Measuring the Economic Benefits of America's Everglades Restoration

An Economic Evaluation of Ecosystem Services Affiliated with the World's Largest Ecosystem Restoration Project

Prepared for The Everglades Foundation
18001 Old Cutler Road, Suite 625
Palmetto Bay, Florida 33157

www.evergladesfoundation.org
305.251.0001

by

Mather Economics
43 Woodstock Street,
Roswell, Georgia 30075

www.mathereconomics.com
770.993.4111

Bobby McCormick, Ph.D., Principal Investigator
Robert Clement, MA
Daniel Fischer, MBA
Matt Lindsay, Ph.D.
Reed Watson, JD MA

with assistance from

Danielle Alderman
Kristina Catani
Joanna Fister
Gabi Huber, Ph.D.
Exley McCormick
Arvid Tchivzhel
Emily Wood, MA

Summary of Results

Everglades restoration will have important and significant economic impacts on several basic services provided by this massive and complex ecosystem. We have split these services into six distinct divisions. For each of these categories, we conservatively estimated, using best available data and economic methods, the increase in economic value of a restored Everglades ecosystem.

Summary of Ecosystem Services Valuation of Everglades Restoration			
	Service	NPV Best Estimate	
1	Groundwater purification	$	13,150,000,000
2	Real Estate	$	16,108,000,000
3	Park Visitation	$	1,311,588,000
4	Open space	$	830,700,000
5	Fishing		
	Commercial	$	524,100,000
	Recreational	$	2,037,000,000
6	Wildlife Habitat and Hunting	$	12,539,900,000
	TOTAL Value of Services	**$**	**46,501,288,000**
	Initial Investment	$	11,500,000,000
	Benefit-Cost Ratio		**4.04**
	All calculations are based on discount rate of 2.1% .		

Our analysis strongly suggests that restoration of the Everglades as described and planned in CERP will have large economic benefits. **Our 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**. The return on investment, as measured by the benefit-cost ratio, assuming a cost of restoration of $11.5 billion, is also high and significant, 4.04, which means for every one dollar invested in Everglades restoration $4.04 dollars are generated. Everglades restoration will also have an incremental impact on employment of about 442,000 additional workers over 50 years. In addition, the Corps of Engineers estimates there will be 22,000 jobs created as a result of the actual restoration projects. Throughout our analysis, we have taken a very conservative approach to estimation. Accordingly our best estimates almost surely understate the return on investment of Everglades restoration.

Summary of Jobs Results	
Sector	**Incremental Jobs**
Commercial Fishing	6,798
Recreational Fishing	36,868
Residential Construction & Real Estate Services	273,601
Tourism (Lodging, Eating & Drinking, Transportation, Retail, Entertainment)	48,552
Agriculture	(3,724)
Wildlife Habitat & Hunting	80,569
TOTAL	**442,664**

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Preamble and Executive Summary

We have been commissioned by the Everglades Foundation to place an economic valuation on Everglades restoration. The Everglades are sub-tropical wetlands – a "River of Grass" and much, much more. In order to catalogue the huge array of potential products and services flowing out of the Everglades, we envision this vast natural cauldron as a firm. Ponder General Electric. Among many other things, General Electric produces medical imaging, jet engines, and financial services. Each of its product lines has revenues and costs. GE manufactures and creates the products, and buyers purchase them. In almost every case, the buyer places a higher value on the product than the purchase price. The Everglades system is like GE, except that buyers do not directly pay for the products they consume. Instead, consumption is enjoyed in large measure without any compensation to the owner or producer, because there is no well-defined owner and nature is the producer.

We approach our job as if the Everglades were a multi-product firm like GE, and we task ourselves with estimating the values that consumers place on its products and services. In that taxonomy, Everglades restoration is akin to a business opportunity, and the Comprehensive Everglades Restoration Plan, CERP, is a detailed business plan. Our job is to produce a set of pro forma financial statements to complement and complete that plan. As with all pro forma projections, we have made assumptions about the future. We have attempted to make our assumptions as reasonable, visible, and transparent as possible so that readers can adjust our findings based upon their own assessment of the proper assumptions. As in any analysis of this type, the best assumption is not always obvious. Therefore, in many cases, we have provided a range of estimates, but we also offer what we think is our best estimate. In all cases where there was no clear choice regarding an assumption, we took the conservative approach. Accordingly, in the analysis you see below, we believe that our estimates are at the lower end of the range (lower bound) and follow best practices in economic methodology.

We have broken this multi-product firm, the Everglades, into six distinct divisions and a seventh catch-all branch. These are:

- $ Groundwater purification and aquifer recharge
- $ Real estate
- $ Park Visitation
- $ Open space
- $ Fishing
- $ Wildlife habitat and hunting
- $ Water quality, biodiversity, and carbon sequestration

Take groundwater purification and aquifer recharge as the first of many services produced by the

Everglades. CERP, if enacted as planned, will restore Everglades sheet flow. Restored sheet flow will, in turn, provide additional fresh surface water and groundwater. Consequently, water available for municipal and private use will be less saline, that is, ground water extracted for use by South Floridians will be less saline and require less electricity to become usable and potable. Because it costs money to desalinate water, one service that a restored Everglades would provide is reducing the cost of desalinating increasingly brackish groundwater. In order to assay this revenue stream, we have assumed that restoration will return South Florida groundwater and surface water to its 1970 levels.[1] Using data from that period, and assuming that restoration would create water of similar salinity to that period, we can project how much money the people of South Florida will ***not*** have to spend desalinating groundwater as restoration unfolds. In other words, Everglades restoration means that groundwater will not be as salty and that less energy will be required to prepare it for human use. Salty water must be treated to remove chlorides. As the groundwater is more salty, it takes more electricity to purify the water for humans. Restoration reduces the amount of electricity required and thus is a direct benefit in terms of energy cost savings. We estimate these restoration savings to come primarily from reduced expenditures on energy which would otherwise be used to filter out more saline pushed through membranes to create usable water.[2]

In Table A below, we report in summary format our results of computing the value of services for all the product lines listed above. In our detailed document that follows, we provide thorough insight into our methods, sources, and our exact assumptions. They are only sketched and summarized here. Each division has associated with it a table detailing the best estimates and a range of estimates that we deem plausible. Again, for parsimony of presentation here, we have not included all the details of our calculations. They are available in the full document below.

[1] Our empirical analysis of ground and surface water supports this assumption. Salinity levels appear relatively constant in ground water test wells up until the early 1970s when they began to grow commensurate with Everglades flow reduction.

[2] While it might be argued that fewer plants will have to built for water purification after restoration, this is not accurate according to our models. Population and income growth will likely necessitate the construction of new plants, but restoration will not preclude these investments. Hence, the virtue and benefit of restoration on groundwater purification comes only from the lower expenditures required to clean the salt from the less briny water not from less capital investment in plants. Plants will have to be built to accommodate increased demand for water, which will not be impacted by restoration.

Table A Summary of Ecosystem Services Valuation of Everglades Restoration			
	Service	NPV Best Estimate	
1	Ground Water Purification	$	13,150,000,000
2	Real Estate	$	16,108,000,000
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Our analysis strongly suggests that restoration of the Everglades as described and planned in CERP will have large and important economic benefits. Our best estimate is that restoration will generate an increase in economic benefits of approximately $46.5 billion in net present value terms.[3] The range of this estimate can be as high as $123.9 billion.

The return on investment, assuming a cost of restoration of $11.5 billion, is also high and significant. Our best estimate is that the benefit-cost ratio is 4.04 with a range as high as 9.78. The bottom line, as our analysis strongly suggests, is that the rewards of restoration far outweigh the economic costs. It is important to note that these are the *changes* in value to a restored Everglades. Our valuation does not represent the total value of services that flow from this ecosystem, currently or in its restored state. It is the incremental or marginal increase in value from implementing restoration.

To provide perspective, Table B below reports computations on (1) the total value of services per person in the 16-county South Florida region, (2) the ratio of total services to total income in 2007, and (3) the present value of total income in 2007.[4] These calculations say that the total value of ecosystem services from a restored Everglades amount to an increase in wealth for each person in the region of about $5,129 on a one-time basis, which is approximately a 0.3 percent increase in their wealth (narrowly defined for purposes here as the present value of income over

[3] We believe that the overall welfare impacts, as distinct from the simple benefits, are even larger. Details on this economic distinction are provided later in this report.

