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ORIGINAL ARTICLE

Using historical information and data to strengthen planning for environmental protection and management at Everglades National Park, South Florida

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Abstract

The early environmental conditions in many national parks fit the favorable description given to Everglades National Park (ENP) at the time of its founding that the park's wilderness and ecological resources were "superlative in value." With the understanding that wilderness does not mean complete human exclusion, this study examines the possibilities, interests, and difficulties associated with establishing the historical superlative state of the park's resources as a target for current restoration efforts. The focus is specifically on ENP, as the park's existence was considered justified only if its superlative and pristine wilderness conditions could be retained in the future. Data were gathered from 18 historical documents obtained from the ENP museum and the online archives of the library shared by Florida International University and the University of Miami. The 1979 Master Plan, 2000 Comprehensive Everglades Restoration Plan (CERP) and other literature provided planning information. Qualitative data analysis was performed using NVivo 11. The findings indicate that the current restoration targets are heavily influenced by shifting baseline syndrome and that outcomes fall short of no net loss of environmental resources. Therefore, the restoration targets not based on the region's resources during the predrainage period are technically achievable but cannot produce a restored ecosystem in the long term. This study concludes that that planning initiatives should go beyond pollution reduction strategies to include historical conditions and acquisitions of conservation lands as targets for ongoing restoration efforts.

Keywords Historical information · Ecological · Restoration · Water · Self-replenishing

Introduction

The changes leading to the poor quality and management challenges of environmental resources in the Everglades region of South Florida span more than 150 years and involve a variety of land-use modifications and growth and development activities. These changes began in 1900 but accelerated in the late 1940s with the creation of the Central and South Florida Project (C&SF Project) designed to meet the rising demand for water and to control flooding. This, alongside the growing human population, urban pressures, and agricultural and other economic developments, has driven the ecological boundaries of the region beyond self-replenishment limits and degraded the natural environment (Trexler et al. 2003). As a result, several conservation management approaches from as early as the 1970s have been tried, and many new approaches are constantly being implemented (Carter 1974, pp. 314). For example, Everglades National Park (ENP) was authorized in 1934 and dedicated in 1947 to protect the natural environment by keeping human and commercial interests at a safe distance. The South Florida experience can be seen in many other protected areas across the globe.

ENP was established to protect what remained of the Everglades and for biological reasons, especially to protect environmental resources from economic development pressures from outside the park (Master Plan 1979; Carter 1974, p. 82). At the time of the park's founding, the resources were described as "superlative in value with existing features so outstanding that if they can merely retain the status quo when protected, the job was a success" (Beard 1938, quote from

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Director Cammerer). The founders of the park argued that "there would rather be a park that may not measure up to what people would want to see, but which, after 50 or 100 years with all the protection that is provided would give the area a natural condition comparable to primitive conditions" (Beard 1938, quote from Director Cammerer). However, most activities outside of the park—pollution from agriculture and urban pressures—have a direct impact on the quantity and quality of natural resources inside the park.

At approximately the same time, ENP was established, and the C&SF Project was created to manage canalization and various constructions to drain and control flooding and create an environment suitable for human settlement, agriculture, and economic development (Davis and Ogden 1994; Ogden 2008). The results of canalization led to the now severely degraded wetland habitats across South Florida (McVoy et al. 2011; Trexler et al. 2003; Hinrichsen 1995). The development impacts of the C&SF Project beginning in the late 1940s led to the creation of the Local Government Comprehensive Planning Bill of 1974 (Carter 1974) and the current Comprehensive Everglades Restoration Plan (CERP) of 2000. The CERP has faced and continues to face declining water quality and quantity challenges, economic and conservation conflicts, declining species diversity, and various other policy constraints (National Academies of Sciences, Engineering and Medicine 2016, 2018).

Writing much earlier than the CERP was developed, Carter (1974) argued that growth policy and comprehensive planning were difficult to implement in the Everglades. It was difficult in the mid-1970s to bring growth and development under control, and the same is true today. In 2011, the Central Everglades Planning Project (CEPP) was created to provide more water flow to the central Everglades than what had been envisioned by the CERP. However, without historical data, narratives, stories, or experiences to help with the construction of goals and restoration targets, the entire Everglades planning project might be experiencing what Pauly (1995) called "shifting baseline syndrome" (SBS). SBS refers to an approach where existing environmental conditions are used as a baseline against which restoration programs are measured, ignoring the initial state of the resources.

The targets under these conditions may correspond to resources that have suffered significant degradation; therefore, when the degraded resources are used to set targets, the desired outcomes may not be met. The primary question is therefore the following: Will the CERP or any other plan currently in the works meet restoration goals to achieve close to a functioning ecosystem or protection that meets the conditions set when ENP was established? There may be no clear answer to this question, as there is consensus in the literature that restoration outcomes may not always attain the historical quality of natural resources. The CERP was formulated based on predrainage conditions (NAS 2018), but moving resources towards the predrainage quality and quantity has proven difficult. Because of other factors, such as sea-level rise as a result of climate change, current restoration reviews recommend abandoning the use of predrainage conditions as restoration targets. Quoting from William Boggess, the chair of the Committee on Independent Scientific Review of the Everglades Restoration Progress (NAS 2018), "Everglades restoration has always been an ambitious and complex endeavor; the current review emphasizes how it is also dynamic and the importance of focusing restoration on the future Everglades, rather than on the past Everglades."

