NOAA National Centers for Coastal Ocean Science

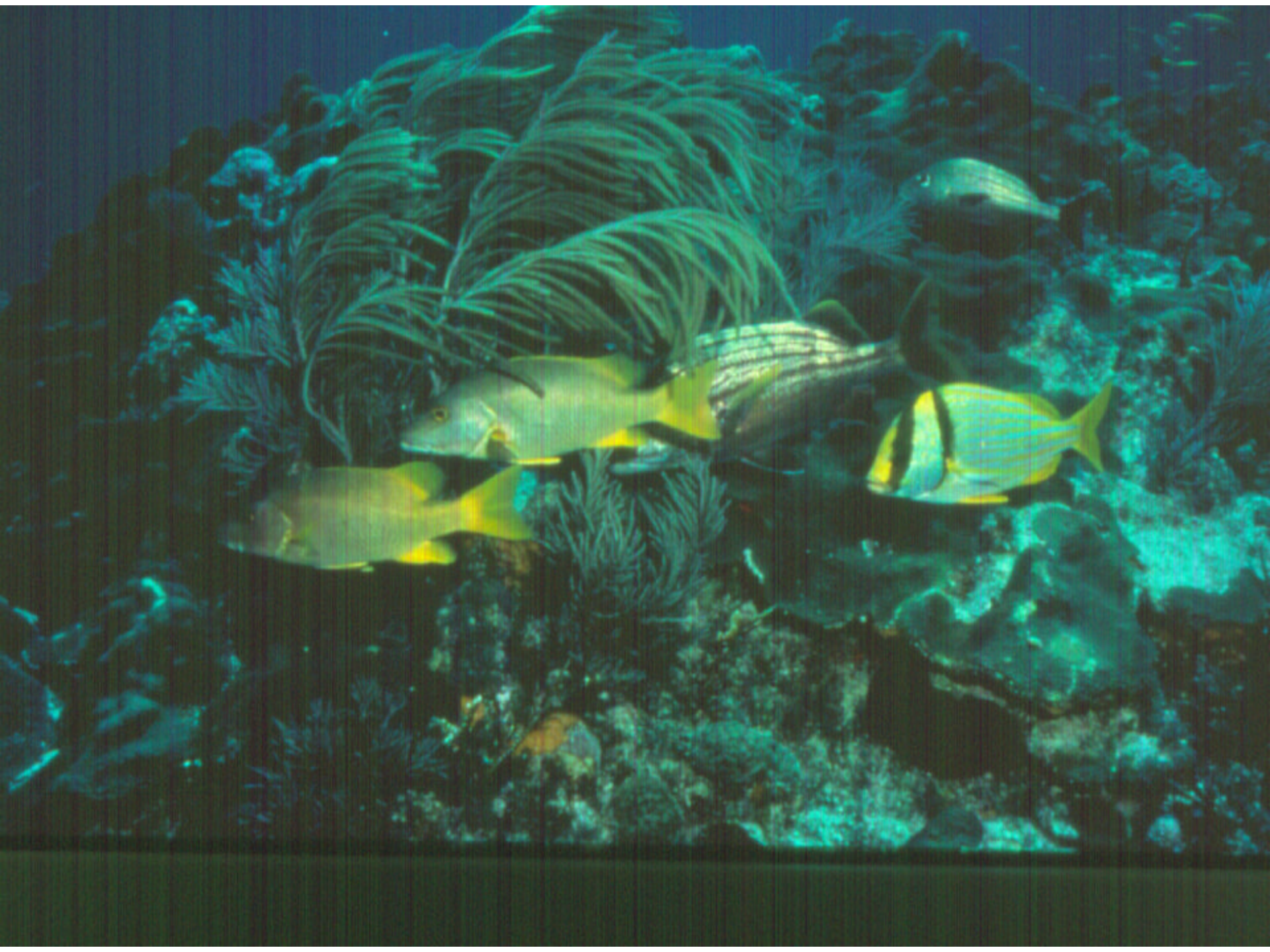
18 June 2002

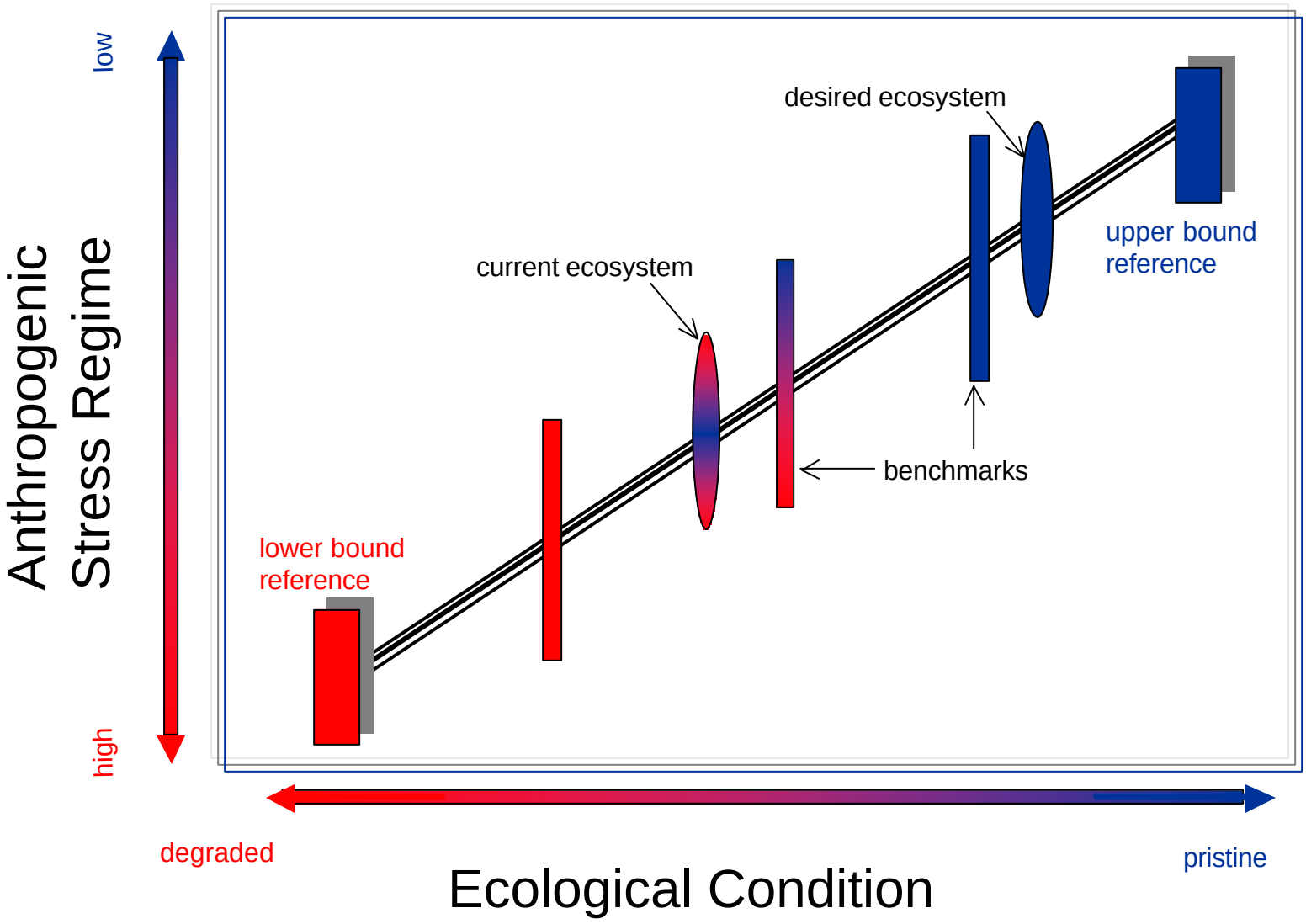
Utility of Ecological Conceptual Models for Environmental Decision-Making

Mark Harwell

Florida A&M University

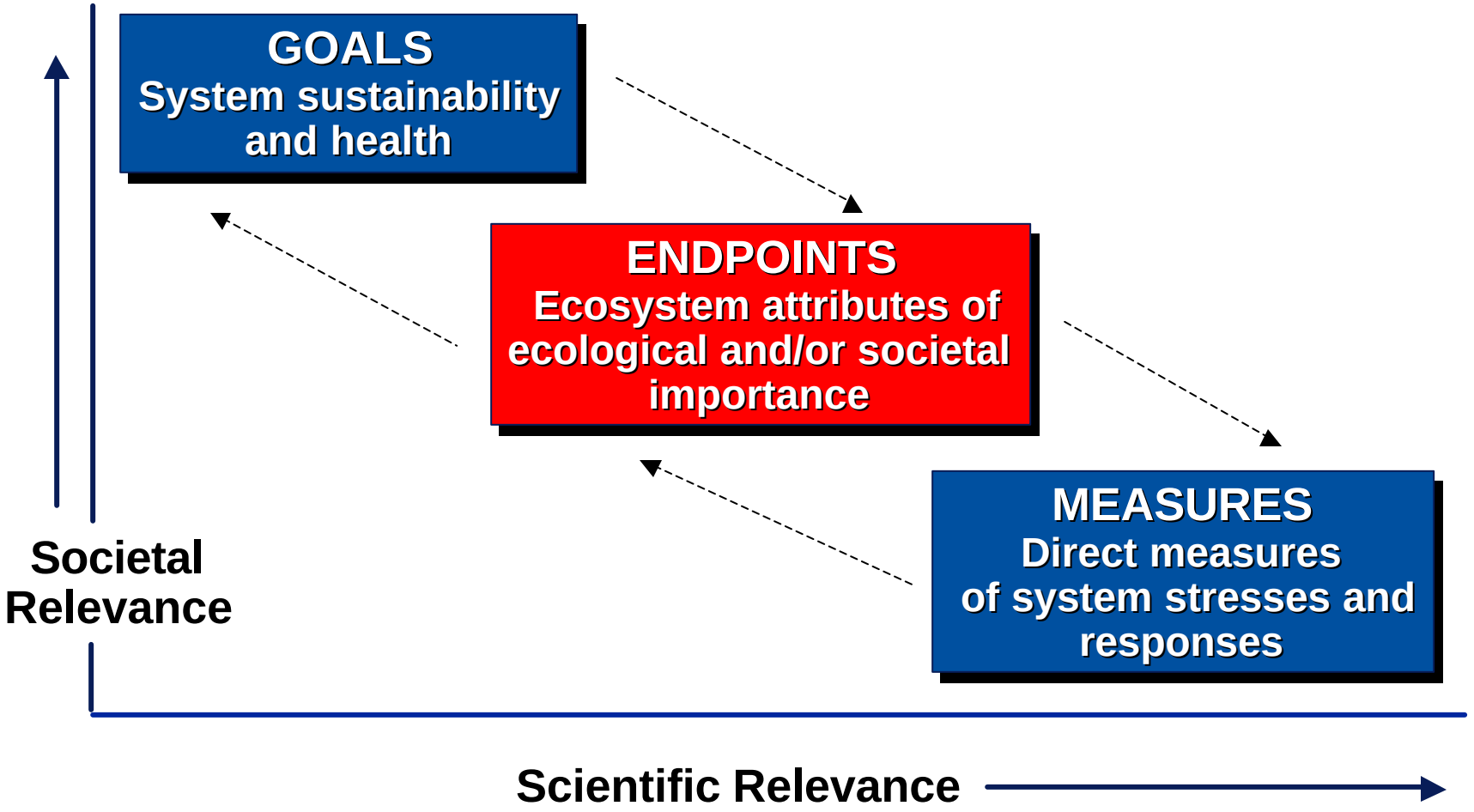
Ecological Endpoints




low
Anthropogenic
Stress Regime
high
desired ecosystem
upper bound
reference
current ecosystem
benchmarks
lower bound
reference
degraded
pristine
Ecological Condition