[4] Using the 2007 Census data on population and income.

the next 50 years or an 12.9 percent wealth increase when compared to their annual income). These computations suggest that the impacts of restoration are not only real and economically meaningful, but also reasonable.

TABLE B Relevance and Impact of Restoration with respect to Income and Wealth		
Value of Services per capita		$ 5,129
Value of Services per dollar of annual income		12.9%
Value of services per npv of income		0.30%

Details

Groundwater Purification and Aquifer Recharge Valuation

Avoided Groundwater Desalination Costs

Groundwater in the coastal counties of the South Florida Water Management District (SFWMD) is becoming increasingly brackish. It will have to be desalinated before most uses. The capital cost of desalination, given the current state of reverse osmosis (RO) technology, is driven by the volume of fresh water that must be produced, which in turn is driven by population growth and perhaps other factors (for instance, climate and income).[5] The operating cost of desalination, on the other hand, is a direct function of the salinity of the water input. Saltier water must go through the RO membranes at a higher pressure, which requires more energy. The restoration of sheet flow according to CERP can be expected to decrease groundwater salinity, because the additional fresh water filtered into the aquifer from above will displace seawater seeping into the aquifer from below. So, conservatively, restoring the Everglades can be expected to result in at least the energy cost savings from desalinating less saline groundwater. We ignore any capital cost savings that might come from possibly having to build fewer desalination plants in the first place. We also ignore labor and maintenance cost savings from using less saline input (instead of assuming, for instance, that RO membranes fail at higher rates when higher-pressure, more saline water is pushed through). This is in keeping with our desire to be ultra-conservative with respect to our estimates. It is reasonable to subjectively estimate that our metrics of benefits are biased on the low side because of this conservative approach.

[5] Our use of the phrase desalination might be confusing to some people. Here we are *not* talking about taking salt out of ocean water instead we are referring to the act of removing salt from brackish or slightly salty fresh groundwater.

Under assumptions detailed below, we estimate that these energy cost savings would be substantial and vary by county within the region. Growing energy costs would increase these estimates. Improvements in desalination technology would decrease them. One assumption that affects our cost savings estimates is whether all the groundwater withdrawn must be desalinated. We have made two different assumptions: first, that all groundwater is to be desalinated, and second, that only the groundwater currently classified as saline must be desalinated.

General Approach and Data Sources

Our model has three steps. First, we used the volume of groundwater withdrawn and its salinity as observed over time to infer the change in salinity over the next 50 years without Everglades restoration. Next, we inferred the yearly desalination cost over the same period using regression analysis and engineering data published by the Texas Water Development Board (TWDB). Finally, we repeated the cost calculations assuming that, if the Everglades were restored, groundwater salinity would return to its 1970 level and stay there even as the volume of water withdrawn grows as population and demand grow.[6]

In other words, we assumed that implementing CERP would result in a new steady state, where the aquifer would be replenished with fresh water to a sufficient extent that it could sustain increased withdrawals with no increase in its salinity. The difference between the discounted streams of yearly groundwater desalination cost with and without the Everglades restored is our estimated economic benefit in the form of avoided desalination costs that can be credited to CERP. In the next 40 or 50 years, south Floridians will still need to desalinate their water, but it will cost them less because after restoration, the water will be less saline.

We collected data on ground and surface water use in SFWMD, by county and by year, from the US Geological Survey (USGS). We collected salinity data from DBHYDRO, the official SFWMD data repository of water research results, and from the National Water Information System (NWIS) maintained by the USGS.

Technical Details on Water Supply Calculations

The USGS collects county-level data on water withdrawals every five years. We are interested in

[6] We have *not* made any adjustment to our predicted levels of ground-water salinity based on any sea-level rise that might accompany global climate change. Restoration is a marginal adjustment to ground-water salinity. If climate change increases sea level and that leads to higher salinity of ground water, it will cost more to clean the water, but that impact is separate and independent of our estimate of any changes in salinity that occur as a result of restoration of sheet flow.

data for the 16 counties in the SFWMD. The earliest available records are from the 1985 data set. The latest available are from 2005. Using these data and yearly population figures by county over the same time span, we extrapolated water use 50 years into the future. Details are provided in the full report below.

One of the DBHYDRO measurements is chloride concentration in milligrams per liter. Each measurement comes with the location of the station and the date it was taken, so it is straightforward to combine them into yearly averages per county. The USGS maintains the National Water Information System (NWIS), a similar online database with its own chloride records, with the same unit of measurement, also with locations and time stamps. Both DBHYDRO and NWIS record salinity separately by groundwater and surface water. In the case of groundwater, we are interested in measurements taken in wells no deeper than 500 ft. Below this depth, the water is saline. Southern Florida's fresh groundwater comes from surficial aquifers, with water withdrawn from depths well above 500 feet.

Groundwater in the 16 counties has been growing increasingly brackish over time. This result occurs even after discarding any samples taken from depths either unknown or greater than 500 feet (Figure 1). It is reasonable, then, to assume that desalination will be needed for all

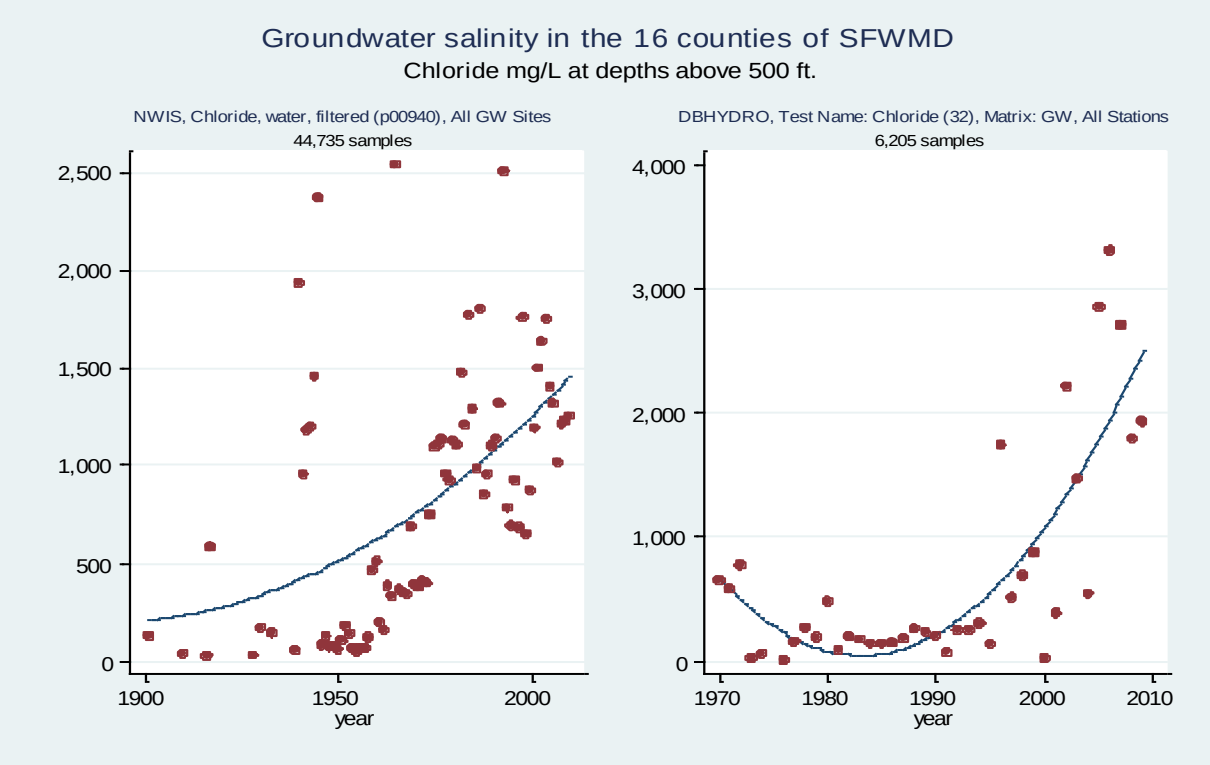

Figure 1 Groundwater Chloride Levels

groundwater withdrawn in SFWMD in the future, whether by private or public water supply systems. Restoring the Everglades will help decrease the expected cost of desalination to the extent that it will succeed in reversing the trend of increasing groundwater salinity. We conservatively assume that surface water will not be affected.

