

# Use of Robustness and Flexibility in Adaptive Management for Addressing Uncertainty

Jim Vearil, Andy LoSchiavo,  
and Tom St. Clair



NCER 2011

# Background

- Concept of using robustness in Water Resources Planning, Engineering, and Management around since 1970's
- Has roots in concept of ecological resilience
- Pioneering work by Buzz Holling and Myron Fiering

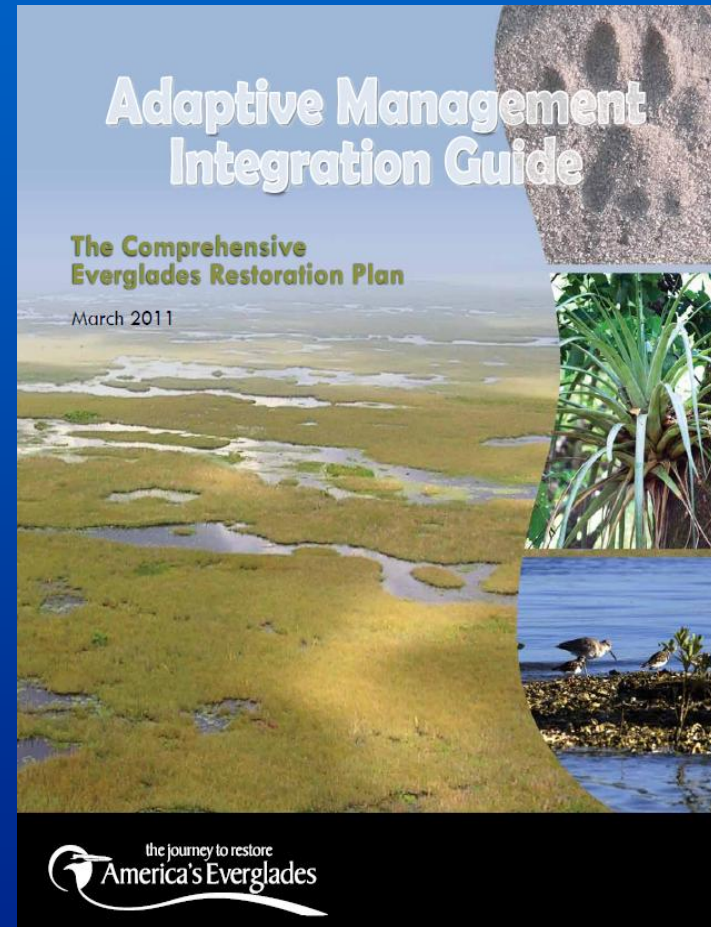
# Robustness - Why and What

- Best way to enhance sustainability is maintain reversibility and robustness
- Reversibility – keep design and management options open for future generations
- Robustness – ability to adapt to varying, unforeseen future conditions with little additional costs
- Robust systems designed to be near cost effective for wide range of possible future conditions

*UNESCO Working Group/ASCE Task Committee on Sustainability (Loucks and Gladwell, 1999)*

# CERP Adaptive Management

- Structured management approach
- Address uncertainty by testing hypothesis
- Link science to decision making
- Adjust implementation when necessary to increase likelihood of restoration success



(CERP AIMG, 2011)

# Introduction – Flexibility and Robustness in CERP

- Natural systems are complex – planning and predicting restoration outcomes is difficult (CERP AIMG, 2011)
- Address uncertainty by incorporating appropriate operational flexibility, robustness, monitoring, assessment into all phases of CERP (CERP AMIG, 2011)
- Robustness – ability of key design parameters to operate effectively in the face of variability and uncertainty of future events (CISRERP, 2006)



# History Can Help Teach Us:

- Why the need for tools to address uncertainty
- “Unintended Consequences of Purposeful Social Action” (Merton, 1936)
- Need to avoid hubris that we know everything
- Henry Petroski - History of engineering provides invaluable case studies