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

(Gentile and Harwell 1996)



Conceptual Model Development

Conceptual Model Definition

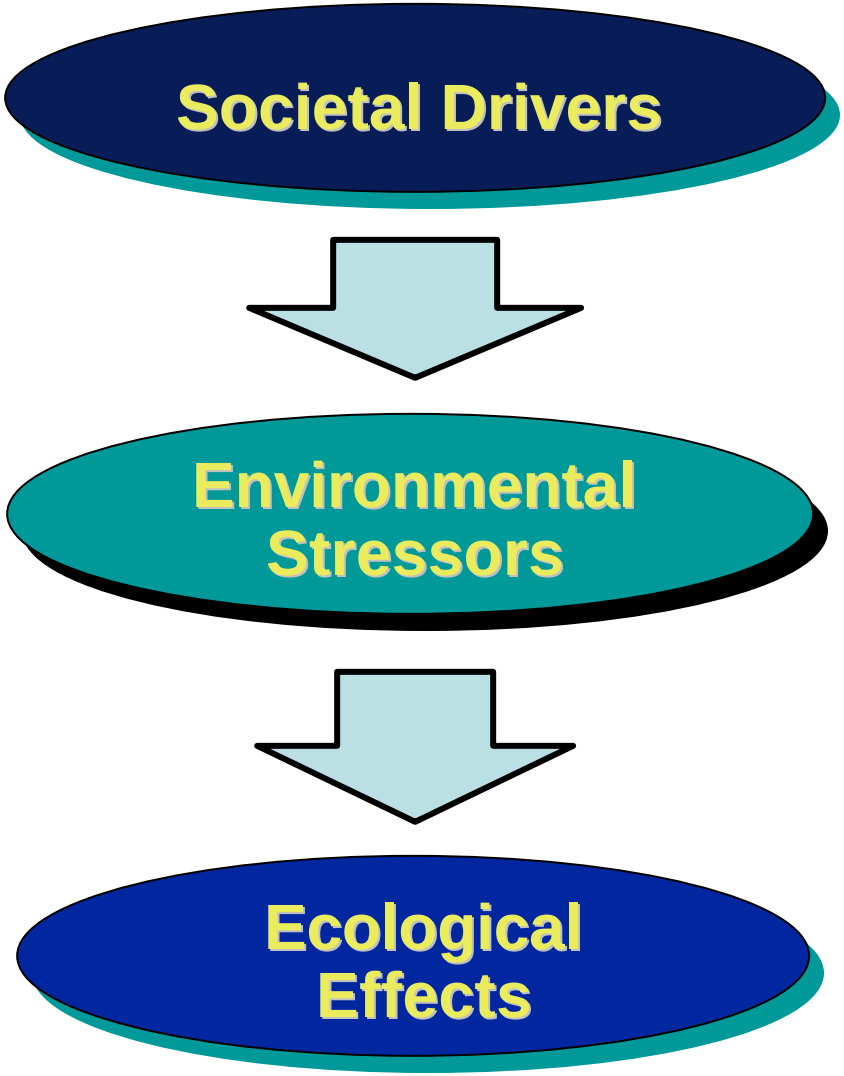
A graphical, text, and spatially explicit representation of potential causal linkages among human activities; sources; patterns of disturbance and stress; co-occurring ecological receptors/systems; and ecological endpoints and measures that describe the spectrum of potential stress-effect relationships

Conceptual Model Benefits

- **Provides explicit expression of the assumptions and understanding of the system**
- **Reduces the dimensionality of the problem**
- **Invaluable tool for learning, communicating, and consensus building**
- **Explicitly describes the linkages among sources, stress, and the ecological components at risk**
- **Template for generating predictive risk hypotheses**

Linkages Between Societal Drivers, Stressors, and Effects

(Gentile and Harwell 1996)



Conceptual Model Format

Societal Drivers
(Landscape Activities)

System Disturbances and Stresses

Stress Regime/Exposure Pathways

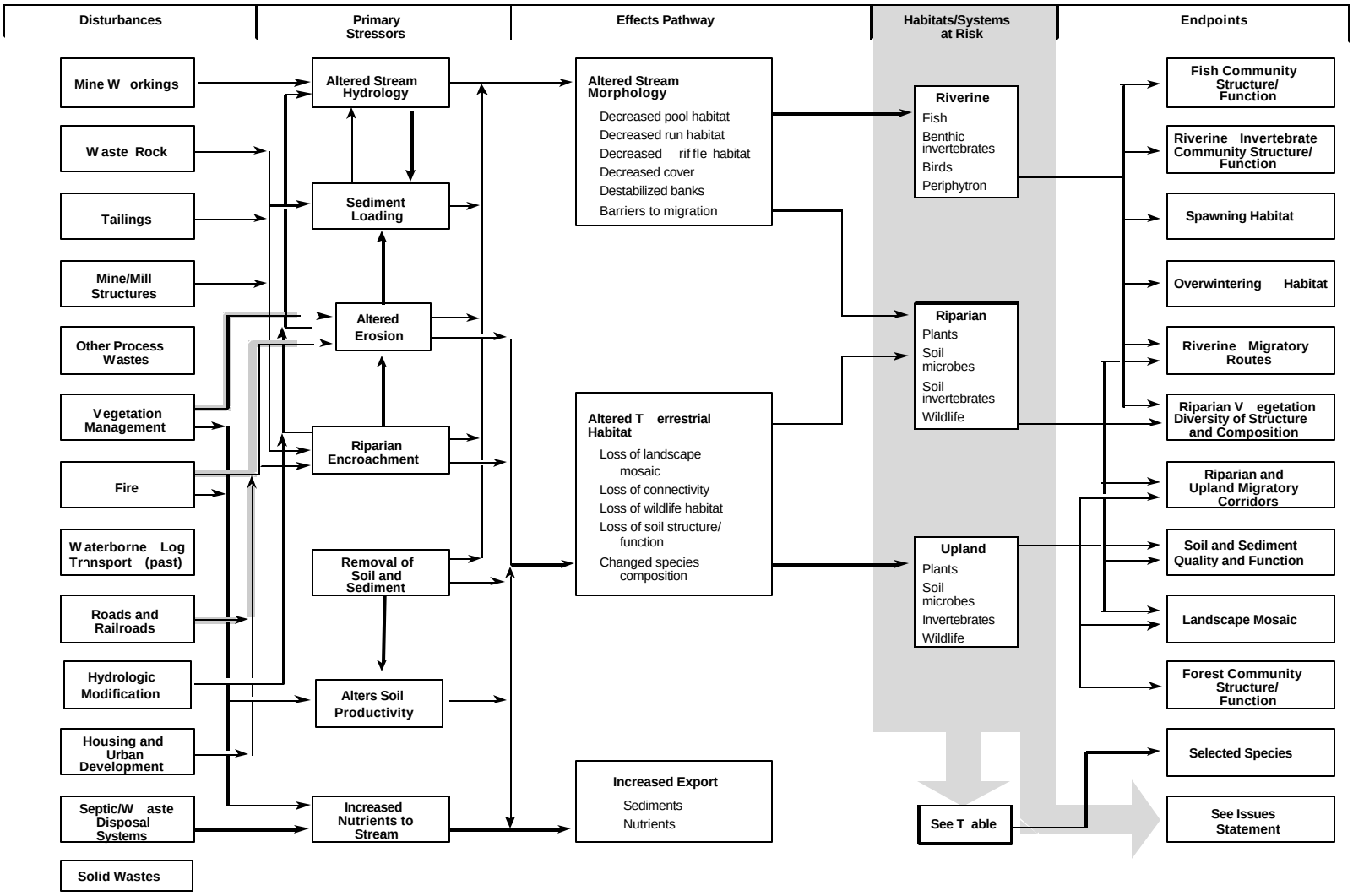
Disturbance/Stress Co-occurrences with Ecological Systems @ Risk

Primary/Secondary Ecological Effects
(Proposed Causal Linkages)

