Aquifer Storage and Recovery Regional Study

ASR Regional Study Ecological Risk Assessment

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Presentation Outline

- Critical Issues (identified in 1999-2002)
- Study Framework / ERA Problem Formation
- ERA Data Collection / Analysis
- Key Findings (Risk Characterizations)
- Recommendations and Uncertainties

Critical Issues Identified by ASR Reviewers

- Potential effects of ASR on mercury bioaccumulation (ASR Issues Team, 1999)
- Regional effects of ASR on Greater Everglades ecosystem (NAS, 2001)

  - ► NAS Review of ASR Regional Study recommended that the risk assessment should focus on identification and measurement of key ecological indicators native to Greater Everglades" (NAS, 2002)

Study Framework / Problem Formulation

ASR ECORISK ASSESSMENT SETTING

- **Multiple ASR installation locations**
- **Multiple Receptors**

Ecological Risk Assessment Objectives

- Prevent toxic levels of ASR related contamination in water, sediments, and biota
- Maintain self-sustaining native fish populations and their habitat
- Reduce eutrophication of surface water bodies
- Protect human health by limiting increases in methylmercury bioaccumulation by resource fish.
- Maintain diversity of native biotic communities
- Ensure the continued existence of native species in the watershed
- Maintain water quality for designated uses throughout the watershed

How does Aquifer Storage Affect WQ?

- Gross Alpha ↑
- Phosphorus ↓
- Hg, MeHg ↓
- Manganese ↓
- Iron↓
- Arsenic ↑
- TOC ↓
- DOC ↓
- Specific Conductivity ↑
- Temp ↑ ↓

- Alkalinity ↑
- Chloride ↑
- Sulfide ↑
- Sulfate ↑
- Potassium ↑
- Sodium ↑
- Magnesium ↑
- Calcium ↑
- Color ↓
- pH ↑

General List of Stressors

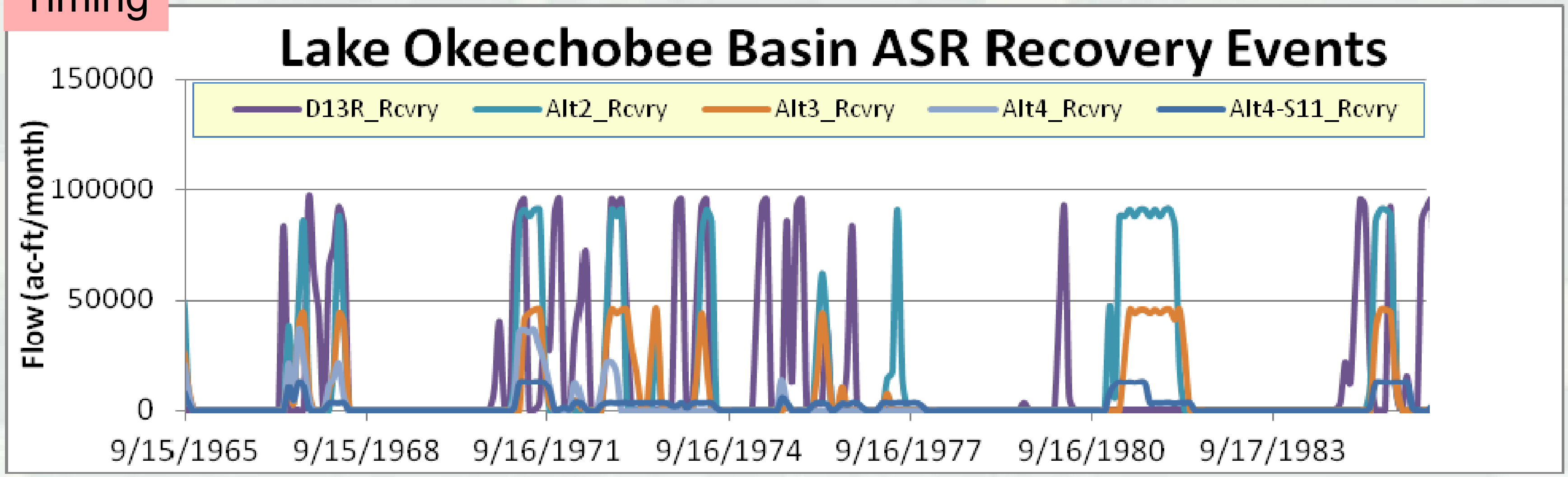
- Nutrients
- General Water Quality Constituents (SO_4, Cl, etc.)
- Trace Metals
- Radionuclides
- Thermal Discharges
- Mechanical Evisceration
- Change in Lake Operations (Stage freq., duration)