The exercise assumes that CERP would result in groundwater salinity restoring to its steady state 1970 level and have no effect on surface water salinity. Without CERP, we assume that salinity would continue to grow along its current path as shown in the right panel of Figure 1.

The Cost of Desalination

Desalination requires a capital investment (building the plants) and an ongoing operating cost (energy used, materials, maintenance, and labor). As the water input becomes more saline, it must be pushed through RO membranes at a higher pressure. Though the baseline of this relationship is dropping as RO technology improves, it remains true that the higher the pressure, the higher the energy expended, and there are no economies of scale in this process. This is of interest to us, because everything else is subject to either scale effects or factors depending on local characteristics. For example, larger plants, as well as plants designed to operate at a higher baseline pressure, have some efficiencies built-in. The cost of disposing of the brine via deep-well injection depends on local geographic options for doing so. The same goes for the cost of disposing of the concentrate (sludge saturated with impurities other than salt).[7] We have not imputed any benefits-estimate to the expected lower cost of brine disposal that will follow from restoration and less desalination. We are uncertain what these cost savings might be, and hence our conservative approach is to note this fact and move on until further information is available.

We estimated the annual cost of energy as a function of water input salinity assuming an energy price of $.08 per kW/h, based on the average electricity price in Florida for industrial use ($.0767 in 2007). Then we projected this annual desalination cost for each SFWMD county--given its projected water withdrawals (ground and surface) and their respective salinity levels given their current path (groundwater salinity expected to rise at a growing rate as shown in Figure 1; surface water salinity, not shown, expected to remain unchanged). Then we repeated the calculations with salinity levels held at their 1970 level.

[7] We assume that it takes 200 psi to treat 3,000 mg/L of chloride water, and it takes about 1,000 psi to treat 30,000 mg/L seawater. Therefore we assume that as salinity grows by a factor of 10, the pressure required grows by a factor of 5. Filling in a few intermediate values, we estimated, via linear regression, the functional relationship between and pressure and salinity.

Water Supply Results

Our avoided desalination cost estimate is the difference between projected desalination costs given the current path of rising salinity versus projected desalination costs holding salinity constant at its 1970 level (our expected environmental effect of CERP). We performed this calculation under two assumptions regarding water withdrawn by public and private parties in the SFWMD over the next 50 years. First we assumed that all water will have to be desalinated; second we assumed that only the water classified as saline will have to be desalinated. Details are provided in the full report below. Though the latter sounds obvious and results, as expected, in a lower estimate, the former is also deemed plausible. Current readings show that all groundwater in SFWMD tested at depths above 500 ft. is saline, to some extent, and growing more saline on average. If not all of it is treated now, it might need to be in the future. Net present values of the yearly savings between 2010 and 2060 are shown in Table 1.

Assuming lowered desalination resulting from restoration of the Everglades, the cost savings from energy-use reduction will be substantial. For purposes here, we made some additional assumptions. First, we accumulated the cash flows over 30-, 40-, and 50-year periods. Second, we discounted the dollar amounts by the current real cost of capital to municipalities in South Florida, 2.1 percent.[8]

We next report our calculations in pro forma format for the other services and products listed above. While we have gone to some length in this section to give a sense of our methods, in the summary sections below we are more succinct and parsimonious, however, complete discussion of all our methods and technical details are provided in each relevant section of the main document.

[8] Details on our use of this particular discount rate are discussed later in the document.

Table 1 Value of Groundwater Purification and Aquifer Recharge Services from Everglades Restoration

Assumptions:	
Total Growth	3%
Income Growth	0%
Population Growth	1%
Energy Cost Growth	2%
Technology	0%
SF Muni Bond Rates	4.50%
Inflation	2.40%
Discount Rate	2.10%
Initial Investment	$ 12,100,000,000

Total Benefits			Return on Investment, water supply only	
Adjusted for Growth	Unadjusted		Adjusted	Unadjusted
$ 27,974,488,275	$13,150,812,909	50 Years	131%	9%
$ 18,671,662,550	$10,306,678,952	40 Years	54%	-15%
$ 11,222,040,888	$7,408,688,810	30 Years	-7%	-39%

County Estimates, Adjusting for Growth

Years	Broward	Charlotte	Collier	Glades	Hendry	Highlands	Lee	Martin
NPV 50	$4,609,492,133	$1,753,556,508	$3,037,706,282	$1,919,983,244	$1,162,162,385	$698,345,814	$424,886,022	$1,914,496,540
NPV 40	$3,109,313,065	$1,269,883,770	$2,155,116,915	$939,722,627	$853,459,336	$481,608,784	$267,666,580	$1,268,848,876
NPV 30	$1,896,237,894	$857,682,344	$1,407,512,215	$266,441,931	$571,550,030	$298,391,864	$145,288,674	$759,955,278

	Miami-Dade	Monroe	Okeechobee	Orange	Osceola	Palm Beach	Polk	St. Lucie
NPV 50	$1,007,782,981	$844,489,817	$445,303,896	$1,933,953,018	$968,626,070	$5,004,265,681	$1,120,046,038	$1,129,391,846
NPV 40	$725,449,099	$592,881,240	$280,842,498	$1,157,340,508	$624,711,897	$3,478,682,745	$701,642,250	$764,492,361
NPV 30	$478,860,798	$377,843,554	$151,122,484	$587,782,360	$361,506,661	$2,205,447,197	$384,229,243	$472,188,362

Water Quality and Residential Real Estate Valuation

Impact of Improved Water Quality

We anticipate that a restored Everglades will improve the quality of surface water in the 16-county South Florida Water Management District.

Water plays an important role in the determination of residential real estate values. Proximity, type (ocean, bay, lake, river, etc.), view, size and quality are among the water attributes that are valued by real estate buyers. For example, lakeside or seaside properties sell at a premium to properties located away from bodies of water. A home on a clear stream trades at a premium to a similar home on a polluted stream. Of course, water and its attributes are only a small part of the bundle of attributes that determine a property's value. House size, quality of finish, proximity to a city, and a great many other factors also play important roles. But imagine a thought experiment of taking a given house and property on some body of water and changing nothing but the quality of the water. Now observe the change in property value associated with that one single environmental change. That thought experiment describes our method.

Economists have developed techniques to quantify the incremental value of environmental attributes. One of the often used and robust techniques employed is hedonic pricing. This method estimates the price people are willing to pay for individual product characteristics, such as a swimming pool or air conditioning, and environmental goods, such as air and water quality, holding other attributes constant. Studies consistently show that the water quality effect is positive; that is, property located on or around high quality water is more valuable, *other things the same*, than property located on or around lower quality water. The magnitude of this effect is generally in the 0.5 percent to 7.0 percent range. That is, some level of water quality improvement can have up to a 7 percent impact on real estate values. The same techniques also find, for example, positive effects on air quality and negative effects on proximity to toxic waste sites. These results are both intuitively and scientifically robust.

For the purposes of this study, our role is to estimate the impact on residential real estate values that will derive from a restored Everglades due to improvements in water quality. The aggregate owner-occupied residential real estate value in the 16-county SFWMD is approximately $976.217 billion. Based on a survey of hedonic estimates of water quality effects, the elasticity of real estate values with respect to water quality is .07054.[9] Assuming that water quality, as

[9] A 100 percent improvement in water quality will produce a 7.054 percent increase in real estate values.

measured by dissolved oxygen, can be returned to 1970 levels as a result of restoring the Everglades, this implies that there is a potential 23.4 percent improvement in water quality.

Combining these estimates, we estimate the incremental value of a restored Everglades on real estate across all 16 counties as:

$976.217 Billion H.07054 X .234 = **$16.08 Billion**

This change represents a 1.65 percent increase in the aggregate value of real estate, which is well within the range of typical studies on water quality effects. However, we have also done what-if analysis, to examine the impacts based on different levels of water quality improvements. The results of that analysis are reported in Table 2, which also lists the county-by-county best estimates of additional ecosystem services forthcoming from cleaner surface water via a restored Everglades. We also estimated the increased value of real estate by assuming that nitrogen levels would not achieve the high levels of 2004 and 2005 hurricane years. These estimates are also reported in Table 2.