The aim of this study is to explain why it is important to incorporate historical conditions of the region with the current ongoing protection and restoration efforts in order to achieve better conservation outcomes. The writings of the people who were in the Everglades before serious modifications were made are valuable sources of data for creating targets. Zedler (2005) argues that all components of an ecosystem must be in place and functioning naturally for a restoration project to be considered complete. Therefore, there is a need to examine the possibilities, interests, and difficulties involved in establishing such early superlative conditions as planning targets, with the aim of attaining some significant level of ecosystem restoration. The idea of establishing and maintaining restoration goals that resemble historical conditions in parks has been questioned and is considered untenable (NPS (National Park Service) 2006; Hobbs et al. 2010). However, leaving out historical information on natural resources is explained by SBS theory: planning targets that neglect historical information ignore the fact that, as resources degrade, so do restoration targets.

This study contributes to the literature by putting into perspective (i) the critical importance of historical conditions as targets for restoration efforts, (ii) the gaps in restoration activities as the CERP continues to adapt and address ecosystem restoration challenges, and (iii) the philosophical concept of not abandoning the predrainage resource conditions as restoration targets because there are no other environmental conditions that can offer the same, similar, or better environmental services to both humans and all other species. The moral duty of all stakeholders is to use restoration targets that will not reduce the quality of environmental services. This means considering targets closer to the initial baseline of the region's resources. It is therefore important to look at the entire Everglades region as an ecosystem with vital relationships and interdependencies whose integrity and continued ability to support all forms of life rest on conservation efforts inside and restoration activities outside of ENP. Although the CERP aims to "improve South Florida's ecosystem by restoring water flows that have changed tremendously over a period of 100 years" (McVoy et al. 2011), the study demonstrates how SBS (Pauly 1995) is playing out in the implementation of the 2000 CERP.

The next section explains SBS and why the historical quality of a natural resource is a better target than some other quality to use for restoration efforts. This is followed by a review of the existing literature and attempts to link Everglades policy research and restoration outcomes. Then, a discussion of the methods and techniques of qualitative research, specifically inductive and deductive approaches, follows. The findings are then presented, and a strong case for using historical conditions alongside scientific data for restoration targets to produce the best restoration outcomes is made. A discussion section follows, and the final section presents conclusions, recommendations, and future research possibilities.

Shifting baseline syndrome theory—why historical accounts are important

Although pristine conditions may not be recreated exactly as they existed in the past, it is critical that restoration initiatives avoid SBS. The incorporation of the historical conditions of key resources as targets to the greatest extent possible in current Everglades restoration plans may be the best policy approach to ensure viable ecosystem restoration outcomes. SBS occurs when scientists adjust restoration targets used to protect resources to conditions that exist during their own generation rather than to historical conditions. The concept of SBS was first used by Daniel Pauly (1995) when he referred to the idea that people's views of pristine conditions tend to shift with every generation, making it difficult to see losses from one generation of scientists to the next. Using fish stocks as an example, he explained that each generation of fishery scientists accepts, as a baseline, the stock size and species composition that existed at the beginning of their careers and use them as a baseline for evaluation. Fisheries have continued to be depleted from one generation to the next, but it is difficult to see the decline, as the new baselines are based on depleted stocks. Trexler et al. (2003) argue that since true historical conditions rarely exist, scientists can recreate historical conditions by describing reference areas or through simulation modeling. This speaks to the significance of historical targets.

Some of the literature contends that restoration to historic levels of resource quality is not achievable and is out of date, as those conditions are too remote in time to use when establishing future restoration targets (Jansen et al. 2016; Hobbs et al. 2010). Other literatures argue that recreating historical pristine and wilderness conditions exhibits respect for "primeval nature" and is a novel undertaking intended to justify the correct policies with interventions that can have greater positive impacts on restoration outcomes (Hobbs et al. 2009). The choice of targets for the CERP and the latest CEPP should therefore include more than just "getting the water right." The concept of "getting the water right" has been described as a fantasy, in part because of the continued worsening relationship between water supply and demand (FDEP 2017; Cattelino 2015).

Given the extent of ecological degradation thus far and impending climate change impacts, Koch et al. (2014) call for a new paradigm that can improve the resilience of the entire ecosystem. Policies that address the underlying causes of water supply and demand conditions and that relate past activities to current plans and future uncertainties can serve to produce better ecosystem restoration outcomes (FDEP 2017). Historical documents and data that explain historical conditions provide reference points that reveal changes in the context of time as well as access to the original records of conditions during the premodification period (Alagona et al. 2012; Grinnell 1910; Hobbs et al. 2009). Such records form the best foundation upon which to set planning targets for restoration.

Through the lens of ecological restoration theory, Falk et al. (2006) define restoration as an attempt to return an ecosystem to some historical state. Falk et al. (2006) also recognize that it is impossible to return a degraded ecosystem to its historical conditions. Therefore, the use of technology, as seen in the greater Everglades, may not compensate for the loss of wilderness conditions and water resources, as these have no viable substitutes (Brennan and Lo 2010, p. 24). The extent to which the CERP provides the capacity for the region to maintain wilderness spaces and sustainable access to a wide variety of high-quality and abundant environmental resources is not so promising because of differing stakeholder needs that are extremely difficult to reconcile. Therefore, the current technological approaches to restoration are designed with a function in mind, that is, to provide instrumental value in order to meet the needs of humans outside of ENP (Brennan and Lo 2010, p. 127) and not the needs of the natural environment for the greater Everglades.

Data and methods

ENP is located at the southern tip of the Florida peninsula and covers 1,542,526 acres of land, approximately half of the area once occupied by the Everglades. Efforts to establish the park were initiated by Ernest F. Coe in 1928 through the Tropical Everglades National Park Association, which was later renamed the Everglades National Park Association (ENPA). Congress authorized the Everglades as a national park project on May 10, 1934, and it was officially dedicated as a national park on December 6, 1947, by President Harry S. Truman (Master plan 1979). It is the third largest national park in the USA, exceeded in size only by parks in Alaska. Originally, the Everglades was a wilderness area covering three million acres from Orlando to Florida Bay, but it has since been reduced to 1.5 million acres of protected ENP land farther to the

southeast. The park itself is intended to be a wilderness of wetlands containing sawgrass marshes, freshwater sloughs, mangrove swamps, pine rocklands, and hardwood hammocks.

