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Accounting for Externalities in Benefit–Cost Measures: An Analysis of a Land Buyout and Associated Projects to Save the Everglades

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As part of efforts to restore the Everglades, in 2008, Governor Crist of Florida proposed the acquisition of 187,000 acres of land from the U.S. Sugar Corporation (U.S. Sugar) for this purpose, but the final purchase in August 2010 totaled only 26,800 acres. This article presents the history behind the alternatives, including the buyout of U.S. Sugar land, to improve Florida's water quality and the health of the Everglades. To determine the benefits and costs of several of the U.S. Sugar land buyout proposals, a spatial price equilibrium model of the U.S. sugar market is developed. Within this framework, all the benefit–cost ratios calculated show that the benefits are less than the costs. Our analysis uses the concept of an Environmental Equivalent, which is the dollar amount of environmental benefits needed from the Everglades restoration or water quality projects to generate benefits that are as great as or greater than its costs. Also, we consider, within the context of ex ante vs. ex post benefit–cost analysis, the developments to clean up the Everglades since the U.S. Sugar land purchase.

Key Words: benefits, buyouts, costs, Everglades, U.S. Sugar Corporation

JEL Classifications: Q1, Q15, Q51

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In 2008, an announcement was made that the state of Florida would purchase 187,000 acres of land and all facilities from the U.S. Sugar Corporation (U.S. Sugar) for the purpose of restoring the Everglades to its natural state. After several modifications to the initial proposed buyout plan, the actual purchase of 26,800 acres was completed in 2010. In a previous analysis we examined the benefits and costs associated with this land buyout using benefit–cost ratios and the concept of an Environmental Equivalent (EE), the amount of perceived environmental gains necessary to result in a net benefit of zero, to examine a variety of scenarios related to this purchase (Schmitz, Kennedy, and Hill-Gabriel, 2012).

After our analysis a number of associated construction projects for the purpose of creating Stormwater Treatment Areas (STAs) and Flow Equalization Basins (FEBs) were initiated.

These projects are a natural extension of the sugar land buyout that was previously analyzed and are complementary to it in achieving environmental restoration of the Everglades. Given the additional benefits and costs associated with these structures, it is appropriate that this new information be incorporated within our framework from the previous analysis to re-evaluate the benefit–cost ratios and EEs associated with the entire project.

We examine the addition of STAs and FEBs in the eastern, central, and western flowpaths of the Everglades, incorporating the costs of these additional projects to the land-buyout scenarios previously considered. Exclusion of the costs of these STA and FEB projects underestimates the overall cost of the project and, in turn, underestimates the environmental benefits related to the entire project. This article provides an example of how benefit–cost ratios are affected when the scope of a project is altered.

Background

The Everglades is a subtropical wetland in southern Florida, encompassing a watershed area of over 18,000 square miles that reaches from the Kissimmee Chain of Lakes to Lake Okeechobee in the north and to the Gulf of Mexico and Florida Bay in the south. At the southernmost end of peninsular Florida, over 1.5 million acres have been designated as the Everglades National Park, and over 729,000 acres have been designated as the Big Cypress National Preserve. The mix of the slow-moving water from Lake Okeechobee and the mild subtropical climate has resulted in a completely unique habitat that is conducive to a wealth of wildlife, including birds, alligators, snakes, and turtles.

Over time, the development of various industrial and agricultural enterprises has reduced the flow of clean water to the extent where the Everglades is now half of its historic size, which has endangered the lives of the wildlife that make the remaining Everglades their home. Humans also depend on the Everglades for their own needs. The Everglades is the primary source of drinking water for more than seven million Americans, more than one-third of Florida's population (The White House, 2012). Although most would argue that something needs to be done to guarantee the continued health of the Everglades, achieving full consensus as to the course of action to be taken has been elusive.[1]

Environmentalists have long sought to restore the historic flow of water from Lake Okeechobee south through the Everglades and into Florida Bay, a dream hampered by more than a century of piping, dredging, and development. Recreating the flow would require acquisition of sugar land in the 700,000-acre Everglades Agricultural Area (EAA), part of which is owned by U.S. Sugar.

In June 2008, advocates and supporters of the Everglades restoration joined together for the announcement of a monumental land acquisition in the EAA. The EAA, which was originally drained for flood control, sits in the natural flowpath between Lake Okeechobee and the Everglades in what is known as the River of Grass. To enable farming in the EAA, water levels on these lands are maintained through the use of pumps and canals that either remove or supply water, depending on the needs of the crops.

This article presents a benefit–cost analysis of 1) the actual August 2010 land purchase of 26,800 acres; and 2) the associated construction of STA and FEB on those 26,800 acres. In addition, we discuss the history behind the various alternatives and attempts to improve the quality and storage of water in the Everglades. In turn, we discuss the improvement of the health of the Everglades as well as the many

[1] There are numerous agencies that have been involved with the plans to restore the Everglades, which make consensus-building difficult. These include the U.S. Environmental Protection Agency, the U.S. Department of the Interior, the U.S. Army Corps of Engineers, the South Florida Water Management District, the U.S. Department of Agriculture, the Florida Department of Environmental Protection, and the state of Florida. In addition to these agencies, there are many other stakeholders involved, including agricultural interests, the Miccosukee and Seminole Tribes, recreational interests, and nongovernmental environmental organizations, including Audubon, and the 57-member Everglades Coalition.

legal challenges involved to achieve this end (Appendix Table 1).[2]

Although our benefit–cost analysis focuses specifically on the impact of the land buyout with reference to the U.S. sugar market in which U.S. Sugar is a major player, we do not estimate the positive environmental externalities that the land buyout generates. The sugar market includes its producers and consumers and is impacted by the U.S. sugar policy that restricts sugar imports through a tariff rate quota (TRQ). The use of the purchased land will generate positive externalities such as improved water quality and the improved health of the Everglades. Without taking these externalities into account, the benefit–cost ratio from the U.S. Sugar land purchase is less than one, implying that costs exceed benefits. To take account of the net positive benefits generated by the land purchase, we use the concept of an EE, which is the dollar amount of environmental benefits needed from the land buyout to generate a benefit–cost ratio equal to one.

