TOC Refuge Water Needs Working Group Technical Summary
May 9, 2008

A. Introduction and Background

In October 2006, the TOC tasked an interagency subgroup with formulating possible recommendations concerning the water needs of the A.R.M. Loxahatchee National Wildlife Refuge (Refuge). This effort was initiated in response to TOC discussions about the need to make recommendations concerning water needs as a foundation for various restoration alternatives being considered. This document summarizes subgroup conclusions and completes the TOC-initiated task. A more detailed set of technical analyses that are the foundation for these conclusions is being compiled.

The Refuge's Regulation Schedule defines stage-based zones whose boundaries vary throughout the year. Following consideration of ecological effects and constraints imposed by other Refuge uses, the current Regulation Schedule was adopted in 1995. The Regulation Schedule mandates discharge of water (termed regulatory releases) from the Refuge when stage is in the highest zone, Zone A1; however, the magnitude of a given release is not specified. In the intermediate zone, Zone B, discharges for water supply are allowed, and under some specific conditions water supply releases must be preceded by inflows of equal volume. In the zone of lowest stage, Zone C, all water supply releases must be preceded by an inflow of equal volume. The mandates of the Regulation Schedule thereby manage Refuge stage primarily via the release of water at high stages, and limiting withdrawal at very low stages. These mechanisms of controlling water, i.e., outflow management, were the only available options when the Regulation Schedule was adopted. Other management options may be available now or in the future. These options include upstream short-term or long-term storage of excess water (e.g., rock pits, other reservoirs, ASR wells), alternative routing of water supply deliveries around the Refuge, flexible diversion alternatives to other STAs and then to other conservation areas (e.g., ECART), and alternatives for water supply (e.g., Site 1 Impoundment and ASR). These potential alternatives provide new opportunities, as well as logistical challenges, for meeting future Refuge water needs.

The "Refuge water needs" is a very broad metric that attempts to satisfy numerous conditions supporting the ecology of the Refuge. The "water needs of the Refuge" is not a single value but may be met through an ***operating strategy*** that adaptively considers net inflow (inflow minus outflow), timing of inflows, temporal and spatial distribution of inflows, and antecedent conditions in the Refuge. In analyzing Refuge water needs, the subgroup employed a suite of complementary approaches that utilized historic records or water stage modeling scenarios.

B. Approaches for Estimation of Refuge Water Needs

Three approaches utilizing existing modeling tools and data available to the working group were employed. Historical analyses utilized publicly-available daily average data available from the SFWMD database, DBHYDRO. Modeling approaches used the South Florida Water Management Model (SFWMM), and the Refuge's Simple Refuge Stage Model (SRSM). Together, these three approaches provide a broader perspective than any single analysis could provide. Each approach involved specific assumptions and had limitations, and results of any analysis should be viewed not for explicit numbers, but in the range of values generated and within the context of the assumptions and conditions underlying its application.

1. Analysis of historical data

Historical flow analysis considered the period from 1995, when the current Regulation Schedule was first implemented, to 2001, when Refuge inflow was reduced by the diversion of the S-6 pump away from the Refuge and prior to the completion of STA-1E which provides a new source of inflows to the Refuge. This relatively short, 6-year period of flow and stage records provides observations representative of a time when Refuge average annual inflows (681 thousand acre-feet per year) exceeded those expected in any currently anticipated future scenarios. The high average inflow for this period was skewed by high inflows, for example, in 1995 inflows were over 1 million acre-feet, as a result of extreme wet weather in the Everglades Agricultural Area. For the purposes of this approach, it was assumed that inflows to the Refuge during this period were more than adequate to meet Refuge water needs. For this particular analysis, a value of approximately 608 thousand acre-feet was considered an estimate of an upper bound on the average annual inflow needed by the Refuge (absent any coordination of inflows and outflows). One alternative water management strategy was developed using the same 6-year period of flow and stage records. In this alternative, it was assumed that, on a daily basis, inflows and outflows could be ***maximally*** reduced by equal amounts by diversion of inflow away from the Refuge; as a result, the 6-year historic period could be reduced to an average annual inflow of approximately 353 thousand acre-feet per year. Under other assumptions, lower average annual inflow volumes can be calculated; however, for this particular analysis, 353 thousand acre-feet per year represents a reasonable estimate for the long-term average annual Refuge structural inflows under the assumed specific management strategy that support the ecology of the Refuge.