Data sources

Data were obtained from 18 historical records, the complete 1979 Master Plan, and the 90 pages of the 2000 CERP known as the "Science Plan in Support of Ecosystems Restoration, Preservation, and Protection" from May 2000, FDEP (2017) and Weisskoff (2005). The sources comprise historical records archived at the Everglades museum, on the ENP website, and in the digital library shared by Florida International University and the University of Miami. Table 1 shows the complete list of data sources. Water supply and demand projection data were obtained from chapter 3 of Weisskoff's (2005) textbook and the Florida Department of Environmental Protection website (FDEP 2017).

Methods

The study used both inductive and deductive grounded theory approaches to explore and analyze data. To understand how much has changed and how those changes have impacted and continue to impact the entire region, the study took an interpretive approach to explore the key historical concepts. Concepts such as wilderness, pristine, preservation, conservation, park, and flooding were used to examine the effectiveness of planning efforts and the nature of the outcomes of the restoration process in the entire Everglades region (Saldana 2013; Gibbs 2007).

An inductive approach was used to explore historical writings, the 1979 Master Plan, the 2000 CERP, and the most recent literature to categorize early and current Everglades conditions and assess how these conditions relate to restoration goals and the expected outcomes (Charmaz and Belgrave 2012; Thomas 2006). The categorization of early and current conditions helps show the different realities of the entire Everglades region. Reality here has two meanings: (i) it shows how the entire region of the South Florida ecosystem has changed and (ii) the current state of the remainder of what was once the Everglades. This was necessary because it was one way to identify the existence or lack of specific activities that are designed to drive "the recovery and preservation of the South Florida ecosystem. A recovered ecosystem is one that once again achieves and sustains those essential hydrological and biological characteristics that defined the undisturbed South Florida Ecosystem" (NAS (National Academies of Sciences, Engineering, and Medicine) 2016, 2018).

To be able to see the connection between this reality and the categorization of various key concepts, a review of historical writings was built upon current research on water management science, techniques, and innovation. This study employed a postpositivist grounded theory as a means of understanding the emerging relationships (Charmaz and Belgrave 2012; Thomas 2006) between various policy approaches to conservation and the use and management of natural resources inside and outside ENP.

A historiographical representation of three critical time periods when the Everglades experienced the greatest natural resource management changes is shown in Table 2. These periods include (i) the period leading up to the establishment of ENP, defined in this study as the predrainage period; (ii) the period between when ENP was established and when the CERP was created, defined here as the drainage period; and (iii) the period from 2000, when the CERP was created, to present day, defined as the restoration period. Basic resource conditions are described during these three periods to show the level of resource degradation and the ecosystem restoration targets in 2000, the present, and the future.

A deductive analysis of water supply (SS) and demand (DD) projections was conducted. This was necessary to demonstrate the extent to which restoration activities impact the water supply and demand conditions. The water supply and demand trends and projections (FDEP 2017; Weisskoff 2005) from 1970 to 2035 were compared. Demand was estimated from six sectors, namely, public supply, domestic supply, agriculture, landscaping/recreation, commercial/industrial, and power generation, while supply estimates included the following sources: rainfall, surface flow, and underground water aquifers in million gallons per day (MGD) (FDEP 2017).

The supply projections were estimated in MGD based on six water use categories: public supply, domestic self-supply, agriculture, landscape/recreation, commercial/industrial needs, and power generation (FDEP 2017). Current water sources include rainfall, surface storage, and underground aquifers. Analysis of the drivers leading to water demand outpacing supply and various strategies for managing both the demand and supply are not the focus of this study. The quality and amount of water available to the population and various sectors of the economy are good indicators of the park's survival and restoration outcomes in the greater Everglades (2000 CERP). Using water supply and demand, a projected comparison of the expected future trends of water in the region was performed, as shown in Table 3. This comparison puts into context the challenges of restoration efforts in trying to provide a water supply.

The CERP was created as a response to the failure of the C&SF Project, which was created in the late 1940s because the latter's goal "to meet water supply and protection needs of 2 million people was increasingly failing to meet the needs of 6 million people in 1990s" (Ogden et al. 2003, p. 138). Population growth has averaged approximately 700 people per day (NAS 2018). At

