October 11, 2004

Mr. James C. Duck
Chief, Planning Division
Environmental Branch, South Florida Section
U.S. Army Corps of Engineers
P.O. Box 4970
Jacksonville, Florida 32232-0019

Re: Comprehensive Everglades Restoration Plan; Draft FWCA Report for Site 1 Impoundment Project, Palm Beach County

Dear Mr. Duck:

The Habitat Conservation Scientific Services Office of the Florida Fish and Wildlife Conservation Commission (FWC) offers the following letter and attached staff report as our draft Fish and Wildlife Coordination Act (FWCA) Report, under the authority of the FWCA of 1958.

Background

The Site 1 Impoundment Project was recommended as a component of the Central and South Florida Comprehensive Review Study Feasibility Report and Integrated Environmental Impact Statement in April of 1999. Subsequently, the Site 1 Impoundment Project was one of the initial 10 projects authorized for implementation in Section 601(b)(2)(C) of WRDA 2000. One hundred percent of the lands necessary for this project are already in public ownership. The proposed location for the Site 1 Impoundment (previously known as the Hillsboro Impoundment) is a 1,660-acre area adjacent to the Hillsboro Canal and south of the Arthur R. Marshall Loxahatchee National Wildlife Refuge (LNWR) in Palm Beach County. The project was originally a component of the Water Preserve Areas (WPA) Feasibility Study, and several alternative project designs were described and evaluated in the feasibility study report (USACE and SFWMD 2001). The preliminary alternative included two compartments totaling 1,660 acres with water levels fluctuating up to 8 feet above grade, surrounded by a seepage collection canal. The S-39A structure would be replaced with a new structure designated as S-527B. The conveyance of the Hillsboro Canal would be increased from the impoundment inflow structure east to the Lake Worth Drainage District (LWDD) E-1 Canal to allow back-pumping of additional flows from the western Hillsboro Canal basin. Water stored in the impoundment

would be used to supplement water deliveries to the Hillsboro Canal, thus reducing demands on the natural system (USACE and SFWMD 2003).

The Site 1 Impoundment Project will capture water that is currently being lost to tide via the Hillsboro Canal, and use it for municipal and industrial water supply deliveries (including protection against saltwater intrusion into the aquifer) in the project area during the dry season. The storage provided by this project is intended to benefit the remaining Everglades ecosystem, especially LNWR and the Everglades-Francis S. Taylor Wildlife Management Area (EWMA), by providing an alternate source of municipal and industrial water supply in the vicinity of the project in lieu of withdrawals of water from the Everglades. The impoundment is also intended to reduce seepage out of LNWR, thereby reducing the need to release water from Lake Okeechobee in order to maintain the LNWR regulation schedule. Furthermore, the retention within the Site 1 Impoundment of a portion of the water previously lost to tide may reduce the harmful effects of freshwater discharges to the estuarine ecosystem at the mouth of the Hillsboro Canal. The project objectives are summarized as follows: 1) achieve target hydroperiods and hydropatterns in LNWR and WCA-2A (Water Conservation Area 2A, which is the northernmost section of the EWMA), and 2) improve habitat functional quality of natural areas and increase extent where practicable (Site 1 Impoundment Project Regional Evaluation Team Review Materials, August 2004).

Alternatives developed in the Restudy and the WPA Feasibility Study were re-visited in the development of the Site 1 Impoundment Project Implementation Report. The Site 1 Project Delivery Team (PDT) used qualitative screening criteria to select two final alternatives. The two alternatives, Restudy Alternative-A and the WPA Feasibility Study Selected Plan, both utilized the 1,660-acre parcel north of the Hillsboro Canal to stack water 6 feet or 8 feet high, respectively. Larger impoundments evaluated in prior studies were eliminated due to a lack of available land and the high cost associated with lands that were available. Smaller impoundments were screened out because they would not maximize use of previously purchased lands to provide additional water storage.

The PDT developed a list of Evaluation Criteria (EC), for use in evaluating the alternatives predicted benefits for LNWR, WCA-2A, and the downstream estuary. Alternatives were compared to one another and to the future-without-project condition. In August 2004, the Interagency Modeling Center (IMC) provided model output for each EC from the Restudy and WPA Feasibility Study model runs. Individual agencies participating in the PDT were then asked to review the EC and provide recommendations. The FWC review is presented in the attached Staff Report, and recommendations are summarized in this letter. We also provide recommendations regarding project planning and maximization of project benefits.

Issues and Recommendations

Below we present a summary of our concerns and recommendations, most of which have already been presented in PDT meetings, emails, or in our October 2003 Planning Aid Letter.

