The Water Resources Development Act of 2006

H.R. 2864

Final Workshop Report

Summary of Legislation
Scientific Evaluation
Case Studies
Controversies
Measuring Success
Conclusion

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Final Workshop Report: The Water Resources Development Act of 2006

Introduction

The Water Resources Development Act (WRDA) of 2006 passed the House of Representatives on July 14, 2005 and the Senate on July 19, 2006. The stated purpose of the Act is "to provide for the conservation and development of water and related resources, to authorize the Secretary of the Army to construct various projects for improvements to rivers and harbors of the United States, and for other purposes."[1] The Act authorizes 700 Civil Works program projects, both old and new. Act provisions reflect the growing and evolving role of the Army Corps in major U.S. water infrastructure and environmental activities. The Army Corps of Engineers Civil Works Program is the agency department responsible for operating water resources facilities that maintain or recover natural resource projects approved by Congress.

In many respects the Act is 'standard' legislation in the vein of past WRDA's, which are intended to be biennial. Before the Act of 2006, there had been no water infrastructure act since the Water Resources Development Act (WRDA) of 2000, which expired at the end of the 2002. Thus, in addition to new unauthorized projects, this bill also addresses awaiting backlogged authorized water infrastructure projects. The Congressional Budget Office (CBO) estimates that H.R. 2864 would authorize some $10 billion in total over 10 years.

The legislation covers hundreds of specific projects and studies nationwide. Large mega-projects associated with a specific region, such as those in the Florida Everglades, the Louisiana Coastal Area, and the Upper Mississippi River and Illinois Waterway System, are addressed in separate titles within the act. The WRDA of 2006 reflects an incremental priority shift within federal water legislation. Focus within this particular version of the bill highlights environmental and ecological restoration and mitigation, as opposed to traditional infrastructure creation projects like dams and harbors construction.

One major part of the Water Resources Development Act aims to improve wetland ecosystems. This part of the legislation spotlights the environmental problem of wetland loss

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[1] United States Cong. House of Representatives. 109th Congress., 1st Session. H. R. 2864 E.H., Water Resources Development Act of 2005, Congressional Bills GPO Access. <http://frwebgate.access.gpo.gov/> 09 June 2006.

and mandates projects to improve these ecosystems' deteriorated functions through the solutions of wetland restoration and creation.

Projects and studies included in the legislation fall into five (5) broad categories: inland navigation and harbors, flood damage and control, shoreline protection and emergency streambank protection, improvement of the quality of the environment and aquatic ecological restoration and finally other projects, such as watershed and river basin assessments, dam safety, and water resources assessments.

As such, this bill tackles many scientifically sensitive issues involving the hydrological cycle. This paper will focus on just one of these many aspects, specifically it will focus on the parts of the act that concern wetlands loss, restoration and mitigation, the science behind this issue, controversies surrounding the science and proposed solutions in the act.

Wetlands

The implementation of the Water Resources Development Act of 20065 (WRDA) as it pertains to wetlands restoration requires fluency of several physical, chemical, and ecological relationships. The science behind the proposed solutions, as well as the feasibility and impacts associated with the implementation of the WRDA are also addressed.

The scientific issues discussed in this section are divided into three general categories: human health risks; flooding and disruptions to hydrology; and habitat degradation and loss. These threats to humans and wetlands occur in part because of the complexity and fragility of wetland systems.

Wetlands are unique environmental systems that, by definition of the United States Environmental Protection Agency (USEPA) and Army Corps of Engineers, are flooded or saturated periodically and contain specific types of wetland soils and vegetation.[2] Maintaining a healthy species interaction is crucial to wetlands sustainability. Thus, when considering wetland restoration or wetland creation, studies should focus on an ecosystem approach that targets the dimensions of water, soil, and habitat as one system. Wetlands can easily be compromised by

[2] US Army Corps of Engineers Waterways Experiment Station Environmental Laboratory. *Corps of Engineers Wetlands Delineation Manual. Wetlands Research Program Technical Report Y-87-1*. 1987.

anthropogenic risks such as pollution and urban expansion. When this occurs the environmental balances that wetland species depend on are threatened.

The healthy interaction between the natural elements in wetlands is crucial to their sustainability. Thus, when considering wetland restoration or wetland creation, studies should focus on an ecosystem approach that targets the dimensions of water, soil, and habitat as one system. When there are anthropogenic risks to wetlands such as pollution and urban expansion, the environmental balances that wetland species depend on are threatened. One of these balances is the nutrient or biogeochemical cycle and it consists of a circuit by which chemicals move between plants and animals, soils, water, and air. Nutrient cycling of nitrogen, phosphorus, and sulfur is particularly important for plant and animal survival.

A second cycle that is crucial to the survival of wetlands is the water or hydrological cycle, which involves the circulation of water through the air and land, as well as surface water and groundwater. Wetlands receive precipitation and overland runoff that accumulate and are transmitted in water bodies and then taken up by plants for photosynthesis.

