

RECOVER Workshop Case Study: Everglades Stormwater Treatment Areas

Background

In 1988, the federal government filed a lawsuit against the state of Florida. The lawsuit claimed that the state was violating the Clean Water Act by allowing excessive amounts of phosphorus to enter the Everglades. The lawsuit alleged that the source of the excess phosphorus was from agricultural activities and that the excess phosphorus was causing irreparable harm to Everglades plants and animals.

Excess phosphorus concentrations have the potential to harm Everglades plants and animals because the Everglades ecosystem has evolved under extremely low levels of phosphorus. The limestone bedrock underlying the Everglades has the capacity to absorb phosphorus. In addition, the Everglades is situated in a sub-tropical climate in which essential nutrients such as phosphorus do not accumulate in soils or sediments, but are recycled rapidly through high plant and animal activity. Therefore, Everglades plants and animals have evolved and adapted to thrive under extremely low concentrations of phosphorus in wetland sediments and water.

Increasing agricultural activity in the 1900s was made possible by the construction of an extensive water management system providing flood control during Florida's wet season, and water supply during the dry season. A large agricultural area developed on 700,000 acres immediately south of Lake Okeechobee, and became known as the Everglades Agricultural Area (EAA). The EAA consists largely of sugarcane, with a smaller area dedicated to vegetables. This agricultural activity resulted in increased non-point source runoff of pollutants, such as phosphorus, from the EAA to the remnant Everglades located downstream.

In the 1980s, federal scientists and resource managers became concerned about changes in Everglades plant communities immediately downstream of the runoff sources. In particular, they noticed that certain areas were being overgrown with cattail, to the exclusion of other wetland plants. Cattail is native in the Everglades, but normally is found in very low abundance. In pristine areas, cattails can be found only around areas of local nutrient enrichment, such as alligator holes and wading bird rookeries. However, cattails were observed to out-compete other species of Everglades plants, particularly sawgrass, under high phosphorus conditions. The most obvious sites of cattail dominance were adjacent to the rim canal of the A.R.M. Loxahatchee National Wildlife Refuge (WCA-1), and in WCA-2A downstream of inflow structures from the Hillsborough Canal. Once cattails replaced the normal diversity of Everglades plants, the resulting solid stand of cattails was very unsuitable habitat for Everglades animals such as fish and wading birds. Scientists also observed that the wetland area dominated by cattail was expanded rapidly, and if unchecked, would soon affect major portions of the remaining Everglades. This concern was particularly serious because over one-half of the Everglades has already been lost to agricultural and urban development.

After four years of legal battles, the lawsuit was settled in 1992, and the federal court issues a Consent Decree that codified the terms of the settlement. A significant part of that settlement was the construction of about 45,000 acres of constructed wetlands to remove excess phosphorus from agricultural runoff. These constructed wetlands, called stormwater treatment areas (STAs), were to be located at the downstream ends of major canals that drained runoff from the EAA into the Everglades. The timeframe for STA design, construction, and beginning of operation was planned to be about 10 years, with an estimated cost of \$800 million dollars. The performance goal for the STAs was to remove phosphorus down to concentrations equal to or lower than 50 ppb. The STAs were to operate in conjunction with Best Management Practices employed by the agricultural industry, designed to reduce inflow concentrations of phosphorus to the STAs.

A prototype STA, called the Everglades Nutrient Removal (ENR) Project, was constructed first to gather information that could be used in the design and construction of the larger STAs. At approximately 3,500 acres, the ENR Project, even as a prototype, was the largest constructed wetland in the world at the time its operation began in 1994. The ENR Project would eventually be subsumed into a larger STA, but for approximately 6 years it provided a wealth of scientific and operational data that would be used in the larger STAs. Although the ENR was designed as a prototype STA, many experimental studies could not be conducted due to its large size and lack of replication. To solve this problem, a series of 30 one-half-acre wetlands was constructed within ENR to serve as an experimental research platform. Their large number and small size afforded the opportunity to conduct replicated experiments with controls, and provided the ability to conduct biological and other manipulations intended to optimize phosphorus removal performance.

Key issues

Inflow concentrations of phosphorus would be considered inconsequentially low in almost any other ecosystem

Phosphorus in agricultural runoff from sugarcane fields is lower than it would be in runoff from almost any other crop. However, because the pristine Everglades evolved under such low phosphorus conditions, even this amount was causing harm and had to be removed. Therefore, the phosphorus performance expectations for the STAs is unusually high.

No comparable wetland treatments systems had ever been built

There was no prior experience from anywhere in the world, much less the Everglades, with constructed wetlands of this large size and high performance expectations. Scientists were literally “writing the instruction manual” as they developed the STAs.