Project Planning Considerations

Avoid impacts to listed species. State-listed species potentially occurring within the project footprint include: *Alligator mississipiensis* (American alligator), *Drymarchon corais couperi* (eastern indigo snake), *Ajaia ajaja* (roseate spoonbill), *Aramus guarauna* (limpkin), *Egretta caerulea* (little blue heron), *Egretta thula* (snowy egret), *Egretta tricolor* (tricolored heron), *Eudocimus albus* (white ibis), *Grus canadensis pratensis* (Florida sandhill crane), *Haliaeetus leucocephalus* (bald eagle), *Mycteria americana* (wood stork), *Rostrhamus sociabilis plumbeus* (snail kite), *Trichechus manatus* (West Indian manatee), and *Speotyto cunicularia floridana* (Florida burrowing owl). We have determined that the gopher tortoise, which was included in our October 2003 Planning Aid Letter, is not likely to occur at the site. Project managers should consult with both the FWC and the USFWS for recommendations on avoidance of impacts to federally listed species, such as the Eastern indigo snake, bald eagle, wood stork, snail kite, and West Indian manatee. Both the FWC and USFWS should be consulted in the event that colonial or solitary wading bird nests are observed within the construction footprint. Florida burrowing owls are known to inhabit ruderal areas, such as canal banks and road berms, in the vicinity of the project. If owls are observed within the Site 1 Impoundment construction footprint, the FWC should be consulted. More information on FWC permit requirements and applications can be found on the web at http://wld.fwc.state.fl.us/permits/permits.html.

Clarify what is meant by the "possibility of discharging water to WCA-2A". Section 3 of the USACE Alternative Formulation Briefing (AFB) material indicates that future analyses may indicate a need to discharge Site 1 Impoundment waters directly into WCA-2A for "environmental restoration and additional flood protection". When queried regarding these AFB statements, the SFWMD revealed that they would like to design the Site 1 Impoundment such that emergency releases could be made to WCA-2A. The possibility of discharging water from the impoundment directly into WCA-2A has not previously been discussed at any of the team meetings, which have been on-going since October 2003. The emergency release of Site 1 Impoundment water into WCA-2A would not be acceptable to the FWC, as the timing of emergency releases would most certainly be during times of excessively high water levels within WCA-2A itself. Furthermore, if the impoundment is capturing water that was previously sent to tide, it would seem logical that emergency releases would simply go to tide. To our knowledge, none of the current suite of alternatives being evaluated in this PIR include discharges from the Site 1 Impoundment into WCA-2A. We recommend that the Site 1 Impoundment not make emergency releases into WCA-2A, as these releases would most certainly exacerbate existing hydrologic perturbations, causing damage rather than benefit to the natural system.

Revise description of expected benefits to WCA-2A. Section 5.2.3 of the AFB review material indicates that the Site 1 Impoundment Project will benefit WCA-2A by providing an alternate storage location for North Springs Improvement District (NSID) discharges, rather than continuing to make those discharges to WCA-2A. This benefit statement is not accurate, as the Everglades Forever Act precludes the NSID from continuing to make poor water quality discharges to the Everglades Protection Area, which includes WCA-2A. So even without the project, the untreated stormwater runoff from the NSID would not be permitted for continued

discharge to WCA-2A. Predicted benefits to WCA-2A as a result of the Site 1 Impoundment Project would instead be indirect water quality and hydrologic improvements associated with reduced municipal, industrial, and agricultural demands being placed on the LNWR and Lake Okeechobee. It is hoped that the reduced demand on LNWR and Lake Okeechobee will provide increased water availability for downstream natural areas, such as WCA-2A, during the dry season.

Maintain existing recreational access. The FWC currently provides access to WCA-2A via a ramp along the L-36 borrow canal just southwest of the proposed impoundment. Road access to this ramp should be maintained.

Further refine operational plan. USACE project managers have indicated that the existing operational plan will be updated prior to project operation. We look forward to this plan revision as an opportunity to improve project benefits to affected natural areas, including WCA-2A. Please consult with our staff for assistance in developing the refined operational plan.

Document evaluation criteria results and conclusions within PIR. We have provided a detailed review of the evaluation criteria model output for WCA-2A in the attached Staff Report. Our review concluded that although model results often predict slight negative impacts to WCA-2A, the mixture of both impacts and benefits predicted does not justify disapproval of the project. Additionally, without any measure of model uncertainty, we have no way of determining whether the slight impacts predicted are actually statistically significant. Finally, we understand the overwhelming need for increased water storage in the regional system. We request that monitoring and adaptive management be used to adjust project operations in order to minimize impacts and maximize benefits to WCA-2A and other affected natural areas.

Opportunities to Increase Project Benefits

Investigate means of eliminating reservoir dry-down. Dry-downs could cause soil oxidation, resulting in flushing of contaminants, including methyl-mercury, phosphorus, and agricultural chemicals, upon re-wetting (USACE and SFWMD 2001). The team should evaluate the feasibility of adapting the operational plan, such that frequent dry downs are eliminated. However, if evaluations indicate that providing increased quantities of water to prevent dry-downs in the reservoir would diminish the ability to improve hydroperiods in upstream natural areas, then restoration of upstream depths and hydroperiods should take precedence.