Next we discuss the additional change in value of services relating to recreation and park visitation that we expect will flow from restoration of this teapot we call the Everglades.

Table 2 Value of Everglades Restoration on South Florida Real Estate via Improved Water Quality

Real Estate Value Improvement - Best Estimate			
County	**Incremental Real Estate Value**	**Years Until Water Quality Goals Met**	**Potential Increase in Real Estate Value at 2.1% Discount Rate**
Broward	$ 3,032,000,000	1	$ 15,777,000,000
Charlotte	$ 261,000,000	2	$ 15,452,000,000
Collier	$ 974,000,000	3	$ 15,134,000,000
Dade	$ 4,379,000,000	4	$ 14,823,000,000
Glades	$ 7,000,000	5	$ 14,518,000,000
Hendry	$ 21,000,000		
Highlands	$ 96,000,000	**Discount Rate**	**2.10%**
Lee	$ 1,058,000,000		
Martin	$ 333,000,000		
Monroe	$ 307,000,000		
Okeechobee	$ 21,000,000		
Orange	$ 1,561,000,000		
Osceola	$ 340,000,000		
Palm Beach	$ 2,807,000,000		
Polk	$ 557,000,000		
St. Lucie	$ 353,000,000		
Totals	$ 16,108,000,000		

Sensitivity Analysis						
	Potential Real Estate Value Improvement Using Various % Change in Water Quality					
Basis	**1%**	**5%**	**23% - Best Estimate**	**25%**	**50%**	**100%**
Suspended Solids Model	**$ 536,000,000**	**$ 5,357,000,000**	**$ 16,108,000,000**	**$ 13,392,000,000**	**$ 26,785,000,000**	**$ 53,570,000,000**
Nitrogen Model	**$ 689,000,000**	**$ 6,887,000,000**		**$ 17,216,000,000**	**$ 34,433,000,000**	**$ 68,865,000,000**

Recreation and Park Visitation Valuation

The Everglades are one of South Florida's main tourist and recreational attractions. The rivers, lakes, and wetlands unique to the Everglades invite sightseeing, photography, bird watching, manatee watching, camping, cycling, boat tours, sailing, airboat tours, canoeing, nature hikes, kayaking, hunting, shelling, saltwater fishing, and freshwater fishing. Logic dictates that Everglades restoration would increase the quality of these activities and, consequently, the number of resident and non-resident visitors to the Everglades. This increase in recreational and tourist activity translates to an economic value that we estimate here.

In economic studies similar to this one, sometimes, tourism is seen as a catch-all category. Here we have tried to use a more laser-like approach and break tourism down into smaller categories of recreation, park visitation, bird watching and wildlife habitat, hunting, and fishing. Thus, we have no overall category called "tourism" per se. However, our approach is deemed superior because it subsumes all the sub-categories and avoids the temptation or problem of doubling counting.

To estimate this economic value, we employed the travel-cost method. The basic premise of the travel-cost method is that expenses people incur while traveling to a recreation site or tourist destination represent the price of admission in the economic sense of opportunity cost. This outlay of expenditures reflects the traveler's willingness-to-pay, that is, the value that a recreationist or tourist places on accessing a particular site. By aggregating the travel expenditures of all visitors to an unrestored Everglades, then projecting a marginal increase in those expenditures attributable to Everglades restoration, we estimated the recreational and tourism component of CERP's economic value.

Our approach has five stages. First, we collected historical data on park visitation in South Florida.[10] Because many recreationists and tourists who travel to the Everglades visit the area's national parks, preserves, state parks, and sanctuaries, we assume changes in park visitation reflect changes in overall tourist and recreational demands. Second, we used data from National Park Service visitor surveys to determine the ratio of residents to non-resident visitors for each park. Third, we estimated county-specific, per-person, per-day travel expenditure figures for both residents and non-residents who visit the

[10] For the Everglades National Park, Big Cypress National Park, Biscayne National Park, The Dry Tortugas, Loxahatchee National Wildlife Reserve and Corkscrew Swamp Sanctuary, we obtained data specific to the total number of annual visits by their recreational activity. For the state parks, we obtained county-specific visitor data.

Everglades parks, preserves and sanctuaries.[11]

[11] There were ten counties with specific data on the average daily expenditure for non-resident tourists. For counties that did not have a non-resident per day expenditure, we used an average daily expenditure of $104.00, calculated by the Fish and Wildlife Conservation Commission for wildlife-viewing in Florida. To estimate resident travel expenditures, we used the National Park Service visitor survey data to calculate an average per day resident expenditure for counties that overlap with a national park: Collier, Monroe and Miami-Dade. For counties that did not have specific data on the per day expenditure for residents, we used the same FWCC wildlife-viewing report which estimated an average daily expenditure of $58.00 for residents.

In our fourth stage of analysis, we established a baseline of recreational and park visitation expenditures by multiplying the county-specific resident and non-resident expenditures by the number of resident and non-resident park visitors. Finally, in our fifth stage, we estimated the marginal increase in recreational and park visitation expenditures under a 2 percent increase in park visitation projected out 50 years. Preliminary regressions of water quality and tourist expenditures confirm this to be a likely scenario. See Table 3.1.[12]

Table 3.1 Recreational and Park Visitation Expenditures 2 Percent Increase over 50 years

County	NPV Incremental Increase
Broward	$103,206,003
Charlotte	$58,458,420
Collier	$178,150,740
Lee	$122,795,151
Martin	$13,306,731
Miami-Dade	$201,075,047
Monroe	$518,206,430
Okeechobee	$987,239
Orange	$25,849,076
Palm Beach	$49,055,665
Polk	$5,519,029
St. Lucie	$34,978,795
Total	**$1,311,588,326**

Our best estimate of the change in tourism valuation is based on a 2 percent increase over 50 years. This amounts to an increase in economic well-being of $1.311 billion in net present value terms.

Open-Space Valuation

If completed, CERP will produce approximately 157,555 acres of preserved open space in South Florida. In the absence of CERP, this land would likely be inaccessible to the public and or developed as Florida's population grows. But with Everglades restoration pursuant to CERP, this land will provide enhanced recreational opportunities and

[12] The counties not listed in this table have tourism benefits in other categories, hunting, wildlife viewing, and fishing.

aesthetic benefits to the residents of South Florida. In this section we quantify these values.

To estimate the value of open-space preservation, we employed a multi-stage process. First, we used data from the Trust for Public Lands to estimate type-specific and county-specific willingness-to-pay (WTP) values per acre of preserved open space.[13]We estimated type-specific WTP values because open space preservation projects of different scale and proximity produce different bundles of aesthetic and recreational benefits.[14] Specifically, we grouped the open space and conservation projects into three types: local open-space bond initiatives, state-wide conservation projects and federally funded wetland preservation projects.

We estimated county-specific WTP values because the marginal value of open-space preservation depends on numerous geographic and demographic variables such as population density and proximity to population centers. Everglades restoration under CERP will encompass restoration projects throughout South Florida, so using geographically specific values adds precision to the open-space valuation.

Averaging across all counties, we estimated WTP values per acre of open-space preservation of $12,133 for county projects, $4,505 for state projects, and $740 for federally funded wetland projects. These figures comport with economic rationale; voters are willing to tax themselves at a higher rate for open space that they can enjoy more often and more easily, that is, local open space.

In the second stage of our analysis, we estimated county-specific open-space value ranges for each CERP project. We did this by multiplying the county, state and federal WTP values by the number of acres yet to be acquired under each specific CERP project. For instance, the "Lakes Park Restoration" project is in the "Lower West Coast" CERP region and has a remaining 40 acres yet to be restored. Because the "Lower West Coast" CERP region overlaps Hendry, Glades and Lee counties, we multiply an average of those three counties' local ($12,133)[15], state ($2,716) and federal ($740) WTP values by 40 to estimate a range of open-space values attributable to that particular CERP project. Our open-space value estimates for that project range from $485,331 (local WTP) at the upper bound to $29,600 (federal WTP), with our best estimate being $108,652 (state WTP).

[13] We gathered acreage and expenditure data by cross-referencing the Land Almanac and other conservation databases reported by the Trust for Public Land.

[14] For instance, a municipal park in Broward County generates significantly different open space values than does a federally funded wetland restoration in Glades County.

[15] Because we did not have data for local open space bond initiatives in these counties, we used the state-wide average of $12,133.

