Assessing Ecological Risks to Biscayne Bay

South Florida Ecosystem Restoration Working Group Meeting

24 July 2001

UNIVERSITY OF MIAMI
RSMAS
ROSENSTIEL SCHOOL OF MARINE & ATMOSPHERIC SCIENCE

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- **Carla Senior**
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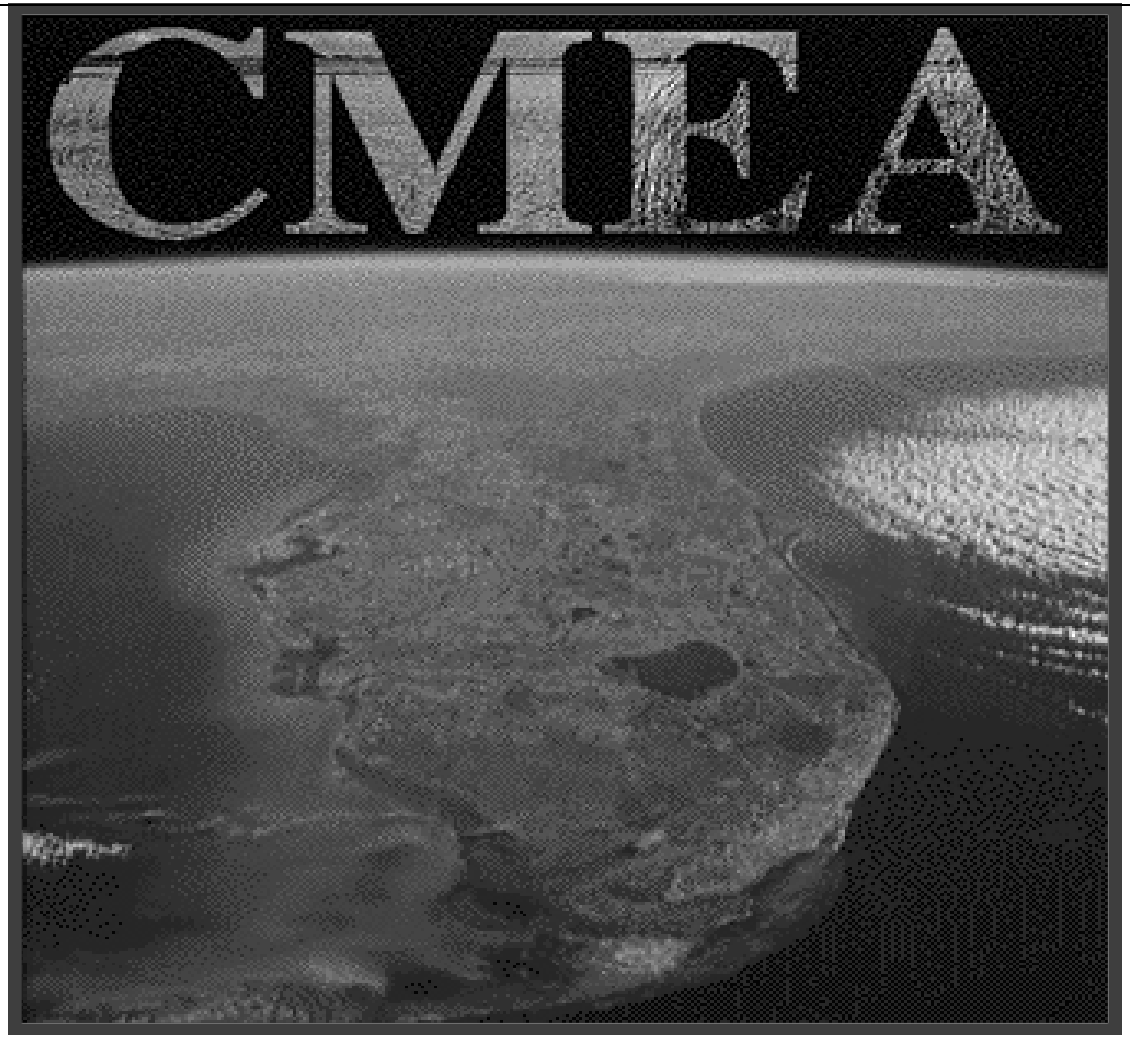
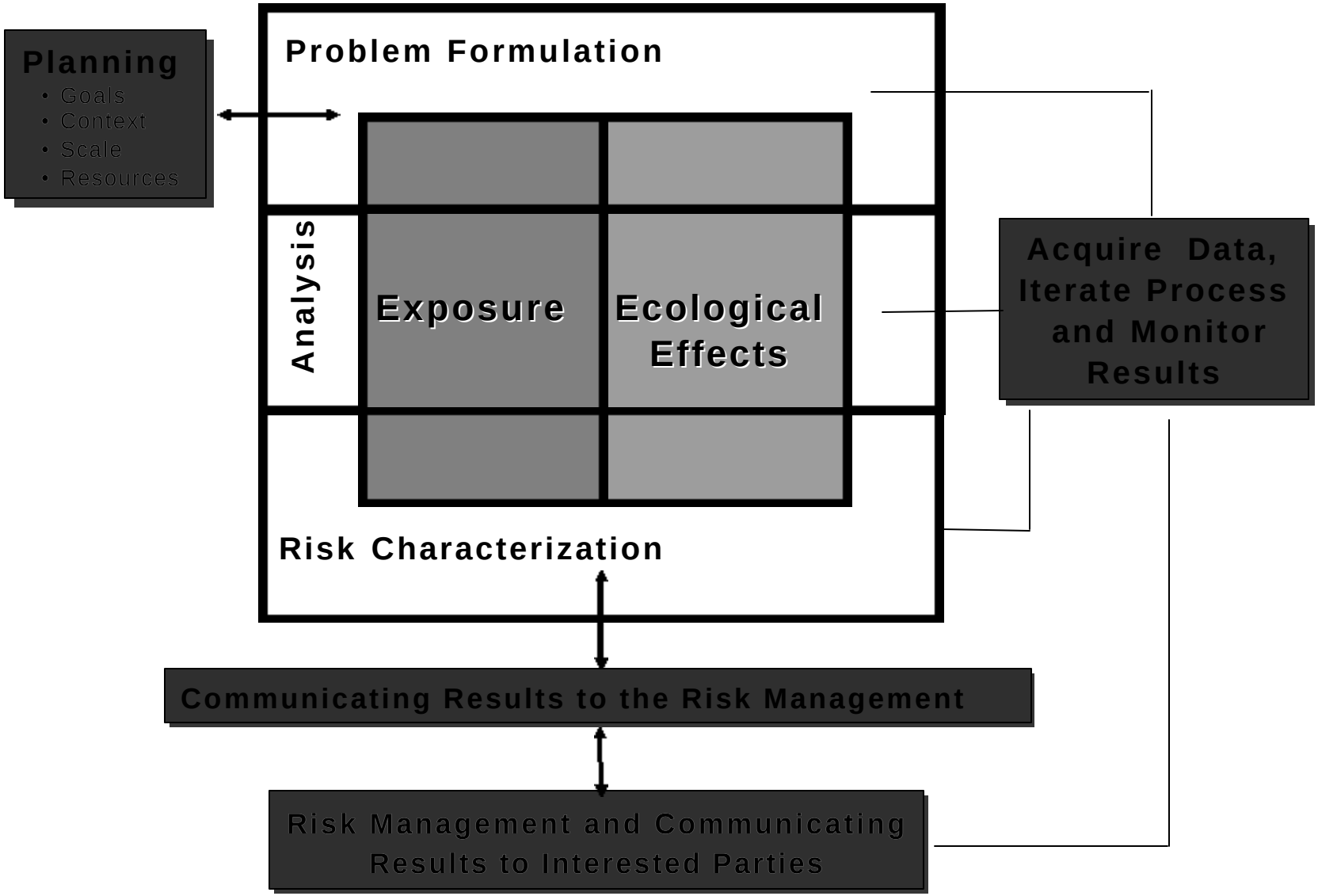


Framework for Ecological Risk Assessment

(EPA 1992, 1997)