Benefit–cost analysis should take into account the ever-changing market conditions and changes in institutional incentives. Schmitz, Kennedy, and Hill-Gabriel (2012) consider only an ex ante assessment of attempts to clean up the Everglades. In this article, we also execute an ex post assessment by taking into account such investments as reservoir construction that were assumed to be sunk costs in Schmitz, Kennedy, and Hill-Gabriel (2012). By so doing, we show the EE that is needed to generate net positive benefits. Importantly, although the size of the EE increases, the positive environmental benefits increase even more.

Legal Issues

Many environmental cleanup projects are confronted by legal challenges that are often costly both in terms of legal costs and the delay and/or downscale in conservation efforts. Delayed environmental projects can dampen future environmental benefits. Legal challenges to the U.S. Sugar land acquisition and its proposed funding mechanism were filed by the Miccosukee Tribe of Indians of Florida and by the New Hope and Okeelanta Corporations, which are subsidiaries of a rival sugar grower, Florida Crystals Corporation.[3] These and other opponents of the sugar land acquisition often focused on the cost and the use of a bonding authority to pay for the purchase, arguing that negotiations should have resulted in a larger windfall for the state of Florida. The Miccosukee Tribe claimed that the purchase of the U.S. Sugar land would delay Everglades restoration. "This is a death warrant for the Everglades. . .it sucks away all the money devoted to projects now in the pipeline," said Dexter Lehtinen, a lawyer for the tribe.

By spring of 2008, separate litigation had been ongoing involving the 16,000-acre storage reservoir project. The project, known as the EAA A-1 Reservoir (A-1 Reservoir), was originally planned as part of a larger 50/50 cost-share agreement between the state and federal governments under the Comprehensive Everglades Restoration Plan (CERP) project. To make progress on the project sooner, the South Florida Water Management District (SFWMD) began construction on its own outside of the CERP framework. Environmental groups filed suit against SFWMD, arguing, among other things, that this project should not be completed by the state alone without following the procedural requirements and protections carefully outlined in CERP. The SFWMD Governing Board voted to suspend construction of the A-1 Reservoir pending the outcome of this

[2] Although the initial June 2008 proposal involved the purchase of 187,000 acres of land and all assets of U.S. Sugar, the proposal was revised in December 2010 (Schmitz, Kennedy, and Hill-Gabriel, 2012).

[3] Florida Crystals Corporation opposed the buyout of U.S. Sugar land. One of the reasons may be that U.S. Sugar was in serious financial trouble and Florida Crystals Corporation was interested in buying out U.S. Sugar land while the U.S. economy was in a depressed state. Some accounts are that Florida Crystals Corporation made two written offers to join in the sales deal but U.S. Sugar refused. Fortunately for U.S. Sugar, although the Florida buyout of the original magnitude did not occur, its financial woes were greatly reduced as a result of the strengthening sugar market. Between January 2007 and January 2010, domestic U.S. sugar prices increased by 30–35%.

litigation. With the advent of the U.S. Sugar land buyout, new opportunities for examining the best locations for storing water closer to Lake Okeechobee, and treating water closer to its point of discharge into the Everglades, SFWMD voted to cancel construction of the A-1 Reservoir.

There were financial consequences because of the SFWMD decision to suspend the A-1 Reservoir project. The courts held that SFWMD had to pay the A-1 Reservoir's contractor a $2 million-a-month penalty for suspending the work. SFWMD eventually paid $25 million in penalties and fines for canceling the A-1 Reservoir contract on top of the $282 million it had already spent on construction. However, as discussed subsequently, this decision would fall in line with further court orders directing SFWMD to focus only on water quality improvement projects.

There were additional ongoing legal challenges and proceedings involving efforts to clean up the Everglades. In its natural state, the Everglades ecosystem thrives with extremely low levels of nutrients. The addition of nutrients, like phosphorus, which comes from the influx of fresh water from Lake Okeechobee into the salt water Everglades, can change the oligotrophic nature of the ecosystem that supports the characteristic abundance of life that makes the Everglades unique and diverse. The River of Grass in Lake Okeechobee is continuously impacted by the negative effects of excessive phosphorus. As technical and scientific experts began to study the potential for using land acquired from U.S. Sugar for restoration projects, the vast majority of experts agreed on one thing: the land slated for use as the A-1 Reservoir is situated at a place in the landscape that could be highly beneficial to water quality treatment and the Everglades could receive a greater benefit if a treatment project such as an STA were constructed on the EAA land rather than on the A-1 Reservoir. The decision to cancel the contract was criticized by many of the same critics of the U.S. Sugar land purchase because $282 million had already been spent on the A-1 Reservoir construction.

