.epa.gov/owowwtr1/wetlands/facts/fact16.html

This is a short (approx 15 min.) video designed for a general audience that emphasizes the importance of providing outdoor, nearby nature, experiences for children – emphasis is on wetlands and includes interviews with wetlands scientists and environmentalists. Web site has directions for saving/ downloading video.
www.epa.gov/wetlands/education/wetlandsvideo/

A series of wetlands fact sheets on most aspects including an overview of wetland types, functions and values, threats, restoration, and monitoring and assessment.
www.epa.gov/owow/wetlands

The EPA wetlands helpline
http://water.epa.gov/type/wetlands/wetline.cfm

U.S. Fish and Wildlife Service – National Wetlands Inventory
www.fws.gov/wetlands

The U.S. Fish and Wildlife Service is the principal federal agency that provides information to the public on the extent and status of the nation's wetlands. This site provides a wealth of useful information and tools including wetland status reports (national and regional), Google Earth *with wetlands maps overlay and digitized wetlands maps. Perhaps the most useful tool is the "Wetlands Mapper," which visually displays the results of the national wetlands inventory, based primarily on an analysis of aerial photographs. Wetlands are identified, mapped and then superimposed on topographic maps. The inventory does not identify all wetlands in an area, but probably the most significant ones. The "Wetlands Mapper" allows viewing of identified wetlands either on-line or hard copy maps can be ordered for every state (see "Hard Copy Orders"). Each map is mapped as a polygon with an imbedded code that indicates the specific wetland type and other information related to this site.*

The WetlandsMapper shows the location of wetlands identified on National Wetlands Inventory (NWI) maps and integrates digital map data with other resource information. The following links provide a useful introduction to this feature:

- Wetlands Mapper Documentation and Instructions Manual (www.fws.gov/wetlands/_documents/gData/WetlandsMapperInstructionsManual.pdf)
- Frequently Asked Questions: Wetlands Mapper (www.fws.gov/wetlands/_documents/gData/QuestionsAnswersAboutNewMapper.pdf)
- Frequently Asked Questions web page (www.fws.gov/wetlands/FAQs.html)

NWI wetlands data can also be viewed with Google Earth. Instructions and a link to do so are included at the NWI web site.

This U.S. Fish and Wildlife site also includes Wetlands Status and Trends Reports, *which provide long-term trend information about specific changes and places and the overall status of wetlands in the United States. The historical database provides photographic evidence of land use and wetlands extent dating back to the 1950s. This provides an accurate record to assist in future restoration efforts.*

Status and Trends Reports available on the web site include:

- NOAA/USFWS joint report on Coastal Wetland Trends 1998-2004 (www.fws.gov/wetlands/_documents/gSandT/NationalReports/StatusTrendsWetlandsCoastalWatershedsEasternUS1998to2004.pdf)

- Status and Trends of Wetlands in the Conterminous United States 1998 to 2004 (Dahl, 2006) (www.fws.gov/wetlands/_documents/gSandT/NationalReports/StatusTrendsWetlandsConterminousUS1998to2004.pdf)
- Status and Trends of Wetlands in the Conterminous United States 1986 to 1997 (www.fws.gov/wetlands/_documents/gSandT/NationalReports/StatusTrendsWetlandsConterminousUS1986to1997.pdf)
- Wetlands Status and Trends in the Conterminous United States, Mid-1970's to Mid-1980's (www.fws.gov/wetlands/_documents/gSandT/NationalReports/WetlandsStatusTrendsConterminousUS1970sto1980s.pdf)
- Status and Trends of Wetlands and Deepwater Habitats in the Conterminous United States 1950's to 1970's (www.fws.gov/wetlands/_documents/gSandT/NationalReports/StatusTrendsWetlandsDeepwaterHabitatsConterminousUS1950sto1970s.pdf)

Links to other resources such as the National Wetlands Plant List and an EPA evaluation of the impact of climate change on coastal wetlands are also available.

Oregon Wetlands Explorer
www.oregonexplorer.info/wetlands/

This joint project of Oregon State University, The Wetlands Conservancy and Oregon Division of State Lands was first launched in 2009 as "a useful tool for anyone doing wetland work in Oregon." It is primarily designed for wetlands professionals, but educators (especially those in Oregon) will find some useful information here. The following are included:

1. *Statewide database of wetlands maps, hydric soils, FEMA flood zones, Wetland Reserve Program (WRP) sites, wetland mitigation banks. Local wetland inventories and recommended priority sites for conservation*
2. *A tool for rapid assessment for wetlands*
3. *Oregon-related information on various wetland topics*
4. *Wetland GIS and vegetation plot data*

Society of Wetland Scientists
www.sws.org/

The Society of Wetland Scientists (SWS) is the premier professional organization for wetland scientists and other professionals in the field. SWS publishes, Wetlands*, the leading journal on wetlands science and issues. Their web site has a number of resources that educators will find useful. Several are described below:*