A comprehensive study of problems facing wetlands and restoration efforts must consider the interactions between the water, soil, and vegetation as well as each component individually. According to the Convention on Biological Biodiversity[3] an ecosystem is defined as a "dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit." The ecosystem approach to solving these problems provides a strategy for the integrated management of land, water and other living resources in hopes of promoting conservation and sustainable use of our limited resources.[4] It aims to manage the ecosystem based on its multiple functions and uses. Sustainable use implies that resources can be consumed in a manner that does not pose a threat to present or future generations. While human needs are central to this approach, exploiting the ecosystem is not. In other words the ecosystem approach does not focus on short-term economic growth, but rather at a long-term sustainable of resources that ensure both the well-being of humans and nature as well as the health of the world's economy.

These problems are addressed as they pertain to three general categories: human health risks, impacts to hydrology, and habitat loss and degradation. The WRDA categorizes these

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[3] United Nations Environment Programme. *Convention on Biological Diversity* at http://www.biodiv.org/convention/articles.shtml?lg=0&a=cbd-02

[4] Shepherd, Gill. (2004). *The Ecosystem Approach: Five Steps to Implementation*. IUCN, Gland, Switzerland.

concerns as water quality improvements, seashore protection, flood control, habitat creation, road and canal demolition, and the construction of fish ladders.

Services Provided by Wetlands

Pollution Control:

Healthy wetlands provide free services to society. To emphasize the importance of wetlands, a brief review of the hydrological cycle is helpful. As rain falls, it flows through domestic, farming and industrial areas carrying with it the pollutants. Common pollutants include metals, fertilizers, pesticides, as well as viruses and bacteria. These pollutants then re-enter the water cycle and are deposited into the water bodies (i.e. rivers, lakes, oceans etc. . .). Wetlands have an enormous capacity to filter pollutants out of runoff, similar to a water treatment plant. Waters in wetlands typically flow slowly through the system – this causes chemicals to settle to the bottom and adhere to soil particles. After settling, some chemicals may be absorbed by plant roots and microorganisms in the soil. This is both an advantage (i.e., wetlands can naturally remove chemicals from wastewater) and risk as relatively high concentrations of pollutants can accumulate and pose health risks for humans that come in contact or ingest them.

Oftentimes, we're left with difficult choices: leave the contaminated sediments in place, or remove and dispose of them elsewhere.[5] Natural events such as floods, or human-induced structural changes such as construction or dredging, can disturb sediments and re-introduce the chemicals, increasing the risks of exposure to humans, plants and animals.

There are certain types of chemicals that are toxic to humans and accumulate in the tissues of wetland organisms such as fish, birds, and plants. Over time, the organisms can take in more and more of the chemical to hazardous levels (known as bioaccumulation), and may be passed to other animals higher up in the food chain, including humans.

Another risk to human health that can be caused by introducing chemicals into wetlands is the potential damage to groundwater drinking water supplies6. Groundwater supplies are recharged by rain, snowmelt, or water seeping from overlying water bodies such as wetlands so

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[5] Committee on Geosciences, Environment, and Resources. *Restoration of Aquatic Ecosystems: Science, Technology, and Public Policy*. National Academy of Sciences. 1992: 292. 19 June 2006 < http://www.nap.edu/catalog/1807.html>.

[6] Anacostia Watershed Toxics Alliance. *Charting a Course toward Restoration: A Toxic Chemical Management Strategy for the Anacostia River.* (date n.p.) 22 June 2006 <http://response.restoration.noaa.gov/book_shelf/1046_Management_Plan.pdf>.

disease-causing bacteria and other pathogens could potentially enter drinking water supplies. Types of soils present in wetlands are often resistant to the downward flow of water; however, it is possible that contaminants discharged into wetlands can enter drinking water aquifers. For infants, the elderly or those with illnesses, these contaminants have the potential to be fatal.

In addition to their filtration ability, wetlands capacity to hold water allows for the replenishment of ground water bodies. Some anthropogenic efforts can provide a passive contribution to surface water quality. Such efforts can vary from connecting floodplains, planting vegetation and controlling discharge to prevent eutrophication and algae blooms; this blending dilutes pollutants without diminishing the beneficial amounts of nutrients and sediments and thus provides a better habitat to living beings.

The Impacts and Feasibility of Implementation

Because water is at the core of our existence, it is important that its quality be maintained. High water quality consists of low concentrations of polluting chemicals; a balance of the conditions that support healthy aquatic life (such as good habitat and enough oxygen); and a healthy diversity of aquatic life. Wetlands are valued for their ecological function and their role in maintaining biodiversity. However, their health is highly affected by sewage discharge and agricultural runoffs, and thus creates a social dilemma.