General List of Receptors

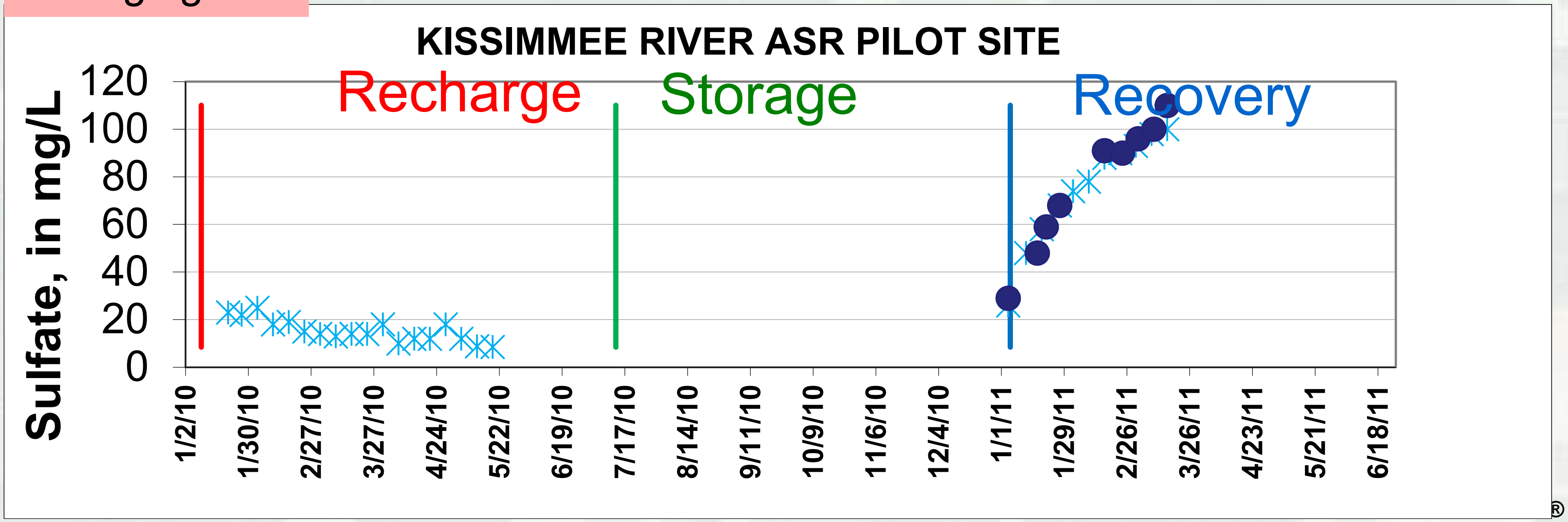
- Fish & Wildlife
- Humans
- Manatees
- Periphyton
- Zooplankton
- Macrophytes (rooted emergent, submersed)