Ecological Endpoints

Measurements

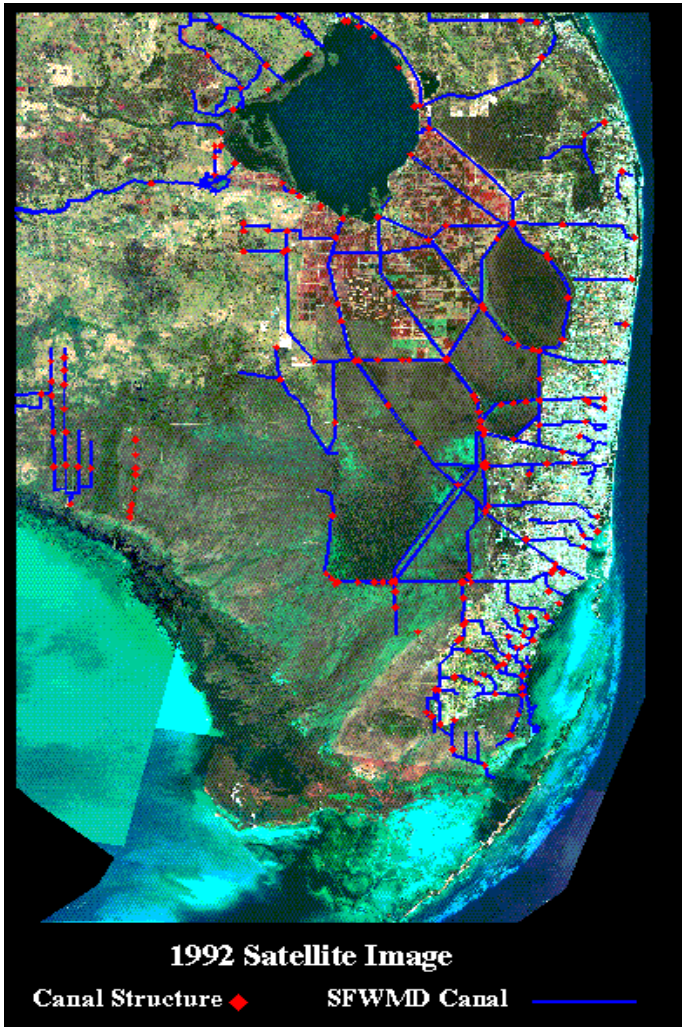
Watershed Physical Stress Model



THE SOUTH FLORIDA LANDSCAPE

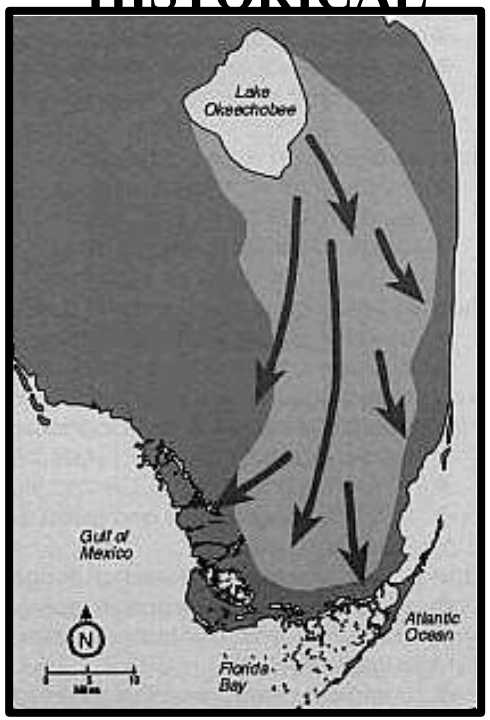
THE SOUTH FLORIDA ENVIRONMENT:

- Over 6 million people along narrow coastal ridge
- Rain-driven hydrology with large inter-annual variability
- Extensive water management system
- Diverse mosaic of plant and animal communities
- Multiple land uses
- Connectivity to coastal ecosystems



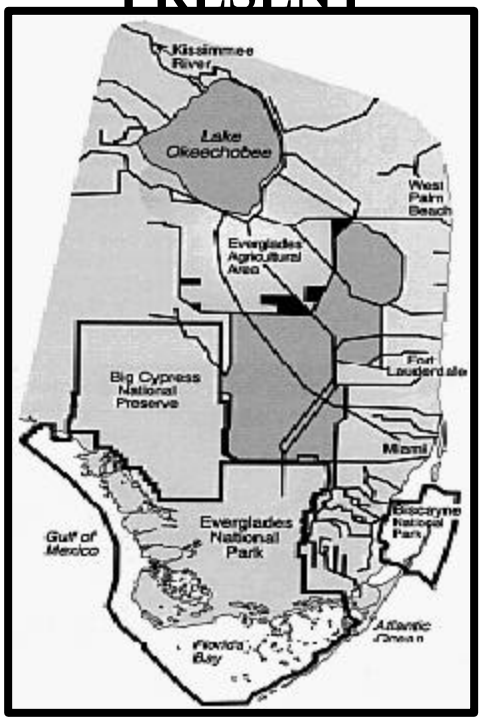
Anthropogenic Changes

HISTORICAL



RESTORATION GOALS

PRESENT

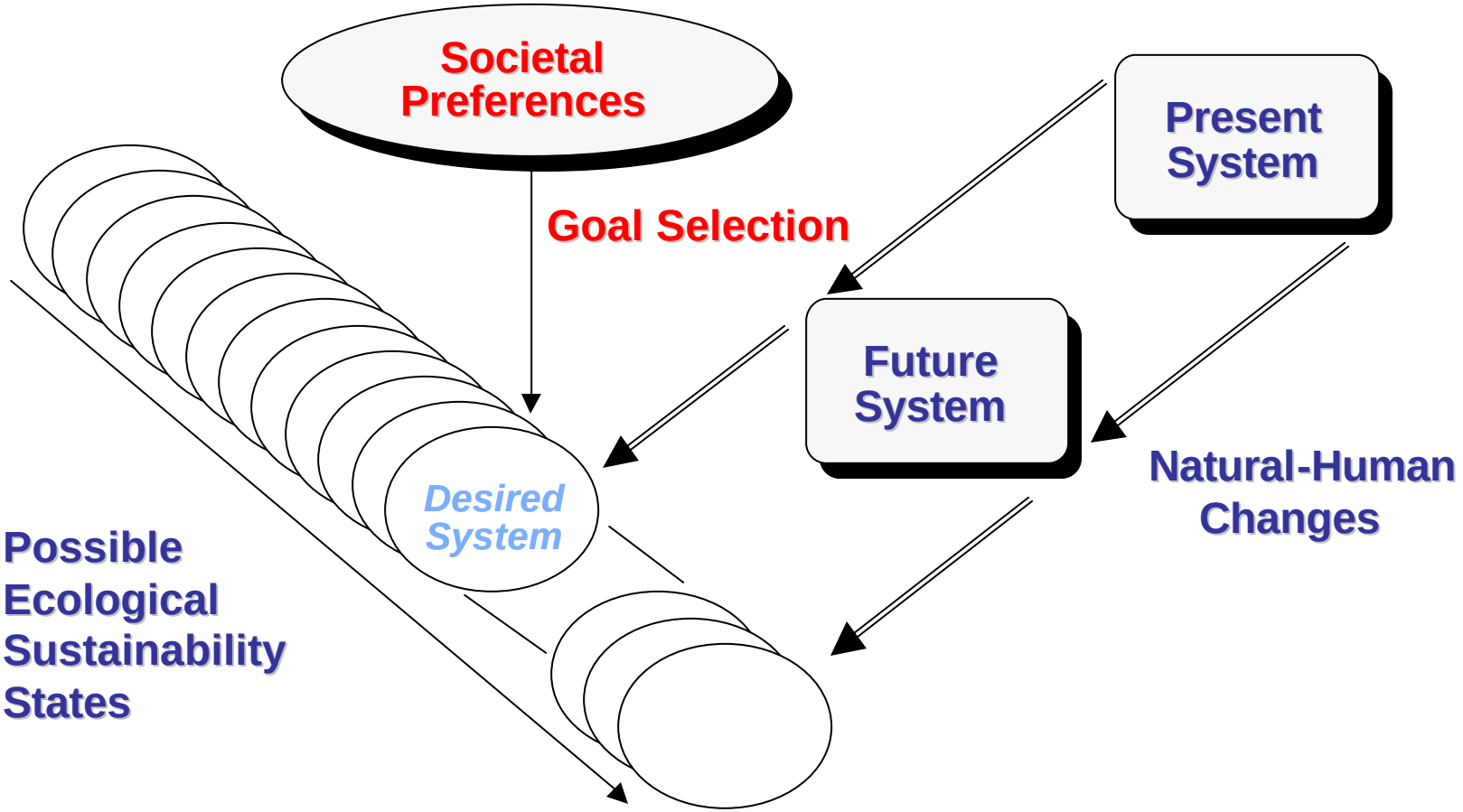


- **CONNECTED HABITATS**
- **INTEGRATED NATURAL HYDROLOGY / SHEETFLOW**
- **NATURAL HYDROPERIOD**
- **LOW NUTRIENTS**

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

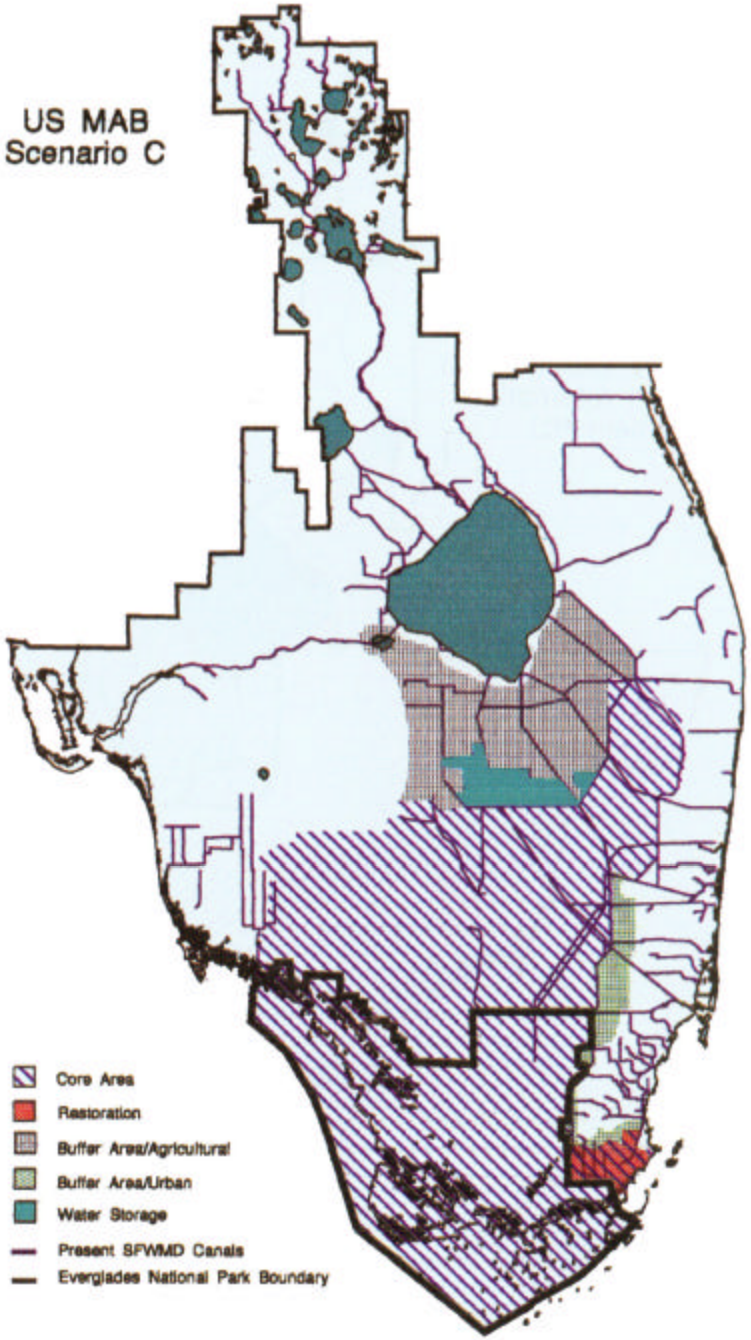
Framework for Societal and Ecological Sustainability