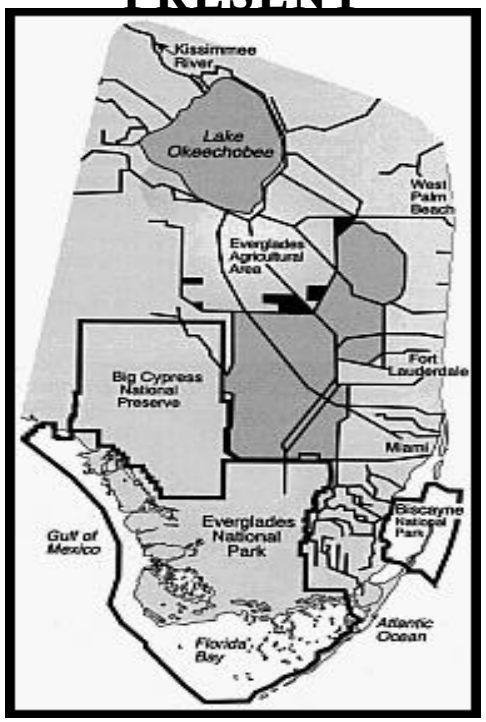


Anthropogenic Changes

HISTORICAL

RESTORATION GOALS

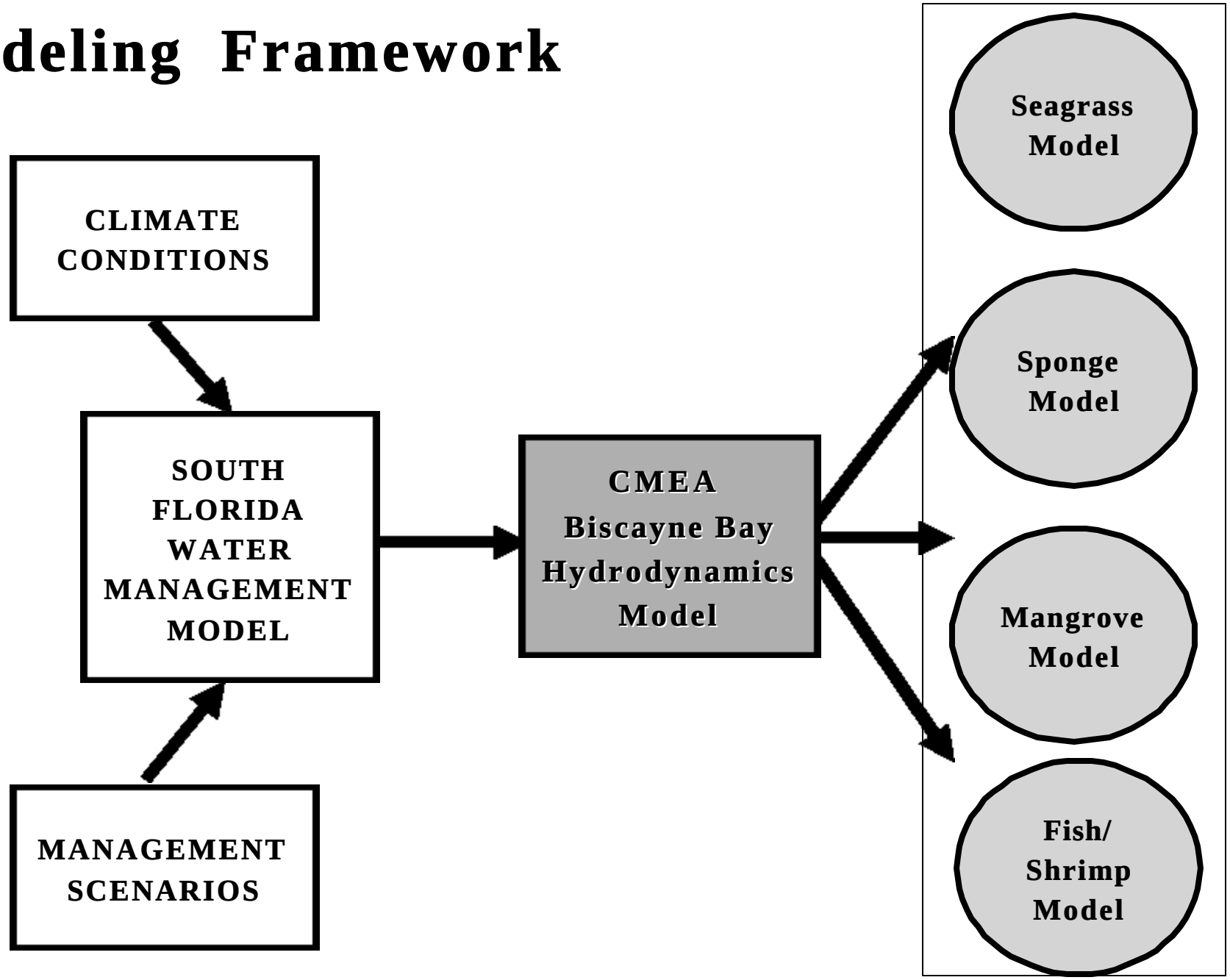
PRESENT



- **CONNECTED HABITATS**
- **INTEGRATED NATURAL HYDROLOGY / SHEETFLOW**
- **NATURAL HYDROPERIOD**
- **LOW NUTRIENTS**

- **FRAGMENTED HABITATS**
- **MANAGED HYDROLOGY / REDUCED FLOW / PULSED RELEASES**
- **ALTERED HYDROPERIOD**
- **HIGH NUTRIENTS**

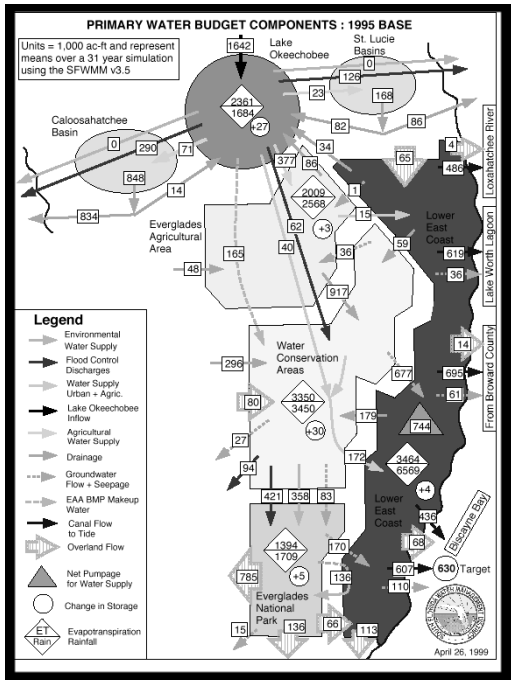
Modeling Framework



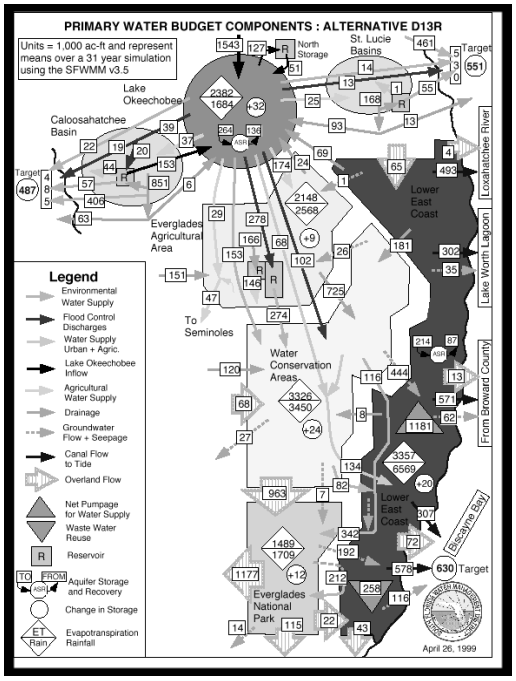
RESTORATION SCENARIOS

TWO MANAGEMENT SCENARIOS

95 BASE



D13R

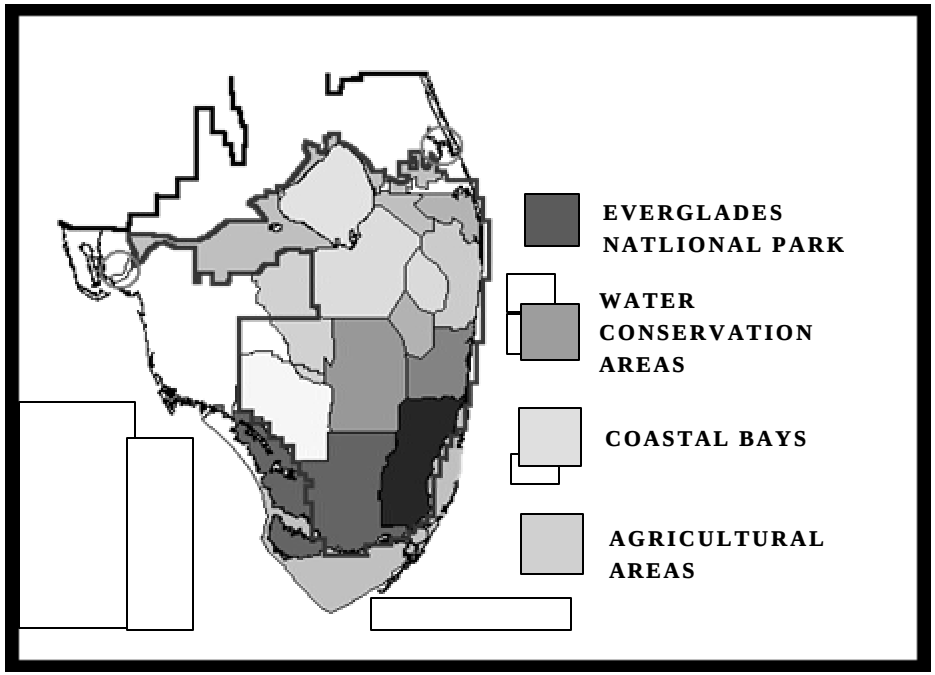


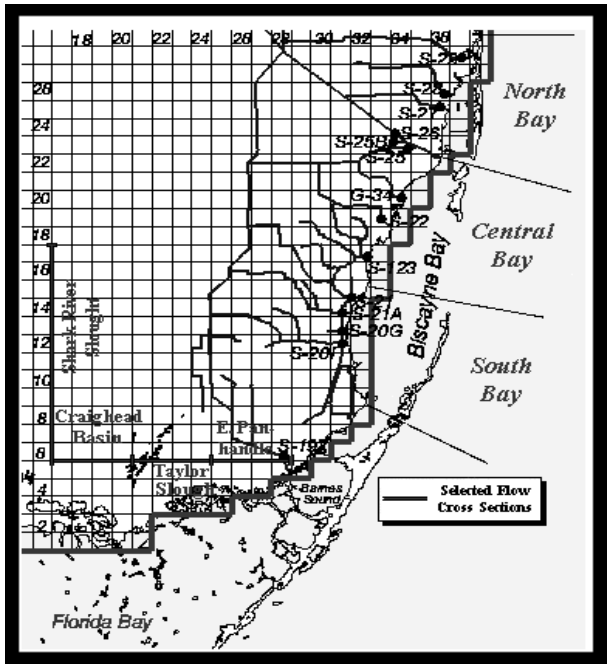
OUTPUT = WATER QUANTITY, TIMING, DISTRIBUTION

SOUTH FLORIDA WATER MANAGEMENT MODEL

- regional-scale hydrologic model that simulates physical processes in the natural and human systems in South Florida.

- network comprised of 1,746 2-mile square grid cells that cover the coastal urban areas, Everglades Agricultural Area (EAA), the Water Conservation Areas, and Everglades National Park.





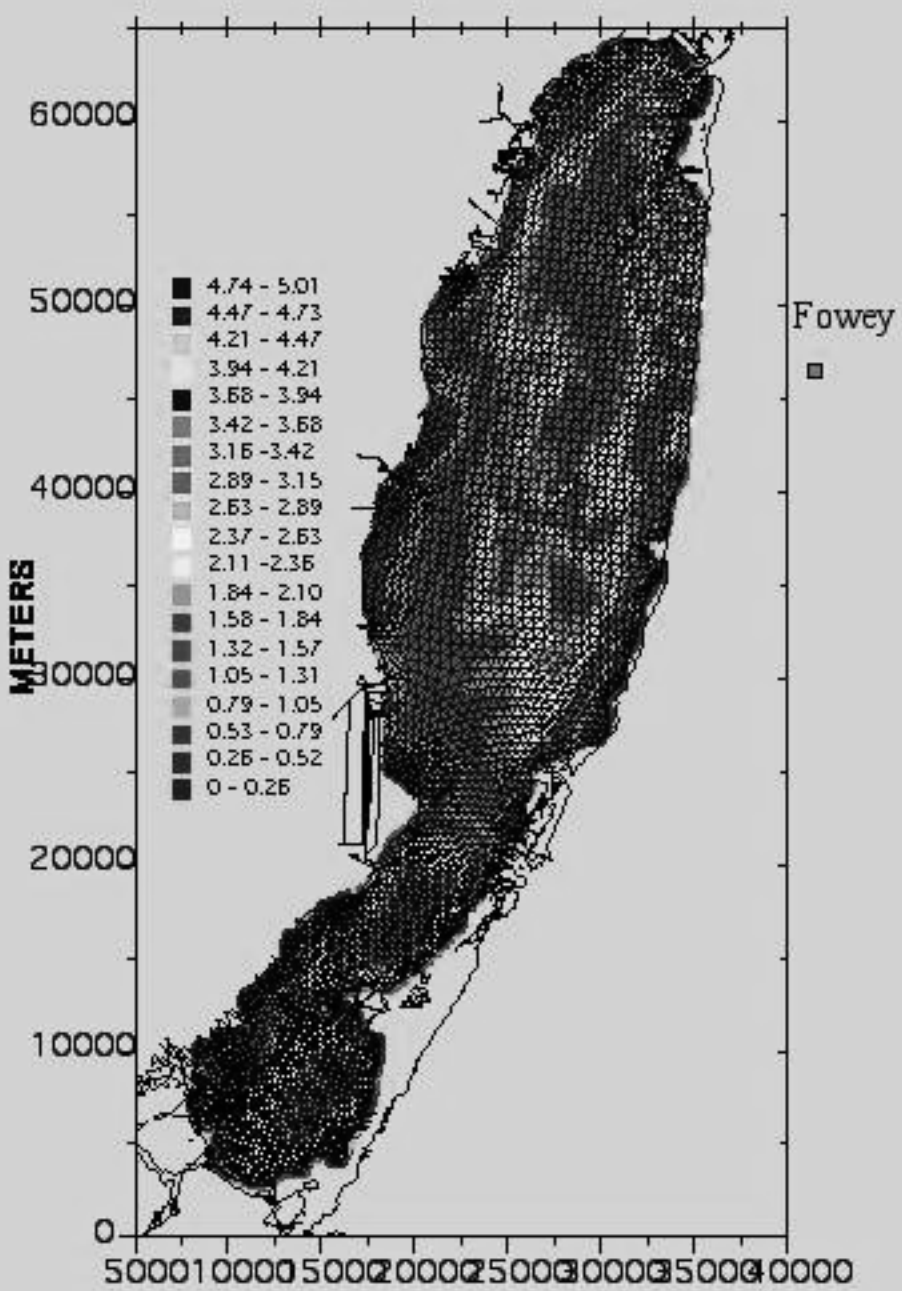
Biscayne Bay
2-D vertically integrated model