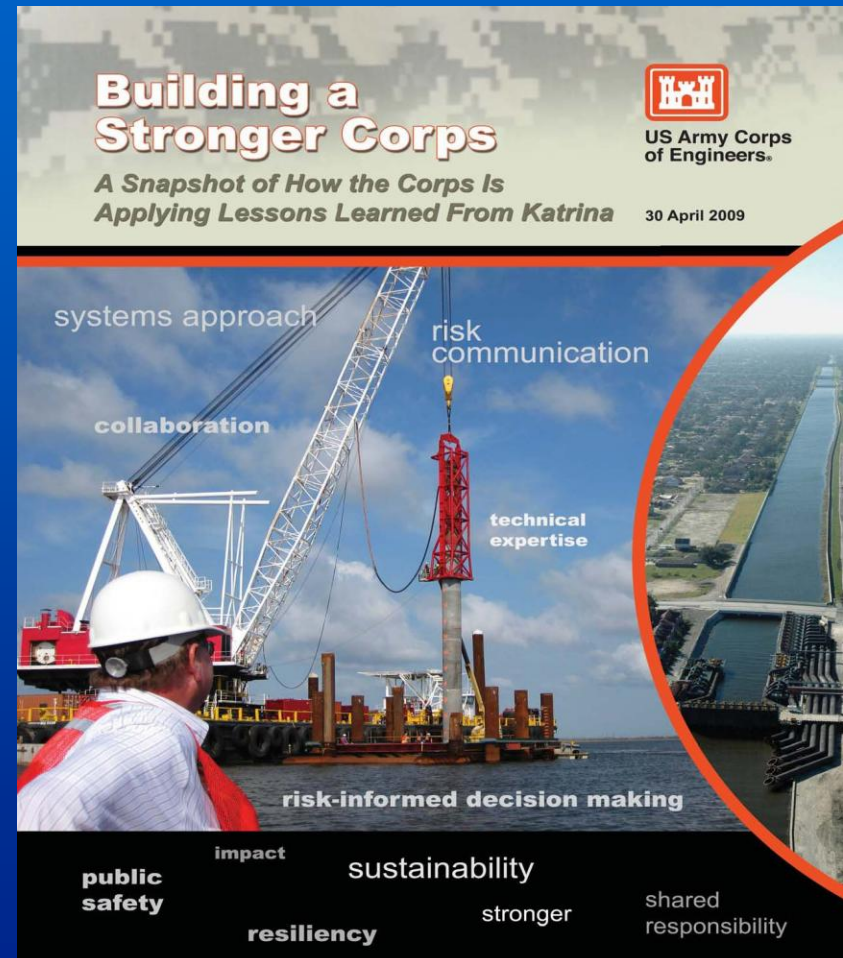
River of Interests:  
Water Management in South Florida  
and the Everglades, 1948-2000

by  
Matthew C. Godfrey, Historian  
Historical Research Associates, Inc.  
with contributions by Theodore Catton



# Lessons Learned - Robustness and Flexibility

- Army Corps of Engineers' *Learning Organization Doctrine* (2003)
- Hurricane Katrina lessons – Corps of Engineers Actions for Change
- "...A commitment to organized and transparent adaptive management is the only rational solution to an uncertain future."



# Hydraulic Engineering Example of Robustness

- Problems with unbalanced gate openings
- Gate pier extensions would fix the problem with unbalanced gate openings

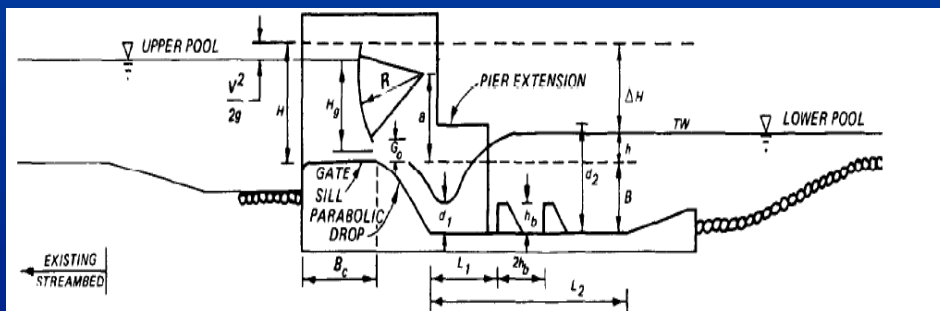


Figure 5-1. Definition sketch of typical navigation dam



# CERP AIMG Examples of Robust and Flexible Options

- Weirs designed for crest height changes without major retrofitting
- Multiple projects designed in phased increments to allow for mid-course corrections
- Use multiple smaller pumps instead of a few big ones
- Purchase land/easements to provide for additional water storage during flood periods