Characteristics of Exposure

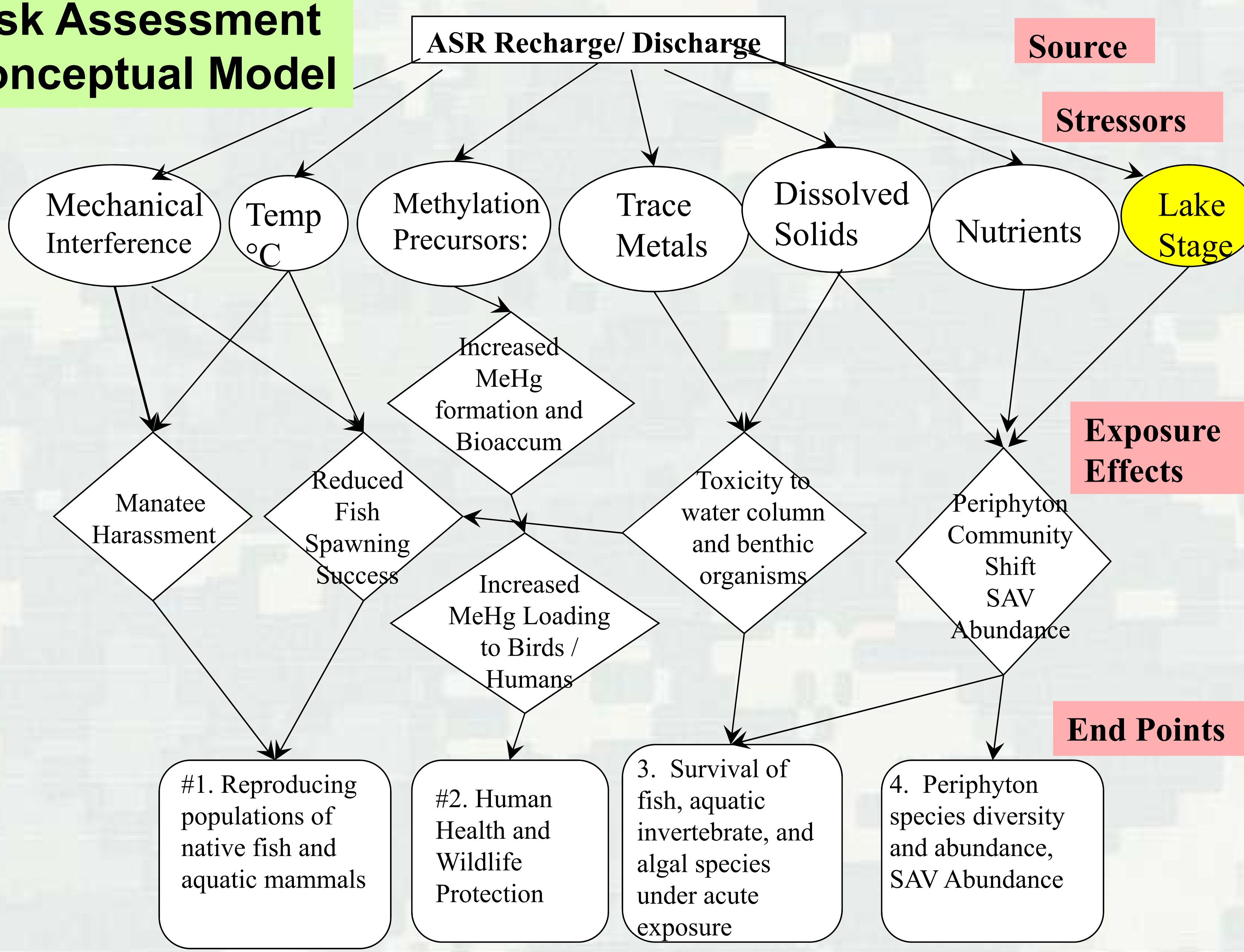
Timing



Changing WQ



Risk Assessment Conceptual Model



ERA Data Collection and Analysis

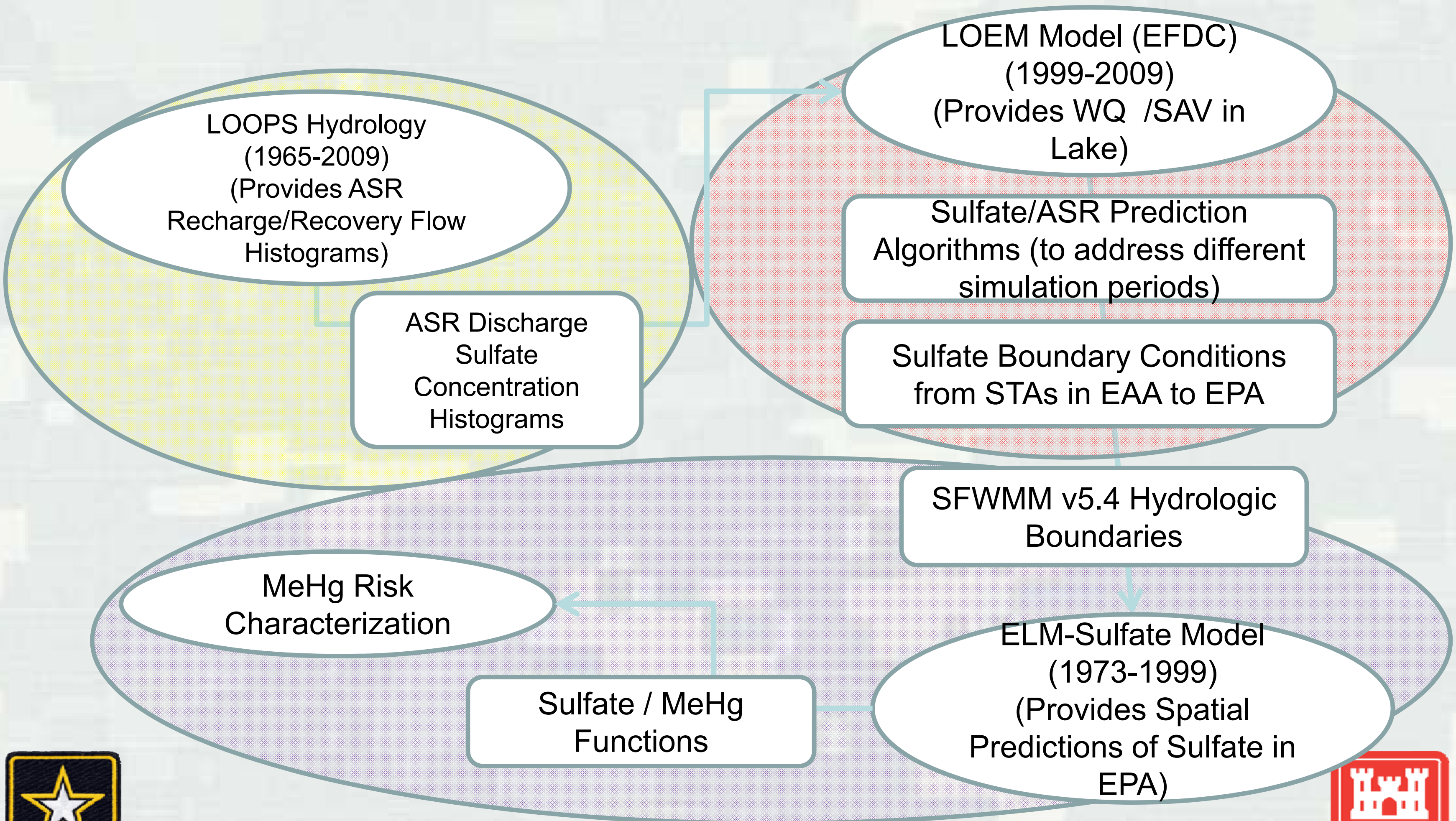
Lake O ASR Scenarios Evaluated for this Study

- ALT-1 (Baseline): No ASR wells in basin.
- ALT-2 (Scenario 1): 200 Upper Floridan ASR Wells in Basin
- ALT-3: 100 Upper Floridan ASR Wells in Basin
- ALT-4 (Scenario 9): 48 Upper Floridan, 32 Avon Park Permeable Zone (APPZ), 120 Boulder Zone (BZ) ASR Wells in Basin
- ALT-4S11(Scenario 11): 48 Upper Floridan, 32 APPZ, 120 BZ ASR Wells in Basin with controls on recovery rate.

Studies to Evaluate End Points

- #1 (Fish and Wildlife Reproduction): Analysis of frequency and duration of discharge, thermal characteristics, fry entrainment potential assessment.
- #2 (Human Health and Wildlife Protection): Simulated SO_4 fate / transport and link to methylmercury formation in Lake O and Greater Everglades, bioaccumulation studies using freshwater mussels.
- #3 (Survival of Aquatic Species): Perform Acute / chronic toxicity testing of recovered water at two ASR sites, stream condition index sampling at KRASR outfall.
- #4 (Periphyton / SAV Abundance): In-situ exposure at KRASR to assess impact to periphyton, simulation of SAV biomass and coverage using Lake O water quality model.