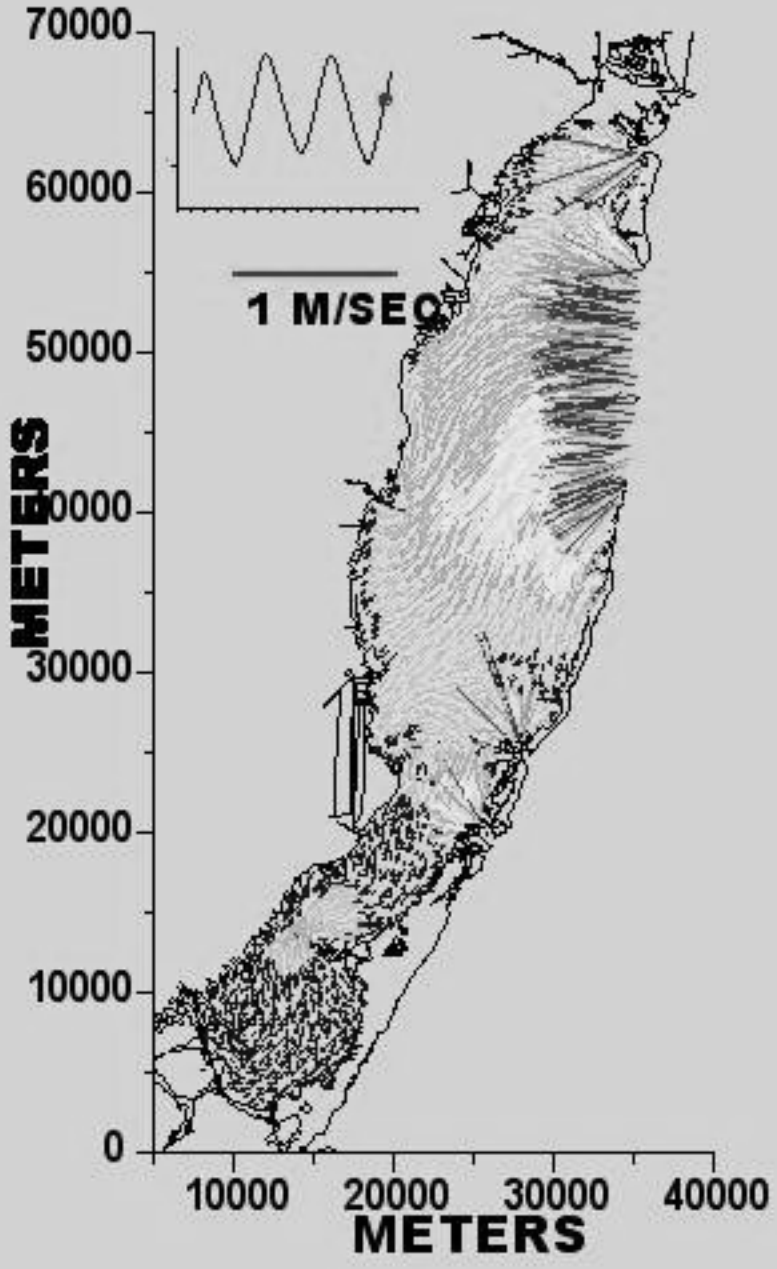
Forcing:

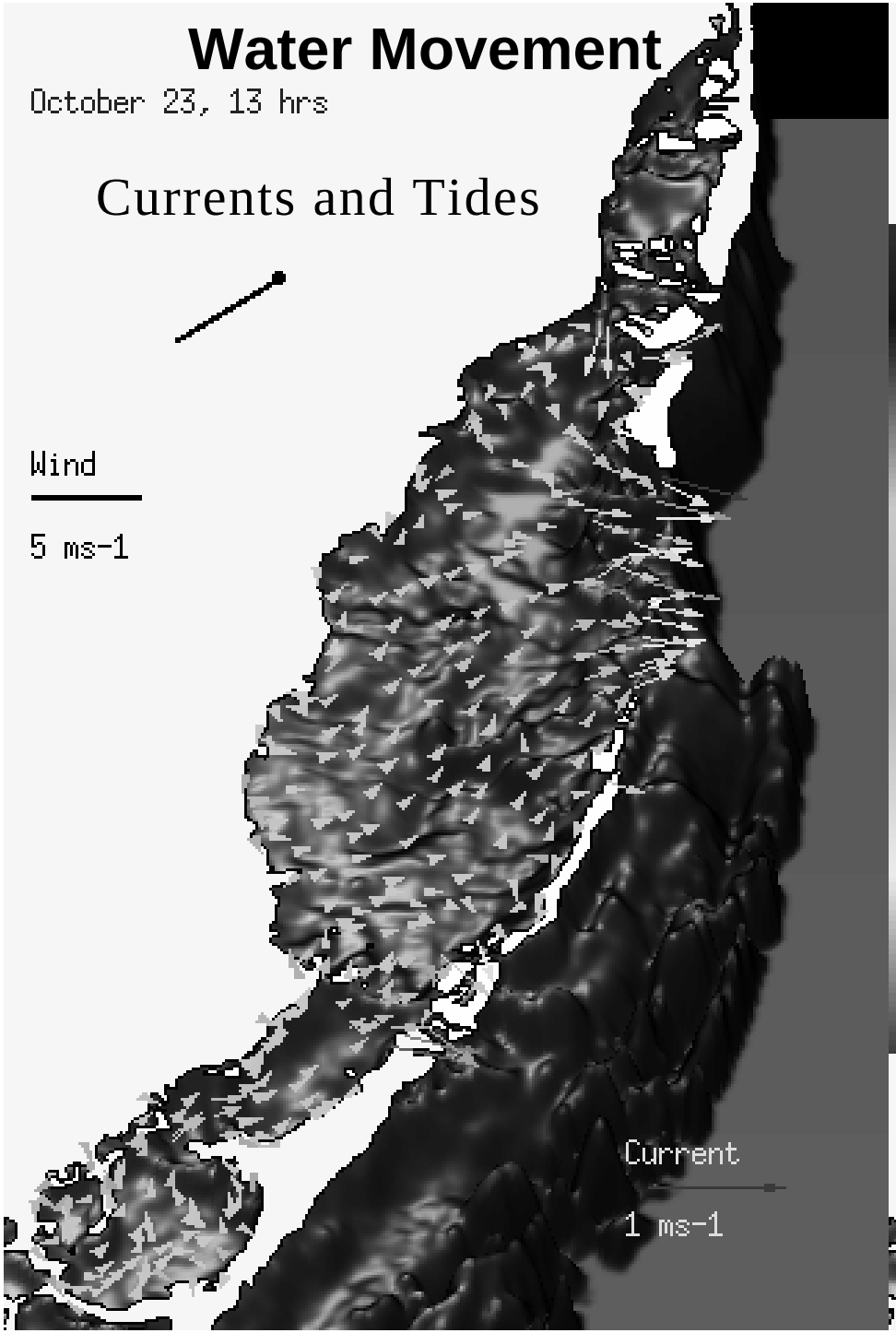
- Wind
- Tide
- Runoff, groundwater, P-E

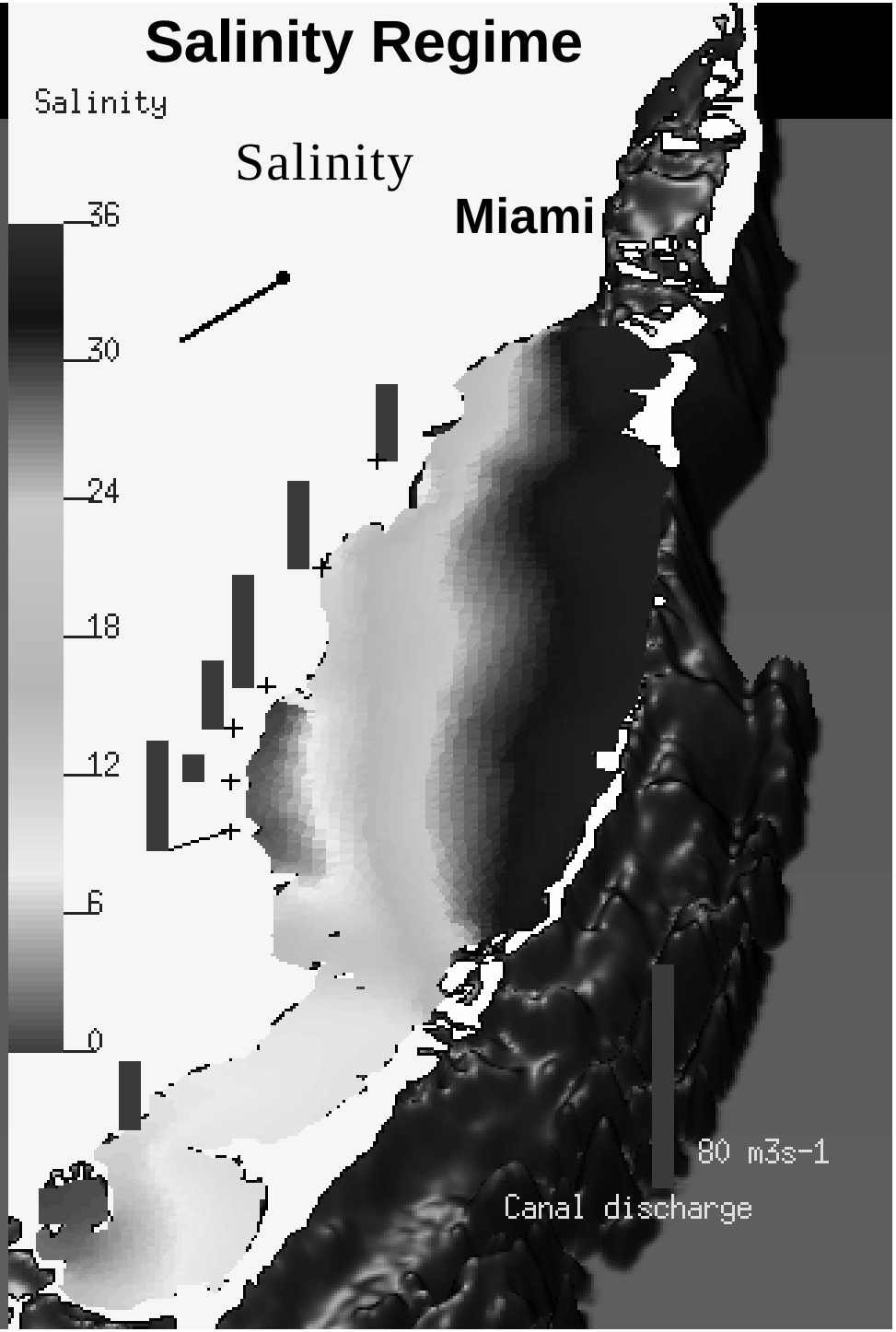
Finite element grid:

- 3407 nodes
- 6364 elements
- "200 to 500 m resolution"




70000
60000
50000
40000
30000
20000
10000
0
METERS
1 M/SEC
10000
20000
30000
40000
METERS

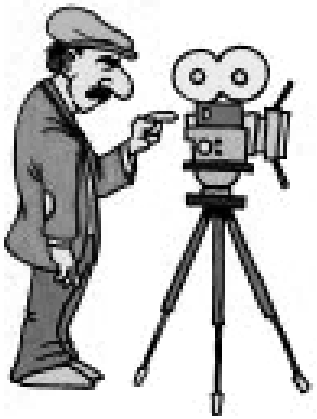

Water Movement
October 23, 13 hrs
Currents and Tides
Wind
5 ms-1
Current
1 ms-1

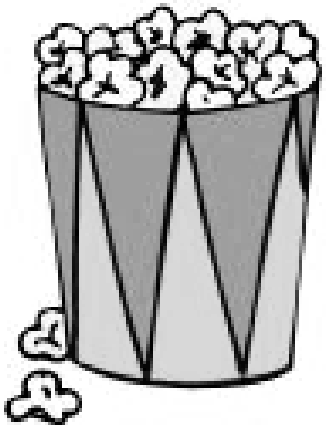

Salinity Regime
Salinity
Salinity
Miami
36
30
24
18
12
6
0
80 m3s-1
Canal discharge

a

s

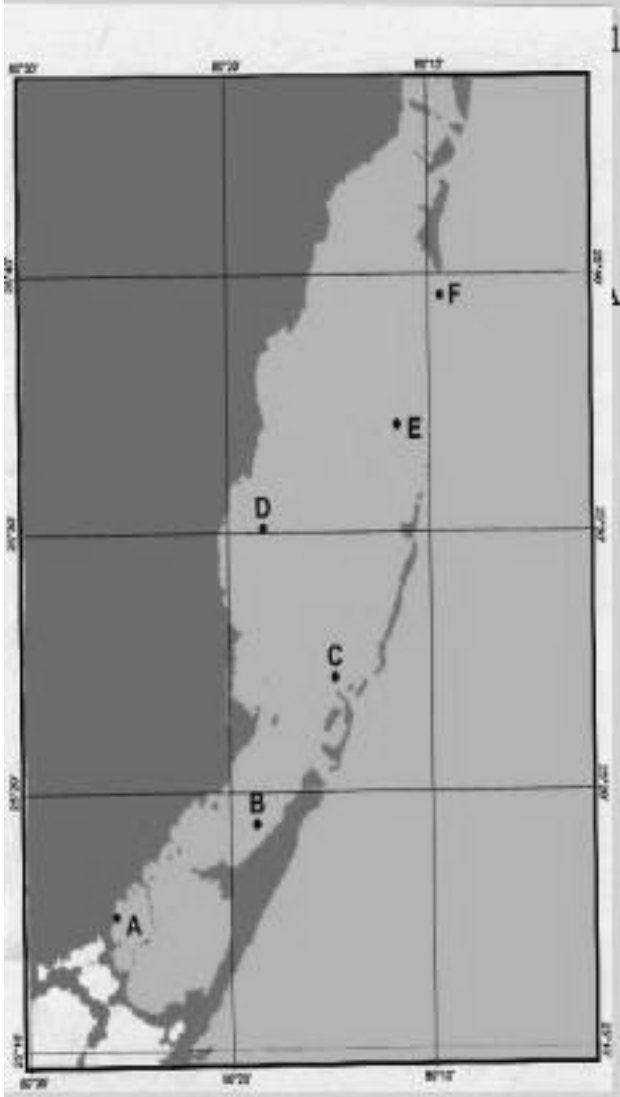
QuickTime™ and a
Planar RGB decompressor
are needed to see this picture.