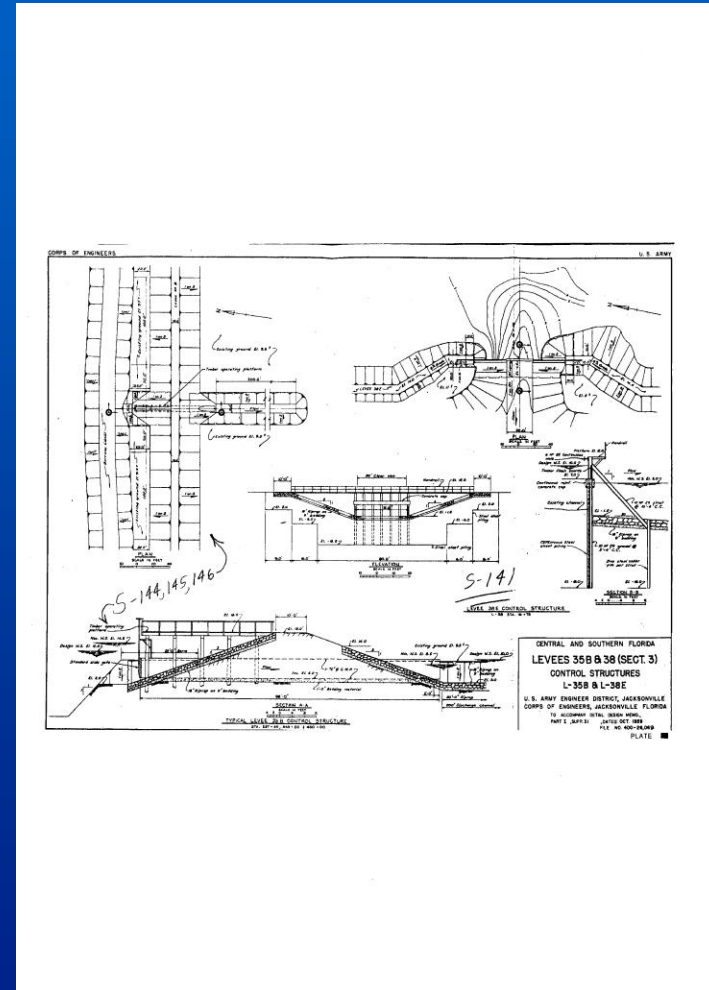
# Some Challenges to Using Robust Alternatives and Operational Flexibility

- Can cost more
- May not be the “optimal solution”
- How to measure the benefits of robust alternatives?
- Lack of appreciation, understanding, or willingness to deal with uncertainties
- Short term versus long term view
- Crossing interdisciplinary boundaries
- Trust issues
- Stakeholders desire for certainty