2. SFWMM Scenario Statistical Analysis

Two existing 36-year SFWMM runs (1965-2000) were compared to a set of Refuge hydrological criteria providing a wide range of yearly inflow/outflow conditions. These model runs which are designated ECPBase and EAA_ECB simulate assumed "existing" conditions based on historic climatic conditions with Refuge outflows simulated using estimated water supply demands and associated regulatory releases. To characterize a modeled-year where Refuge water needs were assumed to be met, initial-year selection criteria required that within a year no weekly average canal stage may fall below 14 feet NGVD, and that at least two weekly average canal stages in December be above 17.5 feet NGVD. Using these criteria, the average annual inflow in selected years was roughly 500 thousand acre-feet for both model runs. The subgroup agreed that it is desirable to meet the referenced stage criteria most, but not all years (i.e., in some years, lower stages would be beneficial), so the 500 thousand acre-feet was considered to be an upper bound of long-term average annual Refuge inflow volumes that support the ecology of the Refuge. It was also observed in the two models runs that the Refuge began some years with a fair volume of water already detained, requiring as little as 200 thousand acre-feet over the remainder of the year to meet the desired target stages due to the good starting conditions and local rainfall. Therefore, based on this analysis and the water management strategy modeled, the long-term average annual Refuge inflow volumes necessary to support the ecology of the Refuge fell in the range of 200 thousand to 500 thousand acre-feet per year.

3. Comparison of SFWMM with SRSM Simulation

The SRSM model was run for the same period as the SFWMM ECPBase run using similar climatic and inflow records. There was good agreement between the model runs, with predicted marsh stages from each model being within 0.1 foot at most times. The largest deviation between the models occurred in 1989 during an extreme drought. The SRSM was used to test sensitivity of model predictions to various perturbations. As expected, it was found that the model is sensitive to the level of water supply withdrawal when comparing between recent levels of water supply withdrawal and the base model. A more surprising result is that there was a similar level of sensitivity to how regulatory releases are managed. Sensitivity to the level of inflow was also examined. As long-term average annual SRSM inflows were increased, it was found that when structural inflows are above 600 thousand acre-feet per year, regulatory releases generally increase to the extent that little additional water is retained within the Refuge.

4. Summary

In summary, the estimation of the range of desirable inflow volumes through the Refuge structures involves complexities, assumptions, and uncertainties. Three different approaches were employed, and the subgroup reached a technical conclusion that no single method is clearly superior to other methods of estimation, and that each approach has specific strengths and weaknesses. At the present time, it is best to use stage as a surrogate performance measure for the “water needs of the Refuge” when evaluating alternatives in lieu of an annual inflow volume.

C. General Conclusions

1. The Refuge’s Regulation Schedule is an extremely flexible and robust tool to manage stages within the Refuge. Analyses demonstrated that multiple Refuge ecological performance measures were achieved with long-term average annual structural inflow volumes that ranged from as low as approximately 200 thousand acre-feet to as high as approximately 600 thousand acre-feet depending on many factors, such as antecedent conditions, structure operations, rainfall, etc. Desirable long-term average annual inflow volumes are therefore likely within this broad range of 200-600 thousand acre-feet per year, and are highly dependent on timing of inflows and outflows relative to the Regulation Schedule, precipitation, and real-time water management practices.

2. Potentially beneficial changes to water management strategies in the Refuge could require modification of the current Refuge Regulation Schedule as well as the Central and Southern Florida Project's Master Water Control Manual.

3. Refuge hydrological conditions are sensitive to both the timing and operational practices of regulatory releases. Opportunities for optimizing these operations should be explored further.

4. The desirable range of Refuge inflow volumes is also sensitive to water supply withdrawal quantity and timing. Projects which provide water supply alternative sources and temporal flexibility can play a significant role in reducing desirable long-term average annual inflow volume needs.

5. Decisions concerning Refuge water management must consider multiple objectives; this subgroup was not tasked with addressing other objectives such as water supply or water quality.

6. Upstream and downstream impacts of changes in Refuge inflow and resulting regulatory releases also were not considered by this subgroup, but should be considered prior to recommending meaningful changes to water management strategies in the Refuge.