In a separate court proceeding that set a 10 parts per billion phosphorus standard for water entering the Everglades,[4] the Miccosukee Tribe and Friends of the Everglades asked that SFWMD be required to reinitiate and complete construction of the A-1 Reservoir. Citing a lack of patience waiting for the U.S. Sugar land purchase to be finalized and any subsequent planning for use of the land purchased, U.S. District Judge Moreno entered an order compelling construction of the A-1 Reservoir. SFWMD sought to be relieved of this requirement to construct the reservoir, citing changed circumstances. This issue was referred to a court-appointed Special Master. On August 30, 2010, Special Master John Barkett issued a report, which agreed that the circumstances had changed to an extent that SFWMD should not be required to reinitiate construction of the A-1 Reservoir and that water quality improvements might best be served by building an STA or some other treatment project on A-1 lands rather than the A-1 Reservoir itself. On March 22, 2011, Judge Moreno ratified this decision, allowing the project to be targeted to water quality improvements.

In yet another lawsuit concerning water quality in the Everglades, U.S. District Court Judge Gold found that the state of Florida was violating its requirements under the Clean Water Act by extending the deadline for compliance with the ten parts per billion phosphorus standard and held that the U.S. Environmental Protection Agency (EPA) had not fulfilled its own Clean Water Act duty to require Florida to comply with water quality standards. As directed

[4] *U.S.A. v. SFWMD et al.*, Case No. 88-1886 (S. Dist. Fla.). Some describe this lawsuit and the accompanying Settlement Agreement as the event that prompted Everglades restoration. The Settlement Agreement recognized the impact of nutrients in water flowing from sugar farms that make up the vast majority of land in the EAA. "At the present time, the ecological integrity and ultimately the survival of the [Everglades National] Park and [Arthur R. Marshall Loxahatchee National Wildlife] Refuge are threatened by the inflow of EAA drainage water containing excess nutrients. Indeed, the high levels of phosphorus in EAA discharges constitute the most immediate water-quality concern facing the Everglades system. EAA drainage that flows directly into the Refuge contains average phosphorus concentrations ten to 20 times higher than background concentrations."

by Judge Gold, on September 3, 2010, EPA issued an Amended Determination, setting forth specific steps under a specific enforceable schedule that EPA and the Florida Department of Environmental Protection (FDEP) must meet to achieve water quality standards in the Everglades. To fulfill these requirements, the Amended Determination directs SFWMD, the state agency responsible for construction, to build new water treatment projects.

EPA directed specifically that SFWMD construct 42,000 acres of STAs. EPA then outlined the steps to reach this goal: 1) complete the purchase of land from U.S. Sugar and begin seeking additional land acquisition in the EAA; 2) either construct STAs on land acquired from U.S. Sugar or initiate a trade for other land on which STAs will be built; and 3) use the 16,000 acres of formerly A-1 Reservoir land to construct a large STA. In April 2011, Judge Gold entered an order giving EPA authority to take over control of Florida's water quality permit program if Florida continues to delay implementing needed improvements.

In the fall of 2011, the state of Florida through the FDEP and SFWMD developed an alternative plan to meet the water quality goals that is purportedly less costly than the plan developed by EPA. The plan was unveiled after Florida Governor Rick Scott met with EPA Administrator Lisa Jackson and other federal officials to discuss the technical merit of the SFWMD plan and the potential for it to meet the water quality goals. The state plan also identified the A-1 Reservoir land for use when improving water quality and considered projects on the land purchased from U.S. Sugar. In June 2012, a compromise plan, described in more detail subsequently, was agreed on that uses land purchased from U.S. Sugar and the A-1 parcel.

Although interrelated, these proceedings are in fact separate. Therefore, if not for the pending purchase of the U.S. Sugar lands, the EPA and federal court requirements for additional STAs would likely have required land acquisition through means such as eminent domain without the benefit of willing sellers and without the flexibility to negotiate the price or current use of the land. Both parties would likely be in much less favorable conditions without willing seller negotiations.

Current Developments

After completion of the U.S. Sugar land purchase, there were a number of developments regarding the 26,800 acres purchased from U.S. Sugar by SFWMD in December 2010. Changes in political leadership, economic conditions, and legal directives determined the proposed use of the acquired land.

The land purchased from U.S. Sugar was concentrated in two parcels: 17,900 acres of primarily citrus land in Hendry County beside the existing STAs known as Southern Gardens and 8900 acres of sugarcane land in Palm Beach County, east of Lake Okeechobee.

In a related development, in June 2012, Florida Governor Rick Scott and EPA came to an agreement about additional needs for infrastructure projects that would remove phosphorus pollution from water flowing to the Everglades. Although SFWMD has already constructed 57,000 acres of STAs that recreate wetlands to naturally filter phosphorus out of water, violations of the legal standard known as water quality "exceedances" have been documented as recently as 2010, demonstrating the need for additional water quality improvements.

The June 2012 water quality agreement outlines a plan to construct 6500 acres of new STAs over a 12-year timeframe. In addition to the creation of STAs, the plan is to construct a number of FEBs. When operating STAs over the past decade, SFWMD learned that the effectiveness of the creation of wetlands was prevented by periods of either too much water or too little water, both of which could cause the plants that filter the phosphorus to die. FEBs are water storage facilities adjacent to existing STAs that can regulate how much water is available for each STA and in turn make STAs more effective. The goal is 110,000 acre-feet of water storage. The plan also divides the water quality needs of the Everglades into three regions, referred to as the Western Flowpath, Central Flowpath, and Eastern Flowpath. All of the land purchased from U.S. Sugar, in addition to land already in public ownership, is projected to be needed to implement this water quality agreement. The full projected cost of the plan is $880 million.