In the final stage of our analysis, we aggregated the range of open-space values across the remaining acres of each CERP project. We report these aggregations for county, state and federal WTP values. These type-specific value estimates define the range of possible open-space values from Everglades restoration. Because CERP most closely matches the kind of open-space preservation projects used to calculate the state-level WTP value, the state-level WTP estimate is our best estimate of the total open-space value attributable to Everglades restoration under CERP. That estimate is **$830,733,000** in net present value terms.

Table 4.1 Open Space Valuation Increase from Everglades Restoration

CERP Region	Counties	Open Space Value Increase
Everglades Agricultural Area	Palm Beach and Hendry	$31,187,000
Everglades, Florida Bay, and Keys	Broward and Miami	$318,739,000
Lake Okeechobee Watershed	Okeechobee, Glades, and Highlands	$30,509,000
Lower West Coast	Hendry, Glades, and Lee	$41,611,000
Miami Dade County	Miami-Dade	$115,507,000
North Palm Beach County	Palm Beach	$5,752,000
Upper East Coast	Martin and St. Lucie	$215,220,000
Water Preserve Area	Palm Beach, Broward, and Miami	$72,208,000
	Total	**$830,733,000**

Table 4.2 summarizes these calculations, our assumptions, and our sensitivity analysis.

Table 4.2 Changes in Value of S. Florida Open Space Associated with Everglades Restoration

Lagged Response	
Years Until Increase Begins	**Present Value of Delayed Increase**
1	**$813,646,000**
2	**$796,911,000**
3	**$780,520,000**
4	**$764,467,000**
5	**$748,743,000**

Possible Range of Values		
Various WTP/Acre of Open Space		
Local	**State**	Federal
$2,763,345,000	**$830,733,000**	$116,593,000

Fishing Valuation

Everglades fishing is a big business, and it stands to be even bigger business if the Everglades are restored along CERP guidelines. Florida is fishing. To best catch the changes in fishing associated with restoration, we have broken our analysis into commercial and recreational components. There is little difference, however, in the analysis or the methods used.

Commercial Fishing

We obtained data on commercial catch per species for each of the relevant South Florida counties for the years 1986 through 2008.[16] Earlier data are considered unreliable. We assumed that restoration will enhance commercial fish catch, owing to increased sheet flow. We estimated the change by comparing current levels to peak levels in the late 1980s. To be conservative, we assumed that a restored Everglades would provide 75 percent of the difference between current catch levels and catches in 1989, the first year in which there are reliable data.

The estimates for expected post-CERP value (75 percent of 1989) and total future dockside value depend on the length of time it takes the fishery to recover after the Everglades project is completed.[17] We calculated future dockside value by summing catch in all Everglades counties for each species, multiplying this by .75, then multiplying these estimated numbers for future catch by the per-pound 2009 price for

[16] Commercial catch data obtained from Steve Brown at the Florida Fish and Wildlife Research Institute; this data can also be viewed at http://research.myfwc.com/features/view_article.asp?id=19224.

[17] It is plausible that there will be a short period of diminished catch after Everglades restoration as salinity levels adjust in Florida Bay and elsewhere.

each species.[18] We summed these values to obtain the expected future dockside value post restoration. We estimate that there will be an increase of $23,271,221 per year in catch, after the fishery is fully restored. This is a 43.3 percent increase from current (2008) value. Table 5.1 shows the present value of commercial fishing value increases over a 50-year period assuming a 0, 20-, and 30-year fishery restoration timetable.

Our best estimate is that commercial fishing catch will increase, in present value terms with a 2.1 percent discount rate, by a total of $524 million (assuming a 20-year time to full recovery for the fishery).[19]

Table 5.1 Estimates of Commercial Fish Catch Increase From Everglades Restoration

			Time for Fishery to Recover After Everglades Restoration		
Discount Rate			Immediately	**20 Years**	30 Years
2.1%		NPV Increase	$716,129,276	**$524,131,653**	$441,139,562

[18] This method may slightly overestimate the impact of recovery as fish prices may fall as larger quantities are brought to market. At this point in our analysis we have not determined the geographic scope of the relevant fish markets and hence cannot determine whether the increased catch will impact price.

[19] As a check on our estimates, we also estimated the change in fishery catch using data from the net ban that went into effect in Florida in 1995. This method suggests that Everglades restoration will increase catch by about 57 percent. To be conservative in our forecasts, we use the earlier, lower estimates already discussed.

Recreational Fishing

Largemouth bass is the most common freshwater fish targeted in the Everglades region.[20] Thus, we chose to use increase in recreational catch of bass as a proxy to estimate the increase in economic benefits for recreational anglers due to CERP restoration.

On average, each recreational angler catches 59 bass each year in Southeast Florida, with an estimated marginal value per fish of $4.32.[21] The FWC 2006 survey of Fishing, Hunting and Wildlife estimates that each angler in Florida spends 17 days fishing (this is an average of residents and non-residents). Therefore, we estimated that on average, anglers currently catch 3.47 bass per day fishing.

We again assumed that restoration will restore 75 percent of total fish population, as used to estimate the changes in commercial fishing catch. The estimates for commercial fishing suggest that there is potential for a 49 percent to 56 percent increase in commercial fishing catch post-CERP. It is assumed that this percent increase in commercial catch can likewise be applied to recreational fishing.

We conservatively used the minimum estimate of a 49 percent increase in commercial fishing catch for our estimate of increased recreational fishing catch. This provides a potential estimated increase in catch per angler per day of 1.7 bass. The total number of fishing licenses sold[22] in 2008 in the 16 Everglades counties was approximately 362,300.[23] However, the FWC states, "It is important to note that only about half of Florida anglers actually have to purchase a license due to various exemptions, so these numbers do not reflect participation."[24] Therefore, we multiplied angler licenses in Everglades counties by two in order to estimate the number of anglers fishing in these counties. We assumed this number (724,600) is an appropriate, though likely low-end, estimate for the number of anglers fishing in Everglades counties in a given year.

The FWC estimates the average number of days spent fishing per angler at 17, which leads to an estimated 12,318,200 angler-days fishing in the Everglades. We multiplied this estimated number of angler days by the estimated increase in Everglades recreational

[20] A survey of Everglades anglers by Fedler provided this information; 40 percent of saltwater angler days are spent targeting largemouth bass.

[21] http://myfwc.com/CONSERVATION/FishingBassConservationCenter_Value.htm.

[22] This includes both residents and nonresidents for freshwater licenses, saltwater licenses and combination licenses.

[23] Stronge, W.B. *The Economics of the Everglades Watershed and Estuaries: Phase 2 - 2010 Update of Data Analysis* (March 2010). Prepared for the Everglades Foundation.

[24] http://myfwc.com/CONSERVATION/Conservation_ValueofConservation_EconFreshwaterImpact.htm.

bass catch (per day, per angler) post-CERP (1.7) to get an estimated increase of 20,940,940 bass caught each year. The estimated increase in value due to restoration (based on a marginal value per bass of $4.32) is then $90,464,861 for each year after restoration is complete.

Table 5.2 shows the present value of recreational fishing value increases over a 50-year period using this estimate of a $90,464,861 increase in value each year after CERP is completed. This is calculated for both a 20- and 30-year restoration period (assuming catch increases linearly over those years), as well as for instant restoration.[25]

Table 5.2 Estimates of Recreational Fish Catch Increase From Everglades Restoration

Discount Rate	**Time for Fishery to Recover After Everglades Restoration**			
		Immediately	**20 Years**	30 Years
2.1%	**NPV Increase**	$2,783,890,688	**$2,037,516,539**	$1,714,891,823

Our best estimate is that Everglades restoration will increase the value of recreational fishing by a total of $2.04 billion in net present value terms.

Wildlife Habitat and Hunting Valuation

While fishing is a major recreational activity in Florida, hunting and wildlife viewing are popular pastimes as well. In this section, we detail our estimates of these economic impacts.

There are two important hunting groups in the Everglades: deer and waterfowl (primarily ducks). Restoration stands to impact hunting, it turns out, both positively and negatively. Deer have moved into and flourished in the drained wetlands of the Everglades, and ducks have been driven out. Restoration will reverse these recent trends.