The water cycle in wetlands emphasizes the need to deploy efforts in cleaning our rivers and minimizing polluting discharges. The deteriorating quality of water will have multiple effects on our ecosystem in terms of destroying aquatic life that will in turn cause the depletion of other animals higher above in the food chain reaching to humans. Other than its direct impact on aquatic and wildlife, water quality has indirect impacts on the health of soil and vegetation (transported via irrigation or as a result of overloading the water body the chemicals will absorbed by the soil and taken up by the vegetation and eventually deadly chemicals will enter our food chains), which will in turn have great risks on human health.

Flood Control

There are three general areas of WRDA projects that pertain to hydrological improvements associated with wetlands restoration and creation. They are flood control, erosion and shoreline protection, and road and canal demolition.

Flood control is one main consideration of the WRDA with regard to wetland restoration and creation. Wetlands serve to provide flood protection because dense wetland vegetation can slow the flow of water with plant root systems to help to hold soil in place, the wetland soils and terrain allow for the long-term storage and slow release of water, and less floodwaters result in less erosion. Recent research indicates that the surge of water associated with a storm that flows into adjacent inland areas is reduced by one foot for every square mile of wetland that is restored.[7] Louisiana wetlands manage flood and storm surges from both the north and south: the wetlands receive drainage from approximately two-thirds of the continental United States from the Mississippi River prior to its discharge to the Gulf of Mexico[8]; these same wetlands help buffer Southern Louisiana during such storms as Hurricane Katrina.

Wetlands are particularly useful downstream of urban areas where the increased rate of runoff from paved areas and buildings create more and faster loads of water to control. Without wetlands to protect against floodwaters, storm surges and hurricanes pose a greater risk. The USEPA estimates that a 1-acre wetland can store 1 to 1.5 million gallons of water.[9]

Water flow patterns and water levels are critical to providing nourishment to plants and animals within the habitat and disruptions can be devastating. Manmade water diversions such as dams and dikes, and the over-pumping of nearby drinking water sources can change where water flows in a wetland and, as a result, areas of a wetland can dry out and the level of groundwater can be lowered. Over-pumping water out of an aquifer can lead to an imbalance between the wetlands and an adjacent saline water body like an ocean. To compensate for the rapid removal of groundwater and potential changes in underground pressures, salty water can rush into freshwater wetlands (i.e., saltwater intrusion), causing injury to sensitive plants and animals, and contaminating sources of drinking water.

The solution to degrading flood control capabilities is addressed in the WRDA with such programs as the Comprehensive Everglades Restoration Plan (CERP). There are four components to flood control studies and planning: the right amount of water must be delivered to the places that need it most; the quality of the water must be healthy enough for the environment;

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[7] Martin, Glen. “Wetland Restoration Seen As Crucial.” *San Francisco Chronicle*. 5 September 2005: A4.

[8] Blanco, Kathleen Babineaux. “Saving Louisiana’s Delta.” *Global Issues. Shared Oceans, Shared Future. An Electronic Journal of the U.S. Department of State* 9.1 (April 2004): 29 pars. 16 June 2006 <http://usinfo.state.gov/journals/itgic/0404/ijge/gj06.htm>

[9] “Functions and Values of Wetlands.” *EPA Fact Sheet 843-F-01-002c*. September 2001: 1-2.

the timing of water held and released into the ecosystem should be modified to mimic natural flow patterns; and finally water should be stored in means of redistributing to the ecosystem, urban and agricultural users in times of need.

In the Everglades, the WRDA will build more than 300 injection wells in order to store water (approximately 1.6 billion gallons a day) at 1,000 feet underground in the upper Floridian aquifer. This will limit the water loss in evaporation; as well as discharge stormwater to above the water table and allow natural filtration by the unsaturated zone. CERP flood control plan considerations include the installation of catch basins to separate out large debris prior to injection, and shallow infiltration trenches backfilled with gravel to create a preferred flow pathway, adding impervious barriers to the levees to block loss of water, installing pumps near levees to redirect water back into the wetland, and holding water levels higher in undeveloped areas between the Everglades and Palm Beach, Broward and Miami-Dade counties.

At other project sites, the WRDA funds the installation of open channels for water flow diversion. The principal concern with canal construction is designing an adequate flow rate and a stable construction. Therefore, engineers must carefully perform gradient measurements to ensure that a continual slight downward slope exists and have gentle sloped sidewalls to minimize pressure build-up on the canal sides. Minimal slopes will decrease turbulence and pressure exerted on the canal walls and floor.

During construction activities such as canal, habitat, and wetlands installations, the excavation of fill and native soil material is inevitable. Excavated fill and soil is then stockpiled as close to the work site as feasible, and then transported off site for disposal unless it is to be reused. On-site reuse of native soils is often the preferable alternative to maintain the area's natural geologic conditions. Prior to transporting the native soils offsite for disposal or reuse, it is typically necessary to confirm the non-hazardous nature of the material. This is performed by sampling for chemical compounds.