The Southern Gardens land purchased from U.S. Sugar is in the Western Flowpath of the water quality agreement plans. There are two separate projects proposed to be constructed on the 17,900 acres: 1) an FEB adjacent to existing STA five and STA six that can store 11,000 acre-feet of water (planning is in the early stages of development, so the exact land footprint and acres of land needed to achieve this storage is unknown but is likely in the range of 2000–3000 acres) and 2) a 15,000-acre wetland restoration project that will restore former citrus land to a mosaic of short- and long-hydroperiod wetlands as well as upland habitats for endangered species like the Florida Panther. Although this is neither an STA nor FEB, this project is included as part of the water quality plan because restoring natural wetlands can contribute to natural phosphorus removal.[5]

The 8900 acres of land east of Lake Okeechobee is in the process of being traded for one or more parcels of land more suitable for project needs. The water quality plan includes three features in the Eastern Flowpath: 1) a 45,000 acre-foot FEB; 2) a 4700-acre STA; and 3) a 1800-acre STA.

In another interesting development, a proposal is underway for SFWMD to acquire land known as Mecca Farms from Palm Beach County. Under this proposal, SFWMD would acquire 1919 acres in exchange for $30 million and a trade of some of the former U.S. Sugar land valued at $25 million. The land will be used for a project that is part of the Comprehensive Everglades Restoration Plan known as the Loxahatchee River restoration project. This is being referred to as "replacement features" within the water quality plan because the land once planned for the Loxahatchee CERP project will now be used for one of the requisite STAs or FEBs, whereas the Mecca Farms property will instead be used for the CERP project. This is an important element of the plan because advocates of the CERP project are very focused on ensuring that the water quality plan does not have the ultimate effect of interfering with other environmental benefits of CERP.

Finally, although it was not a part of the U.S. Sugar land purchase, some argue that the purchase was to blame for the failure of SFWMD to finish construction on the A-1 reservoir, which was originally part of CERP. As the prospect of having land available for water storage closer to Lake Okeechobee became viable, most scientists aligned on the opinion that the A-1 land was better suited for a water quality project and not for a deep storage reservoir. As such, the A-1 parcel is now part of the water quality plan. A 54,000 acre-feet FEB is proposed for the A-1 site and is the major element of the Central Flowpath in the water quality plan. This is also one of the earliest of the elements of the water quality plan expected to be completed. In the summer of 2012, the U.S. Army Corps of Engineers filed a Notice of Intent to complete an Environmental Impact Statement, which was needed before SFWMD could obtain necessary permits to complete the FEB; construction is expected to begin by the summer of 2013. Notably, the previous construction already completed for the reservoir is necessary toward the FEB construction. As a result, although this is one of the larger infrastructure elements of the water quality plan, it is estimated to cost only $120 million of the $880 million plan.

These events should be kept firmly in mind in the benefit–cost analysis that follows. Later in this article, we discuss conceptually how the incorporation of legal costs could influence the benefit–cost ratios and, in turn, could affect the environmental benefits necessary to generate a benefit–cost ratio greater than 1 from the sugar buyout.

Theoretical Considerations

For the purposes of this benefit–cost analysis, a spatial price equilibrium framework similar to that of Kennedy and Schmitz (2009) that incorporates economic welfare measures (Just, Hueth, and Schmitz, 2004) is developed to determine the welfare impact on producers and consumers resulting from the reduction of

[5] A funding plan for this wetlands restoration project is under development. Under consideration is using wetlands mitigation fees paid by rock miners in the "Lake Belt" mining region in Miami–Dade County.

agricultural land. The sugar policy scenario considered in this analysis involves the United States supporting its domestic price through means of a nonrecourse loan program and using a binding TRQ to insulate its domestic sugar market from the rest of the world. Given this, in our model, the U.S. sugar market takes the world price as given.

Three sectors are used within this framework: domestic production, imports, and domestic consumption. Domestic consumption Q_C is comprised of products produced domestically, Q_S, and/or imported, Q_M, such that

$$(1) \qquad Q_C = Q_S + Q_M,$$

where Q_M is determined exogenously by the domestic government through its choice of the TRQ level. Given the initial domestic supply and demand functions, the domestic price will adjust to changes in Q_M, which will result in producers adjusting Q_S based on their supply function and consumers adjusting Q_C based on their demand. A market-clearing price will be achieved when Q_S and Q_C, resulting from the new Q_M, meet the conditions in equation (1).

The resulting changes in quantities consumed, produced, and imported are used to partially determine the benefits and costs to society that accrue as a result of the land buyout. These impacts to the agricultural sector are combined with other benefits and costs related to Everglades restoration to determine the overall benefit–cost ratio.