Table 1 Details on the data sources

Writer/sources	Description
Model Land Company	Founded by Henry Flagler to acquire public lands and transition them into development.
Newspaper clippings from 1920	These collections contain photocopies of newspaper articles and web-based news articles on the developments and changes that have taken place in South Florida national parks.
Marjory Stoneman Douglas	Long-time defender of wilderness areas in the greater Everglades.
Ernest F. Coe	Leader in the establishment of ENP.
Minnie Moore	An advocate of the Seminole Indians of Florida.
Governor Caldwell	Governor when ENP was dedicated.
William Shelton	Wrote one of the research papers on the impact of agriculture on water pollution in the Everglades.
James Carson	Staunch supporter of the drainage and reclamation of the Everglades for developmental purposes.
Senator Claude Pepper	Supporter and senator in 1947 at the time of ENP dedication.
James Franklin	Landowner with interests in several townships who helped build the road networks to support development.
Daniel Beard	First superintendent of ENP.
University of Miami presidential letters	Sought to maintain the Everglades in a natural state to serve as a laboratory for university research.
President Truman	President at the time ENP was dedicated; his speech was instrumental in the protection of the Everglades.
C&SFFCD/SFWMD	Central & South Florida Flood Control District that later became the South Florida Water Management District, which was created to manage floods, water resources, the water supply and natural systems.
Superintendent reports	From 1947 to 1968; cover meetings and planning by park managers regarding day-to-day operations.
Photographs	Pictures stored in the museum that show the early conditions and states of the natural resources.
Park Commission papers	Executive meetings of people who sought to have ENP established.
Research papers	Collections of published research studies on a variety of natural resources such as wildlife, water, and vegetation as well as fire and its effects.
1979 Master Plan	Ties the historical accounts of natural resources to expected future changes in the Everglades.
2000 CERP	Latest restoration plan evaluated by this study. Its primary goal is to "get the water right."
SFEAP 2000	South Florida Ecosystem Assessment: Everglades Water Management, Soil Loss, Eutrophication and Habitat
Florida Department of Environmental Protection (2017)	Water supply and demand trends and projections
Weisskoff R (2005), textbook, chapter 3	Water supply and demand trends and projections

the same time, developed land is also expected to increase from 6.4 million acres in 2010 to 11.6 million acres in 2070 (NAS 2018). Table 3 shows the actual water demand in MGD from 1970 to 2015 and the projected demand from 2015 to 2035 (FDEP 2017; SFWM 2017; Weisskoff 2005, chapter 3). In this context, the projected water demand increases by approximately 108% from 2000 to 2035 (Weisskoff 2005, p. 72). The current freshwater SS is approximately 3500 MGD, whereas the DD is 23,000 MGD. The SS and DD are projected to be 3800 MGD and 26,000 MGD, respectively, by 2035. This level of demand will likely put the current water sources and the entire South Florida ecosystem under severe stress unless supply sources are improved and diversified. Similar to the C&SF, as of 2019, the CERP was failing to meet the water needs of 8.2 million people.

Table 2 Historiographical conditions of the Everglades

Resource condition measurement variables	State of natural conditions and greatest influences		
	Predrainage period/least human interference Time leading up to the establishment of ENP (1900–1947)	Drainage period/serious human interference Time from when ENP was established to when the CERP was created (1947–2000)	Restoration period Time from when the CERP was created to 2020
Human population	By the end of this period, 500,000 people lived in South Florida	By the end of this period, 6 million people lived in South Florida	As of 2018, there were 8.2 million people living in South Florida
Ecosystem health –wilderness, habitat, and soil and water quality and quantity	During the early 1900s, there were no canals, and the Everglades (i) "was defined in part by water: highly seasonal rainfall; slow, unimpeded, sheet-like water flow; and a large storage capacity that prolonged wetland flooding" (SFEAP 2000); (ii) "contained the largest single body of organic soils in the world covering 3000 mile^2 and accumulating up to 17 ft in thickness" and (iii) "ecosystem was nutrient-poor leading to a diversity of wildlife habitats, such as sloughs, sawgrass marshes and wet prairies of well-developed periphyton communities" (SFEAP 2000).	By 2000, 50% of the Everglades wetlands had been irreversibly drained using extensive construction of canals and levees that impeded the natural flow of water (SFEAP 2000). The region experienced serious soil losses due to agricultural practices to the extent that the median organic soil thickness was 4.2 ft (SFEAP 2000). There was a significant increase in nutrient (carbon, sulfur, nitrogen, phosphorus and mercury) loading from agricultural areas with "eutrophic impacts on periphyton communities, low dissolved oxygen in the water, conversion of wet prairies and sawgrass to cattail and diminished wading bird foraging habitat" (SFEAP 2000).	"The CERP is focused on restoring, preserving, and protecting the south Florida ecosystem while providing water to other related needs" (NAS 2018). However, more than 50% of the water that flowed south "towards the ENP through ridge and slough wetlands, marl prairies and saw grass plains is now diverted to other uses or the ocean and does not reach its historic destination" (NAS 2018). "The quality of the water remaining in the system is compromised by high nutrients (carbon, mercury, sulfur, phosphorus) and other contaminants from urban, agriculture and industrial development, and has adversely changed land formation and vegetation patterns" (NAS 2018).
Restoration efforts	This was a period of strong competing interests between those that wanted to see the Everglades region remain in wilderness and pristine conditions and those who wanted the area to be drained and made suitable for agriculture and human settlements (Gonzalez 2005).	In 2000, the South Florida Ecosystem Assessment Project (SFEAP 2000, pp. 19) recommended that "evaluation of restoration success must be based on a reliable pre-restoration baseline for ecosystem conditions."	NAS (National Academies of Sciences, Engineering, and Medicine) (2018), the latest review of the progress towards restoring the Everglades, recommend that "rather than focus on restoring to predrainage conditions, should instead focus restoration on the future of the south Florida Ecosystem.

Findings

Historical data for the Everglades are abundant, spanning more than 100 years. The collections at the museum consist of 700 linear feet of records related to natural resource management that date as far back as the early 1900s. These collections contain information about the changes that have taken place and the state of natural and cultural resources. There are also records on the maintenance of the facilities in the park, the administration of the park, interpretations of the park's early history and the educational purpose of the park.

The major collections fall into two categories. First, collections from people who advocated for the protection of the Everglades include the papers of Dr. Bill Robertson, who was a research biologist at the park for 40 years, as well as those of Marjory Stoneman Douglas, Ernest F. Coe, and Daniel Beard. Mr. Coe is known as the father of the Everglades, as his efforts were the major impetus behind the establishment of ENP, and Mr. Beard was the first superintendent of the park when it was established. Second are collections from the people/entities that wanted the Everglades drained and converted into a commercial agricultural region.