Incorporate existing vertical structure into designs for the impoundment. Fish and wildlife habitat would be improved if, during reservoir construction, standing timber were left in place within the impoundment. When the St. Johns Water Management District left standing timber within the Stickmarsh/Farm 13 Reservoir, reservoir operations were not negatively impacted and the recreational value is believed to have been greatly enhanced. Timber provides habitat and detritus for lower levels of the food chain, upon which fish, birds, and reptiles rely. The vertical structure of clusters and/or individual trees or snags offers perching, nesting, and roosting structure for birds, and habitat for turtles and other reptilian fauna (Kadlec and Knight 1996).

Incorporate native riparian vegetation and littoral shelves into design of the impoundment. The habitat functional value of the Site 1 Impoundment could be improved by establishing native vegetation along the seepage collection canals and the impoundment levee. Similarly, as recommended in Section 7.6.2 of the Draft WPA Feasibility Report, "ground cover could be improved by designing topographic shelves along the levee at optimal elevations" (USACE and SFWMD 2001). Establishment of riparian and littoral vegetation will: enhance the food web; provide habitat for reptiles, small birds, and other wildlife; and improve water quality by intercepting sediments, removing nutrients, and reducing near-shore water temperature (USACE and SFWMD 2002).

Incorporate deep-water refugia into the impoundment. Under the plan recommended by the WPA Feasibility Study, the Site 1 Impoundment would be subject to wide variations in water level. Severe draw-downs of the impoundment could lead to significant fish kills. Deep-water refugia provide important habitat for aquatic wildlife (e.g. fishes, herpetofauna, and aquatic invertebrates) during periods when the surrounding area is dry and act as a "seed source" of aquatic organisms upon subsequent re-flooding of the reservoirs. Deep-water refugia may also provide temporary feeding grounds for avian species such as wading birds and enhance nutrient removal from the water column by allowing uninterrupted submerged aquatic vegetative (SAV) growth (USACE and SFWMD 2002). The 1.7-acre refuge described in the feasibility study appears too small for a 1,660-acre reservoir. We recommend that at least 10% of the total reservoir area be excavated to a depth of 4 feet below reservoir floor elevation.

Incorporate features for maintaining dissolved oxygen (DO) levels. The Draft WPA Feasibility Report and SEIS, Section 7.10, states that the Site 1 Impoundment is projected to release effluent with DO concentrations approximately 34 percent lower than those of inflow waters (Inflow = 4.90 mg/L; Effluent = 3.09 mg/L), but slightly exceeding 3 mg/L (USACE and SFWMD 2001). As projected DO levels fall toward the low end of the range acceptable for fish, we recommend that features to improve DO levels within the impoundment be investigated during the detailed design phase.

Incorporate features that will improve discharged water quality. The Draft WPA Feasibility Report and SEIS, Section 7.10.2, indicates that the Site 1 Impoundment will exhibit only a moderate capacity to improve water quality in terms of total phosphorus, suspended solids, and pathogenic organisms (USACE and SFWMD 2001). Since some of this water will ultimately reach the estuarine and marine systems, water quality enhancement should be incorporated into the project design. Reservoir designs that allow for extended hydraulic residence time and incorporate littoral and riparian vegetation or other water quality enhancement features could improve discharge water quality.

Incorporate additional recreational access features. As Florida's population continues to expand, recreational pressure on existing public lands is increasing, and new impoundments created by CERP can serve as valuable recreational resources. We understand that a Corps Guidance Memorandum is being drafted specifically to direct projects to consider integration of recreational features into their detailed designs. The Site 1 Impoundment, which will cover approximately 1,660 acres, has the potential to be a valuable new recreational resource, and

FWC staff from the FWC South Regional Fisheries Office will provide suggestions on incorporation of appropriate recreational features during the detailed design phase.

Incorporate features to enhance aesthetics of the reservoir. The Draft WPA Feasibility Report and SEIS, Section 7.14, states that implementation of the WPA project itself may not improve aesthetics in the project footprint (USACE and SFWMD 2001). However, the lack of aesthetic value predicted in the WPA project footprint is not inevitable. Many of the features recommended for improvement of water quality, habitat functional value, and recreational value will also enhance aesthetics of the area.

In conclusion, we recommend that the USACE and SFWMD: 1) consult with FWC and USFWS permit staff for guidance and permit requirements as needed; 2) do not target WCA-2A as the recipient of the Site 1 Impoundment's emergency releases; 3) refine the project's operational plan to increase benefits to WCA-2A and other natural areas; 4) maintain existing recreational access; and 5) pursue opportunities for increased project benefits during the detailed design phase. For more information on FWC permitting requirements, please refer to the list of contacts provided below. Questions regarding our concerns and recommendations can be directed to Ms.Yvette Alger at the Habitat Conservation Scientific Services Office ("Scientific Services") in Vero Beach (772-778-5094). We will continue to provide feedback as the project is further developed.

Sincerely,

Brian S. Barnett, Director
Office of Policy and Stakeholder Coord.