Let B_i represent the summation of benefits accruing from restoration project i and let C_i represent the summation of costs associated with that same restoration project. The benefit–cost ratio for project i, R_i, is shown as

$$(2) \qquad R_i = B_i/C_i.$$

Although the benefits and costs associated with a number of economic activities can be determined based on observed supply and demand relationships, there are other impacts such as environmental benefits that are more difficult to ascertain. To account for this, we define an *EE* (EE_i) to represent the environmental benefits resulting from project i. Incorporating the EE into equation (2) yields the following benefit–cost ratio:

$$(3) \qquad R_i = (B_i + EE_i)/C_i.$$

In cases in which environmental or other benefits cannot be measured, excluding them from the calculation can result in a benefit–cost ratio that is less than 1, implying that the benefits of the project are lower than its costs. Calculation of an EE such that

$$(4) \qquad EE_i = C_i - B_i$$

and substituting for the EE_i in equation (3) yields a benefit–cost ratio of 1. This EE represents the minimum level of additional benefits that must accrue to the project for a rational policymaker to consider the project to be of benefit to society.

Empirical Analysis and Results

In our analysis, simulations are conducted for alternative quota levels and for alternative supply and demand price elasticities using Microsoft® Excel. Given the observed supply and demand quantities at the base-price level, linear supply and demand curves are used to determine: 1) the market-clearing equilibrium given the initial amount of land used to produce sugar and a specific import quota; and 2) the market-clearing equilibrium given a reduction in the amount of land used to produce sugar and a specific import quota. The domestic quantities and prices are then used to calculate the respective changes in producer and consumer surplus that result from each scenario. Additional details regarding this model and its calibration can be found in Schmitz, Kennedy, and Hill-Gabriel (2012).

Environmental Equivalent

Each of the scenarios analyzed within the context of the U.S. sugar market shows a net loss to society from the proposed U.S. Sugar land buyout. When we consider the environmental rationale behind this government project, we identify an EE that would bring the net benefit–cost ratio of this project to one. The EE consists

of environmental benefits such as added wildlife net of costs.[6] (We calculate later the EE needed to obtain benefit–cost ratios of various magnitudes greater than 1, recognizing that policy analysts are not in a position to determine the benefit–cost ratio necessary for a project to be deemed appropriate.)

However, decisions are often not made solely on economic grounds. Thus, there could be a shortfall in the EE needed to generate a benefit–cost ratio of one or greater for a given project. This happens in the case in which the notion of an EE is replaced or augmented by a Political Lobbying Equivalent or even a Political Corruption Equivalent that can partly or fully make up for the shortfall between benefits and costs in benefit–cost calculations.

Hypothetically, for a benefit–cost ratio of one, the EE necessary would be much less than the EE needed to achieve a larger benefit–cost ratio. For example, Mather Economics (2010) concluded that the benefit–cost ratio resulting from restoring the Everglades was 4.04.

The relationship between benefit–cost ratio calculations and the EE can be illustrated with respect to the legal hurdles associated with the buyout discussed earlier. By ignoring the legal costs, we overstate the benefit–cost ratio for the sugar land buyout. Likewise, we understate the EE needed to achieve a given benefit–cost ratio. The addition of legal costs will lower the benefit–cost ratio and will raise the dollar value of the EE. On the other end of the spectrum, we also fail to estimate the cost savings of having land in public ownership before facing new legal requirements. If the court requirements to build new projects had come out before the land was purchased, it would have likely required costly eminent domain proceedings to buy new public land.

Final Land Purchase

A final agreement was reached on the land purchased in late 2010 that involved the state of Florida purchasing 26,800 acres of land from U.S. Sugar for $7365 per acre for a total of $197.4 million. This final agreement encompassed a much smaller land area than did the earlier proposals. The parcels are slated to be used to construct a series of STAs and other water quality treatment projects, which was one of the purported goals of the 187,000-acre scenario. The reduction in acquisition size and the associated reduction in capability to construct restoration projects on the land raise issues with respect to which inputs contribute to the potential environmental benefits. Will a land buyout that is only 15% the size of an alternative plan result in only 15% of the environmental benefits associated with the larger acreage? Conversely, if it were the STA providing the environmental benefits, would the environmental benefits double if twice the number of STAs were built? These scale issues are critical for conducting an appropriate benefit–cost analysis.

As pointed out earlier, although Governor Crist initiated the buyout of U.S. Sugar land to clean up the Everglades, and although the processes were largely unrelated, acquiring some land in the EAA would have been necessary to achieve EPA's Everglades water quality standards.

To compare earlier proposals with the final agreement, we examine a hypothetical purchase of 187,000 acres at a market value cost of $4000 per acre along with the actual agreement to purchase 26,800 acres at a cost of $7365 per acre. These scenarios include the information available at the time of the land purchase (Schmitz, Kennedy, and Hill-Gabriel, 2012). Comparisons of each of these scenarios include both $401.5 million for STA construction costs on the newly acquired land and $300 million for costs already incurred toward STA construction.[7] Our analysis also accounts for producer and consumer impacts in the sugar

[6] We also did not analyze the potential for cleanup cost savings that either result from taking land out of agricultural production or result from preventing additional application of phosphorus and other nutrients.