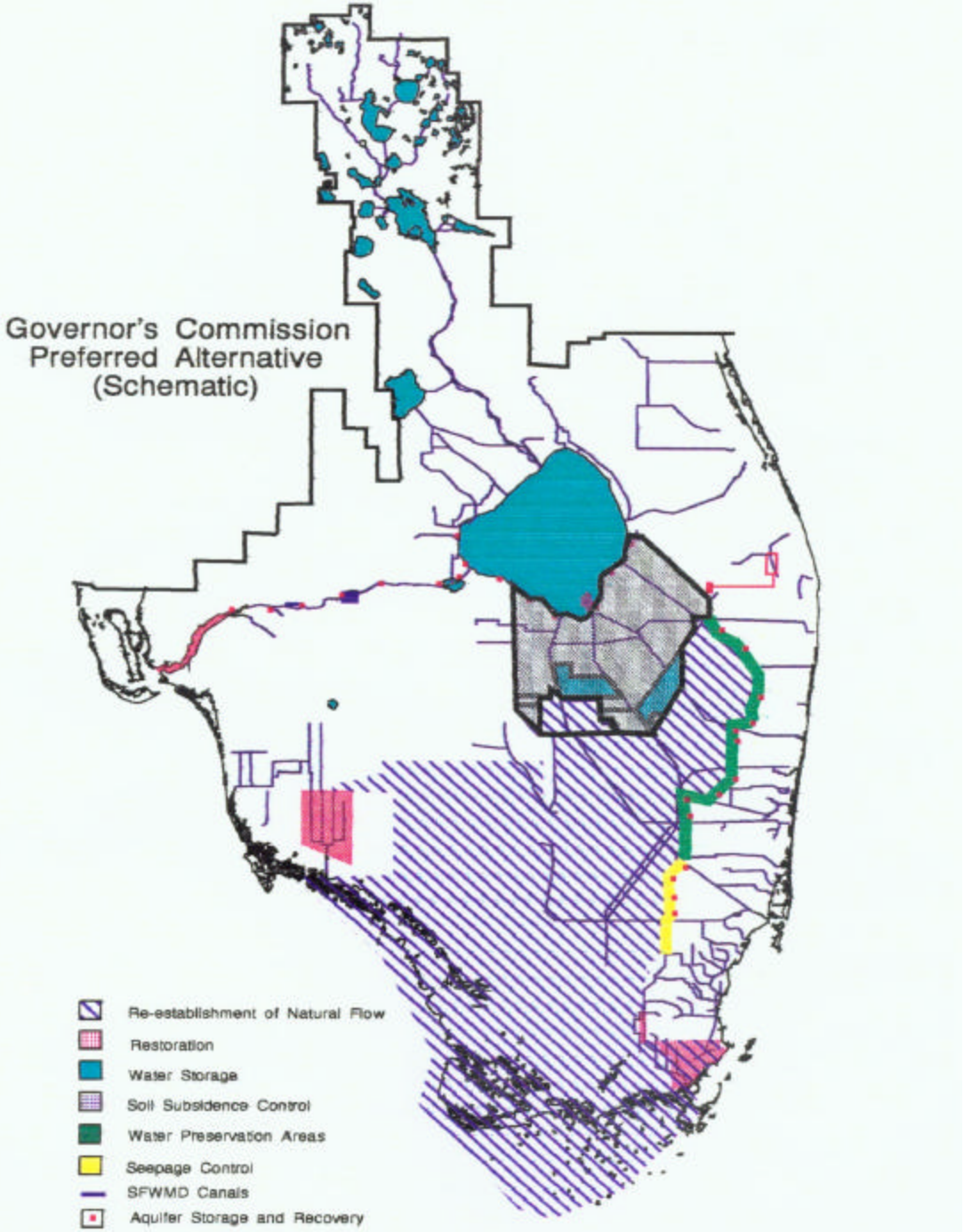
(*Harwell et al. 1996*)



Everglades Defining Characteristics

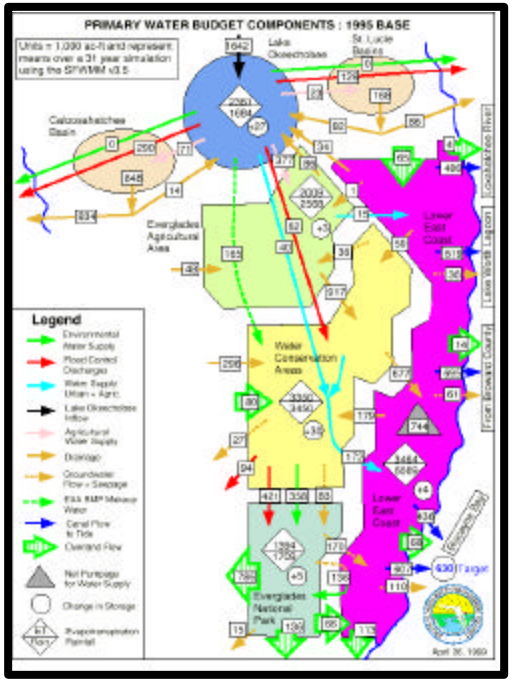
- Large spatial scale
- Dynamic water storage/sheet flow
- Natural hydroperiod
- Habitat heterogeneity/connectivity
- Oligotrophic water quality


US MAB
Scenario C
Core Area
Restoration
Buffer Area/Agricultural
Buffer Area/Urban
Water Storage
Present SFWMD Canals
Everglades National Park Boundary

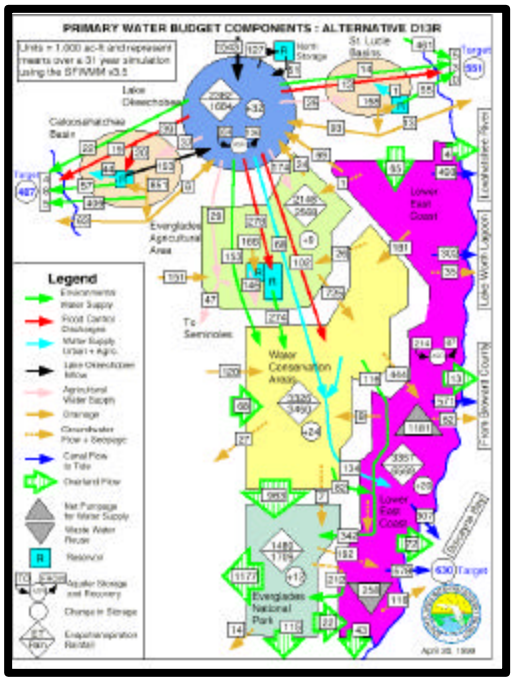

Governor's Commission
Preferred Alternative
(Schematic)
Re-establishment of Natural Flow
Restoration
Water Storage
Soil Subsidence Control
Water Preservation Areas
Seepage Control
SFWMD Canals
Aquifer Storage and Recovery