Table 3 South Florida water demand and supply projections

Years	1970	1975	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025	2035
Water SS	800	1200	1400	1600	1850	2000	2400	2900	3150	3300	3500	3700	3800
Water DD	5000	5100	12,500	11,000	14,000	13,000	14,500	17,000	18,000	22,000	23,000	25,000	26,000

Source: FDEP 2017; Weisskoff 2005, chapter 3

These people include James Carson, an attorney in Miami who supported drainage and extensive reclamation of the Everglades, and the Model Land Company (MLC) founded by Henry Flagler. There is also a digital library accessible to the public that is shared between Florida International University and the University of Miami and contains historical records in a digital format of nearly every person who has been involved in ENP.

Role of history in restoration in the Everglades

Historical events that shaped the current state of resources in the Everglades followed two parallel paths. One path was traveled by the people who advocated to keep the region in its primitive, pristine and undisturbed condition and the other was traveled by those who wanted the region drained and made suitable for human settlements and economic development (Gonzalez 2005). The people who sought to maintain the region's primitive and pristine state intact feared that draining the region to allow human settlements and farming activities would eventually destroy the ecological system of the Everglades. They were correct; in her book, "River of Grass" (page 392), Marjory Stoneman Douglas says that "South Florida is probably the worst place on earth to put millions of people. The capacity of the earth for compensation and forgiveness after repeated abuses has kept the planet alive, but it has encouraged more abuse."

On the other hand, James Carson and others, such as Henry Flagler, supported drainage and encouraged more settlements through the activities of the MLC. James Carson, "promoted drainage and reclamation" of swamplands during the first quarter of the twentieth century. The "MLC and its associated organizations grew to encompass sales and the promotion of Florida throughout the country. The MLC focused on advertising the agricultural and industrial potential of the land and influenced the development of the South Florida region from a tropical frontier to a modern civilization. Through a myriad of activities as a corporate land enterprise, the MLC affected the economic, agricultural, political and social growth of the area" (Digital library special collections).

Despite the arguments from people who wanted to restrict development and growth in South Florida, the region has undergone a wholesale transformation from what was once a fully functional ecosystem to what is now a beautiful built-up and commercial urban region. Although the current planning initiatives are clearly listening to these two groups of people, the CERP's approach will not lead to "a fully functional and restored ecosystem at a rate resulting in no-net-loss" (Cairns Jr. 1995, pp. 4) of ecological resources. The continued decline in ecological resources puts into question the CERP's restoration approach of getting "the water right" using mainly the construction of treatment plants and storing and "managing the flow of water to deserving areas, including the park, all year round" (2000 CERP).

Current planning efforts in perspective

Restoration efforts have come to a point where they also seem to split into two paths: (i) there have been efforts for the last 20 years to restore the Everglades towards predrainage conditions, but (ii) the latest recommendation focuses restoration outcomes on the future of the Everglades, rather than on the past Everglades (NAS 2018). In the latest restoration review (NAS 2018), reviewers argue that due to climate change effects and sea-level rise that are projected to impact South Florida, the "Greater Everglades of the year 2050 and beyond will be much different from what was envisioned at the time of the CERP conceptual plan."

While not underestimating the possible outcomes of this new recommendation, restoration targets based on predrainage conditions should not be ruled out entirely. Historical (predrainage) targets are based on known resource conditions that originated from a naturally evolved ecosystem without human modification (Attfield and Belsey 1994, pp. 47). Until these targets are clearly defined, or if they are not clearly defined, the future conditions of the Everglades can come about in two ways: restoration by natural processes or restoration as a product of human intervention. Restoration outcomes from these two approaches will be significantly different. "Restoration albeit designed by humans, need not to have a shallow or anthropocentric motivation and need not conflict with the natural development of natural resources" (Attfield and Belsey 1994, pp. 48), but this has not been the case in the Everglades. Moreover, the new approach to restoration assumes that there are other ways (maybe through technology) to compensate for the lost environmental services from natural sources. Restoration targets that cannot preserve, maintain or improve the pristine wilderness conditions might satisfy the needs of humans but not those of the entire ecosystem.

Therefore, it is critical to develop a restoration framework that, although will not attain the historical conditions of the Everglades, attempts to do so through the use of both predrainage targets and the future state of the Everglades. First, there is a need to recognize that "wilderness" or "primitive" conditions are an end in their own right and are analogous to an endangered species in need of preservation (Oeschlaeger 1991, pp. 4). The restoration efforts need to be directed towards recreating and preserving the wilderness and primitive values of the region, which can be defined only by the past Everglades and not the unknown future Everglades. In the long run, a restoration framework that supports harnessing the power of natural processes and functioning ecosystems

rather than expensive humanmade technologies (Oeschlaeger 1991, pp. 4) will mitigate climate change impacts and should be the basis for setting restoration targets.

This would require the CERP to start investing in areas such as the acquisition of more land from private developers for conservation purposes (NAS 2016). For example, restoration of hydrologic features of undeveloped wetlands will not prevent development pressures from impeding improvements in ecological conditions. The CERP is currently focused on re-establishing the original historical conditions in the remaining Everglades (NAS 2016). This policy should also be extended to areas around the park as a buffer to prevent pollution and development pressures so that ENP can begin to recover its historical, primitive, and pristine conditions.

Restoration, but unable to move towards a restored ecosystem

In the face of these challenges, historical voices, especially those of people who advocated for preserving the Everglades in a pristine condition, are critical and would offer a feasible platform for setting planning targets that can produce no net loss of ecological resources. Historical voices have led to writings that describe the challenges and events that took place earlier and explain the difference between the actual state of resources now and the ideal conditions then.