[7] Cost estimates at the time that the 187,000-acre purchase was proposed for constructing water quality projects ranged from $400 million to $1.5 billion. The cost of just over $700 million is used as an estimate of the costs to construct projects on these properties and assumes that STAs will be constructed.

industry, a lease benefit from a no-cost lease to U.S. Sugar for three years (valued at $400 per acre, per year, nominal value), and the net sales benefit to U.S. Sugar. As shown in Table 1, the 187,000-acre project results in a net welfare loss of between $1.0 and $1.3 billion and a benefit–cost ratio of 0.097–0.122 depending on whether the preacquisition restoration costs are included. The smaller project then results in a welfare loss of between $0.5 and $0.8 billion and a benefit–cost ratio of between 0.125 and 0.187. It is important to note that in the case of the 187,000-acre buyout, we assume the per-acre purchase price is equal to or closer to our market value of the land, which results in a zero net benefit to U.S. Sugar. An EE of over $1.309 billion is required for the benefits of this project to equal the corresponding costs with the purchase of 187,000 acres at $4000 per acre. Although the per-acre land acquisition price is

Table 1. Producer, Consumer, and Environmental Impacts, and Benefit–Cost Ratio of the Government Buyout of U.S. Sugar Lands Considering U.S. Producer and Consumer Welfare: $e_d = -0.5$ and $e_s = 0.5$[a]

Components	Buyout with National Producer and Consumer Gains					
Acres in buyout	187,000	26,800	26,800	26,800	26,800	26,800
Purchase price per acre	$4000	$4000	$7366	$7366	$7366	$7366
Appraised value per acre	$4000	$4000	$4000	$7000	$7000	$7000
Government cost—land	$748,000	$107,200	$197,400	$197,400	$197,400	$197,400
Government cost—STA construction	$401,500	$401,500	$401,500	$401,500	$401,500	$401,500
Government cost—sunk costs	$300,000	$300,000	$300,000	$300,000	$300,000	$300,000
Net sales benefit to U.S. Sugar[b]	$0	$0	$90,200	$9,800	$9,800	$9,800
Lease benefit to U.S. Sugar[c]	$218,837	$31,363	$31,363	$31,363	$31,363	$31,363
Net producer gain	$302,239	$46,211	$46,211	$46,211	$46,211	$46,211
Net consumer gain	–$380,923	–$55,631	–$55,631	–$55,631	–$55,631	–$55,631
Indicators including sunk restoration costs						
Environmental equivalent (EE)[d]	$1,309,347	$786,757	$786,757	$867,157	$1,766,057	$3,599,813
Net benefit	–$1,309,347	–$786,757	–$786,757	–$867,157	–$867,157	–$867,157
Benefit–cost ratio without EE	0.097	0.027	0.125	0.035	0.035	0.035
Benefit–cost ratio with EE	1.000	1.000	1.000	1.000	2.000	4.040
Indicators excluding sunk restoration costs						
Environmental equivalent (EE)[d]	$1,009,347	$486,757	$486,757	$567,157	$1,166,057	$2,387,813
Net benefit	–$1,009,347	–$486,757	–$486,757	–$567,157	–$567,157	–$567,157
Benefit–cost ratio without EE	0.122	0.043	0.187	0.053	0.053	0.053
Benefit–cost ratio with EE	1.000	1.000	1.000	1.000	2.000	4.040

Source: author calculations.

Note: The first scenario involves the proposed 187,000-acre buyout at $4000 per acre. The second through sixth scenarios involve the actual 26,800-acre buyout at a $4000 purchase price and an alternative of approximately $7366 per acre purchase price with different EE levels.

[a] Dollar values, with the exception of per acre prices, are in thousand dollars.

[b] Net benefit to U.S. Sugar is comprised of the government payment less an appraised value of either $4000 or $7000 per acre.

[c] The EE is the amount of perceived environmental gain necessary to result in a net benefit of zero.

[d] The EE is increased in scenarios 3 and 4 to obtain benefit–cost ratios of 2.00 and 4.04.

STA, Stormwater Treatment Area.

greater in the final agreement, the decreased amount of land acquired decreases significantly the overall cost of the project, which results in a smaller EE of $786.8 million necessary for the 26,800-acre project. This implies that less environmental and related benefits are necessary for the smaller project to breakeven. However, it does not imply that fewer environmental benefits actually exist.

Mather Economics (2010) finds a benefit–cost ratio of 4.04 based on benefits that include groundwater purification, real estate, park visitation, open space, commercial and recreational fishing and hunting, and wildlife habitat (in addition, their calculations of the net present value of these benefits used a 20- to 50-year time horizon that would tend to increase their benefit–cost ratio). We determine that the EE, through the use of revealed preferences, needs to be large to achieve a benefit–cost ratio of 4.0. The Mather study (Mather Economics, 2010) of the full $11.5 billion Everglades restoration effort over a 20- to 50-year timeframe noted that the best estimate is that restoration will generate an increase in economic welfare of approximately $46.5 billion in net present value terms that could range up to $123.9 billion. This analysis is assuming that 83,500 acres of land in the EAA would be taken out of agricultural production; 43,500 acres would be used for STA construction; and 40,000 acres would be used for reservoir storage.

Given the final land purchase agreement of 26,800 acres, the EEs required for different benefit–cost ratios are presented in Table 1 (columns 5 and 6). In the case of the fifth scenario, the environmental benefits resulting from this project would need to be over $1766 billion to achieve a benefit–cost ratio of 2.0. Alternatively, the environmental benefits would need to be nearly $3.6 billion to achieve a benefit–cost ratio of 4.0 (Mather Economics, 2010).