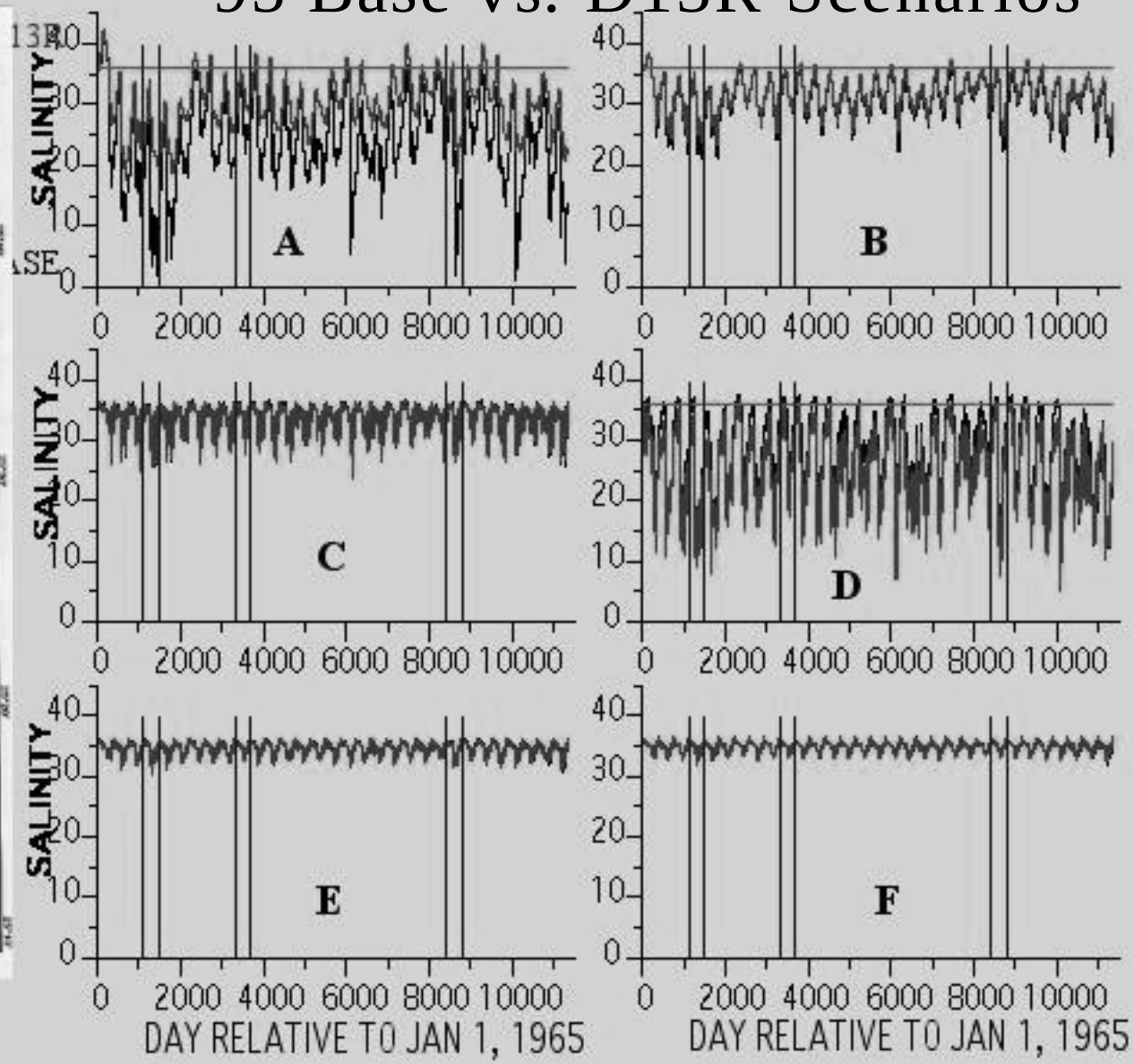




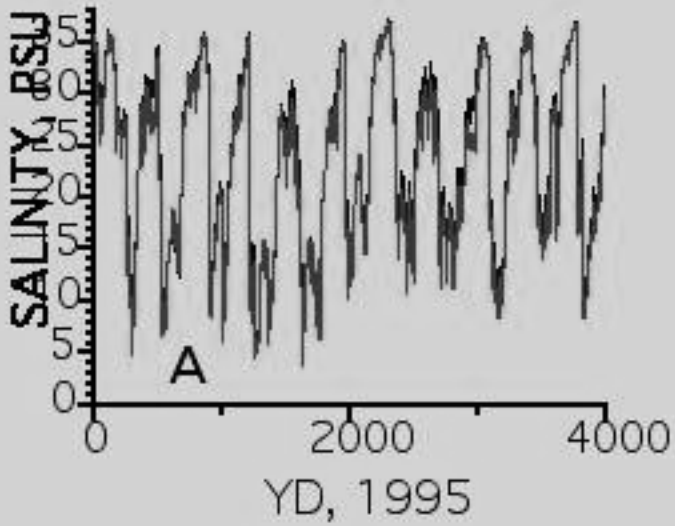
MODEL OUTPUT
Salinity Movies

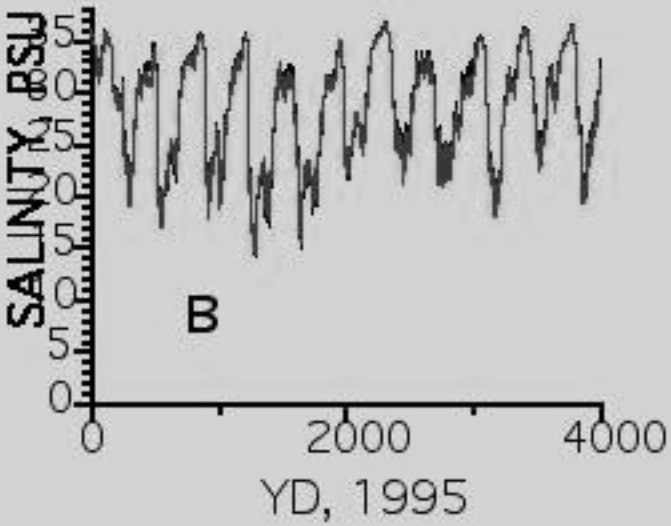
95 Base vs. D13R Scenarios



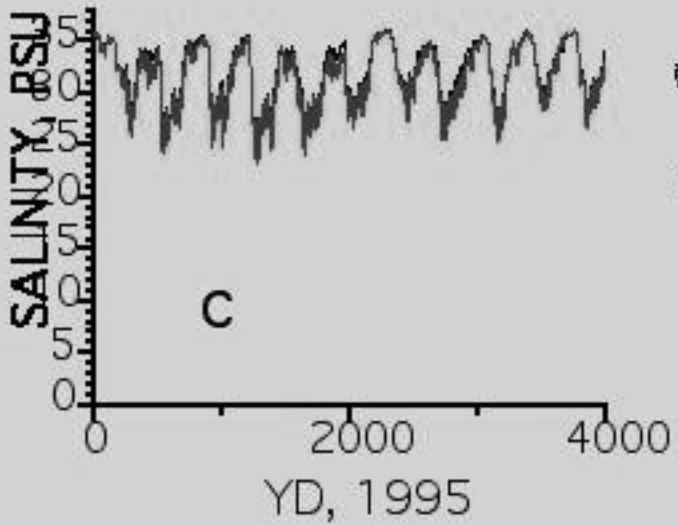


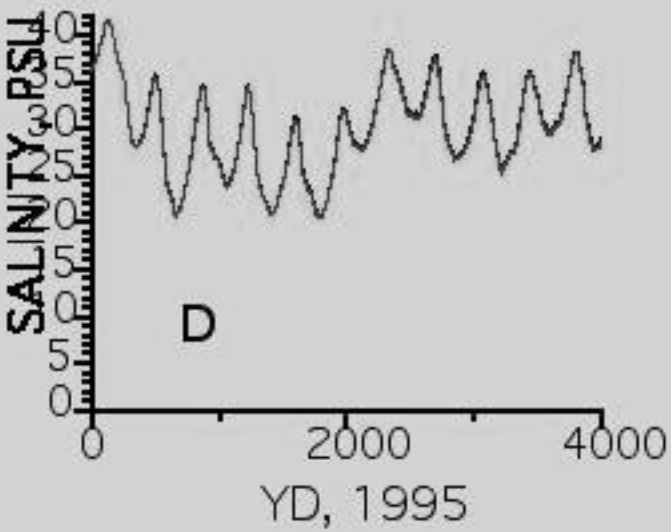
D13R vs. D13R4 scenarios



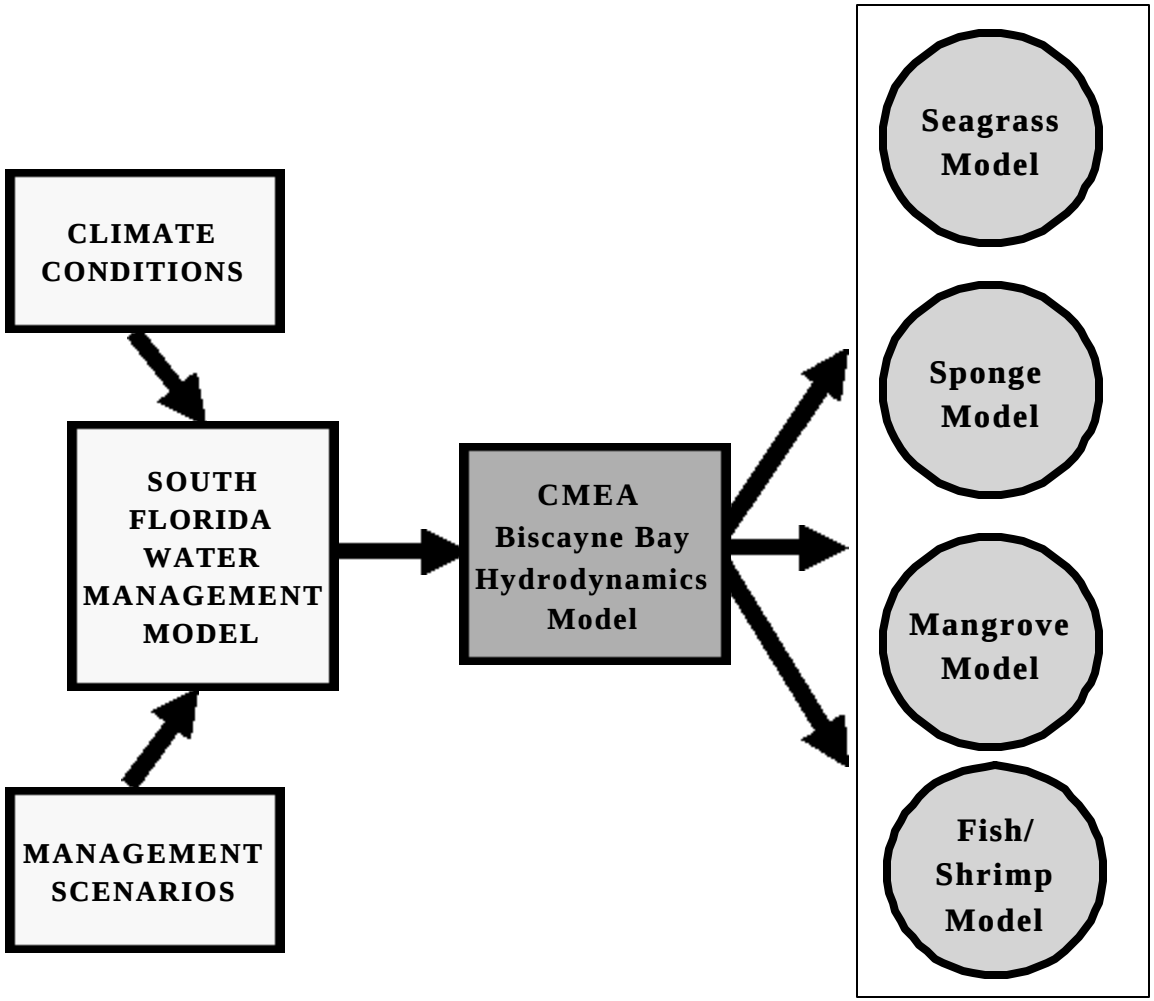


D13R
D13R4



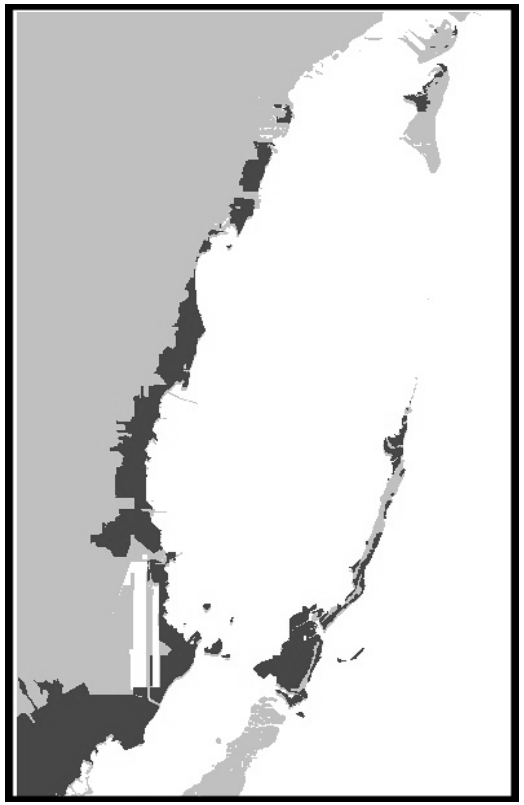


CMEA SEASCAPE MODEL



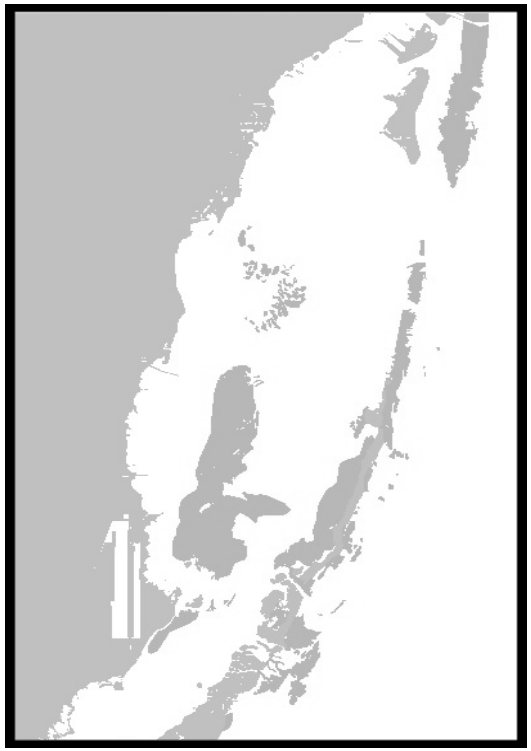
BISCAYNE BAY HABITATS

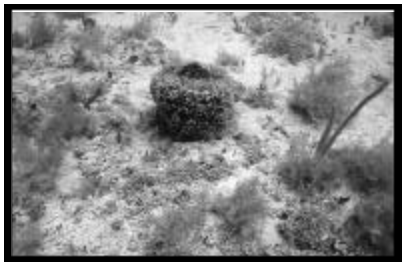
SEAGRASS COMMUNITIES



MANGROVES

HARD-BOTTOM COMMUNITIES





SEAGRASSES IN BISCAYNE BAY

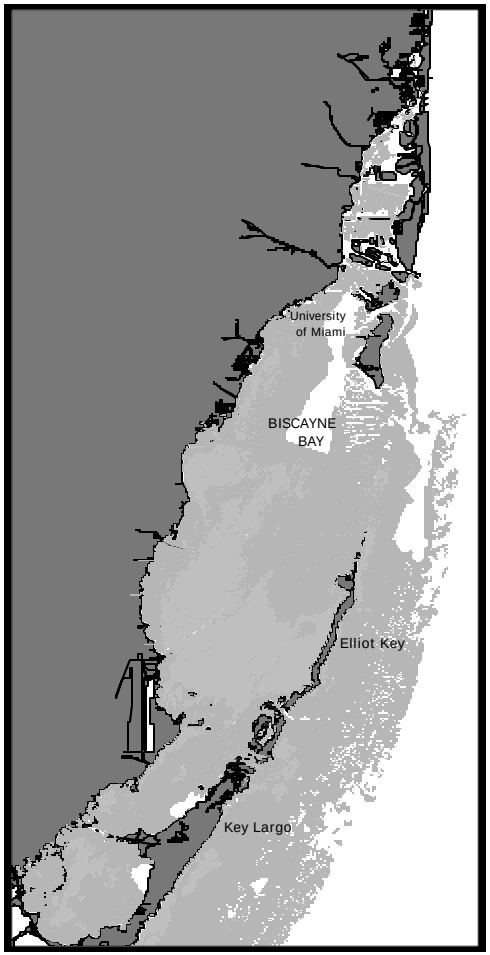
- **Seagrasses are the dominant, keystone benthic components in Biscayne Bay, covering > 70% of the bottom**
- **Seagrass beds provide essential nursery habitat for important fish and invertebrate species**
- **Seagrasses contribute to the Bay's productivity and carbon budgets, stabilize sediments, and preserve water clarity**