TOC Refuge Water Needs Working Group

Technical Summary

May 20, 2008

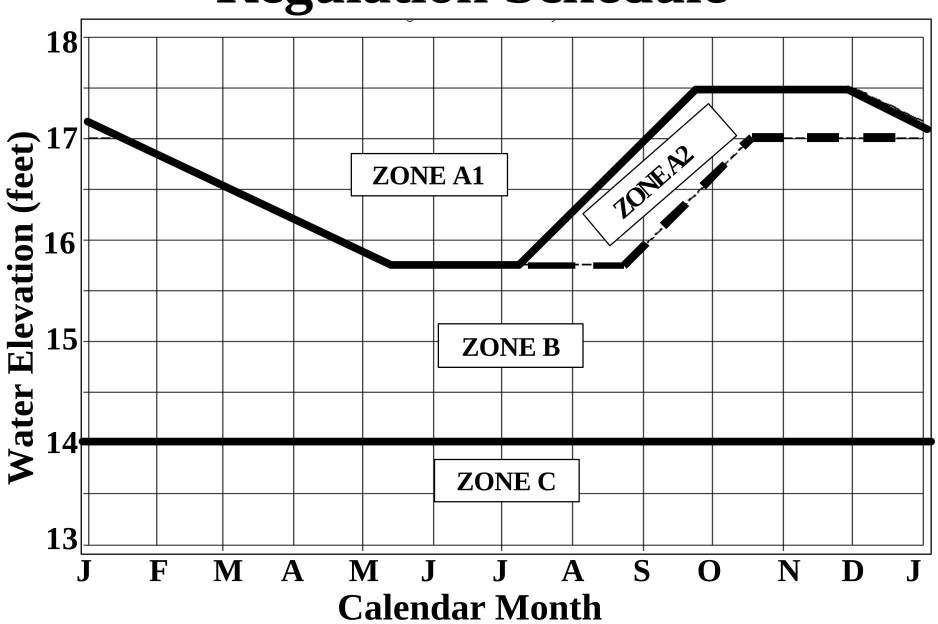
Introduction & Background

- Initiated October 2006
- Purpose – Investigate and formulate recommendations to the TOC
- Membership – more than 30 participants
  - SFWMD
  - FDEP
  - Corps
  - DOI
  - Others
- Process – draft analyses discussed via emails, calls, meetings
- Targeted finding areas of consensus

Acknowledgements

- Our work was based on previous monitoring, studies, and publications.
- Data analysis & review primarily by
  - Mike Waldon (USFWS)
  - Shawn Komlos (Corps)
  - Wossenu Abtew (SFWMD)
  - Tracey Piccone (SFWMD)

Regulation Schedule



Refuge Regulation Schedule

- Designed to provide improved habitat while meeting water use and flood control needs
- Focuses on outflow management – regulatory releases – to control stage
- New opportunities and challenges now possible

Work Group Approach

- The “Refuge water needs” is a very broad metric that attempts to satisfy numerous conditions supporting the ecology of the Refuge.
- The “water needs of the Refuge” is not a single value but may be met through an ***operating strategy*** that adaptively considers net inflow (inflow minus outflow), timing of inflows, temporal and spatial distribution of inflows, and antecedent conditions in the Refuge.
- In analyzing Refuge water needs, the subgroup employed a suite of complementary approaches that utilized historic records or water stage modeling scenarios.

3 Approaches

1) Analysis of historical data – looked at 1995-2000, a high inflow period
   - 681 thousand ac-ft/yr average over period
   - Reduction to 608 with little effect on water budget
   - 353 is reasonable minimum with inflow management
2) SFWMM Scenario Statistical Analysis – examined 2x2 model runs; analyzed 72 simulated years
   - Needed inflow in range 200-500 thousand ac-ft/yr
3) Comparison of SFWMM with SRSM Simulation – compared models; made alternative model runs
   - Stage is insensitive to long-term average inflow above 600 thousand ac-ft/yr

Summary

- No single method is clearly superior to other methods of estimation.
- Each approach has specific strengths and weaknesses.
- At the present time, it is best to use stage as a surrogate performance measure for the “water needs of the Refuge” when evaluating alternatives in lieu of an annual inflow volume.

General Conclusions – 1:

- The Regulation Schedule is an extremely flexible and robust tool to manage stages within the Refuge.
- Multiple Refuge ecological performance measures were achieved with long-term average annual structural inflow volumes that ranged from 200 to 600 thousand acre-feet depending on many factors, such as antecedent conditions, structure operations, rainfall, etc.
- Desirable long-term average annual inflow volumes are therefore likely within this broad range of 200-600 thousand acre-feet per year.
- Needed inflow is highly dependent on timing of inflows and outflows relative to the Regulation Schedule, precipitation, and real-time water management practices.

General Conclusions – 2:

- Potentially beneficial changes to water management strategies in the Refuge could require modification of the current Refuge Regulation Schedule as well as the Central and Southern Florida Project's Master Water Control Manual.

General Conclusions – 3:

- Refuge hydrological conditions are sensitive to both the timing and operational practices of regulatory releases.
- Opportunities for optimizing these operations should be explored further.

General Conclusions – 4:

- The desirable range of Refuge inflow volumes is also sensitive to water supply withdrawal quantity and timing.
- Projects which provide water supply alternative sources and temporal flexibility can play a significant role in reducing desirable long-term average annual inflow volume needs.

General Conclusions – 5:

- Decisions concerning Refuge water management must consider multiple objectives; this subgroup was not tasked with addressing other objectives such as water supply or water quality.

General Conclusions – 6:

- Upstream and downstream impacts of changes in Refuge inflow and resulting regulatory releases also were not considered by this subgroup, but should be considered prior to recommending meaningful changes to water management strategies in the Refuge.