This newly developed web page was designed to document the impact of the Deepwater Horizon oil spill in the Gulf of Mexico on wetlands. It includes insights from wetland scientists, links top pertinent resources and digital photographs.
www.sws.org/oilspill/

This page lists links to specific short courses in wetlands training – delineation, hydric soils, plant identification, restoration, mitigation, and constructed wetlands.
www.sws.org/training/

This is a directory of wetland-related academic programs at U.S. colleges and universities.
www.sws.org/colleges/

These "position papers" on various wetlands topics are designed to "increase public understanding of wetlands issues and to promote sound public policy." They are written by experts in the field and are based on the best available science. Topics include oil effects on wetlands, mosquito control, mitigation banking, performance standards for wetland restoration and creation, and definitions of wetland restoration. The papers are brief, well-referenced and provide excellent background for educators with a particular interest in specific wetland issues. They are also suitable to assign as student reading to provide a basis for discussions on wetland issues.
www.sws.org/wetland_concerns/

The SWS also publishes the "SWS Research Brief," which helps translate wetland research results for a non-technical audience. The research of selected wetlands scientists is highlighted in each brief. These make excellent student reading and serve to familiarize students with the process of science – how scientists formulate questions, collect data, present their findings and draw conclusions from them.
www.sws.org/ResearchBrief/

Some topics include:

- *Restoration of mangroves*
- *Invasive plants in wetlands*
- *Impact of elevated CO_2 levels on wetlands*
- *Impact of hurricane Katrina on wetlands*
- *Relationship between marshes, mosquitoes and malaria*

The SWS education page is designed with the college educator in mind and is intended "to facilitate sharing of techniques, skills, tools and ideas on and about wetlands education." See for educational resources including labs, field activities, courses, links to other web sites, etc. The Society of Wetlands Scientists also maintains a list of colleges and universities that offer courses or programs in wetland science or ecology.
www.sws.org/education/

Here are some examples of materials that college instructors will find most useful:

1. *Links to general information on wetlands*
2. *Syllabi, lab exercises and exams for wetlands courses*

NOTE: Instructors with an interest in teaching wetland concepts using digital imagery and aerial photography will find the "Wetland Education Through Maps and Aerial Photography" (WETMAAP) site to be particularly useful.

3. *Digital images collection for wetlands education*

U.S. Army Corps of Engineers
www.usace.army.mil/CECW/Pages/techbio.aspx

The Army Corps of Engineers has primary responsibility for waterways in the United States and is the primary agency that regulates wetlands at the federal level. As a focal point for federal wetlands management, this site has links to lots of wetlands resources. Those that are most relevant to this series of modules include the following:

Wetlands delineation and classification

- Corps Wetlands Delineation Manual (www.el.erdc.usace.army.mil/elpubs/pdf/wlman87.pdf)
- Regional Supplements to the Corps Delineation Manual (www.usace.army.mil/CECW/Pages/reg_supp.aspx)
- USFWS National Wetlands Inventory (www.fws.gov/wetlands/)
- Classification of Wetlands & Deepwater Habitats of the U.S. (www.npwrc.usgs.gov/resource/wetlands/classwet/index.htm)
- Recognizing Wetlands - An Informational Pamphlet (www.usace.army.mil/CECW/Documents/cecwo/reg/rw_bro.pdf)

Wetlands functions and values

- Current HGM Information and Guidebooks (http://el.erdc.usace.army.mil/wetlands/hgmhp.html)
- Hydrogeomorphic Approach to Assessing Wetland Functions (http://el.erdc.usace.army.mil/wetlands/hgmhp.html)
- National Plan to Implement the Hydrogeomorphic Approach to Assessing Wetland Functions (www.usace.army.mil/CECW/Documents/cecwo/reg/hydro_geo.pdf)
- Wetland Functions & Values - A Report by the National Science Foundation, 1995 (www.usace.army.mil/CECW/Documents/cecwo/reg/wet_f_v.pdf)
- Consequences of Losing or Degrading Wetlands
- U.S. Environmental Protection Agency Wetlands Information Website http://water.epa.gov/type/wetlands

Mitigation banking

- Federal Guidance for the Establishment, Use and Operation of Mitigation Banks (http://water.epa.gov/lawsregs/guidance/wetlands/mitbankn.cfm)
- National Wetland Mitigation Banking Study: Technical and Procedural Support to Mitigation Banking Guidance, 1995 (www.iwr.usace.army.mil/index.php?option=com_content&view=category&layout=blog&id=7&Itemid=3/iwrreports/WMB-TP-2.pdf)
- National Wetland Mitigation Banking Study: Model Banking Instrument, 1996 (www.iwr.usace.army.mil/index.php?option=com_content&view=category&layout=blog&id=7&Itemid=3/iwrreports/WMB-TP-1.pdf)
- National Wetland Mitigation Banking Study: The Early Mitigation Banks: A Follow-up Review, 1998 (www.iwr.usace.army.mil/index.php?option=com_content&view=category&layout=blog&id=7&Itemid=3/iwrreports/98-WMB-WP.pdf)