Was it even possible that the STAs would achieve the design target of 50 ppb?

A very large expenditure of public and private money was obligated on the basis of very limited scientific information.

How large should the STAs be to achieve their performance target of 50 ppb?

Because of the relative lack of scientific information on phosphorus removal performance of constructed wetland in the early 1990s, STA design was based on conceptual and modeling studies. For example, there was considerable uncertainty in the amount of wet and dry phosphorus deposition from the atmosphere, so a wetland phosphorus budget had to be developed with very little information. Phosphorus uptake potential of the STAs was estimated by a few soil cores, in which phosphorus deposition rates were determined by estimating the age of discrete layers in the soil, and relating that to the amount of stored phosphorus in each of those layers.

What is the best mechanism to ensure that STA design, construction, and operation is based on the best science possible?

The lawsuit settlement dictated STA construction on a strict time schedule, and precious little scientific data were available to guide their design. Because of the very large size of the STAs and the complexity of land acquisition, design, and construction, newly developed science had little opportunity to provide guidance at the beginning stages. Once the design of STAs had been fixed (about 4 years into the 10-year process), the only changes that new science could affect were small design modifications, and the operation of the STAs once they were constructed. Large-scale modifications in STA design later on would be very expensive and time-consuming.

Obstacles encountered

Delays in land acquisition – Because much of the land for STA construction was owned by the agricultural industry, acquisition of large acreages was time-consuming and fraught with legal, budget, and policy issues.

Lack of scientific data – As mentioned previously, much of the engineering design work had to be based on very limited scientific data.

Lack of prior experience across disciplines, particularly between engineering and biology/ecology – The engineers needed detailed design parameters very early in the process, and before the requisite scientific studies had been completed. The engineers needed precise, definite answers; the biologists were reluctant to provide answers that exceeded the precision and accuracy of their current knowledge.

Contracting/construction delays – Because of the large size and complexity of the STAs, there were inevitable problems in contracting and construction, including the bankruptcy of one major contractor.

Science/management/policy linkages

Given the paucity of scientific information, especially at the beginning, there was little need or incentive for such linkages. As related scientific studies were conducted and results made available later in the life cycle of the project, this information was provided

to the engineers and minor modifications to the design were made. One of the strongest drivers this project remained the Consent Decree, which mandated a specific construction deadline for each of the 6 STAs, and created a compliance framework for water quality at downstream locations.

Lessons learned

The entire STA project is a prime example of adaptive management, implemented before the concept became well-known and incorporated by restoration practitioners. The lawsuit settlement highlighted the ongoing demise of the Everglades from phosphorus-laden water; STAs were considered to be the most promising initial step, despite the lack of scientific information; appropriate science was conducted as soon as possible, and results were fed into the STA design process; and scientific studies continue to determine ways to optimize the phosphorus removal performance.

The ENR Project proved to be a very good way to integrate science into the process of designing and building larger STAs. The concept of STAs was implemented before adequate science was available, but good science became an integral part of the process. The ENR Project served its initial 6 years as a science and data collection platform, and then became part of a larger STA during the final 4 years of the STA project. Because data were collected from a wetland landscape that was part of the future STAs, these data were very relevant throughout the process.

Adaptive Management Strategy Development Workshop #1 Appendix 2: Discussion Questions for Case Study 2

Everglades Nutrient Removal - Stormwater Treatment Areas (STAs)

Understanding the drivers. The STAs were mandated due to the settlement of a major lawsuit.

- Did litigation make the implementation of an adaptive management approach easier or more difficult?

Stakeholder dynamics. Controversy related to the lawsuit and its settlement involved the agricultural industry – a stakeholder with tremendous economic capacity and political power.

- What are the implications of having the involvement of heavily invested stakeholders coming from a variety of perspectives have on entities trying to implement science-based adaptive management? Can you relate this to a current issue or project with which you're involved? How might a process be designed so as to constructively harness the energy, interest, and input of major stakeholders?

Uncertain science, complex systems, time lags. Enrichment of Everglades wetland sediments with excess phosphorus occurred over decades, and science tells us that recovery of sediments from this enrichment may take even longer.

- What are the implications of being dependent on adaptive management feedback from very slow ecological processes? How can adaptive management processes be robust at time scales that transcend terms of political offices, perhaps even professional careers?

Data collection. Even as data from ENR were being used for full-scale STA design, efforts were underway to reduce further data collection due to budget constraints. In addition, data collection efforts for full-scale STAs were cut drastically as the STAs were brought online, thus limiting information on internal dynamics that would be useful for future optimization.

- How can CERP insure that data collection continues in a manner that will allow full realization of adaptive management over long time periods?