The Impacts and Feasibility of Implementation

A large component of the WRDA as it pertains to the Everglades deals with accumulating and storing water for future use – approximately 80 percent of the new water captured will be directed to the environment and created wetlands, and 20 percent will be used to enhance urban and agricultural supplies. Installation of injection wells serves to decrease evaporation, decrease land demand (less land is required for storage), decrease cost (surface water storage facilities have a greater cost effect than underground unit because of land resource utilization). Therefore, its benefits are not purely environmental; there is a substantive economic component and the WRDA builds ties between the local area's environmental resources (i.e., the Everglades) and commercial interests.

Erosion and Shoreline Protection

Shorelines are considered an ecological and physical barrier from the waterfront. Causes of erosion should be addressed in order to further study the impacts and possible mitigation measures. Natural causes of waterline bank erosion are the tides and currents induced by wind, the size and frequency of these waves destabilizes shorelines and the eroded material is washed away by other currents and thus opens way for further chipping of the banks.

Some may argue that the following cause may be induced by anthropogenic activities, the flow area and water level fluctuation. The former may indeed be a result of human activities such as overuse of water that depletes the limited quantity available; however snow and ice have a great impact on shoreline erosion, as they damage vegetation and designed protective measures. On the other hand, water levels if increased, give rise to stronger waves; and if decreased leave saturated banks in unstable conditions.

Anthropogenic activities accelerate natural erosion. Such acceleration is a result of boat-induced currents, flow constrictions and sediment retention caused by dam construction and finally vegetation destruction (cutting down forests). As a result, mitigation measures addressing shoreline protection should include dam construction in a manner that allows sediment transport from the upper stream down the coast, planting a buffer zone of natural vegetation along the shoreline as to fix the soil and prevent erosion. Rules and regulations should be enforced to reduce the effects that motorboats have on the stability of shorelines; laws should also control deforestation and water consumption.

The Impacts and Feasibility of Implementation

The protection of shorelines from erosion will provide more land in an ever growing demand on space. These lands are home to many species and wildlife that are key species in maintaining a healthy food chain, and are vital for the survival of the ecosystem as a whole. Conditions at the project site dictate the limitations and type of equipment needed (tolerance of vegetation and protection materials to seawater must be considered). Costs are relatively high as to overcome poor construction conditions, repairs and maintenance will probably be costly as well, and thus need to be considered in designing a project.

Road and Canal Demolition

The demolition of roads and canals that hinder wetland restoration is another component of the WRDA. Demolition is an integral part of the WRDA because it serves to interrupt desirable water flow and create fragmented habitats that isolate plant and animal species. For example, in the Picayune Strand in Florida, several roads rise a few inches to a foot above the adjacent ground. These roads intercept water that would otherwise flow across the ground surface10.

One goal of the WRDA is to reduce the elevation of the roads to match adjacent land surfaces. Material will be pushed aside and leveled and excess fill would be accumulated and used to plug up unwanted canals. In the Everglades, over 240 miles of canals and levees will be removed to reestablish natural sheetflow of water. Sheetflow typically results in minimal consistent flows of water at gentle gradients to maximize the water's residence time in the wetland. Increasing residence time improves the wetland's pollution filtering capabilities. Roadway lowering will entail road reconstruction at a lower elevation. One key scientific consideration for construction is the commitment of minimal surface water flow ponding (i.e., to permit as natural a sheetflow regime as possible). Since the construction will be at the same location as the old roadways, the long-term negative effects of the road lowering and change to land resource use will be minimal.

The Impacts and Feasibility of Implementation

The demolition or major adjustments to infrastructure such as roads and canals may potentially impact the community and commercial interests quite significantly. Since the WRDA involves such a large number of projects, the general conclusion that the benefits outweigh the costs must be addressed on a case-by-case basis. For example, water diversion to supply wetlands with a reliable water source may detract from water available at other locations.

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[10] Picayune Strand Restoration Project (Southern Golden Gate Estates Hydrologic Restoration Project) Biological Assessment. US Army Corps of Engineers. October 2004.

For other projects, such as the Everglades restoration portion of the WRDA, a new water diversion system will provide the wetland, agricultural, and industrial interests with a sustainable water system. Roads and canals create preferred pathways for water flow, and transforming them to natural systems creates hydrology acceptable for wetland systems. Demolition entails heavy equipment dismantling concrete and other construction materials, debris storage and post-construction sampling, and transportation off site for disposal. Critical considerations are worker safety, creating gentle slopes for water flow, water diversion during construction, and debris containment to minimize contaminated runoff.