- National Wetlands Mitigation Action Plan (www.usace.army.mil/CECW/Documents/cecwo/reg/Mit_Action_Plan.pdf)
- IWR - Wetlands and Regulatory (www.iwr.usace.army.mil/index.php?option=com_content&view=category&layout=blog&id=7&Itemid=3/publications.cfm)

Plants and soils

- NRCS Soils Website (www.soils.usda.gov/)
- Field Indicators of Hydric Soils in the U.S. ftp://ftp-fc.sc.egov.usda.gov/NSSC/Hydric_Soils/FieldIndicators_v7.pdf
- National List of Vascular Plant Species that Occur in Wetlands:
    - 1996 (www.usace.army.mil/CECW/Documents/cecwo/reg/plants/list96.pdf)
    - 1988 (www.usace.army.mil/CECW/Documents/cecwo/reg/plants/list88.pdf)
    - National Wetland Plant List (NWPL) https://rsgis.crrel.usace.army.mil/apex/f?p=703:1:2631898853215485
- NRCS Plants Database (www.plants.usda.gov/java/)
- Center for Aquatic and Invasive Plants - University of Florida (www.plants.ifas.ufl.edu/)
- Global Invasive Species Database (www.issg.org/database/welcome/)
- Interactive Key to Wetland Monocots of the U.S. (www.npdc.usda.gov/technical/plantid_wetland_mono.html)

Sources for Digital Images

Barras, J.A. 2007. Satellite images and aerial photographs of the effects of Hurricanes Katrina and Rita on coastal Louisiana. U.S. Geological Survey Data Series 281.
www.pubs.usgs.gov/ds/2007/281

Bureau of Land Management Image Library
www.blm.gov/wo/st/en/bpd.html

Most of the images in this web site are "public domain" and can be used without further authorization from the BLM.

The Integration and Application Network (IAN)
www.ian.umces.edu/imagelibrary/

The Integration and Application Network (IAN) is an initiative of the University of Maryland Center for Environmental Science. IAN emphasizes environmental problems in the Chesapeake Bay and its watershed. Although registration is required, there is no cost to download images.

The Natural Resources Conservation Service Photo Gallery
www.photogallery.nrcs.usda.gov

The Natural Resources Conservation Service Photo Gallery provides a comprehensive collection of natural resources and conservation-related photos from around the U.S. They are available for non-commercial use, free-of-charge with proper acknowledgement (described on web site).

NBII Life – Library of Images From the Environment
www.life.nbii.gov/dml/home.do

The National Biological Information Infrastructure (NBII) Library, Images from the Environment (LIFE), provides high-quality environmental images that are freely available for educational use. The collection includes images of plants, animals, fungi, microorganisms, habitats, wildlife management, environmental topics, and biological study/fieldwork. Images are annotated with background information(context, scientific names, location, habitat classifications, etc.), greatly improving their use as educational materials.

NOAA Photo Library/NERR Collection
http://www.photolib.noaa.gov/nerr/index.html
This collection includes images of estuaries in the National Estuarine Research Reserve System. Collection contains more than 1000 photos with images of landscapes, habitats, and individual specimens with descriptions.

U.S. Department of Agriculture PLANTS Database
www.plants.usda.gov

Plant images may be used for non-commercial use although copyrighted images require notification of the copyright holder.

The Society of Wetland Scientists
www.sws.org/regional/pacificNW/photo.html

The Ramsar Convention on Wetlands
www.ramsar.org/cda/en/ramsar-media-photos/main/ramsar/1-25-126_4000_0__

Has a good collection of photos from sites that have met Ramsar criteria.

U.S. Environmental Protection Agency Image Gallery
www.epa.gov/newsroom/pictures.htm

EPA maintains several collections of photographs and other images available for use by the public. Please note that while photographs and graphic materials produced by the federal government are not subject to copyright restriction, some photographs included in these collections may be copyrighted. Please observe carefully all rights and permissions information.

U.S. Fish and Wildlife National Digital Library
www.fws.gov/digitalmedia/

The U.S. Fish and Wildlife Service's National Digital Library is a searchable collection of public domain images, audio/video clips and publications. Permission is not required for use; however you are asked to give credit to the photographer or creator and the U.S. Fish and Wildlife Service.

U.S. Forest Service
www.fs.fed.us/photovideo/

USDA Forest Service's "Find-a-Photo" site allows access to thousands of copyright- free wildlife, fish, wildflower and environmental education photographs, donated by Forest Service employees, their partners and volunteers.