TWO MANAGEMENT SCENARIOS

95 BASE

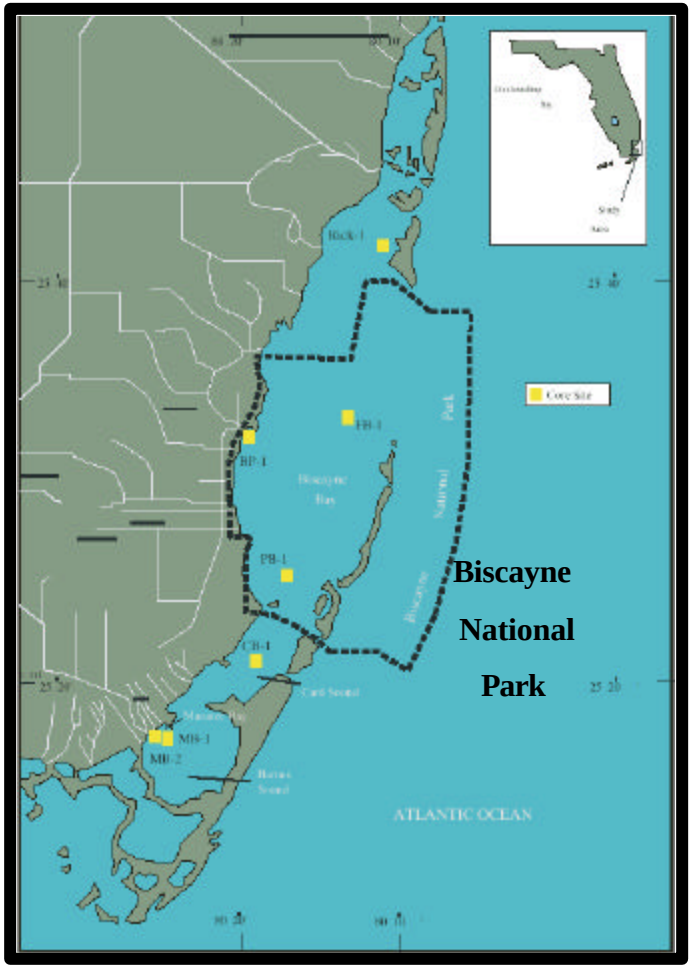


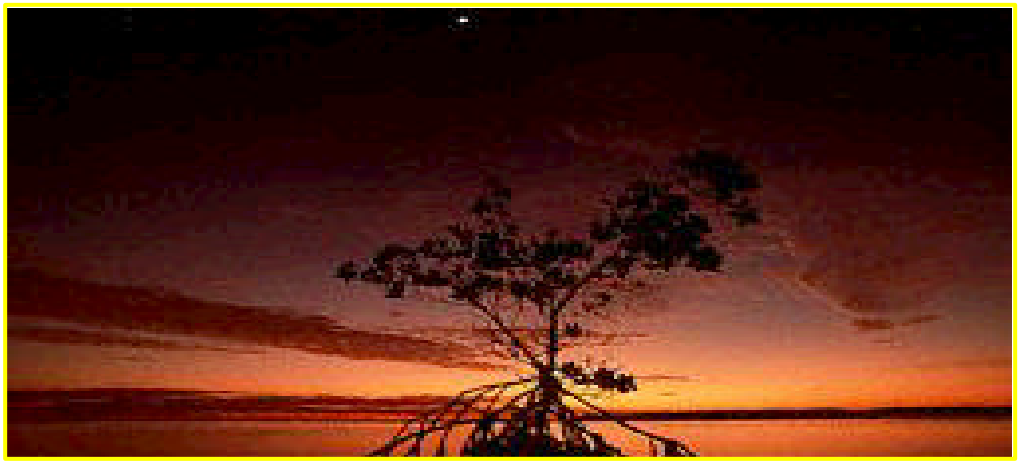
D13R4



OUTPUT = WATER QUANTITY, TIMING, DISTRIBUTION

BISCAYNE BAY

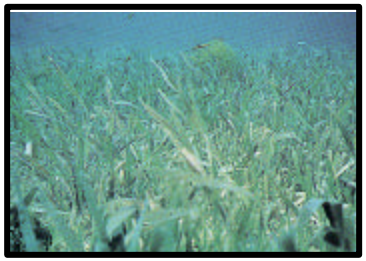


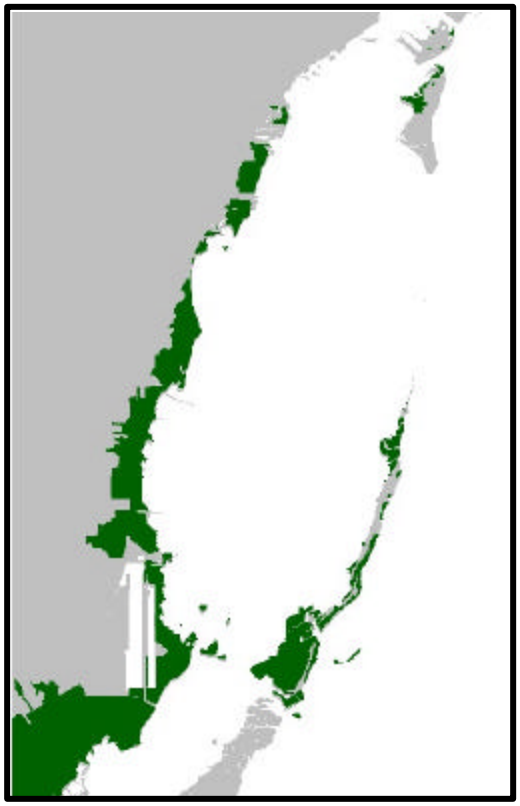


- **Shallow, subtropical estuary with depths of 1-3 m**
- **Benthic habitats dominated by seagrasses and hard-bottom communities. Coastal habitats dominated by mangroves**
- **Supports recreational and commercial fisheries**
- **Has undergone important changes in hydrology in the last 50 years**
- **Potential effects from restoration**