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Enclosure
CC: Mr. Ken Ammon, SFWMD, West Palm Beach
Mr. Jay Slack, USFWS, Vero Beach
Mr. Chuck Collins, FWC, West Palm Beach
Mr. Scott Sanders, FWC, Tallahassee
Mr. Greg Knecht, DEP, Tallahassee

FWC Permitting Contacts

- Steve Lau, Habitat Conservation Scientific Services -- (772) 778-5094 – General FWC permitting.
- South Regional Nongame Biologist, Division of Habitat and Species Conservation – (561) 625-5133 – Technical assistance regarding osprey, burrowing owls, and least terns.
- Ron Mezich, Imperiled Species Section – (850) 922-4330 – Manatee permitting and construction guidelines.

Internet Resources

- http://wld.fwc.state.fl.us/imperiled/default.htm FWC Imperiled Species Web page
- http://wld.fwc.state.fl.us/imperiled/pdf/Endangered-Threatened-Special-Concern-2004.pdf FWC Imperiled Species List
- http://wld.fwc.state.fl.us/permits/default.htm FWC Wildlife (non-marine) Permit Web page
- http://endangered.fws.gov/ USFWS Endangered Species Program

Literature Cited

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U.S. Army Corps of Engineers and South Florida Water Management District (USACE and SFWMD). 2001. Central and South Florida Project Water Preserve Areas Feasibility Study: October 2001 Draft Integrated Feasibility Report and Supplemental Environmental Impact Statement. Jacksonville District Office: Jacksonville, FL.

U.S. Army Corps of Engineers and South Florida Water Management District (USACE and SFWMD). 2002. Preliminary Draft Alternative Plan Evaluation Criteria Hierarchy: Everglades Agricultural Areas Storage Reservoirs, Phase 1. Jacksonville District Office: Jacksonville, FL.

U.S. Army Corps of Engineers and South Florida Water Management District (USACE and SFWMD). 2003. September 2003 Draft Project Management Plan: Site 1 Impoundment. Jacksonville District Office: Jacksonville, FL.

BCC: Ms. Rebecca Weiss, USACE, Jacksonville
Ms. Jane Tutton, USFWS, Vero Beach
Mr. Barron Moody, FWC, West Palm Beach
Ms. Diane Crigger, DEP, West Palm Beach

Staff Report for the Site 1 Impoundment Project FWCA Draft Report

Yvette R. Alger
Florida Fish and Wildlife Conservation Commission
Habitat Conservation Scientific Services Office
October 11, 2004

Below we provide a review of the Evaluation Criteria (EC) output for the Site 1 Impoundment Project alternatives. Our review is focused on Indicator Regions (IR) 24 and 25, which are situated within WCA-2A; we recommend that the USACE and SFWMD consult with the USFWS regarding the EC review for the Arthur R. Marshall National Wildlife Refuge.

The summary presented herein covers EC assessment for both the Last-Added-Increment (LAI) and the Next-Added-Increment (NAI). The LAI compares the predicted effects of the project combined with all other Comprehensive Everglades Restoration Plan (CERP) projects in the future (year 2050) against the future without any CERP projects (2050 Base). We also compare the two alternatives, Restudy Alt-A and WPA-SP, to determine which offers the most benefits to WCA-2A when combined with the rest of CERP. The NAI evaluates the predicted effects of the project on its own, without the rest of CERP, against the future without any CERP projects (2010 Base). The model runs used to perform these evaluations are described in the table below.

Model Run	**Description**	**Use**
2050 Base	Model year 2050, assuming no CERP projects are implemented.	For the LAI evaluation, this model run is compared against the Restudy Alt-A and WPA-SP to evaluate the effects of the two alternatives compared to a future-without-project condition.
2010 Base	Model year 2010, assuming no CERP projects are implemented.	For the NAI evaluation, this model run is compared against the 2010 WPA to evaluate the effects of the impoundment as a stand-alone project, compared to the future-without-project condition.
NSM	This is the Natural System Model, which is an approximation of natural hydrologic conditions occurring prior to the drainage and flow alterations associated with the Central and South Florida Project.	For both the NAI and LAI evaluations, NSM conditions are used as restoration targets in most of the WCA-2A Evaluation Criteria.
Restudy Alt-A	Alternative evaluated in the Restudy, consisting of a 1,660-acre impoundment with water stacked up to 6	This alternative model run also includes all other CERP projects, and is therefore used in the LAI evaluation to determine how CERP as a whole will

	feet deep.	compare to the without-project base condition. This model run is also compared to the WPA-SP run, to determine which alternative performs better.
WPA-SP	The WPA Feasibility Study Selected Plan (SP), consisting of a 1,660-acre impoundment with water stacked up to 8 feet deep.	This alternative model run also includes all other CERP projects, and is therefore used in the LAI evaluation to determine how CERP as a whole will compare to the without-project base condition. This model run is also compared to the Restudy Alt-A run, to determine which alternative performs better.
2010 WPA	The WPA Feasibility Study Selected Plan (SP), consisting of a 1,660-acre impoundment with water stacked up to 8 feet deep.	This alternative includes only the Site 1 Impoundment and any other CERP projects implemented as of 2010. Since there are no other CERP projects included in this run that strongly affect the Site 1 Impoundment study area, this alternative is used in the NAI evaluation to determine the benefits that can be attributed specifically to the Site 1 Impoundment Project.

