

Arthur R. Marshall Loxahatchee National Wildlife Refuge

General Refuge hydrologic needs and a proposed performance measure for River-of-Grass alternatives

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Arthur R. Marshall Loxahatchee NWR

- Established in 1951 under the Migratory Bird Act of 1929 "for use as inviolate sanctuary, or for any other management purpose, for migratory birds."
- A 50-year license agreement between the USFWS and the South Florida Water Management District allows the USFWS to manage Water Conservation Area 1 as a National Wildlife Refuge
- Purpose within license agreement is to "... to promote the conservation of wildlife, fish, and game, and for other purposes embodying the principles and objective of planned multiple land use."



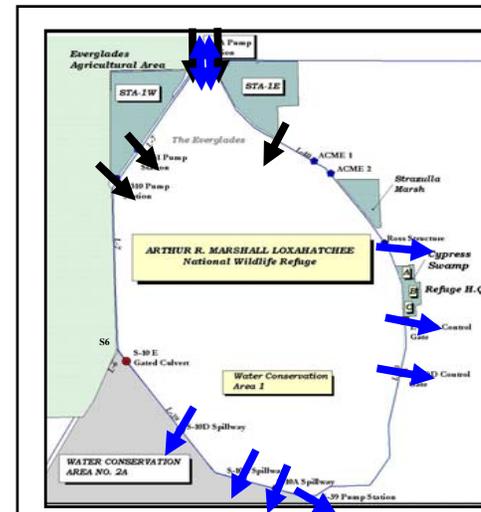
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Refuge Background



Source:
Light and Dineen, 1994

- Established in 1951
- Impoundment ~1961
- 144,000 acres
- Tree Island-Ridge-Slough
- Soft-water system
- Formerly sheet-flow
- Circumscribed by canal
- Consent Decree for WQ



Current Refuge Inflows and Outflows

- Current Inflow (black arrow)
- Current Outflow (blue arrow)

General Refuge hydrological needs

- Marsh stage to be at top of regulation schedule 3-4 weeks 4 out of 5 years
- Sufficient stage recession each year between January and April to encourage wading bird foraging success, with no stage reversals during this time
- Interannual stage variability that mimics natural patterns as much as possible

General Refuge hydrological needs (cont.)

- Minimize occurrence of exposed soils, particularly in the northern Refuge, that encourage germination of non-native plants
- Avoid extreme dry conditions that lead to muck fires
- Ensure that Refuge hydrological needs are met using clean water (i.e., complying with 17 ppb WQBEL)

Why we can't return to a flow-through system

- Because the perimeter canal is inside the levee, increase flows would occur only in the canal and in the Refuge periphery, and would result in even deeper water in the already too-deep southern Refuge
- Extreme and undesirable changes in Refuge infrastructure (such as internal levees) would be required to force sheetflow through the Refuge interior
- Creation of the WCA-1 impoundment may have resulted already in topographic changes that have resulted in loss of ridge and slough habitat conducive to sheetflow

Why do we not want extreme infrastructure changes

- The Refuge already is a highly engineered system dependent upon pump stations, water control structures, levees and canals
- Additional infrastructure (e.g., additional perimeter and/or internal levees) have further negative impacts on Refuge habitat, are expensive to construct, maintain, and operate, and make the Refuge even more unnatural than it is already

Meeting Refuge Hydrologic Need?