Using data for 17 statewide Wildlife Management Areas, we computed the ratio of the economic value of hunting in the WMAs located within the Everglades to the economic value of hunting in WMAs statewide. From the lower-bound estimates for each WMA's value, we calculated the ratio of hunting expenditures in the Everglades to the entire state. We then multiplied this ratio by the U.S. Fish and Wildlife Service's estimate of the total

[25] We also estimated the total number of anglers in Everglades counties using the ratio (number Everglades counties)/(number counties in Florida) and multiplied this by the estimated 2.8 million anglers fishing in Florida. We then used this ratio to estimate the number of anglers in the Everglades to recalculate the increase in bass caught and increase in value. The results are numbers that are similar and suggest that either assumption is appropriate.

economic value of hunting in Florida, $377,394,000 annually. This method leads to a baseline estimate of $175,000,000 per year that hunting in the Everglades contributes to the Florida economy.

Fluctuations in water levels are partly responsible for current high mortality rates among deer in South Florida. CERP estimates that, with the restoration of the Everglades, white tail deer populations will be reduced to pre-drainage numbers, but that deer mortality due to drowning and starvation will decrease. CERP estimates suggest that deer hunting in Big Cypress National Preserve should not be impacted in either direction, but that deer hunting in Everglades WMA will be adversely affected. For purposes of this model, we assumed no net change in deer hunting in Big Cypress and a decrease of 75 percent in Everglades and Rotenberger WMAs. The decrease is due to lower deer populations and more difficulty in accessing huntable areas. While CERP does not make the Holey Land or Rotenberger as wet as the Conservation Areas, we assumed that the Rotenberger deer hunting would respond similarly to the Everglades. In effect, as the discussion below reveals, we believe that this is a worst-case scenario for deer. We further assumed that Holey Land would undergo half the total effect of Everglades or Rotenberger, because it is already partially rehydrated. It has already seen a notable transition from deer hunting to waterfowl hunting as a result of these higher water levels.

The Everglades occupy the western portion of the Atlantic Flyway in Florida. Increasing year-round water levels in Everglades and Rotenberger WMAs would provide more ideal habitat for waterfowl. It would also induce a shift in hunting patterns in these areas from primarily deer hunting to primarily duck hunting, as seen in Holey Land WMA after its restoration.

We used the rehydration of Holey Land WMA as a measure of the consequences of restoration on hunting in the Everglades. This rehydration, which began in 1991, drastically changed hunting patterns within the Holey Land WMA, and we expect a similar shift in the overall Everglades. We used days of hunting to estimate percent changes.

While the marginal impact of Everglades restoration on hunting expenditures might be negative, the expected change in wildlife-viewing expenditures is almost surely positive and far larger than the potentially negative impact on hunting expenditures. The expansion of habitat produces additional services, primarily through viewing of birds and other wildlife. We have already computed the additional value of viewing by tourists. Here, we estimate the habitat impact on resident viewings in and around their homes, local bird and wildlife watching. The increased demand from restoration will also be reflected in increased expenditures on bird watching equipment such as feeders, food and

binoculars.

The U.S. Fish and Wildlife Service estimates that the State of Florida generates more than $3 billion in annual expenditures by wildlife watchers.[26]Of the 1.5 million people who engage in away-from-home wildlife watching each year, more than 1.1 million engage in waterfowl watching and 1.29 million watch other non-game water birds. In comparison, only 421,000 engage in viewing of large land mammals.[27] Using data for 17 statewide Wildlife Management Areas, for purposes of scaling the state total to the region, we used as a proxy the ratio of the economic value of hunting in the WMAs located within Everglades to the statewide value. We then multiplied this number by the U.S. Fish and Wildlife Service's estimate of the total economic value of wildlife watching in Florida, which was $3.08 billion annually. This leads to an estimated value of $1.43 billion per year that non-consumptive wildlife recreation in the Everglades contributes to the Florida economy.

The primary source of wildlife-watching value in Florida comes from bird-watching, primarily of wetlands species, either waterfowl or wading birds.[28] CERP estimates significant habitat improvement for water-reliant bird populations, specifically waterfowl and wading birds. The Everglades occupy the western portion of the Atlantic Flyway in South Florida. Consequently, a large portion of migrating waterfowl pass through the Everglades on their way from Canada to the Caribbean. Increasing year-round water levels in Everglades and Rotenberger WMAs along with Everglades National Park will provide more ideal habitat for waterfowl and non-game wetlands birds. It will also induce a shift in wildlife watching demand in these areas due to increased quality relative to other areas.[29]

CERP estimates improved habitat for the following endangered species:

- West Indian Manatee
- American Crocodile
- Snail Kite
- Wood Stork
- Cape Sable seaside sparrow

[26] Table 31; page 39; FWS – FHWAR. We conservatively excluded from our calculations the "special equipment expenditure" category because we are attempting to measure the habitat-only demand and not travel or tourism-related demand. If we had included this effect, overall impact of restoration would be calculated to be much higher. "The special equipment" category of expenditures is large, as it includes RVs, travel trailers and the like. Our intent here was to capture local viewing, not tourism. This avoids a potential double-counting problem.

[27] Table 26; page 35; FWS – FHWAR.

[28] Table 26; page 35; FWS – FHWAR.

[29] CERP Sections 8.7 and 8.8.

We estimated the baseline value of habitat and non-consumptive wildlife appreciation in the Everglades. We used wading bird populations as our indicator metric for habitat value in the Everglades. The University of Florida estimates that, just prior to drainage, there was a stable population of approximately 70,000 mating pairs of wading birds. This is our reference benchmark for restoration. Using 2006 bird populations, our conservative best estimate is that restoration will return these numbers to 75 percent of the 70,000 mating pairs reference benchmark. We then estimated the marginal impact of changes in species populations on demand for viewing, providing an annual improvement in habitat value of approximately $424 million.

Though we have estimated a portion of these values in our recreation and park visitation model which measures park visitation changes, wildlife viewing generates additional values not captured by our park visitation model. These values should be considered when evaluating Everglades restoration, particularly to local residents who derive pleasure from the increased number of animals residing around their homes. To fully capture the value of the impact of restoration on wildlife habitat and hunting, we summed the values from habitat and hunting calculations. Our best estimate is that Everglades restoration will increase wildlife habitat and hunting services by $407.4 million annually.

As a final word about habitat and hunting, it is important to note that the impact on hunting will only be negative if significant numbers of deer hunters do not transition to duck hunting as duck populations expand. The experience with Holey Land restoration suggests that it is complicated to forecast the impacts on hunting associated with expansive additional CERP restoration. On the one hand, it appears that additional duck populations attract people to duck hunting, and this is reasonable from the point of view of economic theory. It may also be true that existing duck hunters will chose to hunt locally more often and forego trips to distant duck hunting areas such as Louisiana, but we cannot estimate these shifts with any precision. In order to be conservative, we have assumed a very low elasticity of substitution between deer and duck hunting and a low elasticity of new duck hunters. Accordingly, our negative estimate on hunting is probably biased, and the likely outcome is not so dire. Additional information on hunter switching could refine this estimate.

Other Everglades Valuations, Miscellany

There are four broad areas of ecosystem services that, at present, we have not conclusively valued that might be forthcoming or enhanced as a result of Everglades restoration: the potential for carbon sequestration, potential fire-damage reduction, the potential for enhanced water purification, peat accretion and soil build-up, and the option value of unknown compounds and life forms living in the Everglades. While these values

stand to be real and to change in important ways as the Everglades are restored, we are not prepared at this point in time to offer estimates of the pro forma financial calculations for two reasons. First, the science of these services is somewhat unsettled and unclear, compared to the other services, and second, the markets for these services are immature and undeveloped. Hence, while there is rampant speculation about how these services might be highly valued and special, we are not presently prepared to put hard numbers to these theories, regardless of what they might turn out to be.

We can note that if the world moves to a market for carbon sequestration, and such markets are developing, the amount of carbon sinking in the Everglades could be important. Our best estimate at this time is that the amount of carbon sequestered is small, but we have low confidence in that assessment. Moreover, the future of these markets is highly uncertain. So basically, while we acknowledge the potential for important values of carbon sequestration services and changes that might flow from restoration, in order to maintain our conservative stance, we will not add any hard numbers. As time proceeds, we will revisit our position on this topic.