Habitat Degradation and Loss

Wetlands are some of the most biologically productive natural ecosystems in the world; their productivity and diversity of species they support are comparable to tropical rain forests and coral reefs. Although only five percent of the United States is covered by wetlands, these habitats are home to 31 percent of our plant species.

This abundance of plants and animals is being threatened by sewage and runoff discharging pollutants that can interrupt reproductive processes, inhibit growth, cause deformities, or result in high mortality rates. For example, agricultural fertilizer commonly contains high levels of the element, nitrogen, and elevated nitrogen levels in incoming runoff can lead to rapid growth of algae – these microorganisms then thrive and deprive fish and other aquatic species of the oxygen they need to survive,[11] a process known as eutrophication.

Wetlands are also home to federally threatened and endangered species. The United States Fish and Wildlife Service estimates that up to 43 percent of these species rely either directly or indirectly on wetlands for their survival.[12] As the degradation of wetlands continues, the fate of these species and other local plants and animals becomes uncertain as habitats disappear and indigenous species are forced to compete with non-native species that may have entered the wetland in an effort to escape its own habitat loss or a change in living conditions.

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[11] Committee on Geosciences, Environment, and Resources. *Restoration of Aquatic Ecosystems: Science, Technology, and Public Policy*. National Academy Press. Washington, D.C. 1992: 267. 19 June 2006 <http://www.nap.edu/catalog/1807.html>.

[12] United States Geological Survey.

The destruction and degradation of wetlands not only affects the systems within the confines of the wetlands (i.e. water flow, nutrient-rich soil, and supporting plant and animal life), but also results in larger scope issues. The science of wetlands restoration inCorpsorates three major components that consider the health of wetland soil, animal and plant life, and consistent hydrology, and these three components are inter-related. For example, a decrease in wetland buffering capacity has resulted in increased water flow downstream and more rapid flow decreases the sedimentation of nutrients and other chemicals into wetland base sediments. The loss of wetlands can also destroy habitats that are vital for bird migration patterns and can alter the economy of an area dependent on aviary breeding grounds and affect local predators that rely on bird populations.

The Impacts and Feasibility of Implementation

Since the creation of wetland habitats inCorpsorates improvements made to hydrology, soil health, and animal and plant habitats, these projects are potentially complex and require extensive planning to assure that the three components work in concert (e.g., water diversion to one area will disrupt flow to another). Although there is a great deal of variability regarding these projects, habitat creation will invariably involve restoring natural functions and native species, understanding the science of how wetland components relate with each other, using natural fixes, and designing for self-sustainability. Anticipating future changes is also an important consideration because habitats are dynamic.

Habitat creation typically involves heavy construction (e.g., soil excavation and installation to mimic natural land features and support hydrologic sheet flow), stocking topsoil with a variety of wetland vegetation that are soil and climate-specific, and preventing erosion to minimize the potential of stream bank erosion, which can cause a decrease in topsoil and damage to newly planted seeds and saplings.

The majority of the larger WRDA habitat creation projects take place in undeveloped areas with large potential benefits of created wetlands relative to potential detriments (e.g., Louisiana coastal wetlands will serve key storm buffering functions, and Florida Everglades restoration will support long-term thriving of the environment in this tourism-reliant area). There are fewer development and commercial interests in wetland areas, and it is therefore possible that negative impacts to local economic interests will not be great.

Major Projects Within H.R. 2864

An examination of the wetland restoration and creation projects in the Florida Everglades, the Upper Mississippi River-Illinois Waterway, and Coastal Louisiana demonstrate this bill's capacity to confront the problem of wetland loss. The projects associated with these three regions satisfy the requirements of specific restoration plans: the Upper Mississippi River (UMR) Restoration Plan, the Comprehensive Everglades Restoration Plan (CERP), and the Louisiana Coastal Ecosystem Restoration Study.

The Upper Mississippi River

The ecosystem of the Upper Mississippi River - Illinois Waterway is a temperate river artificially maintained by a 1200-mile lock and dam system designed to host high-volume commercial ship transport of goods along the Mississippi River.

The Mississippi River/Illinois Waterway is an ecologically significant region in the upper Midwest. The area is home to nearly 500 species, with ten federally endangered species, and is a crucial migration corridor for nearly half the country's waterfowl and shorebirds. There are four wildlife refuges and three national parks along the waterway directly affected by ship pollution. Water transportation and navigation is a crucial economic interest throughout the region and challenges environmental resource interests. The nature of the lock and dam system has altered the movement of some species and changed the temperature and oxygen concentrations in the water. Congressional research asserts the entire ecosystem is rapidly declining and on the verge of collapse.

The WRDA intends to improve 700,000 acres of habitat along the river/waterway corridor. The project aims to monitor and improve the conditions surrounding erosion, sedimentation, and species' health. The difficulties the project faces regard the scope and measurements of success for the stated goals. Measuring and monitoring ecosystem health is inherently complex. The project is focused on restoration along the navigation channel, not the whole watershed area, and therefore may only have limited effects on the ecosystem problems at hand. The barges that dominate the channel traffic will continue to cause environmental degradation, and this small-scale improvement project may not make a significant difference in overall ecosystem health.