Modeling System to Predict WQ/SAV Impacts to Lake O and Water Conservation Areas



Key Findings

ASR Effects on Primary Receiving Water Body (Kissimmee River)

Toxicology: Testing of recovered water at the KR ASR Pilot facility showed no acute toxicity and sporadic chronic toxicity of unknown origin.

Benthic Community: Stream Condition survey indicated no change to community structure in vicinity of KR ASR outfall; however, the quality of the baseline benthic community is low so effects may not have been observable.

Periphyton Community: No impact to periphyton community observed at KR ASR outfall; however, study data was limited and not statistically robust.

Water Quality: Arsenic in recovered water exceeds the SW standards during initial recovery events but then meets SW and drinking water standards for subsequent event.

Fisheries: Impacts minimal for small clusters. Risks increase with ASR cluster size and cluster density.

ASR Effects on Lake Okeechobee

Ecological Performance:

The hydrogeologically preferable alternatives (ALT4, ALT4-S11) do perform similarly to CERP projections of reduced discharges to the northern estuaries; however, these alternatives have limited water recovery so increases in lake stage during drought periods are minimal. Positive effects on SAV coverage are expected to be minimal as a result.

Water Quality: Sulfate and chloride increase substantially with ALT2, but it is temporary and generally return to baseline conditions once lake refills due to rainfall and upstream runoff. TP concentrations in lake not affected regardless of alternative. Though sulfate increases, effects to MeHg conditions considered to be minimal due to predominant sandy, non-aerobic sediment conditions in lake as well as already elevated sulfate concentrations in lake.

ASR Effects on Greater Everglades

- ASR related increased sulfate concentrations/loads are temporary and occur in areas primarily adjacent to inflow canals within the WCAs and ENP.
- MeHg formation is expected to increase and decrease depending upon the proximity to discharges and the baseline sulfate concentrations as they compare to MeHg optimum concentrations. (In areas where baseline SO4 concentration is below optimum for methylation, then formation increases. In areas where baseline SO4 is above optimum, then methylation may be inhibited.)

Recommendations and Uncertainties

Uncertainties

- Availability of in-stream mixing water potentially required by NPDES permits as a protection from chronic toxicity may limit multiple ASR well installations within some receiving water bodies.
- Fisheries impacts possible in sensitive areas and are limited to DO attractive nuisance and spawning impacts to cool water species.; other issues, such as H2S and Entrainment &Impingement can be designed to avoid risk) particularly for multiple wells within one receiving water body.
- Benthic Invertebrate community not likely to be impacted in areas with poor stream condition index; however, this needs closer review at more “natural” sites.
- Periphyton Studies not extensive enough to draw firm conclusions due to limited data collection.

Implementation Recommendation : Tiered Implementation and Investigation of CERP ASR

TIER	DESCRIPTION	ACTIVITIES	SCOPE OF RISKS	2013 ERA Uncertainty
Tier 1	Pilot ASR Facilities (2 Built)	Multi-year cycle testing as part of Ecological Risk Assessment	Localized Impacts, Reversible, Short Term	Low
Tier 2	Initial CERP ASR Installation. (5 to 10 Wells per site)	Long-term Cycle Testing. *Revision of Ecological Risk Assessment*	Sub-regional impacts, Reversible, Short term	Medium
Tier 3	Full Scale CERP Implementation (100 to 300 wells)	Full Operations. Routine monitoring	Regional Impacts, Semi-reversible, Long term	High

Primary Study Contributors

- Mark Shafer, P.E., USACE: Coordinated study tasks, LOOPs modeling, LOEM WQ model ASR boundary conditions.
- Steven Schubert, USFWS: Fish/wildlife impacts assessment, helped develop study plan and conceptual model.
- Isabel Johnson, Golder Associates, Inc: Toxicology, metals bioaccumulation, ERA risk assessment framework
- Kang-Ren Jin, Phd., SFWMD: LOEM water quality / SAV modeling
- Andrew Rodusky, Phd., SFWMD: Periphyton impacts assessment
- Carl Fitz, Phd., Formerly with Univ. Florida: Everglades Landscape Modeling of ASR sulfate
- William Orem, Phd., USGS: Sulfate assessment Lake Okeechobee, Greater Everglades.
- David Krabbenhoft, Phd., USGS: Mercury methylation impacts in Greater Everglades.

End

Thank You