BISCAYNE BAY HABITATS

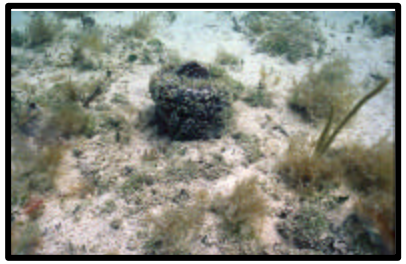
SEAGRASS COMMUNITIES



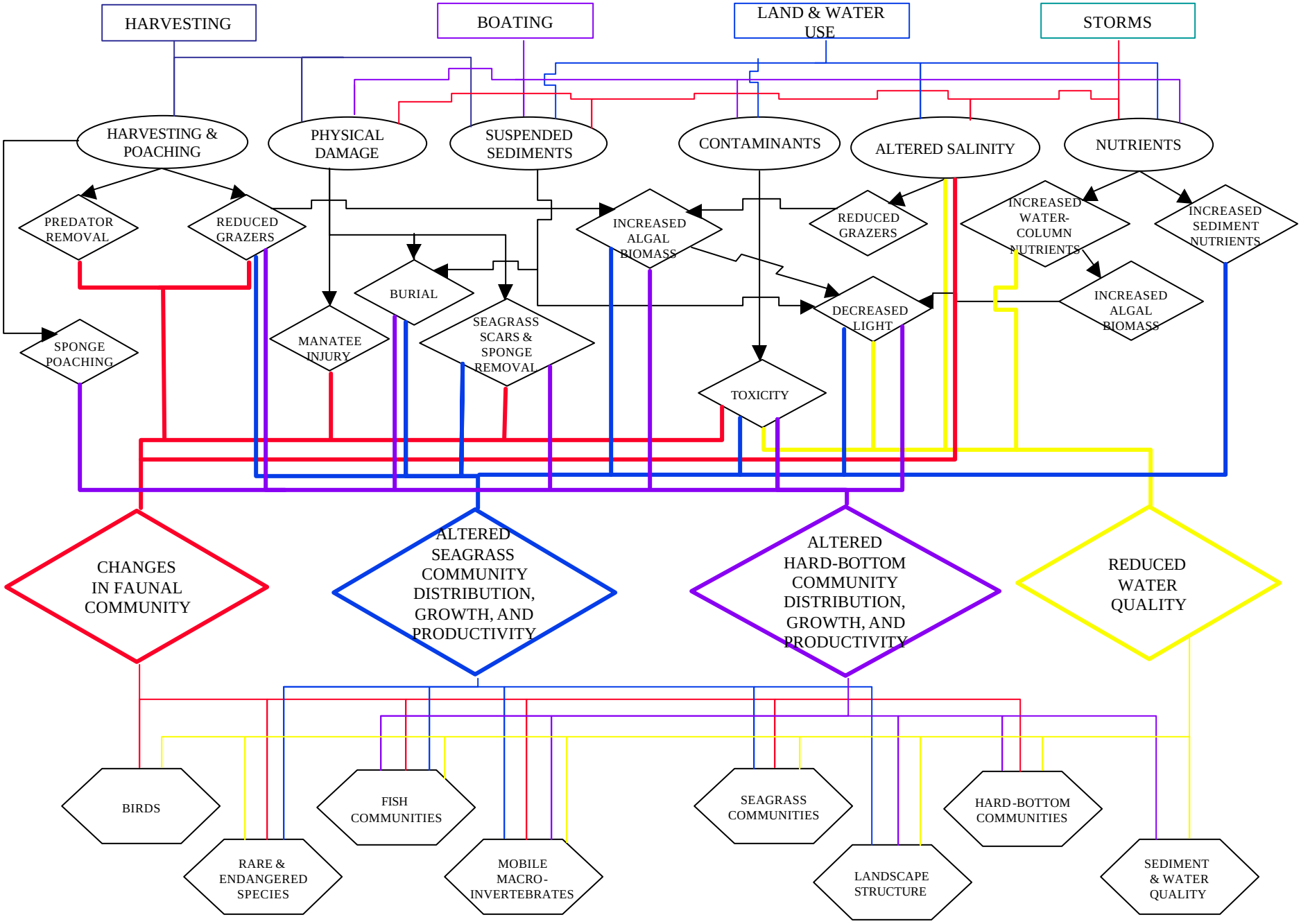


MANGROVES

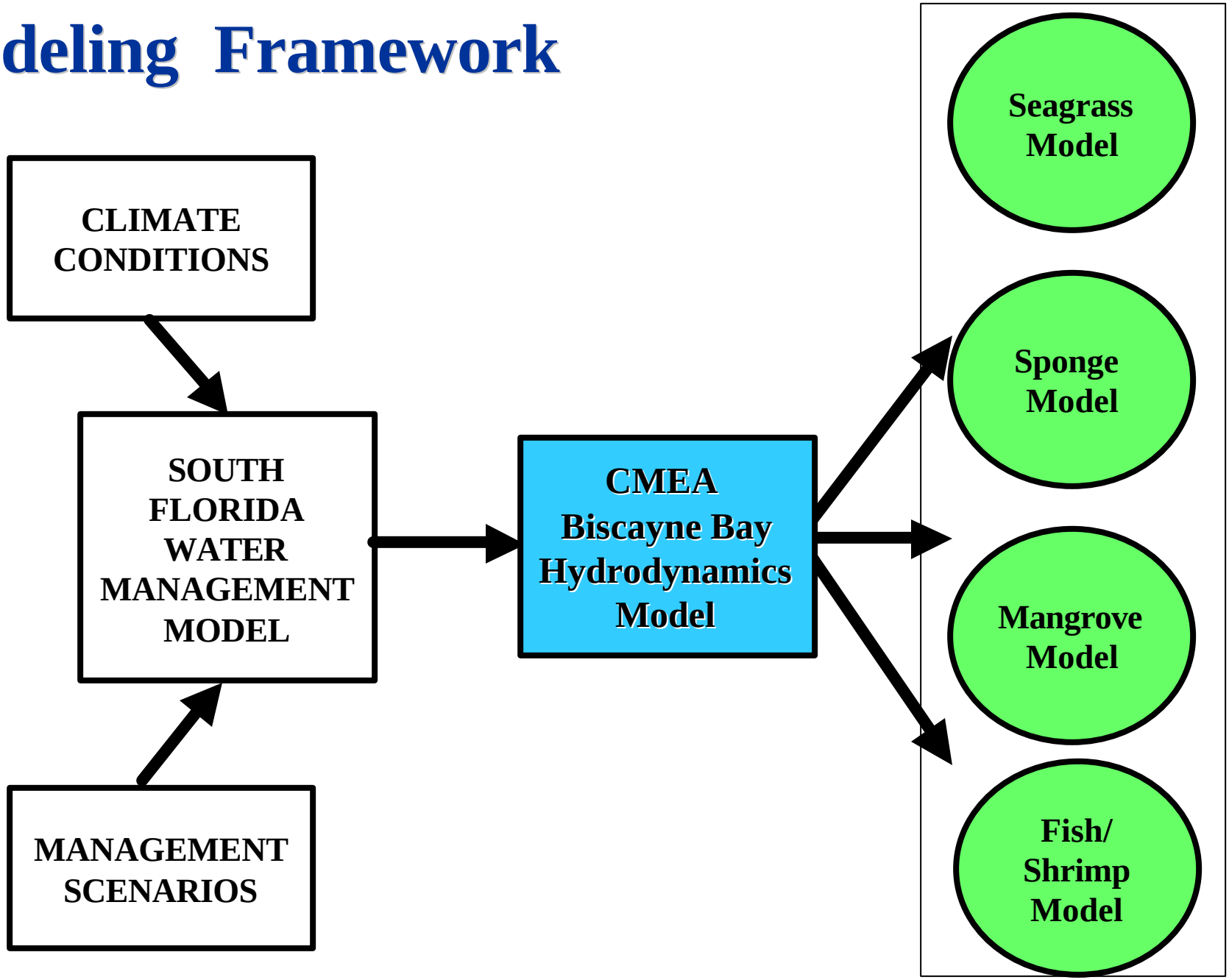
HARD-BOTTOM COMMUNITIES



Biscayne Bay Conceptual Model

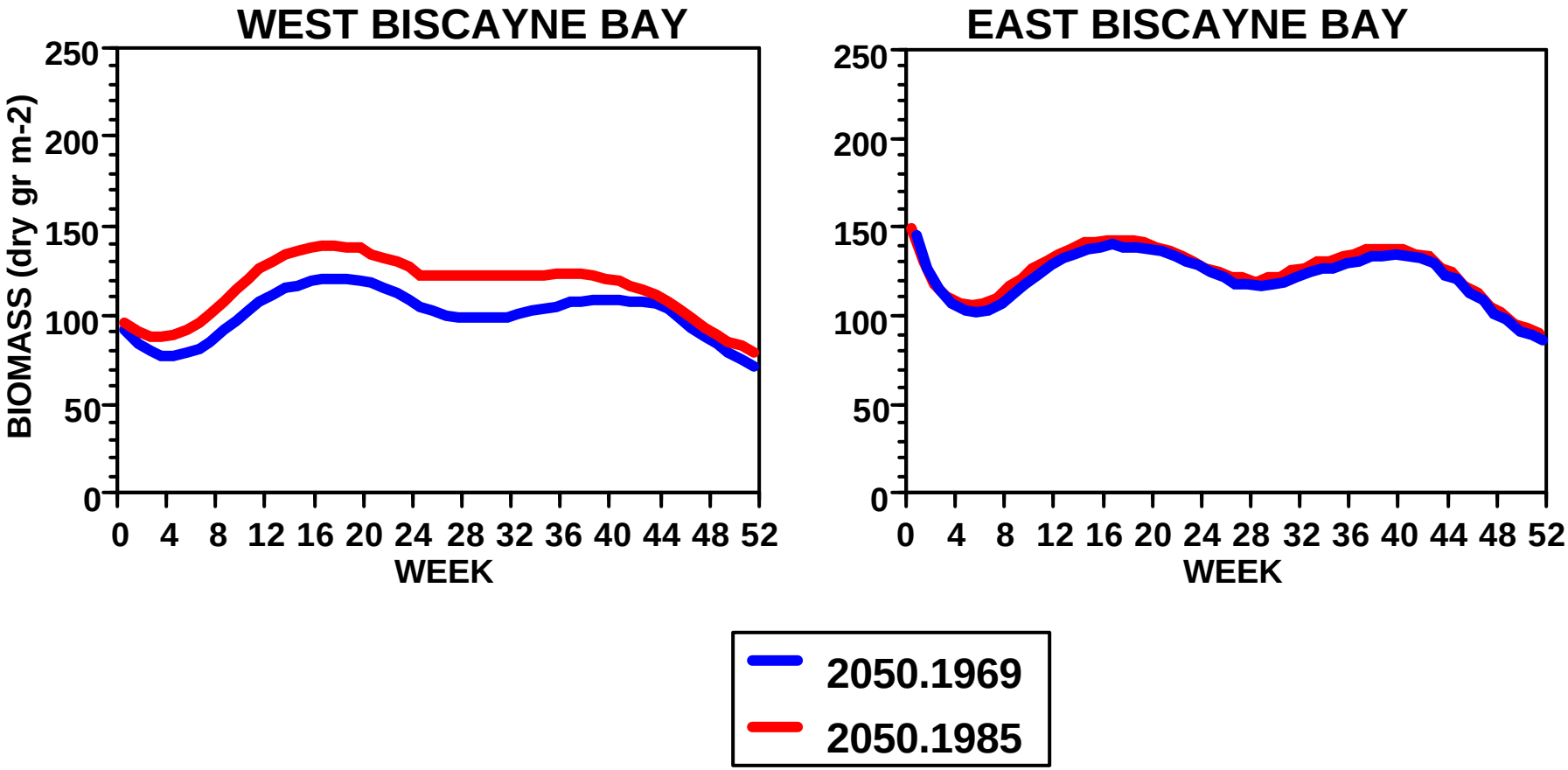


Modeling Framework