Additional Projects

Since completion of the final land purchase agreement, a number of environmental restoration projects have been initiated that are related to the former U.S. Sugar land purchase. The plans for the A-1 Reservoir have been modified to incorporate the previous construction as a component of a 54,000 acre-foot FEB for the Central Flowpath. In addition, 17,900 acres of the U.S. Sugar land purchase are targeted for the construction of an 11,000 acre-foot FEB and a 15,000 acre wetland restoration project in the Western Flowpath, and 8900 acres of land east of Lake Okeechobee are being used to acquire land for a 45,000 acre-foot FEB; a 4700-acre STA; and a 1800-acre STA in the Eastern Flowpath.

As seen by the addition of specific projects in conjunction with the U.S. Sugar land acquisition, the dynamics of Everglades' water quality improvement efforts provide a good example of what happens to our measures of benefits and costs as plans change as a result of legal, political, or other considerations. Table 2 presents a detailed listing of costs and benefits related to the 26,800 U.S. Sugar land buyout along with the associated construction projects as mentioned previously. Note that the costs and benefits related to the U.S. Sugar land buyout in Table 2 correspond to the scenario presented in Table 1, column 4.

Two EEs are calculated for each scenario: one is based on a benefit–cost ratio of 1.00, and the other is based on a benefit–cost ratio of 4.04 as indicated in the Mather study. Based on the benefit–cost ratio of one, the EE indicates that minimum environmental benefits will accrue in the amount of 1) $165.657 million resulting from the land acquisition; 2) $186.016 million resulting from FEB and earthwork construction in the Western Flowpath; 3) $453.707 million resulting from FEB construction in the Central Flowpath; and 4) $522.276 million resulting from FEB and STA construction in the Eastern Flowpath for a total minimum benefit of $1.328 billion in environmental benefits. The total value of environmental benefits increases to $5.364 billion when the Mather Economics (2010) benefit–cost ratio of 4.04 is used.

It is important to note that the calculations presented here incorporate $282 million in prior construction costs, or what were previously considered sunk costs, that had been incurred in the construction of the A-1 Reservoir. We chose to include this number in our calculations

Table 2. Costs and Partial Benefits Associated with U.S. Sugar Land Buyout and Associated Construction[a]

	U.S. Sugar Land Buyout	Western Flowpath	Central Flowpath	Eastern Flowpath	Total Project Benefits and Costs
Acres in Buyout	26,800	17,900		8900	
Purchase price per acre	$7,366				
Appraised value per acre	$7,000				
Land acquisition cost	$197,400				$197,400
FEB, STA, and other construction		$130,000	$120,000	$365,000	$615,000
prior construction costs			$282,000		$282,000
associated project costs		$56,016	$51,707	$157,276	$265,000
Net sales benefit to USS	$9800				$9,800
Lease benefit to USS	$31,363				$31,363
Net producer gain	$46,211				$46,211
Net consumer gain	–$55,631				–$55,631
Net benefit	–$165,657	–$186,016	–$453,707	–$522,276	–$1,327,657
Environmental equivalent (EE) with benefit–cost ratio of 1.00	$165,657	$186,016	$453,707	$522,276	$1,327,657
Environmental equivalent (EE) with benefit–cost ratio of 4.04	$669,254	$751,506	$1,832,978	$2,109,997	$5,363,734

[a] Dollar values are in thousands with the exception of per acre values.
FEB, Flow Equalization Basin; STA, Stormwater Treatment Area; USS, United States Sugar.

because this work will contribute directly to the building of FEBs in the Central Flowpath. Although there was little dilemma regarding its inclusion in this case, had this "sunk" cost not had any bearing on the current projects, there would have been reasons supporting both its inclusion and exclusion. Inclusion would provide a more accurate representation of the total costs, whereas exclusion would better account for the lack of benefits received.

Conclusions

The state of Florida's buyout of land owned by U.S. Sugar and associated projects to restore the Everglades required significant accompanying environmental benefits to be justified on economic grounds. When calculating the EE needed to generate benefits greater than costs, we recognize that the EE approach to program implementation can be undermined by noneconomic arguments. Often policies are introduced within the context of public choice theory, in which a Political Lobbying Equivalent or Political Corruption Equivalent plays a key role.

Although the purchase of land from U.S. Sugar did not materialize on the scale initially envisioned, in hindsight that plan may have been a catalyst toward accomplishing what was needed for improving Everglades water quality. The smaller purchase executed in 2010 still focused on acquiring strategically located lands from willing sellers. The construction of strategic STAs and FEBs requires appropriate land. By acquiring lands strategically aimed at improving the quality of water flowing to the Everglades, progress was made toward correcting environmental issues that continued to hinder the overall Everglades restoration efforts.

Because Schmitz, Kennedy, and Hill-Gabriel (2012) did not consider the STA and FEB construction in the Eastern, Central, and Western Flowpaths, the corresponding EE underestimated the minimum level of net environmental benefits necessary for the project to be considered worthwhile. The analysis presented in this article provides disaggregated

EEs representing the minimum net benefits for each component of the project as well as an aggregated EE representing the minimum net benefit for the entire project. Although our analysis does not determine where these benefits will occur, they are expected to accrue through tourism, job creation, and sustaining resources for both the natural and built environments.

References

Just, R.E., D.L. Hueth, and A. Schmitz. *The Welfare Economics of Public Policy: A Practical Approach to Project and Policy Evaluation*. Cheltenham, UK: Edward Elgar Publishing, 2004.

Kennedy, P.L., and A. Schmitz. "Production Response to Increased Imports: The Case of U.S. Sugar." *Journal of Agricultural and Applied Economics* 41(2009):777–89.