In the case of the UMR, the Corps is directed to complete the following:

- 483 projects of island building and shoreline protection: Protect against shoreline development, as they do not allow building along the restored areas of shoreline. The restored and newly created islands provide habitat for avian and other species dependent on island ecology, and help re-direct water flow to more natural or ecologically advantageous routes. In effect, it also provides places for the Corps to deposit dredge spoil from other related, and unrelated, projects.
- 14 fish passage projects: Attempts to reduce the impact of dams on fish, whose natural migration and life-cycle patterns are interrupted by the limited or halted natural flow of rivers and streams by dams and locks, often physically impeded by the dams and locks themselves.
- 248 floodplain restoration and backwater restoration projects: Will increase habitat, dilute pollution, decrease sedimentation, restore the drying/flooding cycle, prevent erosion and provide some flood control. This mostly constitutes land acquisition for protection and, where deemed necessary, restoration of approximately 105,000 acres of riparian habitat in portions of the watershed. It is expected that the management of much of this land, once acquired and/or restored, would become the responsibility of the US Fish and Wildlife Service.
- 85 water level management, dam operations and alterations: In summary, amounts to dredging dams to remove sediments that have collected. Will contribute to the island building projects, noted earlier.
- 147 side channel restoration projects: Locks, dams, and other channel structures inhibit the movement of fish between and within river segments; fill side channels, backwaters, and wetlands with sediment; and suppress plant growth by reducing water clarity. These projects will mitigate or restore some side channel areas.
- 32 projects to “increase topographic diversity” and increase adaptive management: Refers to incrementally adding dredge spoil to existing islands to beneficially influence hydrology and expand habitat. The “adaptive management” in this case refers to an incremental approach.

Florida Everglades

The WRDA appropriates funds to the Indian Lagoon – South and Picayune Strand, two projects that are components of the large-scale restoration efforts in the Florida Everglades. The Indian Lagoon – South (IRL-S) restoration project illustrates the interests of both economics and the conservation of biodiversity in the Florida Everglades. Congress first acknowledged the importance of protecting this area under the WRDA 2000 Comprehensive Everglades Restoration Plan (CERP). The primary goal of the CERP is "to redirect and store freshwater currently diverted away from the Everglades to the ocean, and use it to restore the natural hydrologic functions of the south Florida system" (CRS, 7). The comprehensive Everglades restoration is the greatest environmental effort made by the Army Corps of Engineers to date with over $8 billion invested over three decades.

The WRDA proposes the creation of new reservoirs, storm water treatment areas, and the restoration of a large expanse of the watershed and floodplain. Large tracks of land are available for purchase adjacent to the lagoon thereby providing feasibility to the restoration goals. The government generated an Environmental Impact Statement regarding the project deems the effort necessary as the Indian River Lagoon is in "imminent danger of ecological collapse."
The Indian River Lagoon is a 156-mile estuary in the Florida Everglades closely connected to the St. Lucie River and canal, and Lake Okeechobee

Rapid and poorly timed freshwater discharge from the St. Lucie canal has significantly damaged the wetland ecosystem in the lagoon. Sizeable deposits of sediment have created a thick "muck" in the lagoon decreasing the water transparency. This muck has significantly damaged bottom communities and the breeding grounds for oysters, shrimp, clams and crab. This environmental degradation not only hinders ecologic health, but also threatens lucrative recreational and fishing endeavors.

The Indian River Lagoon – South project will benefit the area surrounding the lagoon both ecologically and economically. The lagoon project will supplement the large-scale federal and regional Everglade restoration efforts. The improvements to the lagoon will provide increased recreational interest in the area, increase the downstream Lake Okeechobee lakeshore property values, and increase precious habitat reserves for endangered species.

The Picayune Strand is located in Collier County, one of the fastest growing counties in the nation. The Picayune Strand, in the heart of the Big Cyprus Basin is composed of Cyprus trees, wet prairie and subtropical hardwoods. The restoration project outlined in the WRDA of 2006 will retain the hydrology and ecology of over 55,000 acres of wetlands. This project is a specifically clear illustration of the complicated relationship between economics and environmental degradation and improvement.

In the 1940-50s the logging business dominated the area surrounding the Picayune Strand. In the subsequent decade, Floridian developers introduced the nation to the swampland scams. Developers lured people from across the nation to southern Florida attempting to create the nation's largest subdivision. The wetland ecology of the area is incapable of supporting residential development and infrastructure. The federal government intervened and invested $25 million toward the reacquisition of these inhospitable residential lots. After completing the reacquisition, it is possible to move forward with restoration efforts.