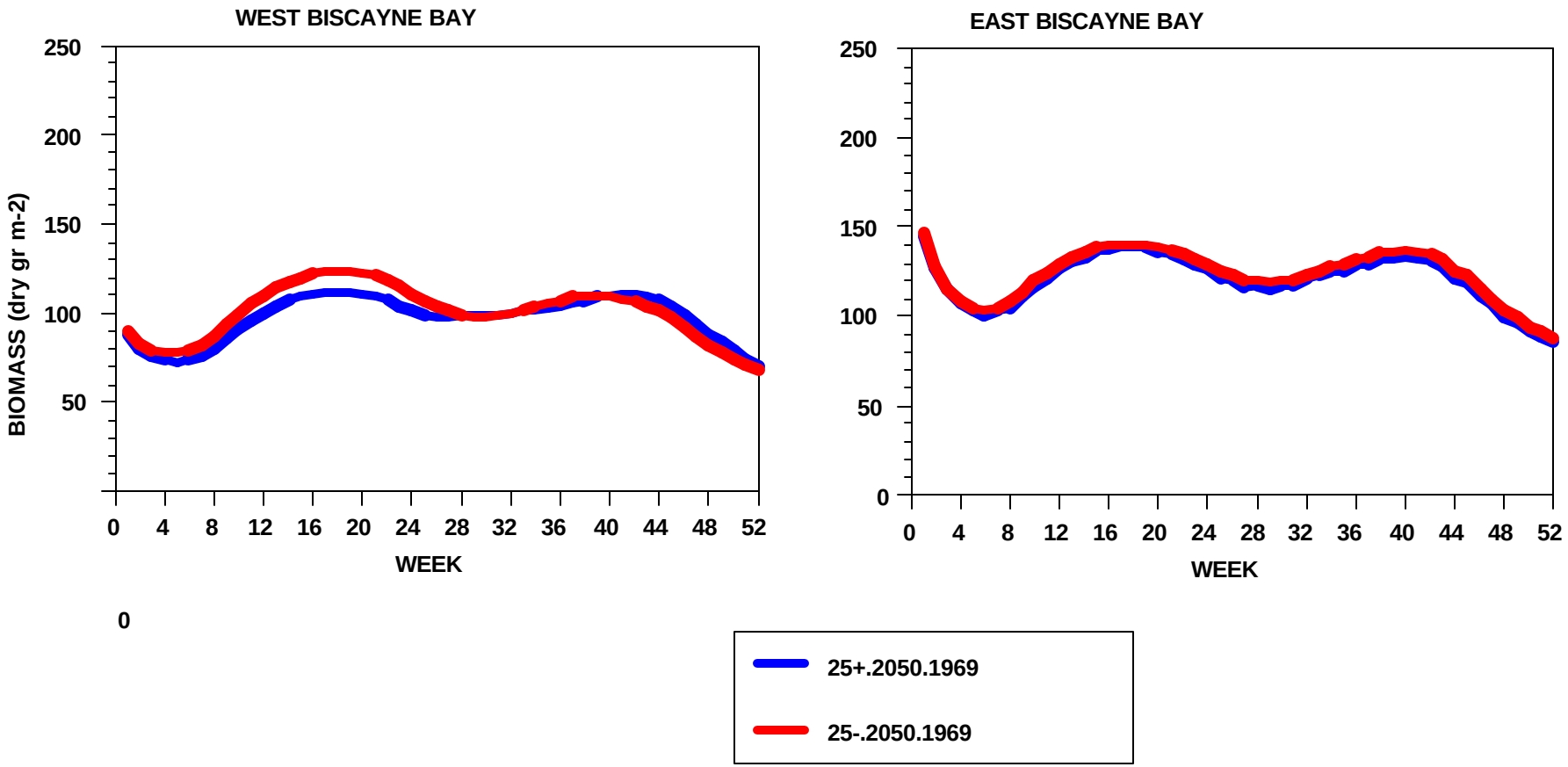


Hydrodynamics Movie

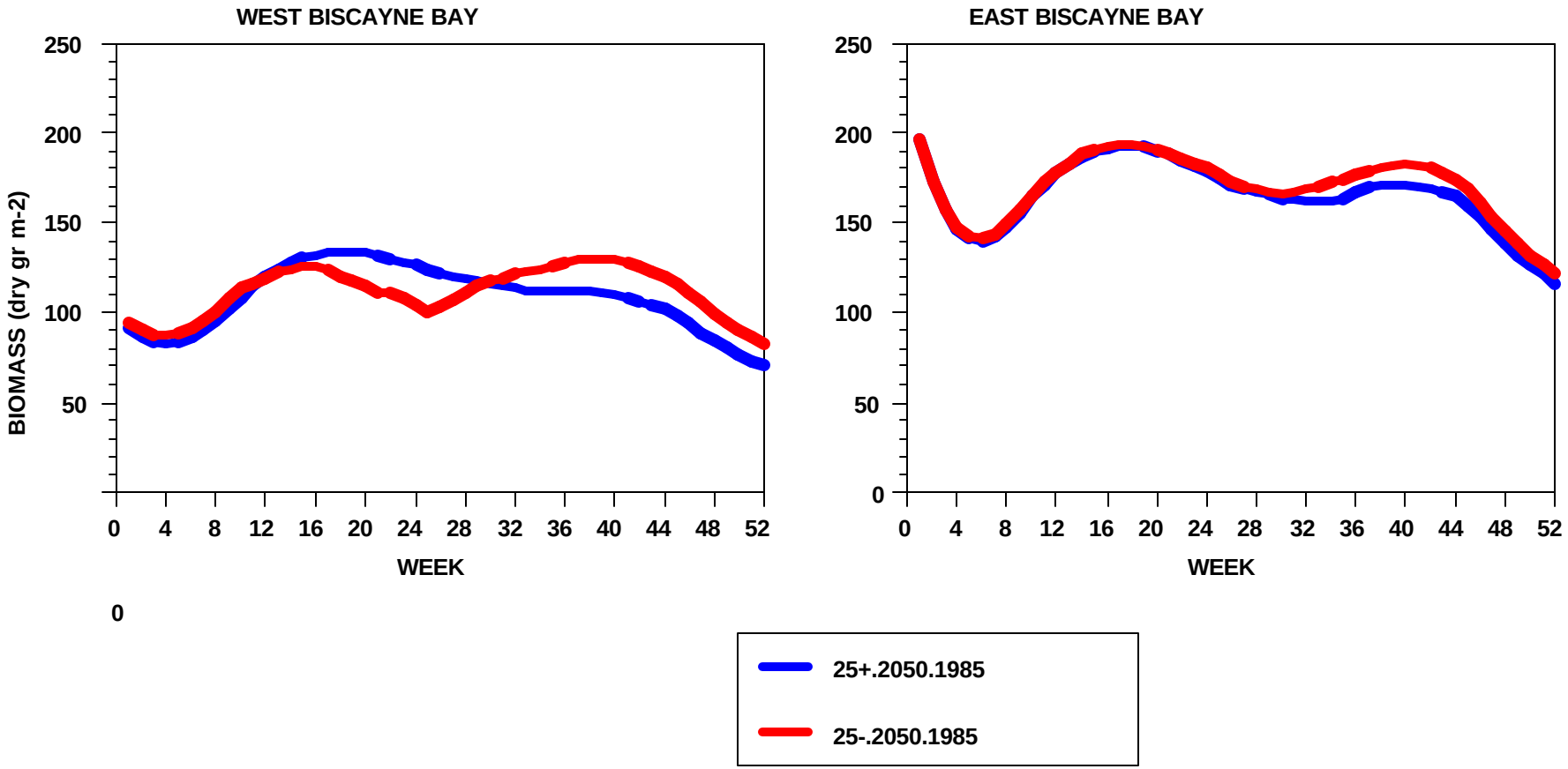
Thalassia testudinum



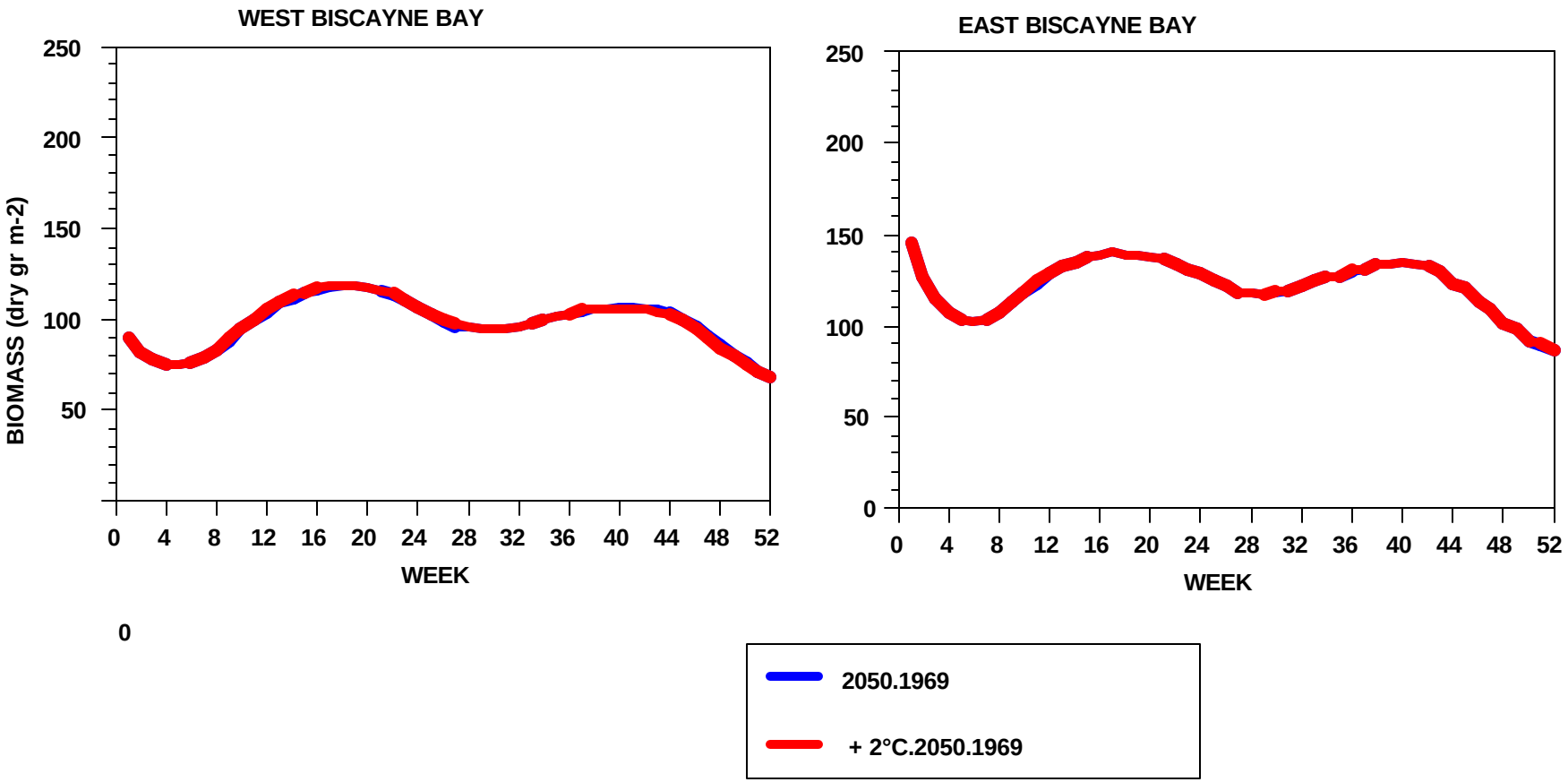
Thalassia testudinum



Thalassia testudinum



Thalassia testudinum



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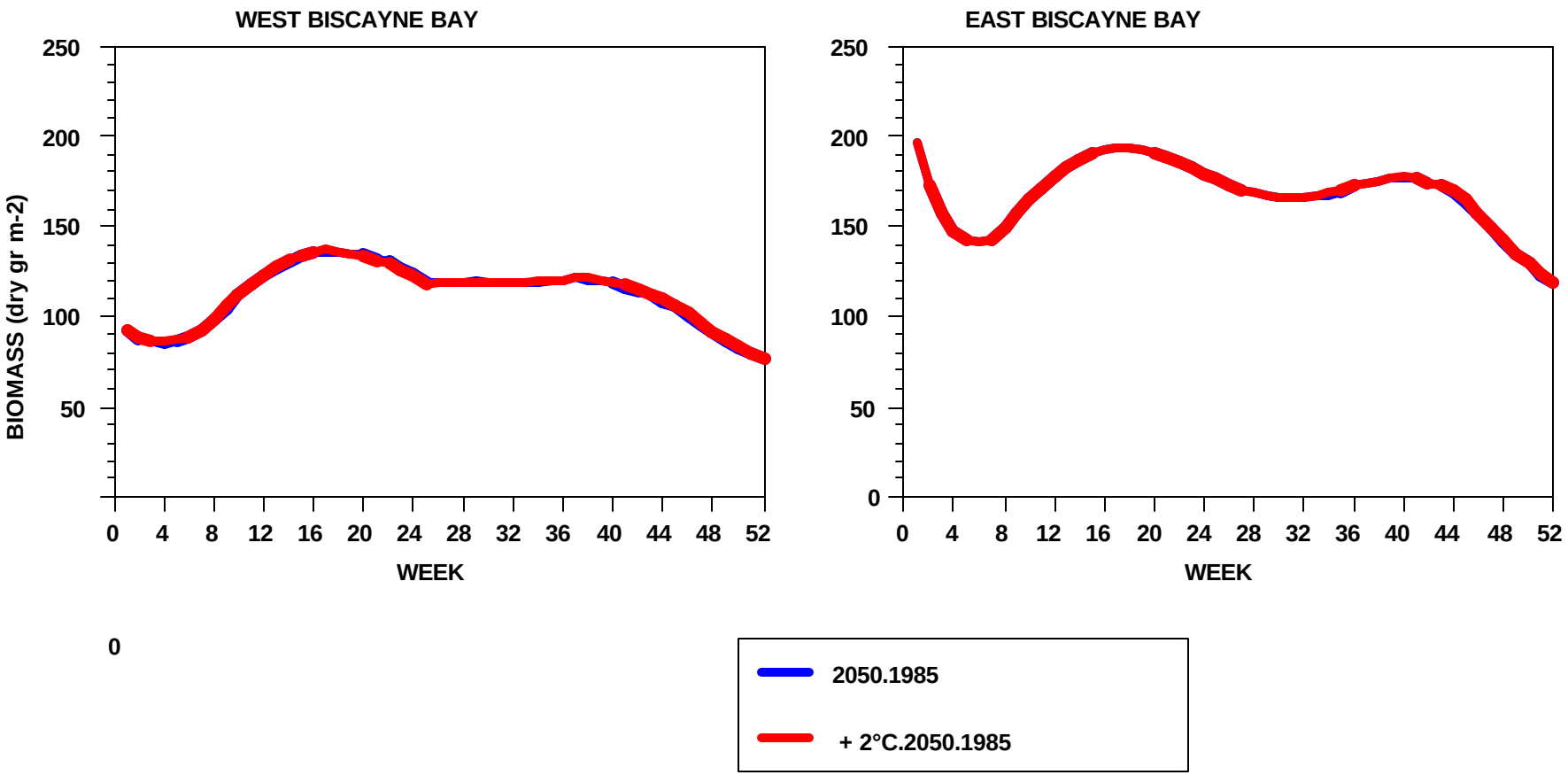