The collections provide a list of people who have had a profound influence on the administration, use, and protection of environmental resources in the region. One of these people was the Director of the National Park Service in the 1930s, Arno B. Cammerer. Mr. Cammerer argued that "I would much rather have a national park created that might not measure up to all everybody thinks of it now, but which, 50 or 100 years from now, with all the protection we could give it, would have attained a natural condition comparable to primitive conditions. If the National Park Service is prepared to follow the strategy thus expressed, the Everglades National Park seems justified. If it is not ready to do this, the Everglades is not justified." Based on this very articulate assertion, the current state of natural conditions does not justify the existence of ENP. The CERP does not subscribe to Cammerrer's assertion, and the statement found in all of the documents that the "problems that must be solved to keep the park in natural conditions are generally unprecedented" is an indication of the serious challenges that must be overcome.

During the dedication of ENP as a national park in 1947, President Truman said this about the park: "today we mark the achievement of another great conservation victory. We have permanently safeguarded an irreplaceable primitive area." According to Carter (1974, pp. 314), the pressures on land and water resources from development, growth, and settlements that started in the early 1900s and continued to have negative impacts on ENP had reached a critical threshold by 1974. As a result, the state passed several legislations to bring growth and development under control, including one that called for the imposition of fees to make "growth pay for growth." This was based on the principle that "growth should not be allowed to outpace or exceed the carrying capacity of natural and man-made systems" (Carter 1974).

The basic question is whether the environmental challenges faced by South Florida can be solved through investments in technological innovations and water storage facilities alone. It looks as though the answer is unequivocally no. The water demand from 2000 is projected to have increased by 108% by the year 2035, an indicator of the difficult task the CERP is up against. This increase in demand, compounded by a projected sea-level rise of 1.5 ft by 2060 due to climate change, will place the scarce freshwater resources at a higher risk of inundation (Koch et al. 2014. The long-term ecological health of the region is trumped by the widening gap between the demand and supply of freshwater resources that the CERP is designed to address.

The management of SS and DD is the foundation upon which the CERP was developed. Figure 1 compares freshwater SS in MGD on the *Y*-axis and DD trends from 1970 to 2015 and projections to the year 2030 on the *X*-axis. As shown in this figure, the DD for freshwater is much higher than the SS, and the gap has been widening over the years and is projected to continue to grow. DD will exceed SS by nearly ten times by 2050 (FDEP 2017). Restoration efforts should therefore include establishing targets for an equilibrium in water quality, water DD, and water SS, with specific initiatives needed to reach those targets. For the CERP, one of the measurements of the restoration outcomes should be supporting the ecosystem itself to close the gap between freshwater DD and SS.

Quoting Howard T. Odum in Carter (1974 pp. 314), "it is unwise to depend on costly technology for tasks, such as advanced waste treatment which can be performed better by natural systems." This is exactly what the CERP is doing, and the latest review of ongoing restoration efforts recommends more investments in technology to mitigate climate change. Therefore, this study proposes that restoration efforts consider historical conditions of the entire region and develop a wide range of other restoration targets aimed at addressing the gap between water demand and supply conditions. Pollution reduction efforts together with water use management without concrete plans to reduce the underlying environmental stressors would lead to an unending cycle of rising investments with increasing costs and more difficult challenges. The greatest challenge for the CERP has been the inability to create conditions that allow the environment to function naturally. This could be achieved if the predrainage conditions were the real restoration target and conservation lands were

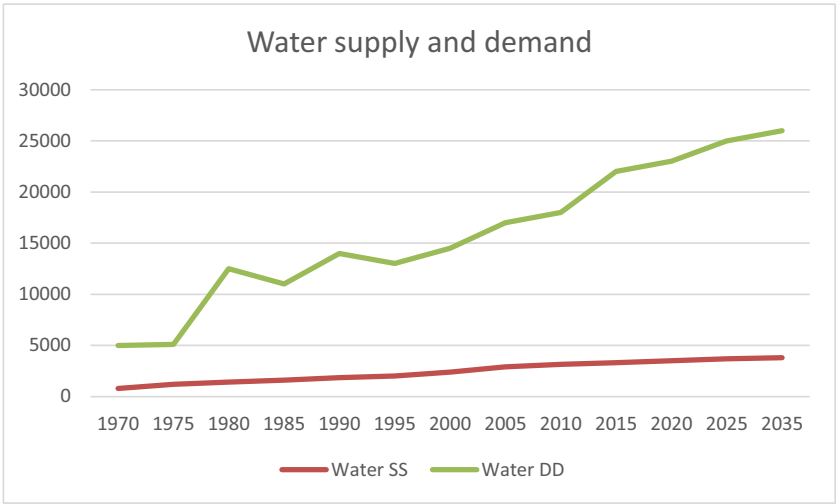

Fig. 1 Past, current, and projected water supply and demand. Source: developed from FDEP and Weisskoff 2005

Source: developed from FDEP and Weisskoff 2005.

purchased to increase the size of ENP and make it "large enough so natural forces can have free rein" (Turner 2012, pp. 306) to support the natural ecosystems.

Focusing restoration on the future Everglades

The founding of the park was justified on the grounds that it would be permanently preserved as a "wilderness." Words that point towards wilderness conditions include "primitive," "pristine," and "superlative," and these can all be summarized in one word, "untouched." These words are not used in the CERP, and rightfully so, perhaps because the region has been transformed into, in James Carson's words "a viable farmland." Projects being undertaken in the greater Everglades, such as water-purifying plants, storage systems, and wastewater-recycling initiatives, are very expensive investments that are useful only if there is continued funding. These projects have no built-in mechanisms for responding to the socioeconomic and biophysical constraints of the region, and they will be costly and unsustainable to implement in the long term, given the economic pressures and unpredictable weather patterns due to climate change.