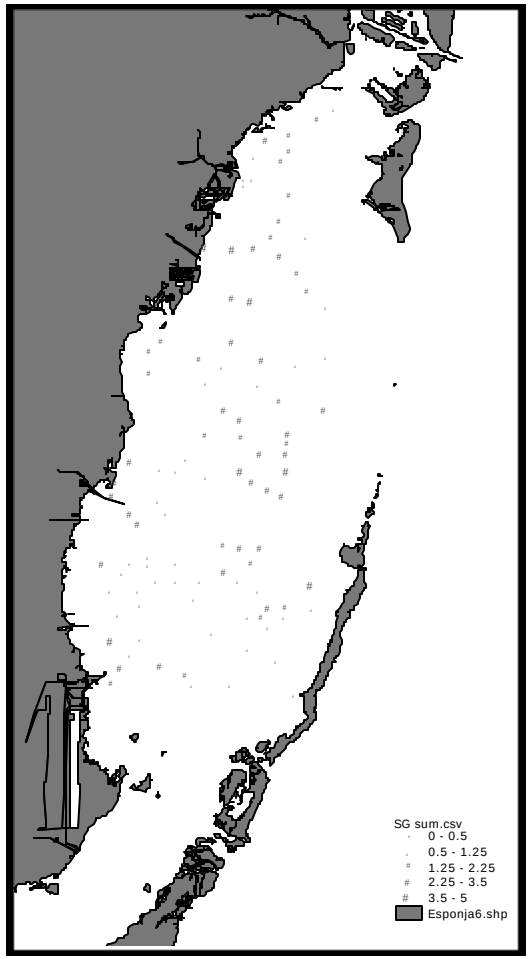
Thalassia testudinum

Halodule wrigthii

Syringodium filiforme

DERM COVERAGE → **FIELD SURVEYS** → **INITIAL CONDITIONS**





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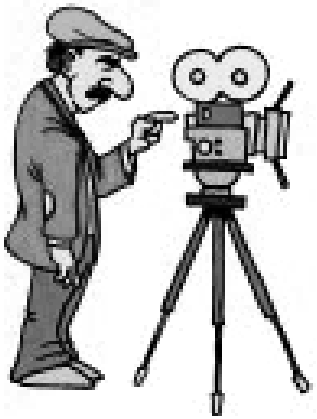
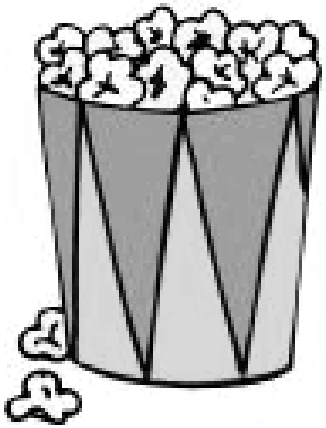




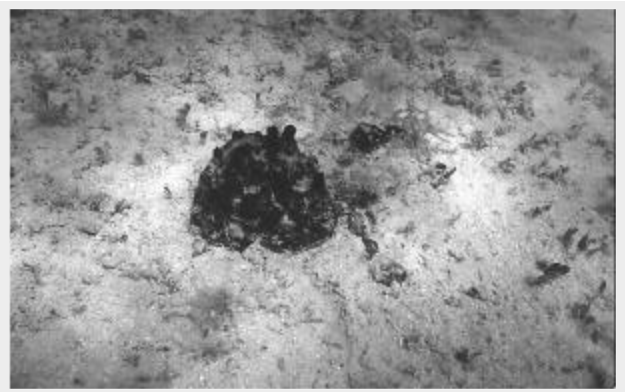
MODEL OUTPUT
Seagrass Movies

SEAGRASS MODELS . CONCLUSIONS

- **Ecological responses to the restoration scenarios are highly localized, species-specific, and mainly concentrated along areas directly affected by canal outflow.**

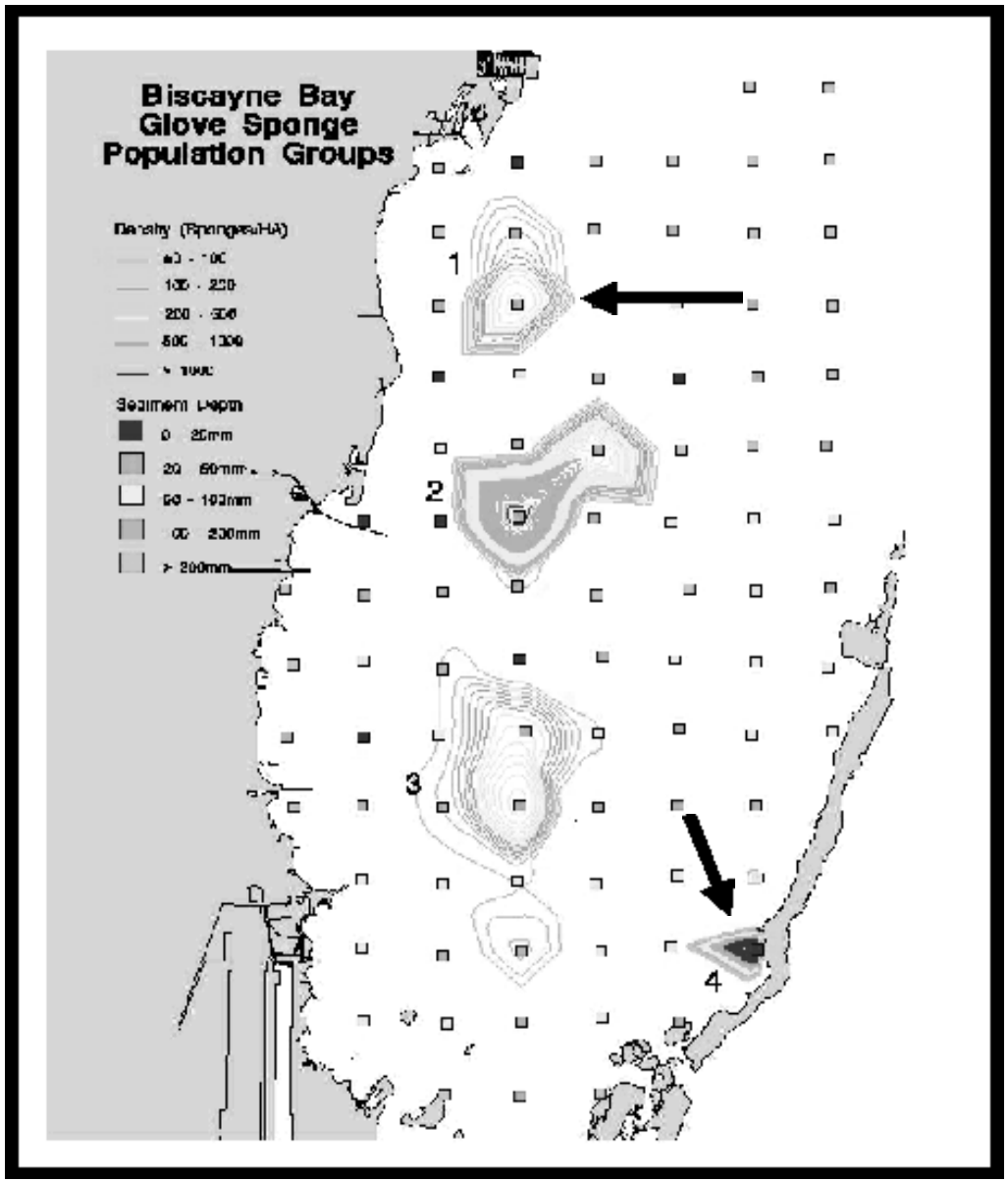
- **For the seagrass communities of Biscayne Bay, no ecologically significant differences in above-ground biomass were found between the simulated scenarios (95BASE and D13R).**

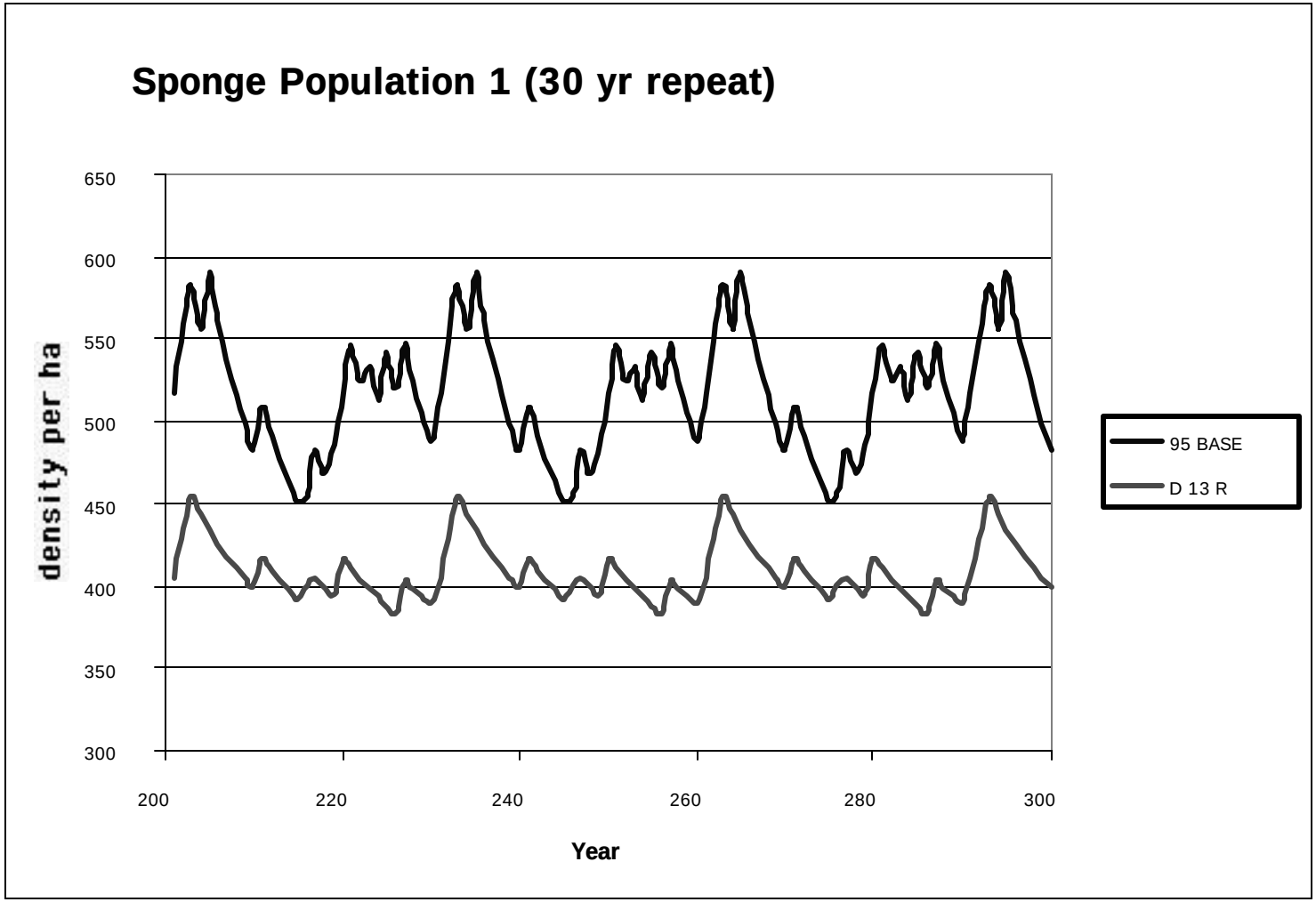
- **The simulations shown here represent the potential impacts of short-term exposure to freshwater pulses. However, the impacts of chronic exposure over long periods could be significant.**