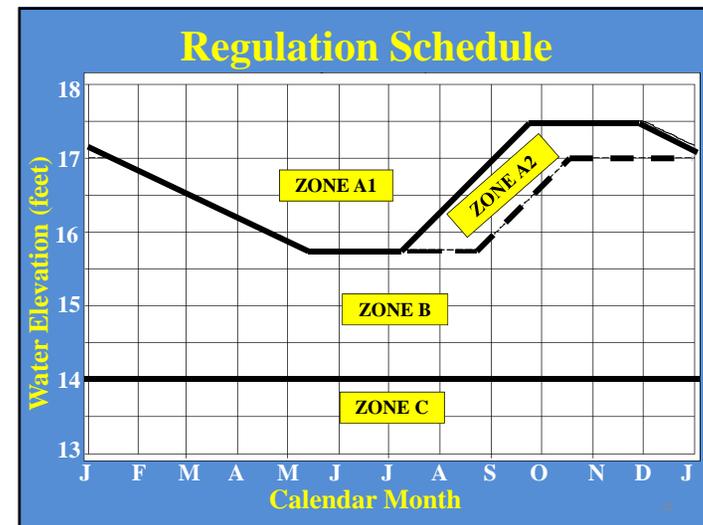
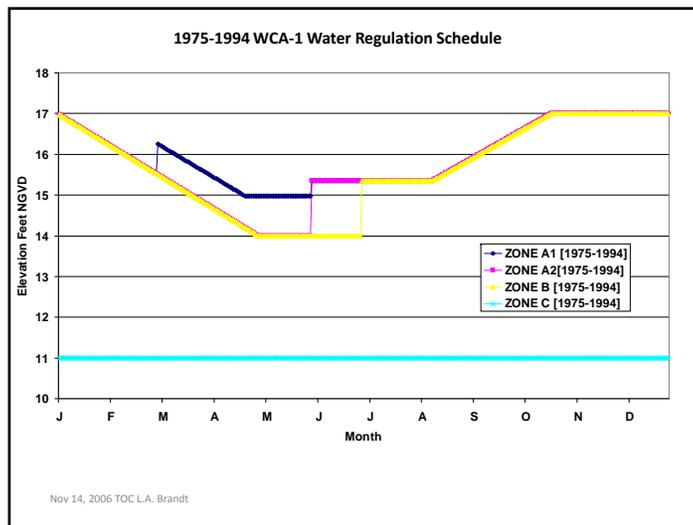
- Total annual inflow statistics are problematic
 - Inflow and rainfall are correlated so there is a danger of improper conclusions
 - Timing is VERY important
 - Higher inflow years dominate statistics of central tendency
 - Higher inflow years often simply have larger releases
 - Operational decisions are important
- Conclusion – Use performance measures (PMs) based on stage not inflow
- A suite of PMs may be developed for use in assessing restoration alternatives

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History, and What We Know

- Refuge regulation schedule controls only Refuge releases
- There have been 4 regulation schedules in Refuge
- 1975-1994 schedule had high-stage too low
- Refuge regulation schedule was revised in 1995 to raise stage
- Refuge has had higher Oct-Jan stages since 1995
- 1995-2001 high-stage conditions were likely adequate; no studies show that stages were excessive
- In 2001, S-6 pump was diverted
- 2001-present high-stages reduced in magnitude & duration

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Refuge Hydrologic Performance Measures

- Possible PMs might measure
 1. Reaching & holding high-stage (most years)
 2. Recession rate (all years)
 3. Reversals (all years)
 4. Avoid extreme dry conditions (most years)
- Select #1 as first PM developed for ROG
 - Other concerns may need to be addressed at a later project stage

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Refuge Hydrologic Performance Measures

Select L-40 Canal (1-8C) Gage for PM Evaluation

- Gage has a long record back to 1950s
- Primary gage for regulation schedule controlling regulatory releases
- At higher stage (>16.5 ft)
 - Stage is uniform across Refuge when high
 - Can therefore use canal stage at 1-8C gage for PM #1 – consistent with regulation schedule

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Narrative: PM 1 – High-Stage