Restoration is defined as "returning a site to some previous state, with the species richness and diversity and physical, biological, and aesthetic characteristics of that site before human settlement and the accompanying disturbances" (Attfield and Belsey 1994, pp. 37). Restoration initiatives therefore cannot ignore or take for granted the amount of knowledge that exists about the original Everglades and the extent of ecosystem component loss if the desired "restoration" is as defined by Attfield and Belsey (1994) above. The literature estimates that the historical environmental conditions of the Everglades have been degraded by approximately 50% (Galloway et al. 1999). This makes it very difficult to attain restoration outcomes that mimic historical conditions using the current approach of the CERP (Koch et al. 2014; Sklar et al. 2005). The CERP does not include efforts to recreate wilderness or primitive conditions outside of the park. Zedler (2005) defines a restored ecosystem as one that can perpetuate itself without outside help. After 19 years of implementing the CERP and eight of implementing the CEPP, the Everglades ecosystem is still far from the level at which it can self-replenish, let alone having the capacity to supply water that meets the demand.

When "the maximum boundaries for the Everglades Park were established by an act of Congress" (Beard 1938), there was some optimism based on the understanding that, should a wise administration be coupled with the rich fertility of the tropics, the region would have all the biological ingredients needed to remain an outstanding place (Arno B. Cammerer). However, there was also great pessimism that any person or group of people delegated to draw up plans for Everglades Park management would be working on a task that was bound to be a definite failure (1979 Master Plan). This is perhaps represented by the statement that "no matter how well the park is planned and managed internally, it cannot survive alone. It will become increasingly important in the years ahead that sophisticated and innovative park management continues to actively pursue a regional partnership with other interests in South Florida" (1979 Master Plan). Through such partnerships (Foster et al. 2016), stakeholders can agree to allow targets that mimic "wilderness" and "primitive" conditions to be incorporated into the CERP policies and be recreated in some key locations outside of the park.

Legislation and park boundaries alone cannot sufficiently protect the water and cultural resources from human activities outside of the park. The key components of ENP are

profoundly influenced by the changing regional structure, which includes human population growth, urbanization, agriculture, politics, funding, and visitors to the park (1979 Master Plan). Other components include the inability to maintain "numerous linkages of the food chains that support the spectacular populations of birds and other wildlife in the park" (NPS 2010; 1979 Master Plan). Current planning initiatives include goals that would ensure that all existing and planned facilities inside and outside the park have as little negative effect on the flow of water and environmental quality in the park as possible. The initiatives place great emphasis on improving controls and strengthening the protection of marine resources to maintain park use within the optimum carrying capacity. The challenge is that human population continues to grow in South Florida and the current plans have not established an optimum carrying capacity for the region.

Discussion

Simply because damaged ecosystems cannot be recovered to their original conditions does not mean that restoration cannot be attempted (Newman and Robbins 2011, pp. 148). The goals of the CERP may fall short in some aspects of restoration, but the project is certainly bringing the complex challenges of ecosystem restoration to light. One goal that can be pursued under the current circumstances is to create a substitute ecosystem through the acquisition of conservation lands (NPS 2010) as buffers around ENP and in areas where the CERP has major water management facilities. Recreating undeveloped lands that help expand the boundaries of ENP will help filter pollutants from farms and in turn preserve the wilderness and pristine conditions within the park.

This is necessary because the initial planning for construction and operational "features did not involve a detailed planning and design work necessary to optimize resources to achieve all ecosystem restoration performance objectives, particularly on a smaller, local scale" (2000 CERP). There is also no consensus on the quality and quantity of water flow patterns that can provide assurance that ecosystem benefits are achieved in all areas that are already degraded. Without a historical baseline and clear program impact criteria, the CERP makes strong assumptions that restoration will provide immediate habitat and water quality benefits to meet the ecological needs of the region. Unless there is a clear and predetermined threshold for ecological needs of the entire region, this may be true only in the short term and at a limited scale.

South Florida environmental conditions have been changing since the enactment of the 2000 CERP. Therefore, although it is the desired outcome, it is important to look beyond the concept of "getting the water right." Unless it involves taking the "engineered swampland riddled with canals and levees" and transforming "it into natural wetlands that flood and drain in rhythm with rainfall" (Culotta 1995), the CERP's efforts will fall short of obtaining a restored ecosystem. Carter (1974, pp. 100) argues that the only way to improve surface water in South Florida is by restoring Lake Okeechobee to levels approaching historic conditions. The CERP does not plan to remove canals and levees or restore Lake Okeechobee to historic levels. Instead, the CERP hopes to restore the entire South Florida ecosystem through investments in nontraditional water techniques, such as capturing and recharging water, reducing groundwater seepage, and controlling floods. Groundwater flows during the rainy seasons are captured and stored in groundwater wells and pumped to ENP during the dry seasons.

Restoration projects are in their pilot stages, and many are continuously undergoing reviews to address "quality issues and determine the level of treatment and appropriate methodologies for that treatment. The main goal is to re-establish ecological as well as hydrological connections, hydrological patterns and sheet-flow systems" (2000 CERP). "The wetlands do indeed revive when freshwater returns" (Culotta 1995), but when advocating for the use of historical conditions as targets for current restoration efforts, one question that needs answers is the following: What do the people want to see in the entire Everglades region, now and into the future?