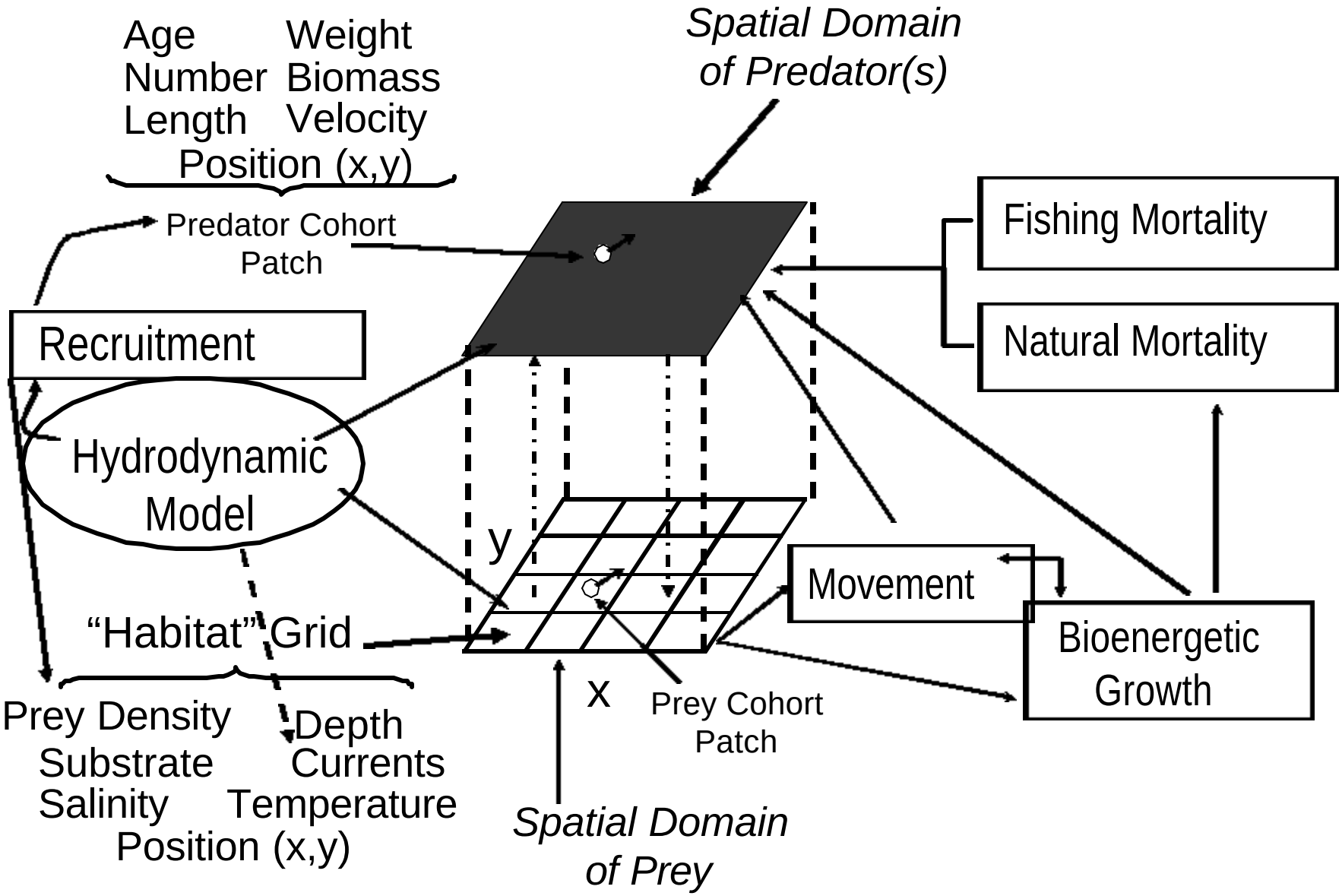
CMEA SPONGE POPULATION MODEL

- **Sponges are important components of hard-bottom communities within Biscayne Bay**
- **They provide habitat for lobsters an juvenile fish and can influence water quality through their filtering action**

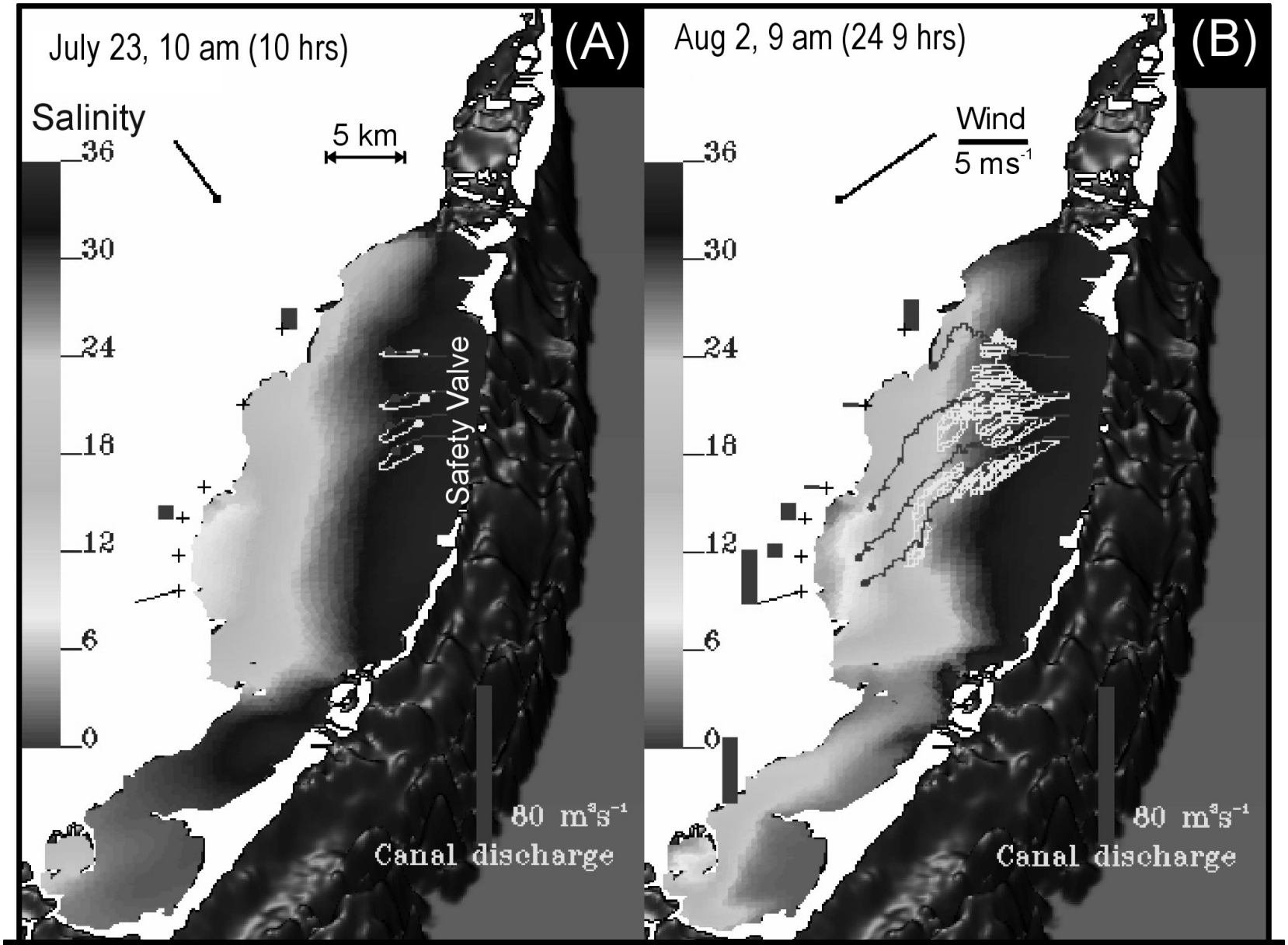



Sponge Population 1 (30 yr repeat)
density per ha
650
600
550
500
450
400
350
300
200
220
240
260
280
300
Year
95 BASE
D 13 R