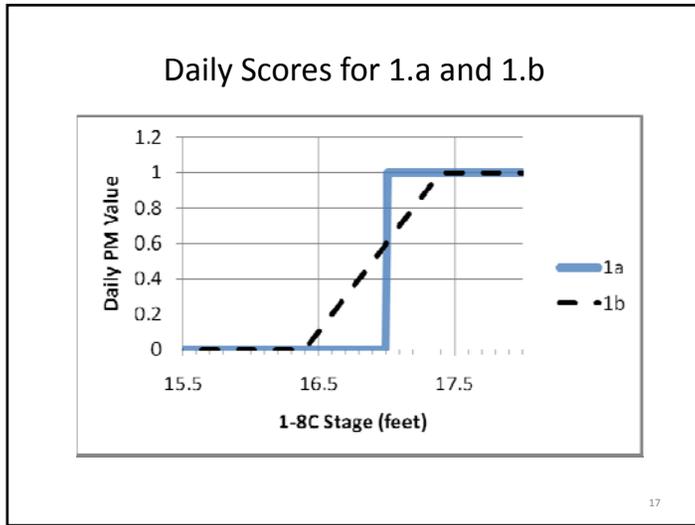
- Higher water (Oct-Jan) needed to:
 - Mimic natural hydropattern in timing & duration
 - Inhibit woody plant expansion in marsh
 - Inhibit wet prairie encroachment into slough
 - Inhibit expansion of non-native plants
 - Store water for ecological & water supply needs
 - Reduce canal water intrusion
 - Reduce phosphorus concentration
- Constraint: For most of the Refuge most years
 - depth > ½ ft 3-4 weeks (21-28 days) in almost all of Refuge
 - Occur at least 3 out of 4, or 4 out of 5 years

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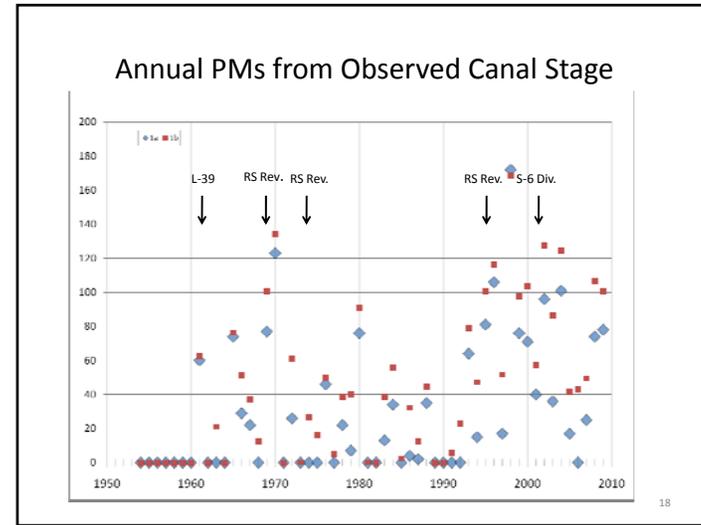
Candidate Annual High Water #1 PMs – Sum daily scores through each water year

- a. Number of days in Florida water year that stage exceeds 17 feet
 - that is, daily score is 0 when stage is below 17 ft, 1 otherwise – target 3-4 weeks in 3 in 4 or 4 in 5 years
- b. Alternative smooth transition similar to a.
 - days above 17.4 ft score 1, days below 16.4 ft score 0, otherwise score = stage-16.4 ft – target derived from relationship to 1.a target

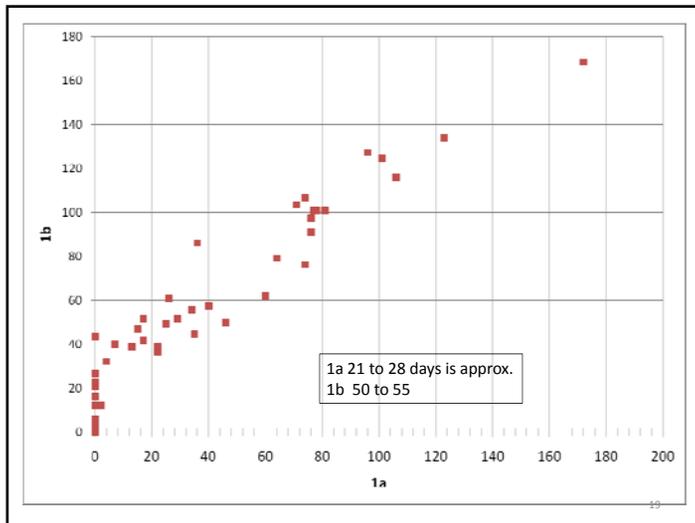
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PM 1.b percentiles