Another topic for further study is the potential for Everglades restoration to improve South Florida's water quality in ways not captured by our real estate and recreation value estimates. Because wetland ecosystems are known for effectively filtering nutrients, we suspect a restored Everglades would produce significant cost savings in water treatment and create opportunities to improve poor water quality. In particular, we have researched the potential for CERP to reduce water quality treatment costs, beach closures and health impacts in South Florida. However, we have chosen to omit the corresponding valuations from this report because there exists significant disagreement in the scientific community over the connection between nutrient reductions and such water contamination cost drivers as harmful algal blooms, beach clean-ups, and shellfish poisoning.[30] Like carbon sequestration, this topic should receive additional attention as this research continues and progresses.

A third topic we might investigate further is the potential value of unknown compounds and life forms in a restored Everglades. These are commonly called "biodiversity values," and we have found evidence of nascent markets in biodiversity. Michele Zebich-Knos reports on a contract between Merck Pharmceuticals and INBio, an NGO in Costa Rica for biodiversity development.[31] The amounts of money at play in this market are not fully public. We are confident that there are others, and this appears to be a fertile area for

[30] See Chapter 7 in the main document for additional discussion on this topic.

[31] "Preserving Biodiversity in Costa Rica: The Case of the Merck-INBio Agreement." *The J. Of Environment and Development*, 6(2)(1997).

further analysis. At present, however, given the high levels of uncertainty, we are not prepared to put hard and fast estimates to these option values. Given the scientific and policy uncertainty over these topics, our omission makes our valuation estimates more robust. However, future work should probably pay close attention to developments here.

There is speculation that the current Everglades is more fire prone because of reduced sheet flow. Fire has been a part of life throughout the nature history of the Everglades, but the real issue here is: How might one go about modeling the reduction of fire and then estimating the economic impact of fewer and less severe fires? According to our principle of a conservative approach to estimating benefits, we refrain from including any air quality or other impacts that a restored Everglades might have on fire duration, intensity or frequency. With that said, we suspect that a restored Everglades might likely have fewer fires or ones of less severity. And, we know that fire can create negative economic impacts. Fires in the Everglades, as they do elsewhere, cause air quality issues via smoke, plus they stand to destroy valuable property. Thus, reduced fires, if they were to be a result of Everglades restoration, would count as an additional benefit. Clearly, additional work is warranted here.

Impact On Job Creation And Earnings

Restoration of the Everglades through the implementation of CERP will impact jobs in the state of Florida. Changes to the different ecosystem services in the Everglades will impact the number of jobs in a variety of industries and the economic activity they generate. In addition, the Corps of Engineers estimates there will be 22,000 jobs created as a result of the actual restoration projects.[32]

It is very important to understand that jobs are *not* an additional benefit above and beyond the present value calculations we have already presented. Instead, they are an alternative way of representing the overall change that is likely to be forthcoming from restoration. Economists often speak of a circular flow of economic activity where firms purchase inputs (land, labor, capital and the like) from households in order to engage production. As compensation for the release of these inputs, households are paid income (sometimes broken into finer gradients called wages, interest, rents and profit). Firms then sell the outputs made from the inputs to households in exchange for money. According to this logical truism, one may count the sales of the goods and services as one measure of the output of the firms, but one might also count the value of the inputs consumed. They have to be equal by the accounting identity. Jobs then are a loose or casual way of talking about the extent of economic activity being one of the primary

[32] See Kopecky report, January 22, 2010.

inputs to production (and hence consumption). Most academic economists would prefer to discuss the sales of the output of the firms rather than the jobs used in production, but for some reason or another, policy makers, pundits and politicians seem to prefer the jobs numbers approach. For sure, jobs are easier to calculate and perhaps easier for lay people to appreciate. Our point here is to respond to that latter audience, but it would be a *big* mistake for anyone to interpret our discussion here as additive. The jobs are *not* in addition to the calculated benefits. They are an alternative way of visualizing the impact of Everglades restoration. We urge the reader to be careful and cautious on this point.

Our approach to estimating net job creation relies on an input/output model that uses data generated by the key components of this study (inputs) to estimate the number of incremental jobs and earnings as a result of CERP (outputs). We calculated outputs using jobs and earnings (or total economy) multipliers from different sources. Unless otherwise specified, we used total economic output multipliers to reflect the impact on the broader economy (direct, indirect and induced jobs). In some cases, we used only direct multipliers to avoid overlap (double counting) among the different sectors. We used the following key inputs and multipliers:

Commercial Fishing

- Input: Incremental dockside value of commercial fisheries (finfish, invertebrates and shrimp).
- Multipliers: Fishing producer employment multiplier (jobs/$ billion export value) from the USDA Economic Research Service and Total Economy multiplier.

Recreational Fishing

- Input: Incremental saltwater and freshwater anglers and expenditures in the Everglades region. We used a modified (50 percent) tourist (visitor) yearly growth-rate to determine the increase in anglers to the region (using the 2 percent tourist growth scenario). The incremental number of anglers (over a growing base) due to a restored Everglades was multiplied by average yearly "fishing-only" expenditures (to avoid overlap with tourism—shopping) to calculate incremental expenditures.
- Multipliers: Employment (jobs per $ million) and earnings (not total economy to avoid overlap with tourism) from Tony Fedler's report: "The Economic Impact of Recreational Fishing in the Everglades Region."

Residential Construction & Real Estate Services

- Input: Incremental value (from the "Potential Value Increase based on 23 percent Improvement in Water Quality" scenario) and subsequent activity in residential construction and real estate services. Elasticity between "increase in real estate value" and "increase in construction activity" was set at 0.5.

- Multipliers: Residential construction and real estate multipliers (Direct + Indirect + Induced) we calculated from "Shimberg Center for Affordable Housing; THE IMPACT OF RESIDENTIAL REAL ESTATE ON THE FLORIDA ECONOMY; 2005 update (Using Roll Year 2004 Property Appraiser Data)."

Park Visitation

- Input: Incremental visitors and expenditures in local park visitation by specific NAICS sector:
  - Hotel and lodging
  - Eating and drinking establishments
  - Transportation
  - Retail trade (shopping)
  - Entertainment
- Multipliers: Total effects multipliers from the REMI II model (from the MGM2 model, the University of Michigan). We utilized Large Metro, Small Metro and Rural multipliers depending on the specific county.

Agriculture

- Input: Decrease in crop acreage (mostly sugar cane = 88%) due to repurposing for stormwater storage and treatment. We used the EAA Water Retention Scenarios – Agricultural Income Loss model (Marcel Aillery, et al) to determine the present value of income loss in an STA+RS (Stormwater Treatment Area + Reservoir = 83,500 acres) scenario. We used a 2.5 adjustment factor to include other crops and potential further land acquisitions.
- Multipliers: We used the USDA Economic Research Service "Sugar Cane and Sugar Beets) producer employment multiplier.

Table 8.1. Summary of Jobs Impact Results

Sector	Incremental Jobs
Commercial Fishing	6,798
Recreational Fishing	36,868
Residential Construction & Real Estate Services	273,601
Tourism (Lodging, Eating & Drinking, Transportation, Retail, Entertainment)	48,552
Agriculture	(3,724)
Wildlife Habitat & Hunting	80,569
TOTAL	**442,664**

In addition to the jobs created by the impacts restoration, there will be jobs created to do the actual work of restoration. The Corps of Engineers estimates that there will be approximately 22,000 jobs created in the construction projects detailed below in Table 8.2 as reported in Kopecky (2010). Table 8.2 is reproduced, unaltered, from that report.

Table 8.2. Direct Job Creation as a Result of Construction, COE Estimates[33]

Appropriation requests were run through IMPLAN (Minnesota IMPLAN Group) software. This is an input-output analysis that attempts to project employment, output and earnings for a given change or event in the economy's activity. This model is typically set up to run at regional levels, but contains a National function as well and this is what was analyzed. There are three types of effects

- **Direct effects** take place only for the industry immediately affected:
- **Indirect effects** concern inter-industry affects
- **Induced effects** measure the effects of the changes in household income. These changes effect the related industries employment.

The category of construction used was Sector 36 (Construction of other new non-residential). This is the closest to our construction technique.