The Indian River Lagoon

The ecosystem has been altered by unnaturally large and poorly timed freshwater discharges arriving from the St. Lucie Canal and other elements of the Central and Southern Florida project of the 1930s. The recommended plan would divert some of the current flow to storage reservoirs as well as to disperse water throughout the ecosystem.

- Acquisition of nearly 93,000 acres of land: In this area, what is not already wetland will be restored, managed, and protected as a wetland to regain some of the natural storage.
- Project to remove 7.7 million cubic yards of "muck" and disposing it elsewhere: This muck is interfering with ecologically beneficial tidal flow, and is largely the result of alteration to the hydrology by canals. It is also expected to improve conditions for benthic (bottom dwelling) marine life in the estuary.

The Picayune Strand

The proposal for the Picayune Strand is to remove roads, canals, and other infrastructure, and is expected to increase freshwater flows to natural areas, lower freshwater surges to the ocean, and improve water quality. Proposed projects include:

- 38 canal plug projects in the four canals: Intended to benefit the ecosystem by impounding water in order to hydrate marshes that were drying out around them.

- 3 pump station projects: Designated for three canals of the four, and intended to manage water flow, in part, to natural areas to compensate for altered hydrology.
- Numerous levees construction projects: Will protect private property from any adverse flooding, and add ecological advantage by preventing freshwater surges into the ocean.
- Road and culvert demolition: Planned demolition of approximately 227 of the 279 miles of existing roads so that road system would be low enough to allow a more natural "sheet flow" of water to more adequately flow into the Everglades system.
- 9 new culverts project: Intended to provide interior drainage to the levees. The culverts would supplement the bridges and culverts that exist today.

Coastal Louisiana

Finally, the Coastal Louisiana Restoration and Protection Project will invest approximately $1.1 billion to improve shoreline health. Louisiana is home to forty percent of the nation's coastal wetlands and these areas were been severely degraded, even prior to Hurricane Katrina. Unnatural sedimentation rates, subsequent marsh compositional changes and wetland loss have caused significant ecological degradation. The regular cycle of hurricanes along the coast also cause continual wetland loss and damage. These events have caused specific problems in recent years including vegetation loss, increased salinity, and erosion.

The project outlined in the WRDA aims to "reverse the current trend of coastal ecosystem degradation." Federal agencies, led by the Corps, in coordination with the state developed several versions of plans to slow the rate of loss and restore some of these wetlands. The Corps' feasibility report proposed activities to divert water from the Mississippi River to carry sediments into nearby wetlands, and to help stabilize the coastline. In the diversions, wetlands are expected to eventually reestablish themselves on newly deposited nutrient-rich sediments.

The Louisiana Coastal Restoration Study projects included in this bill are as follows:

- "Mississippi River Gulf Outlet Environmental Restoration": Attempt to mitigate some of the damage caused by the channel (Mississippi River Gulf Outlet) dug in the 1960s, and widely thought to be responsible for the subsequent loss of over 20,000 acres of wetlands.

The channel is over 2 times the width of when it was first created, and much of these projects would be an attempt to replenish some of that loss along the shore.

- Small Diversion at Hope Canal project: Diverts freshwater into Hope Canal to preserve existing cypress swamps and reduce nutrient loads that contribute to hypoxia in the Mississippi River delta. What is classified as a “small” diversion, between 1,000 and 2,000 cubic feet per second of water, from the Mississippi River would be diverted into the Maurepas Swamp to restore and maintain the health of swamps on the south side of Lake Maurepas.
- Barataria Basin Barrier Shoreline Restoration project: Barrier islands protect the land behind them by diffusing and absorbing the blow of large storms. However, they are often dependent on dune systems or marshes to maintain their integrity, and this project will combine sand replenishment and marsh restoration to attempt to re-create a sustainable barrier island ecosystem.
- Small Bayou Lafourche Reintroduction project: Seeks to divert water from the Mississippi in order to restore natural swamp hydrology (similar to Hope Canal, above).
- Medium Diversion at Myrtle Grove with Dedicated Dredging project: Located at Myrtle Grove, project will divert freshwater to halt land-loss and wetlands-loss. Classified as a “large” diversion project, as much as 15,000 cubic feet per second of Mississippi River water and sediment would be diverted through the West Bank levee into Barataria Bay and dredged sediment would be used to construct wetlands.

The projects highlighted above merely contribute to larger decades-long plans, costing over $3.5 billion dollars ($1.58 billion for Upper Mississippi, $963 million Everglades, $1.1 billion for Louisiana on average over the next five years). These projects demonstrate an expanded awareness of the federal government of urgency of the implications of wetland loss, and the federal responsibility to use national resources to alleviate some of the damage.