Return (yr)	5	4	3.33	3.03	2.5	2
Percentile (1/yr)	20%	25%	30%	33%	40%	50%
1985-1994	1.9	3.3	5.0	5.9	9.8	17.5
1995-2001	65.2	77.3	89.3	96.5	98.6	100.6
2002-2009	45.7	47.9	53.1	60.8	78.8	93.4
1995-2009	51.2	54.4	63.0	75.1	92.9	100.6

Target: 1.b PM -- 4 year return (25 percentile) > 55
(only the 1995-2001 period meets this target)

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Model Evaluation

Before using models to evaluate ROG alternatives for the Refuge, we should test if the models' predicted PMs match observed PMs.

Evaluate 3 Refuge models:

- SFWMM – South Florida Water Management Model v5.4
- SRSM – Simple Refuge Screening Model v4
- MF – DHI MIKE-FLOOD Refuge model v2

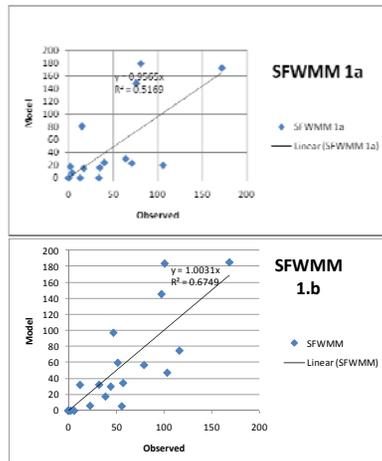
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Model Stage Adjustment

Gage datums in the Refuge not in agreement; differ by roughly +/-0.2 ft. PMs based on canal stage likely need small high-stage adjustment. Small adjustments can make large changes in PMs.

- SFWMM – Decrease stage 0.17 ft
- SRSM – Increase stage 0.09 ft
- MF – increase stage 0.16 ft

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Conclusions

- PM 1.b provides values which are consistent with qualitative assessments
 - The one period believed to have adequate stage is above target
 - Other periods are below target
- Model results are more reliable for 1.b than 1.a
- Various models acceptably project PM 1.b

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Recommendations - alternative evaluation for ROG

- Use PM 1.b as first metric for ROG alternative analysis
 - Exceed 55 at 25th annual percentile (longer than 4 year return)
 - No upper constraint is known
- Any provisionally selected alternative should be further reviewed for other objectives & unanticipated impacts
- Other projects that are likely to affect inflow or high stage might/might not appropriately use this PM
- Additional PMs will be developed for other aspects of Refuge hydrological needs
 - PMs may be applied to ROG and/or other projects

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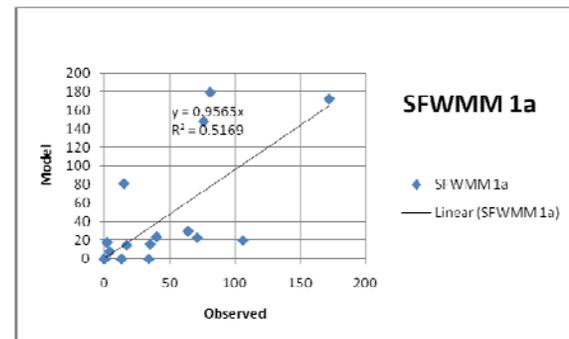
Questions?

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Appendix – Model PM Evaluation

Comparison of Model Predicted to Observed Performance Measures – SFWMM, SRSM, and MF

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