LAI Evaluation

Hydrology

Extreme events

For extreme high water events in northern WCA-2A (IR 24), both alternatives and the 2050 base had a total duration of 1%. This is slightly off from the predicted NSM duration of 0% for the period of record (POR). The magnitude of high events was slightly higher with the WPA-SP (2.97 ft.) compared to the Restudy Alt-A (2.64 ft.) and 2050 Base (2.69 ft.). For low water events, the WPA-SP had a slightly longer duration (4% POR) than the Restudy Alt-A (3% POR) and NSM (3 % POR). The magnitude of extreme low events in the Restudy Alt-A (-1.39 ft.) was similar to NSM (-1.38 ft.) and less than the WPA-SP (-1.46 ft.). Overall, for IR 24, the WPA-SP produces slightly larger magnitude extreme high water events compared to the 2050 Base. Although differences are slight, the Restudy Alt-A appears to perform slightly better than the WPA-SP.

For extreme high water events in southern WCA-2A (IR 25), the WPA-SP, Restudy Alt-A, 2050 Base, and NSM had predicted total durations of 0% for the period of record. For low water events, the WPA-SP had a longer duration (2% POR) than the Restudy Alt-A (0% POR). The longer duration of the WPA-SP approached NSM (4% POR), but performed slightly below 2050 Base (3% POR). The magnitude of extreme low events in the Restudy Alt-A (-1.14 ft.) and WPA-SP (-1.44 ft.) bounded the target NSM depth (-1.33 ft.). While the WPA-SP did not differ markedly from the 2050 Base (-1.48 ft.), the Restudy Alt-A represented a slight improvement over the Base condition. Overall, for IR 25, the WPA-SP offered no improvement over 2050 Base in the magnitude of extreme low water events, and predicted a slight worsening in the duration of extreme low water events. The WPA-SP and Restudy Alt-A yielded similar results, although the WPA-SP did offer a slight improvement in terms of extreme low water durations.

Inundation Pattern

For IR 24, the average annual hydroperiod predicted for Restudy Alt-A (90% of year) was slightly closer to the NSM target (91%) than were the WPA-SP (89%) and 2050 Base (89%). Although the two alternatives predicted the same frequency of inundation events, the duration (weeks/event) was slightly longer for the Restudy Alt-A. For IR 25, the predicted average annual hydroperiod for the WPA-SP (92%) was closer to the NSM target (86%) than was the Restudy Alt-A (96%). The 2050 Base came closest to the target, with a hydroperiod of 90%. Overall, the model predicts no change from 2050 Base with the WPA-SP in the northern region (IR 24), but a slight worsening of conditions (longer hydroperiods) in the southern region (IR 25). In the northern IR, the Restudy Alt-A performs slightly better than the WPA-SP, although the situation is reversed in the southern IR.

Seasonal Amplitude

For IR 24 average maximum weekly depths, the WPA-SP (1.93 ft.), Restudy Alt-A (1.96 ft.), and 2050 base (1.97 ft.) all perform similarly. The lower minimum weekly depths predicted by the WPA-SP (-0.32 ft.) represent poorer conditions compared to Restudy Alt-A (-0.17 ft.), 2050 Base (-0.26 ft.), and NSM (-0.17 ft.). Similarly, the smaller amplitude change associated with the Restudy Alt-A (2.13 ft.) is more reflective of the NSM target (1.70 ft.) than is the WPA-SP (2.25 ft.). Overall, the WPA-SP does not predict improvements over average maximum weekly depths, and generally predicts a slight worsening of seasonal amplitudes, relative to the 2050 Base. The Restudy Alt-A seems to perform better than the WPA-SP.

For IR 25 average maximum weekly depths, both the WPA-SP (1.79 ft.) and the Restudy Alt-A (1.77 ft.) predict slight improvements over the 2050 base (1.86 ft.). Conversely, the higher minimum weekly depths predicted by the Restudy Alt-A (0.03 ft.) represent poorer conditions compared to the WPA-SP (-0.15 ft.), 2050 Base (-0.34 ft.), and NSM (-0.47 ft.). The smaller amplitude change associated with the Restudy Alt-A (1.74 ft.) is more reflective of the NSM target (1.55 ft.) than are the WPA-SP (1.94 ft.) and 2050

Base (2.20 ft.). Overall, although the WPA-SP predicts a slight worsening of average minimum weekly depths, the seasonal amplitude and maximum weekly depths associated with WPA-SP represent an improvement over 2050 Base conditions. Relative to the Restudy Alt-A, however, the WPA-SP generally predicts a worsening of seasonal amplitudes, with wider variations in average depths.

Water Quality

Phosphorus

The total phosphorus loads predicted with the WPA-SP (13.43 kg TP) are higher than with the Restudy Alt-A (11.49 kg TP) and the 2050 Base (11.06 kg TP). The WPA-SP therefore worsens phosphorus loading into WCA-2A, relative to future without project. The Restudy Alt-A offers slightly reduced phosphorus loads, compared to WPA-SP, but these inputs are still greater than 2050 Base loads.