Mather Economics. *Measuring the Economic Benefits of America's Everglades Restoration*. Palmetto Bay, FL: Study Prepared for The Everglades Foundation, 2010.

Schmitz, A., P.L. Kennedy, and J. Hill-Gabriel. "Restoring the Florida Everglades through a Sugar Land Buyout: Benefits, Costs, and Legal Challenges." *Environmental Economics* 3(2012): 72–87. Internet site: http://businessperspectives.org/component/option,com_journals/task,issue/id,196/jid,9/Itemd,74/ (Accessed January 15, 2013).

The White House. *Restoring America's Everglades: Progress and Next Steps for Restoring a Treasured Landscape and Sustaining a Way of Life*. Washington, DC, 2012. Internet site: www.whitehouse.gov/sites/default/files/page/files/everglades_report__13_july_2012.pdf (Accessed January 15, 2013).

Appendix Table 1. Timeline of Policy and Legal Events Related to the U.S. Sugar Land Purchase

5/2/2013	HB 7065 passes the Florida Legislature. The bill approves the June 2012 agreement on new water quality improvement projects to be constructed on land purchased from U.S. Sugar and other land.
8/28/2012	U.S. Army Corps of Engineers submits notice of intent to issue an Environmental Impact Statement regarding SFWMD proposed construction of the A-1 Flow Equalization Basin, an alternative project to the A-1 Reservoir.
6/13/2012	State and federal government agreement to invest an additional $880 million for Everglades water quality efforts, using land purchased from U.S. Sugar and the A-1 property.
10/6/2011	Governor Rick Scott and Florida DEP unveil an alternative plan to U.S. EPA's Amended Determination for achieving water quality targets. The plan uses land purchased in 2010 from U.S. Sugar but purports to improve water quality with projects that cost hundreds of millions of dollars less than EPA's proposal.
5/6/2011	Florida Legislature approves a 30% reduction in the amount of funding SFWMD will have for Everglades restoration, water quality improvements, flood control, and water supply. Existing law is changed so that increasing ad valorem funding requires legislative approval.
4/26/2011	Judge Gold enters an order allowing the U.S. EPA to take over Florida's water quality permitting. The decision can be used to enforce the Amended Determination requirements. Numerous comments in the order focus on Florida's failure to timely reach water quality standards.
3/22/2011	Judge Moreno adopts Special Master recommendations noting that the vast majority of scientific experts agree that the EAA A-1 site will have greater environmental benefit if construction on the Reservoir does not continue and the land is used for water quality treatment.

Appendix Table 1. Continued

11/18/2010	The Florida Supreme Court rules on the issue of Bond Validation, finding that the certificates of participation bonds can be used for the purchase because it provides a valid public purpose with the exception of funding for the option to buy additional acres.
11/2/2010	SFWMD responds to U.S. EPA Amended Determination stating that it cannot/does not have the fiscal capacity to complete the projects EPA set forth, including land acquisition above and beyond the U.S. Sugar purchase and project construction on those lands.
10/12/2010	SFWMD closes on purchase of approximately 26,800 acres from U.S. Sugar.
9/3/2010	EPA issues Amended Determination requiring 42,000-acre expansion of Stormwater Treatment Areas, including use of the 26,800 acres purchased from U.S. Sugar to build treatment projects.
8/30/2010	Special Master to Judge Moreno recommends relieving SFWMD from requirements to construct the EAA A-1 Reservoir because of changed circumstances and the potential use of the land for water quality treatment.
8/12/2010	SFWMD votes to approve purchase of 26,800 acres of land from U.S. Sugar with 10-year option to purchase remaining land reinitiate construction.
3/31/2010	Judge Moreno grants motion seeing a declaration of violations of water quality consent decree; requires EAA A-1 Reservoir reinitiate construction.
5/13/2009	SFWMD approves revised purchase of 73,000 acres of land from U.S. Sugar with 10-year option to purchase remaining land.
1/13/2009	Miccosukee Tribe files motion for administrative hearing seeking a declaration that the December 2008 approval of the U.S. Sugar purchase is valid. This case is appealed to the Florida Supreme Court.
1/06/2009	New Hope and Okeelanta Corporations (subsidiaries of Florida Crystals) file motion for administrative hearing seeking a declaration that the December 2008 approval of the U.S. Sugar purchase is invalid. This case is appealed to the Florida Supreme Court.
12/18/2008	SFWMD approves revised purchase of 180,000 acres of land from U.S. Sugar.
10/13/2008	SFWMD files Complaint for Validation, seeking to validate $2.2 billion in Certificates of Participation. The Miccosukee Tribe and the New Hope and Okeelanta Corporations object to validation. The validation is appealed to the Florida Supreme Court.
7/28/2008	Judge Gold grants summary judgment for Friends of the Everglades and the Miccosukee Tribe, requiring EPA to develop a specific timeframe for state compliance with water quality standards.
6/24/2008	Acquisition of U.S. Sugar is announced—187,000 acres of land and U.S. Sugar assets.
6/01/2008	Work suspended on the EAA A-1 Reservoir, citing *NRDC, NWF, and Sierra Club v. U.S. Army Corps of Engineers*.

SFWMD, South Florida Water Management District; DEP, Department of Energy; EPA, Environmental Protection Agency; EAA, Everglades Agricultural Area.