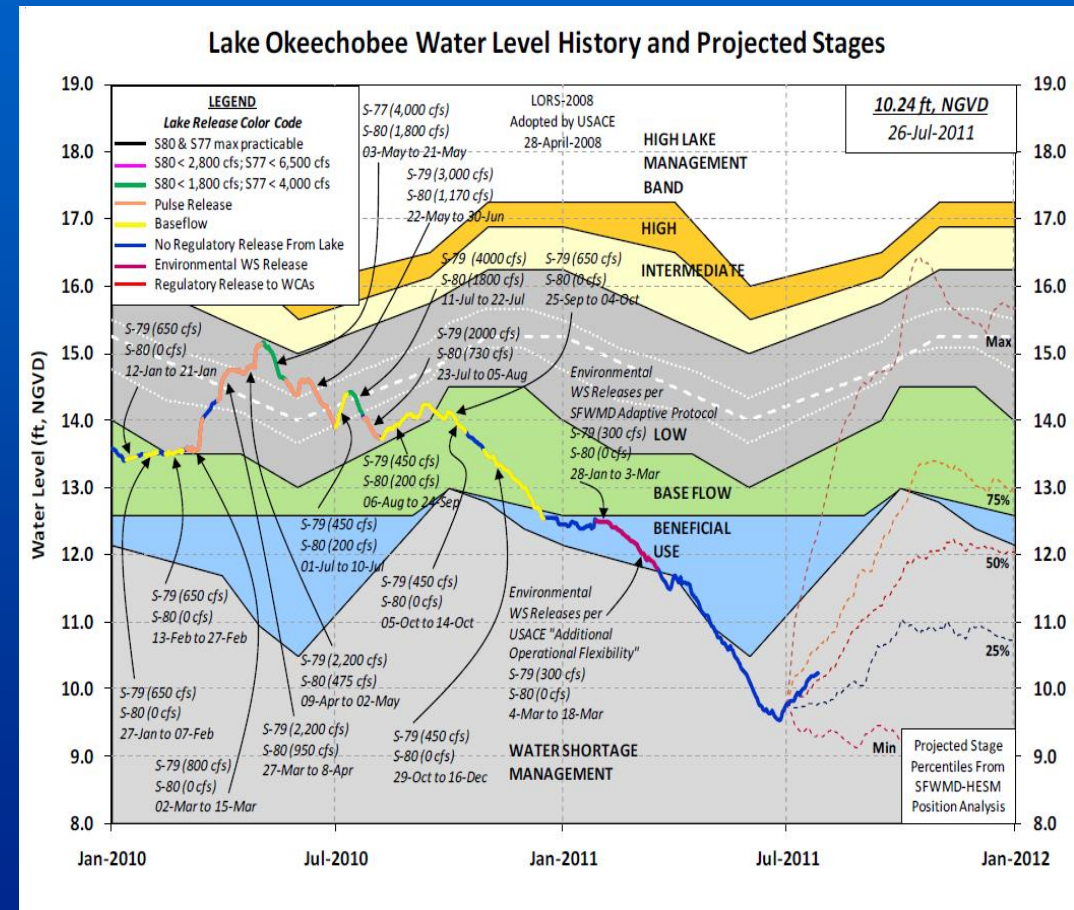
# Operational Flexibility Example

- Weirs versus gated spillways and culverts
- For weirs - stoplogs versus less easily removed sections



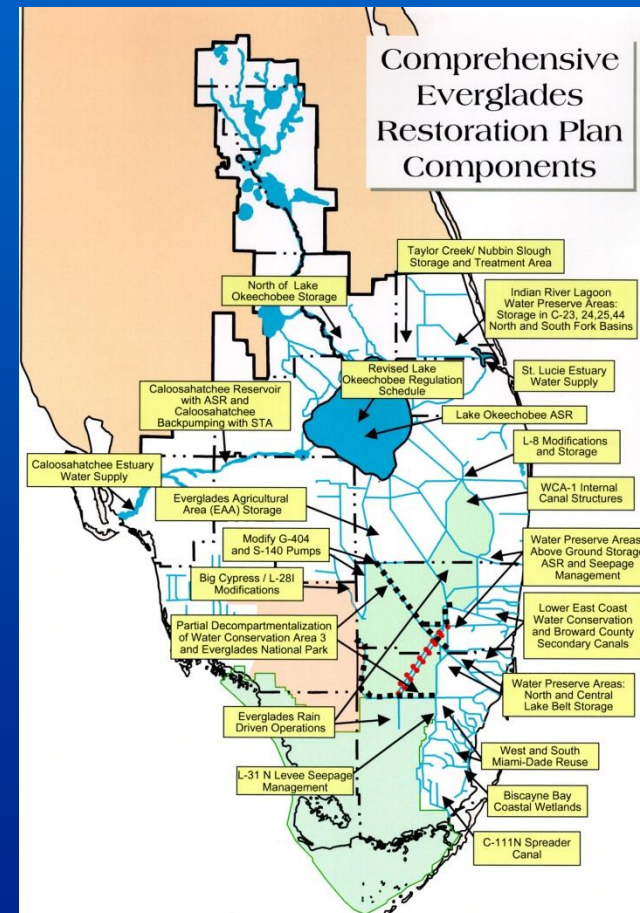
# Questions about Operational Flexibility and Adaptive Management

- Real time operations versus testing hypothesis
- Spatial and temporal scale issues for use in Adaptive Management?
- Can monitoring measure these changes?
- Feedback loop from monitoring and assessment?



# Summary

- Robustness and flexibility can be useful tools for Adaptive Management
- Helps deal with uncertainty and keeps options open for the future
- Challenges to use of robustness and flexibility



# Questions?