CMEA Fisheries Community Model

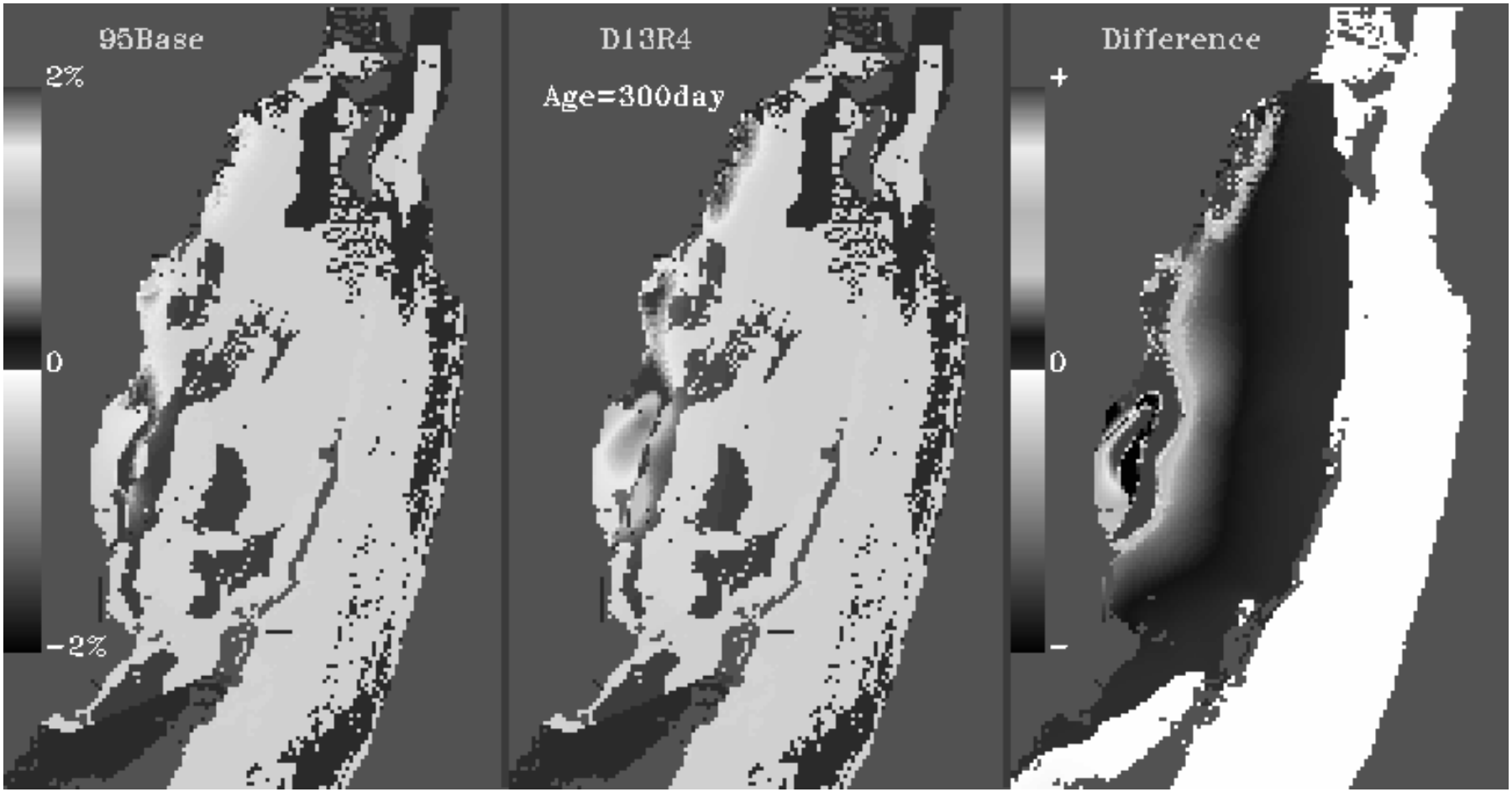


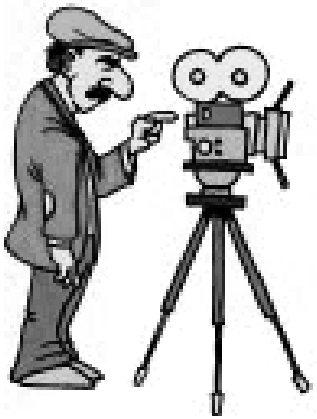
Recruitment of Shrimp and Fish

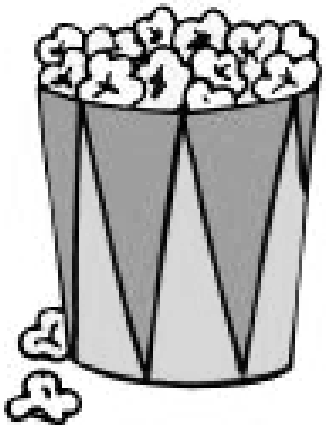


“Habitat” Quality

Spatial Growth Rate Potential for Fish







MODEL OUTPUT
Fish Community Movies

QuickTime™ and a
Photo - JPEG decompressor
are needed to see this picture.

Summary Conclusions

- Ecological Risk Assessment Framework —high utility for assisting the decision-making process

- For past decade, large investments made into CMEA research on Biscayne Bay — field studies, laboratory studies, model development, remote sensing, risk framework

- CMEA now has the modeling tools and framework to make quantitative projections of ecological consequences to Biscayne Bay from changes in water inputs

Utility of CMEA Biscayne Bay Tools

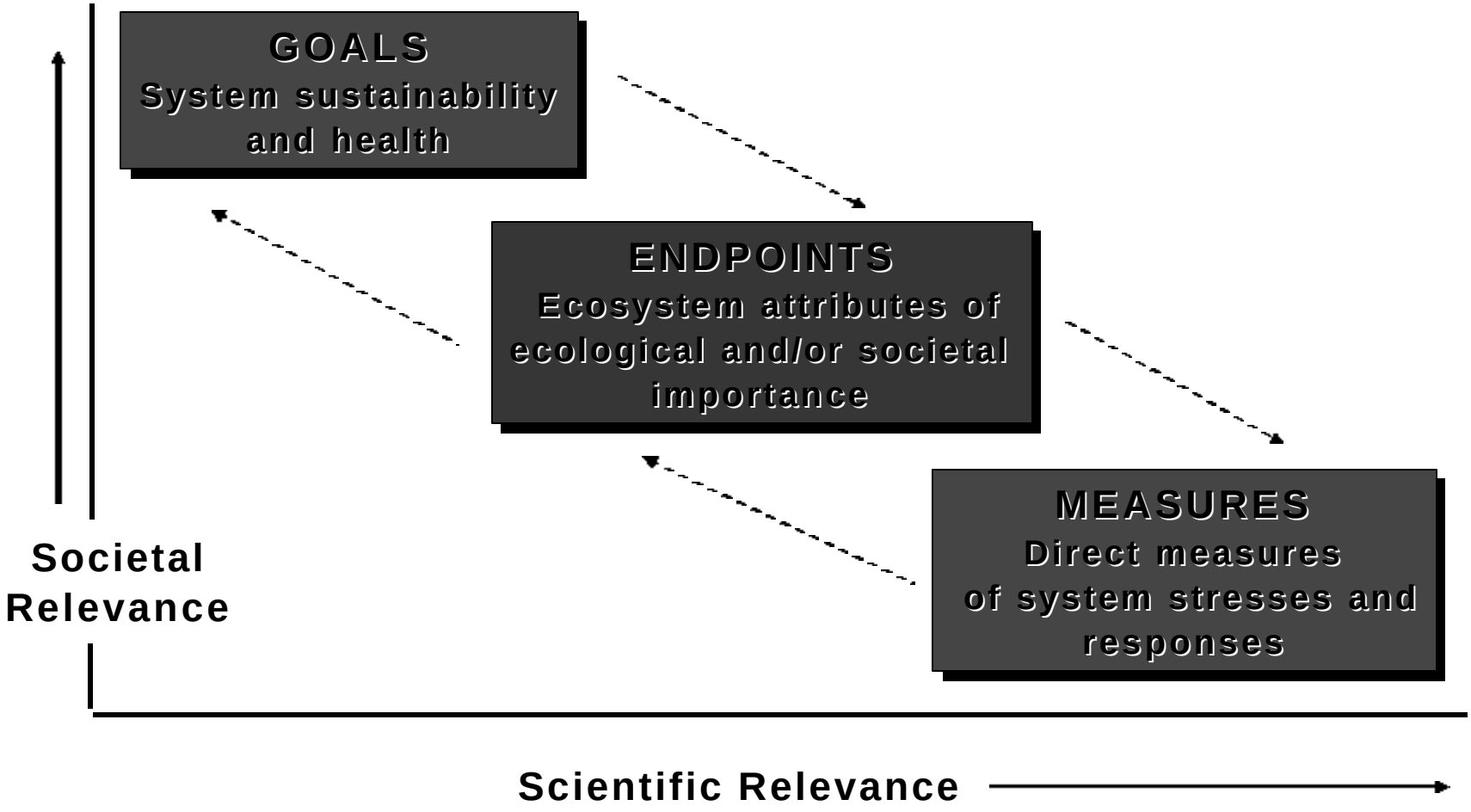
- Assess efficacy of South Florida ecosystem restoration scenarios
- Assess ecological consequences to Biscayne Bay of specific water management system components or operations
- Assess design and efficacy of marine protected areas
- Reverse Assessment Process — use to establish physical performance criteria to achieve spatially explicit ecological results

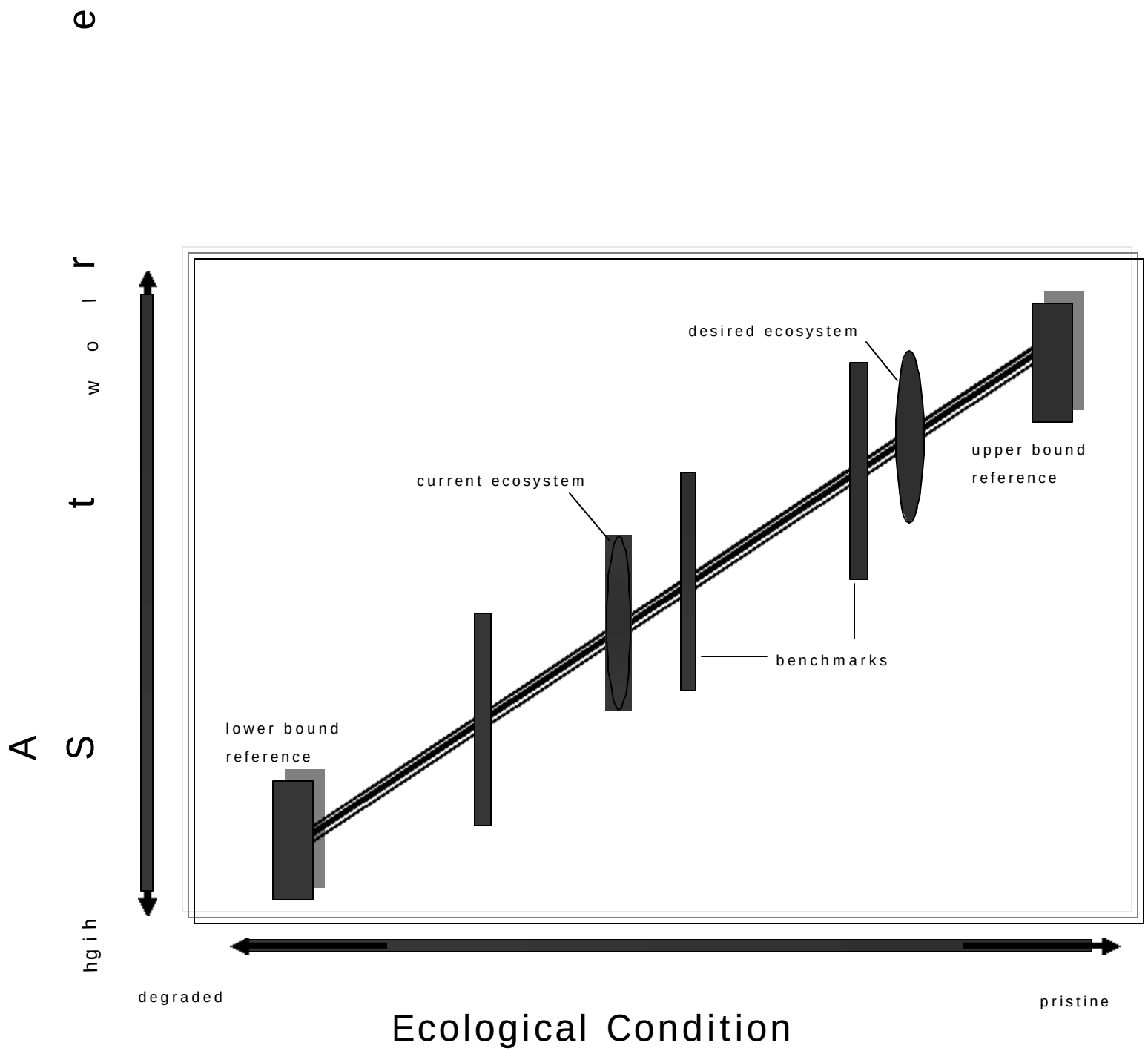
Major Research Needs

- Extensive sensitivity analyses, scenario-consequence analyses
- Integration into goal-setting and decision-making process
- Water Quality Model of Biscayne Bay - critical need to assess effects of other stressors
- Field and Laboratory Studies — much more needed to refine models, extend their applicability, reduce uncertainties
- Integrated research and monitoring program — adaptive management

Relationship Between Societal Goals and Scientific Endpoints and Measures in Ecological Assessments

(Gentile and Harwell 1996)




desired ecosystem
upper bound
reference
current ecosystem
benchmarks
lower bound
reference
A S t w o r e
hgih
degraded
pristine
Ecological Condition

Major Issues

- What are the ecological goals for Biscayne Bay?
- What are the ecological endpoints for Biscayne Bay?
- What are the baseline and reference conditions for Biscayne Bay?

Goal-Setting Process

- Requires specificity with respect to:
  - ecological endpoints
  - spatial distributions
  - temporal distributions
- Use risk assessment tools to assist in articulating ecological goals and endpoints
- Need to establish baseline and reference conditions