South Florida Water Management District
Job Creation in Everglades Restoration
AS RUN BY COE USING IMPLAN
February 1, 2009

Project	Appropriation Request	Direct	Indirect	Induced	Total
Herbert Hoover Dike Rehabilitation **(3)**	$77,000,000	645	382	510	**1538**
C-44 Reservoir and STA	$363,000,000	3042	1801	2406	**7249**
C-43 Reservoir **(1)**	$473,000,000	3963	2347	3135	**9446**
Kissimmee River **(3)**	$31,000,000	260	154	205	**619**
Picayune Strand /FAKA Union Pump Station Works and Road Removal	$57,000,000	478	283	378	**1138**
Picayune Strand /Merritt Canal Pump Station Works and Road Removal **(3)**	$52,000,000	436	258	345	**1038**
C-111 Spreader Canal	$35,000,000	293	174	232	**699**

[33] See Kopecky (2010) which is reproduced here exactly.

C-51/STA1E	$8,000,000	67	40	53	**160**
L31 North Seepage Pilot Project **(3)**	$5,000,000	42	25	33	**100**
Seminole/Big Cypress **(3)**	$3,000,000	25	15	20	**60**
TOTALS(SFWMD PROVIDED)	**$1,150,000,000**	**9636**	**5707**	**7623**	**22966**

On Restoration Costs

Since CERP was ratified 10 years ago, it has become obvious that certain aspects of it were either unreasonable or inappropriate. Accordingly, for this analysis, the original CERP storage projects have been replaced with an alternative storage approach. This adjustment was made due to reasonable doubts that have been raised regarding the feasibility of the original storage options and their estimated costs. In addition, there exists a viable alternative storage method with sound cost estimates. CERP's original cost estimate included costs for the Lake Okeechobee ASR, In-ground reservoirs, and the EAA reservoir. In 1999 dollars, these three projects cost $2.6 billion, which represented 33.2 percent of the total $7.8 billion CERP cost. Since the original plan was completed, the feasibility and costs of these storage options have been reconsidered, and it is likely these costs were underestimated by a considerable amount. For our cost estimate, we have removed these costs from the CERP estimate and replaced the three storage projects with the River of Grass Reservoir storage option that has an estimated cost of $3.2 billion in 2010 dollars. The net effect of these changes is to adjust the total Everglades restoration costs to $11.5 billion in 2010 dollars.

Notes

Diamonds and Water

Economics has a conundrum called the diamond-water paradox. This conundrum ponders why diamonds, which are so unnecessary to life, are so valuable while water, so necessary, is so cheap. The paradox is resolved by noting that the prices of diamonds and water are *marginal* valuations to society of an additional unit of each, *not the total or average value*. The implication of this line of reasoning is profound. For instance, professional football players earn a much higher salary than do high school teachers, yet it is almost surely true that the value of high school teachers to the world exceeds the total value of football players. Marginal values do not reveal total values.

So it is with ecosystem services (or any other product for that matter). Accordingly, if we were to capture the *total* value of Everglades restoration, we would have to engage a

more complicated and detailed process. Suffice to say here, our estimates are not total estimates. They only capture a portion of the total value of restoration. There is considerable consumer surplus, to use economic jargon, that is not captured by our methodology. Thus, our approach understates the total value to society of spending resources to restore the Everglades. Indeed, based on other studies, our gut feeling is that the true total benefits are several times larger than our marginal valuation estimates.

Consider Figure 2. Our calculations reported here effectively estimate the shaded area labeled E. There is potentially a much larger area, labeled CS, that represents economic well-being, or willingness to pay, which buyers or consumers of services obtain without paying for them. We call this consumer surplus. It is the unrequited or unpaid-for happiness that a consumer gets from a purchase, *above and beyond the purchase price.* We have not attempted to estimate this component of economic system services, but as the graph suggests, the area of CS can be substantially larger than the area of E, depending upon the price elasticity of demand for the particular service. As our work progresses, we will attempt to assay and estimate these valuations. They are important to any properly conceived analysis of economic wellbeing or welfare.

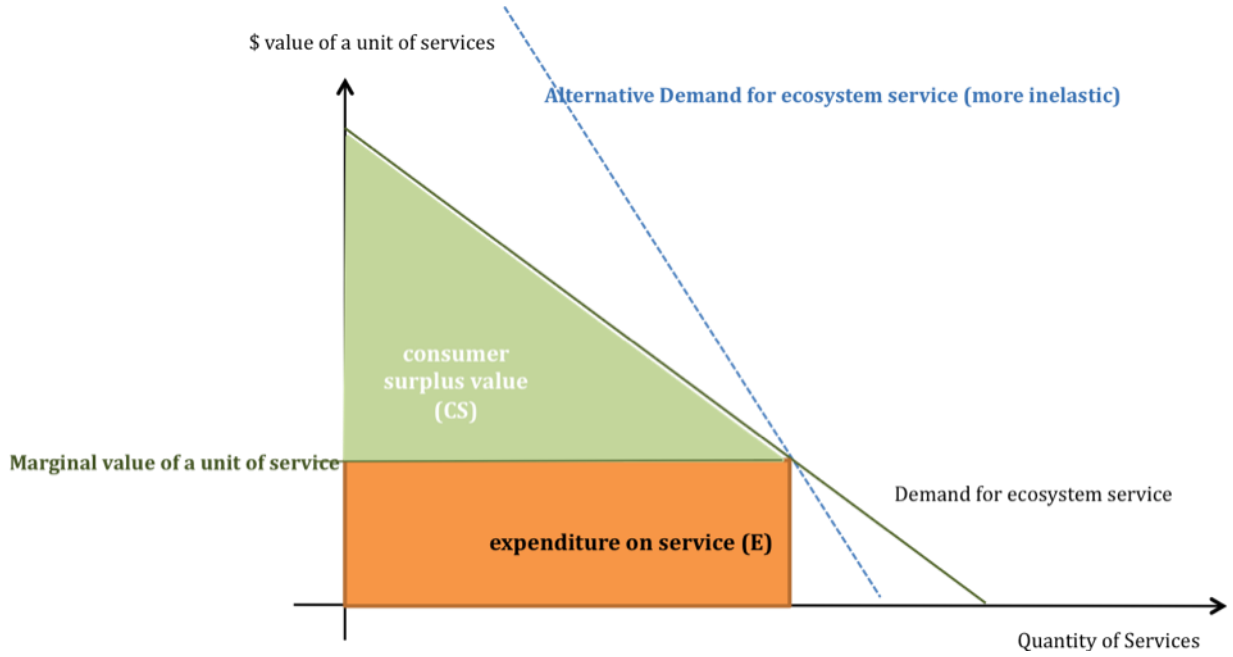

Figure 2 Product expenditure and consumer surplus

Regarding the effect of restoration on jobs, from the point of view of economic well-being or welfare, the important consideration is not total jobs, but incremental welfare

above and beyond the opportunity cost of time or leisure. In a way similar to consumer surplus, most workers are paid wages higher than the underlying value of their time. This is called economic rent or producer. This is measured by the triangle above the supply curve of labor. Therefore, while many people view jobs as an economic good, the real increase in welfare comes not from employment, but from wages higher than the lost alternatives of leisure or home production. We have not estimated these additional benefits in our analysis, but suffice to say that, like the uncounted consumer surplus we mention, it stands to be important and non trivial. Our omission of this additional welfare makes our estimate of return on investment even more conservative.

Outrunning the Bear

At the outset of this evaluation, we promised to execute our assignment according to best practices and methods of economic science. We believe we have lived up to this promise, and we invite all readers to evaluate our success. It bears noting that one of the time-honored tenets of economic methodology, owed to Nobel Laureate Milton Friedman (and many others) is the concept that it takes a theory to beat a theory. In this spirit, while readers may criticize or disagree with our assumptions and techniques here, any such complaints will fall on deaf ears unless a superior alternative is proposed. Put bluntly, we will not accept criticism that simply says, "Your assumptions are wrong." Let the critic propose adequate or superior alternatives. What this means in practical terms is that our work need not be perfect in order to be useful and acceptable. It just needs to be better than the rest. This does *not* mean that we believe we have done our job as well as it can be done. Rather, it is meant to convey that our minds are open to suggestions of better ways to do this project but not to simple statements that our work is wrong or incorrect. The Olympic Gold Medalist need not set a world record to climb to the top of the podium at the medal ceremony. She only need outrun the woman in second place. Of course, we hope that each piece of our work "sets a world record," but we will sleep soundly if our work is better than any other work tendered or suggested.