Ecology

Tree islands

The tree island evaluation criteria used output from a model developed by Wu *et al.* (2003) to evaluate effects of differing hydrologic scenarios on flooding and drought impacts to tree islands. The model predicts the total area of restored tree islands expected for the different project alternatives. The predicted areas are mean hectares of restored tree islands in WCA-2A over the POR (1965-1995). For this metric, data was not available on the Restudy Alt-A alternative. The WPA-SP predicted a reduced coverage of tree island habitat (183 ha), relative to 2050 Base conditions (197 ha) and NSM target conditions (1,353 ha).

Wading birds

The wading bird evaluation criteria uses output from a Wading Bird Habitat Suitability Index (SI), developed for the entire Everglades based on water depths and recession rates (Tarboton *et al*. 2003). For the purposes of this project evaluation, we focused on SI values for WCA-2A. SI scores range from 0 to 1, with higher scores indicative of more favorable conditions for wading bird foraging. The evaluation criteria includes two parameters: 1) the number of weeks that the landscape-level SI is less than or equal to 0.5, with a lower number of weeks being preferred, and 2) the average landscape-level SI over the POR, with a higher SI preferred. For both the number of weeks the SI is ≤ 0.5 and the average SI, the WPA-SP (933 wks and 0.43 mean SI) performs slightly better than the Restudy Alt-A (953 wks and 0.41 mean SI) and the 2050 Base (938 wks and 0.42 mean SI).

Cattails

The cattail evaluation criteria used output from Everglades Landscape Vegetation Model (ELVM) to predict the coverage of cattails under different hydrologic scenarios (Wu *et al.* 2001). The predicted areas are hectares of cattails in WCA-2A during the water year 1995. For this metric, data is not available for the Restudy Alt-A. The WPA-SP predicts a lower coverage of cattails (4,601 ha) compared to the 2050 Base condition (6,044 ha).

Snail kites

The Snail Kite Foraging EC uses South Florida Water Management Model (SFWMM) output to evaluate the average duration of flooding events over the 36-year POR, with 156-260 weeks per inundation event being optimal, and 104-155 or 261-312 weeks/event being marginal for kite foraging. In northern WCA-2A, kite foraging is sub-marginal for the WPA-SP (84 wks/event), Restudy Alt-A (85 wks/event), and 2050 Base (90 wks/event). The WPA-SP and Restudy Alt-A do not differ markedly, nor do either represent an improvement over 2050 Base conditions. In southern WCA-2A, the Restudy Alt-A predicts marginal conditions for snail kites (129 wks/event), whereas the WPA-SP predicts sub-marginal conditions (93 wks/event). Both alternatives offer improvement relative to 2050 Base conditions (77 wks/event). WPA-SP represents an improvement over 2050 Base conditions in southern WCA-2A, but predicts worsened conditions in northern WCA-2A. Restudy Alt-A generally performs better than WPA-SP throughout WCA-2A.

Apple snails

The evaluation criteria for apple snails predicts the effects of differing project alternatives on the population dynamics of apple snails, which are the primary food of the endangered snail kite. Darby (1997 and 2003) has documented a peak in apple snail egg cluster production in March – April, and has suggested that dry-outs below ground level prior to or during this peak can substantially reduce apple snail populations through reduced egg cluster production and reduced hatchling survival. Therefore, this EC evaluates the number of years in which water levels fall below ground surface on April 30, as an indicator of apple snail recruitment success. The restoration target is to have similar or fewer dry-downs compared to NSM. For the northern IR (IR 24), the Restudy Alt-A, WPA-SP, and NSM all predict 11 dry-down years. The 2050 Base predicts slightly more dry-downs (13 years). In the southern IR (IR 25), both the WPA-SP and the Restudy Alt-A predict slightly fewer dry-down years (7 years and 5 years, respectively), which is fewer than expected under NSM (12 years). The 2050 Base matches NSM in this southern IR. Compared to 2050 Base, the WPA-SP offers some improvement (fewer dry-downs) in the northern and southern IR. The WPA-SP and Restudy Alt-A both perform well in the northern and southern IR.

Periphyton

The evaluation criteria for periphyton makes use of a periphyton habitat suitability index (PHSI) developed by Gaiser *et al.* (2003). The HSI values range from 0 to 1, with a value of 1 indicative of optimal conditions for periphyton growth. NSM does not always predict an HSI value of 1.00, presumably because under natural conditions not all of WCA-2A was ideally suited to periphyton growth. Therefore, our target is to match NSM, not to maximize the HSI. In IR 24, the WPA-SP HSI is equivalent to 2050 Base (0.92), and below that of Restudy Alt-A (0.98) and NSM (1.00). In IR 25, both the Restudy Alt-A and WPA-SP predict HSI values of 1.00, which is higher than 2050 Base (0.95) and NSM (0.52). The WPA-SP does not represent an improvement over either 2050 Base or Restudy Alt-A in WCA-2A.