Answering this question requires philosophical thinking (Carter 1974, pp. 14) to understand, explain, and reconcile the needs and wants of various communities that call this region home. Many people might not want to see floods or see others give up their farms or their private properties for the sake of the environment. Viewed through the lens of wicked problems theory (Thompson and Whyte 2012; NPS 2010), there are no definitive solutions shared by all stakeholders. Some means to reconcile various stakeholders' interests would be required. Atisa (2020) argues for the establishment of specific stakeholder participation platforms (SPPs) where people who may or may not hold similar views on an issue come together to find a common understanding of how to collectively address their public or private concerns. SPPs are ideal mechanisms that can link government officials, policymakers, farmers, businesses, and conservation advocates to find ways to rationalize the broadly agreed upon or most beneficial decisions (Atisa 2020).

This suggests that while restoration targets must be feasible, environmental restoration plans should still include historical fidelity, ecological integrity, the as key planned targets (Estenoz and Bush 2015; Hobbs et al. 2009; Doren et al. 2008). Culotta (1995) argues that it is important to include the quality of resources before serious modifications were made to the region as targets. Before the canals, levees and water control devices were constructed, water spilled over the banks of Lake Okeechobee and flowed southward and lazily in what is termed the "River of Grass," measuring 50 miles

wide and less than 2 ft deep (Culotta 1995; Douglas 1988). Through various SPPs, Atisa (2020) argues that stakeholders are able to formally and informally communicate and interact. This makes it easier to harmonize the top-down and bottom-up interests of various stakeholders and might lead to a better consensus on what people would want to see in the Everglades. SPPs are institutionally driven formal or informal forums and may take such forms as partnerships, agreements, contracts, offices/departments, or scheduled calendars of events (Atisa 2020). For example, partnerships are seen here as platforms for creating values that go beyond self-interest, as stakeholders deliberate together on both their shared and differing values. In a partnership, stakeholders are more likely to collaborate and less likely to oppose initiatives that they perceive as unsupportive of their own interests or agendas.

Conclusions

The CERP contains a comprehensive watershed management system designed to achieve environmental and habitat restoration and an improved water supply that involves the elimination of organically enriched sediments from farms and urban areas. This watershed management system comprises new and untested technological approaches. Elimination of pollution from various sources will require more than technology alone. This should also include the identification of specific trade-offs that are acceptable to farmers, urban needs, and other land-use priorities. While a detailed analysis of ecosystem restoration and societal interest trade-offs is beyond the scope of this study, a few recommendations are offered here: (i) trade-offs leading communities to accept offering their lands to increase the acreage of conservation lands around the boundaries of the park should be explored and incorporated into the CERP. This will keep businesses at a safe distance, and the land will act as a buffer to pollutants from the farms. (ii) More work is needed to support a hydrologic connection consisting of a sheet-flow system between Lake Okeechobee and ENP that mimics historical sheet flows, otherwise known as the "River of Grass."

This study explores the ways in which the environmental legacies of the past and human activities have continued to interact and how they influence current policy initiatives developed to protect natural resources in ENP. As Beard (1938) said in the late 1930s, "it is necessary for one to look at the present to see the future – no easy task. Any other approach is impossible. It is not so much what the area is now, but what it is going to be after years of protection and careful administration." It is correct to conclude that the future Mr. Beard was referring to in 1938 is now. The protection given to the Everglades and the nature of the administration used have not stopped the transformation of the region. "Any other approach is impossible" (Beard 1938); therefore, maybe "focusing restoration on the future Everglades, rather than on the past Everglades" (NAS 2018) is impossible.

This study recommends that restoration initiatives within the CERP be expanded to include the re-establishment of wilderness conditions outside ENP through purchases of conservation lands, which should also be given some form of protection. ENP is approximately half the historical maximum size of the Everglades; therefore, increasing the size of the park through the acquisition of additional conservation lands will increase the distance between development activities and the park and reduce such activities near the park. In addition, unless restoration policies are accompanied by restrictions on growth and development, pressures on the ecosystems, water supply, and land will continue (Weisskoff 2005 pp. 277). The CERP has also been slow to "adapt to radically changing ecosystem and planning constraints" (NAS 2016), thus reducing the prospects of better restoration outcomes.

The approach under the CERP, which focuses on water purification projects, storage, and diversion but lacks a policy to support the ecosystem in order to move it towards a self-sustaining state, will remain costly and might eventually fail in the long term. The ideal approach to restoration should involve two policy recommendations: (i) looking to historical superlative conditions as targets so that the region can attain the sustainable, long-term outcome of becoming a self-replenishing ecosystem and (ii) establishing a no-net-loss threshold through acquisition of conservation lands in areas outside ENP that would expand, protect, and preserve the existing wilderness.

Policy discourses being developed to address natural resource problems should avoid SBS and look to history when setting restoration targets. Again, in the words of Howard T. Odum in Carter (1974, pp. 314), "it is unwise to depend on costly technology for tasks, such as waste treatment or water purification as these can be better performed by natural systems," which is possible only when the natural systems are not upset or overburdened. Restoration efforts should invest in activities that support the expansion of wilderness areas, allow natural processes to work, and deliver environmental services everywhere possible and not solely in costly technological innovations.

Future research

Improving water quality and quantity in the Everglades remains a major challenge, yet this goal is characteristic of and the foundation for the survival of the area. The plans mention the need to develop regional partnerships in order to better address water and conservation challenges. It would be a good idea to find ways of developing strong and legitimate formal and informal SPPs where trade-offs and the building of consensus between various stakeholders can be discussed (Atisa

2020). Partnerships not only can be useful tools for building consensus across ideas, needs, and restoration levels but also can add to or reduce frustrations among stakeholders who would like to see specific outcomes from existing policies (Gerlak and Heikkila 2011). Analysis of the drivers leading to the rising water demand and various strategies for managing the demand need to be undertaken and incorporated into all development plans for the Everglades.

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