As a general trend, the Corps appears to be merely being forced to alter some of its practices to some benefit of the ecosystem, but not addressing the more pervasive problems that have resulted from past, present, and future projects. No locks or dams are coming down, only being retrofitted. Dredging has not ceased anywhere, but what is dredged will now be pumped to build marshes and islands somewhere else. Waterways are still being diverted, only some of them now diverted back to areas where they once flowed to encourage swamps and marshes.

In addition, there does not appear to be any indication that this piecemeal approach is based on any priorities. Most of the restoration efforts in the Upper Mississippi and Louisiana appear to be chosen for their feasibility rather than the real positive environmental impact they may make. Currently the Corps uses a "no net loss" policy. This policy allows for the destruction of historical wetlands if replacement wetlands are created elsewhere and are of the same acreage. Finally, many of these projects require the continued intervention of humans in order to function. Many of the water diversions and flow "restorations" are dependent on continued manipulations of the environment. This reduces the benefit of products from these projects when they could apparently be ecosystem services provided for "free" naturally.

Conclusion

Wetland degradation and loss provide critical scientific wetland functions necessary for human health, the wellbeing of wetland habitats, and they provide such vital hydrological services as minimizing the effect of flood waters on our land. This is asserted by the fact that when wetland losses are not mitigated, water quality is harmed, water supplies are strained, flood damages increase, and animal and plant populations and biodiversity suffer.

Proper planning for wetlands restoration and creation efforts requires a comprehensive understanding of the water, soil, and plants and animals in the ecosystem. Chemical effects must also be studied in the event they are introduced to the wetland as pollution runoff or wastewater discharge. Since there are many components to consider and their interrelationships are complex, a solution to one aspect of the problem might be detrimental to another; and thus, scientists need to provide policy makers with the integrated approach of sustainable development.

The examination of the functionality of a deteriorated wetland is processed through two solutions to the problem of wetland loss: restoration and creation. The fundamental controversy is whether or not a man-made wetland ecologically equates to a natural wetland, and if so how to evaluate the success of the project. The US Department of Interior and US Geological Survey have concluded: "It has become apparent that we are lacking basic wetland research techniques that can easily assess: 1) the functions occurring within the wetlands, 2) the role that destroyed wetlands played in the greater watershed/ecosystem health, and 3) the extent to which mitigation wetlands compensate for lost wetland ecosystems. In the midst of the pursuit to create and restore, wetland scientists are becoming aware that the many unknowns make it virtually impossible to provide definitive guidelines for successful wetland assessment and design" [13]

Incomplete understanding of wetland function and standardized measurement compound the controversy surrounding the new or restored wetlands' filtering capacity. At the root of the scientific controversy is the fact that "ecologists have yet to produce simple, fast, and cheap measures of functions such as geomorphic adjustment, primary productivity, nutrient cycling, organic matter accumulation, population persistence, predator-prey interactions, resistance to exotic invaders, and sustainability".[14] Once scientists can measure these functions by a standardized method, the controversy over wetland management will diminish, as it will be more possible to monitor success and progress of each project. Ecologists have yet to reach agreement over function measurement, and therefore cannot objectively measure the success of a restored or created wetland in protecting biodiversity.

Although the full functioning of the ecosystem is difficult to measure, some parameters are available to help estimate the health of ecosystem. A few of these include: species diversity, species population size, the presence of riprap and stabilized upland vegetation, low concentrations of pollution in the water and sediments, and the percolation of water through sediments into the water table. However, wetland ecosystems, the land and all the flora and fauna within it, are more than simply the combination of their parts. Monitoring at the ecosystem level is equally important meaning that the interactions between different parameters should be assessed as well as cause and effect relationships between them.

Using historical conditions as a baseline, ideal success is returning the wetland to pre-disturbed conditions, but other options exist like rehabilitation and replacement. Historical conditions cannot always be regained.[15] Created wetlands may provide definitive success in reducing some of the goal environmental problems, but they cannot be evaluated in terms of total

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[13] Zedler, Joy B. "Wetland Mitigation" Ecological Applications, Vol. 6, Issue 1 (1996) pp. 33-37.
[14] Hunt, Randall J. "Do Created Wetlands Replace the Wetlands that are Destroyed?" US Department of the Interior – US Geological Survey: Fact Sheet FS-246-96.
[15] Interagency Workgroup on Wetland Restoration. "An Introduction and User's Guide to Wetland Restoration, Creation, and Enhancement." March 17, 2006. Available through the EPA website.

ecosystem functioning because no baseline is available. In conclusion, scientists have developed many techniques for monitoring parameters important for the structure and function of healthy ecosystems. Although many monitoring techniques are accurate, inexpensive, and widely available, other parameters like species diversity are more difficult and expensive to track. Examining wetland functioning at the ecosystem level, rather than monitoring disjointed parameters, is also very important but less well understood. Nutrient cycling is one measure of ecosystem functioning but more methods of analysis should be developed so that managers can better understand the complex interactions occurring.