NAI Evaluation

Hydrology

Extreme events

For extreme high water events in northern WCA-2A (IR 24), both the total duration (1% POR) and the magnitude of extreme high water events (2.68 ft.) predicted for the 2010 WPA matched that of 2010 Base. The predicted duration was slightly longer than NSM (0% POR). Extreme low water events were also predicted to occur for the same duration (4% POR) in the 2010 Base and the 2010 WPA. This represents a slight departure from NSM (3% POR). The magnitude of extreme low water events was slightly greater than NSM (-1.38 ft.) for both the 2010 Base (-1.48 ft.) and the 2010 WPA (-1.45 ft.). Overall, for IR 24, the 2010 WPA predicts neither an improvement nor a worsening over 2010 Base conditions.

For extreme high water events in IR 25, both the total duration (0% POR) and the magnitude of extreme high water events (2.51 ft.) predicted for the 2010 WPA matched that of 2010 Base. The predicted duration matched the NSM target (0% POR). Extreme low water events were also predicted to occur for the same duration (3% POR) in the 2010 Base and the 2010 WPA. This represents a slight departure from NSM (4% POR). The magnitude of extreme low water events was slightly greater than NSM (-1.33 ft.) for both the 2010 Base (-1.50 ft.) and the 2010 WPA (-1.51 ft.). Overall, for IR 25, the 2010 WPA predicts neither an improvement nor a worsening over 2010 Base conditions.

Inundation Pattern

For IR 24, the average annual hydroperiod predicted for both the 2010 Base and the 2010 WPA were identical (89% of year), and slightly shorter than the NSM target (91%). Similarly, for IR 25, the average annual hydroperiod predicted for both the 2010 Base and the 2010 WPA were identical (91% of year), and slightly longer than the NSM target

(86%). Overall, the model predicts no change from 2010 Base with the 2010 WPA in either IR.

Seasonal Amplitude

For IR 24, the average maximum and minimum weekly depths and the seasonal amplitude of the 2010 WPA are similar to that of the 2010 Base, and neither alternative is close to NSM. Likewise, for IR 25, the average maximum weekly depths and seasonal amplitude of 2010 WPA are similar to that of the 2010 Base, and neither alternative is close to NSM. The average minimum weekly depths of the 2010 Base (-0.25 ft.) are similar to the 2010 WPA (-0.22 ft.). Generally, there is very little difference between 2010 Base and the 2010 WPA in either IR.

Water Quality

Phosphorus

Both the 2010 WPA and the Restudy Alt-A (2010) exhibit higher total phosphorus (TP) loadings (11.78 kg and 11.68 kg, respectively) to WCA-2A, relative to 2010 Base (11.38 kg TP). 2010 WPA predicts slightly worsened TP loadings relative to 2010 Base conditions and the Restudy Alt-A.

Ecology

Tree islands

The tree island evaluation criteria used output from a model developed by Wu *et al.* (2003) to evaluate effects of differing hydrologic scenarios on flooding and drought impacts to tree islands. The model predicts the total area of restored tree islands expected for the different project alternatives. The predicted areas are mean hectares of restored tree islands in WCA-2A over the POR (1965-1995). The 2010 WPA predicted a reduced coverage of tree island habitat (137 ha), relative to 2010 Base conditions (147 ha) and NSM target conditions (1,353 ha).

Wading birds

The wading bird evaluation criteria uses output from a Wading Bird Habitat Suitability Index (SI), developed for the entire Everglades based on water depths and recession rates (Tarboton *et al.* 2003). For the purposes of this project evaluation, we focused on SI values for WCA-2A. SI scores range from 0 to 1, with higher scores indicative of more favorable conditions for wading bird foraging. The evaluation criteria includes two parameters: 1) the number of weeks that the landscape-level SI is less than or equal to 0.5, with a lower number of weeks being preferred, and 2) the average landscape-level SI over the POR, with a higher SI preferred.

In WCA-2A, the 2010 WPA represents a slight worsening of conditions in terms of the number of weeks with SI $\leq$ 0.5 (983 wks) compared to the 2010 Base (968 wks). However, the average SI is the same for both the 2010 WPA and the 2010 Base (0.40). Overall, the NAI represents either no improvement or a slight worsening of conditions for wading birds, compared to the future-without-project condition.

Cattails

The cattail evaluation criteria used output from Everglades Landscape Vegetation Model (ELVM) to predict the coverage of cattails under different hydrologic scenarios (Wu *et al.* 2001). The predicted areas are hectares of cattails in WCA-2A during the water year 1995. The 2010 WPA predicts a lower coverage of cattails (5,262 ha) compared to the 2010 Base condition (6,186 ha).

Snail kites

The Snail Kite Foraging EC uses South Florida Water Management Model (SFWMM) output to evaluate the average duration of flooding events over the 36-year POR, with 156-260 weeks per inundation event being optimal, and 104-155 or 261-312 weeks/event being marginal for kite foraging. In northern WCA-2A, kite foraging is borderline marginal for the 2010 WPA (103 wks/event), but is sub-marginal for the 2010 Base (85 wks/event). In southern WCA-2A, both baseline and with-project conditions are sub-marginal, but the 2010 WPA (98 wks/event) does offer a slight improvement over 2010 Base (92 wks/event). Generally, the 2010 WPA predicts slightly improved conditions relative to 2010 Base.

Apple snails

The evaluation criteria for apple snails predicts the effects of differing project alternatives on the population dynamics of apple snails, which are the primary food of the endangered snail kite. Darby (1997 and 2003) has documented a peak in apple snail egg cluster production in March – April, and has suggested that dryouts below ground level prior to or during this peak can substantially reduce apple snail populations through reduced egg cluster production and reduced hatchling survival. Therefore, this EC evaluates the number of years in which water levels fall below ground surface on April 30, as an indicator of apple snail recruitment success. The restoration target is to have similar or fewer dry-downs compared to the Natural System Model. For the northern IR (IR 24), the number of dry-down years is similar among the 2010 WPA (11 years), 2010 Base (12 years), and NSM (11 years). For the southern IR (IR 25), the number of dry-down years in both the 2010 Base (11 years) and the 2010 WPA (8 years) are below NSM (12 years). Overall, 2010 WPA conditions for apple snails do not show a marked improvement over 2010 Base.

Periphyton

The evaluation criteria for periphyton makes use of a periphyton habitat suitability index (PHSI) developed by Gaiser *et al.* (2003). The HSI values range from 0 to 1, with a value of 1 indicative of optimal conditions for periphyton growth. NSM does not always predict an HSI value of 1.00, presumably because under natural conditions not all of WCA-2A was ideally suited to periphyton growth. Therefore, our target is to match NSM, not to maximize the HSI. For IR 24, the 2010 WPA predicts slightly improved periphyton habitat conditions (HSI = 0.98), relative to 2010 Base (0.96). For IR 25, the 2010 Base and 2010 WPA predict the same periphyton HSI (1.00), which is twice that of NSM (0.52). Overall, the 2010 WPA represents a slight improvement in northern WCA-2A, and no change from future-without-project conditions in southern WCA-2A.

Summary

LAI

Future-with-project (WPA-SP) versus Future-without-project (2050 Base)

Throughout WCA-2A as a whole, the WPA-SP produces higher TP loads, reduced acreage of tree island habitat, improved apple snail recruitment, improved wading bird foraging conditions, and decreased acreage of cattail monoculture. In the northern IR, impacts of the WPA-SP are greater magnitude and duration extreme events, greater amplitude seasonal depths, and poorer snail kite foraging habitat quality. In the southern IR, the impacts of the WPA-SP include longer inundation durations and increased durations of extreme low water events. Benefits of the WPA-SP in southern WCA-2A are smaller amplitude seasonal depths, lower average maximum weekly depths, and improved snail kite foraging habitat quality. Given the mixed results observed when comparing the WPA-SP to the 2050 Base, it is difficult to ascertain the overall benefits of the project. Generally, most of the benefits are predicted to occur in southern WCA-2A (IR 25), while northern WCA-2A (IR 24) is predicted to be somewhat negatively impacted by the project.

WPA-SP versus Restudy Alt-A

Throughout WCA-2A as a whole, the WPA-SP results in higher TP loads, improved wading bird foraging conditions, and poorer snail kite foraging habitat quality, compared to the Restudy Alt-A. In the northern IR, impacts of the WPA-SP include greater magnitude and duration extreme events, shorter hydroperiods, and larger amplitude seasonal depths. In the southern IR, the impact of the WPA-SP is greater amplitude seasonal depths. Benefits of the WPA-SP for the southern IR included a slight improvement in extreme low water durations and shorter hydroperiods. Similar to the comparison above, results are mixed, but generally WPA-SP provides benefits over the Restudy Alt-A in southern WCA-2A, while the situation is reversed in northern WCA-2A.

NAI

Future-with-project (WPA2010) versus Future-without-project (2010 Base)

For several metrics, including extreme events, inundation patterns, seasonal amplitudes, and wading bird foraging conditions, the 2010 WPA did not differ markedly from the 2010 Base. Negative effects of the 2010 WPA included higher phosphorus loads into WCA-2A, and a reduced acreage of tree island habitat. Benefits of the 2010 WPA included reduced expansion of cattail monocultures, improved snail kite foraging habitat, improved apple snail reproduction throughout WCA-2A, and a slight improvement in conditions for periphyton in northern WCA-2A. Overall, although the 2010 WPA did not offer overwhelming benefits to WCA-2A, the net effect of the project appears to be beneficial.

Recommendation

We conclude that although model results often predict slight negative impacts to WCA-2A, the mixture of both impacts and benefits predicted does not justify disapproval of the project. Additionally, without any measure of model uncertainty, we have no way of determining whether the slight impacts predicted are actually statistically significant. Finally, we understand the overwhelming need for increased water storage in the regional system. We request that monitoring and adaptive management be used to adjust project operations in order to minimize impacts and maximize benefits to WCA-2A and other affected natural areas.

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