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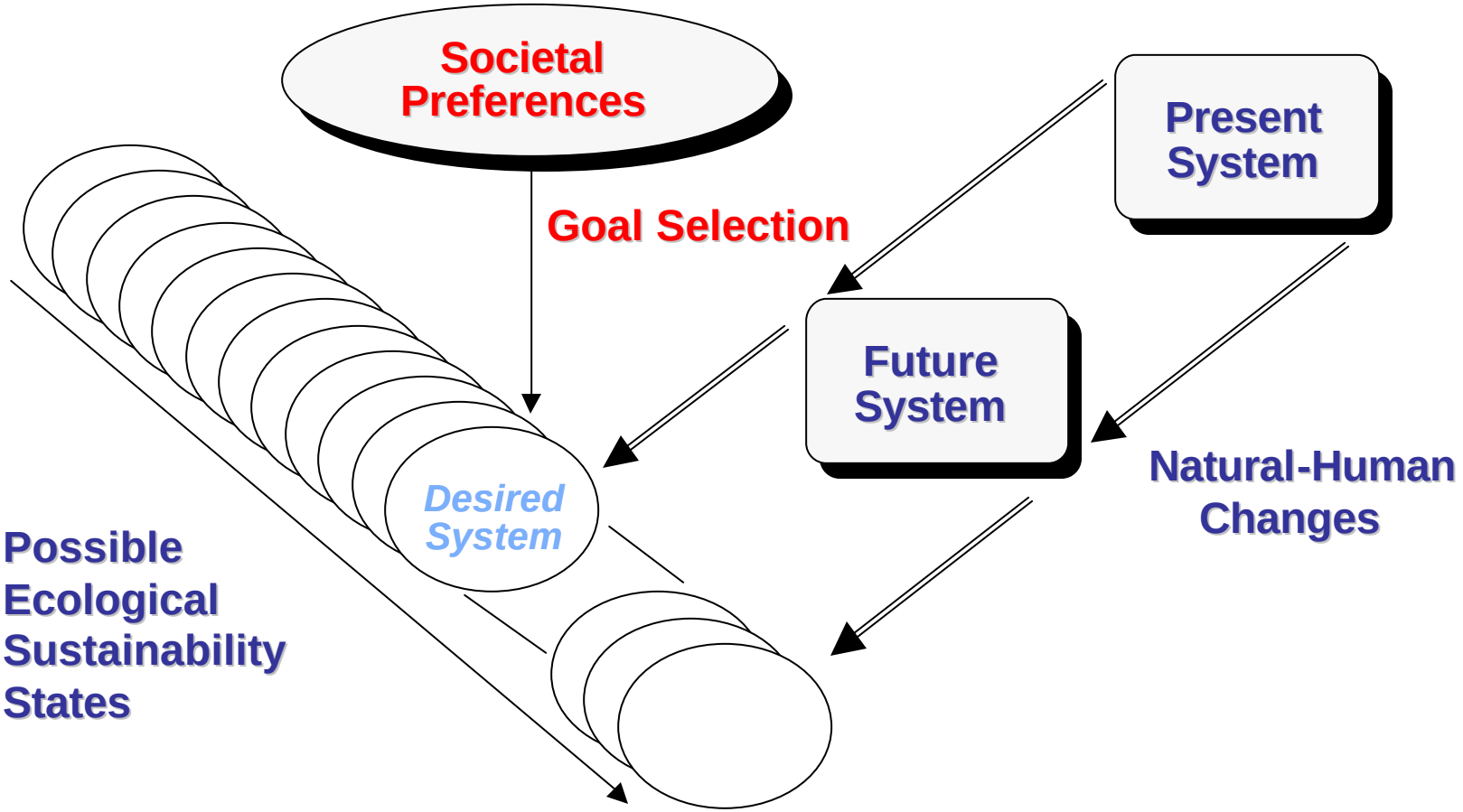
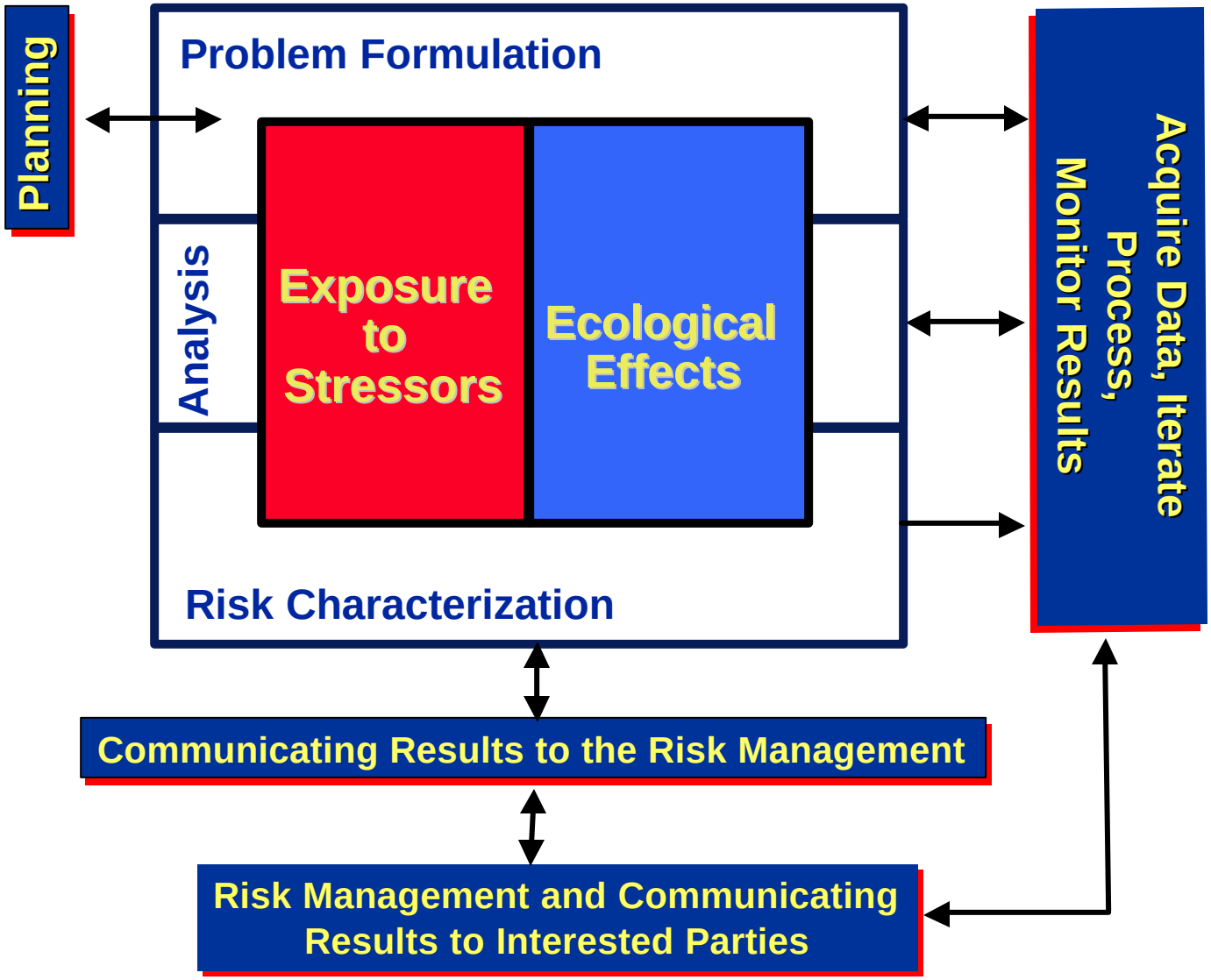
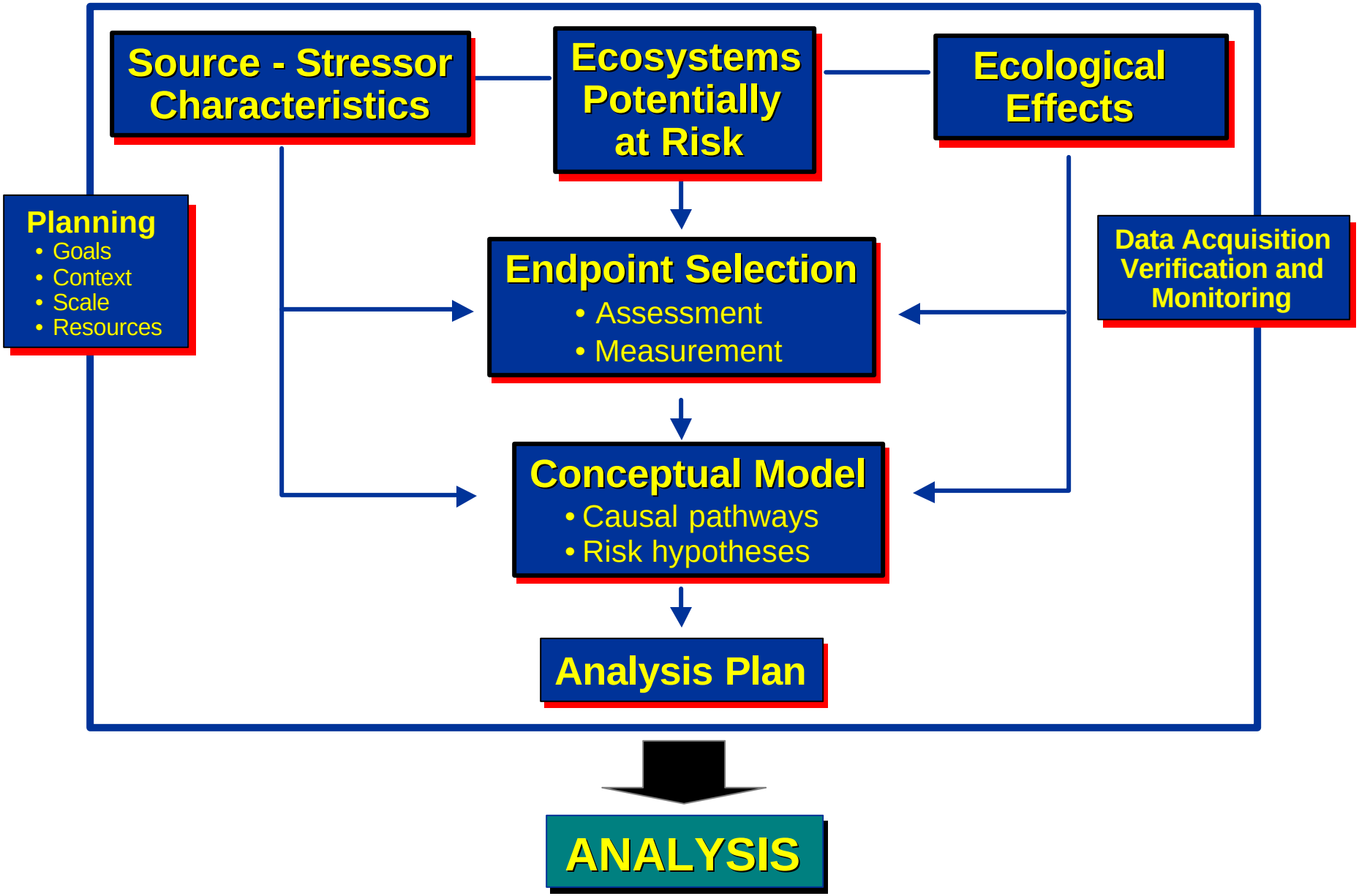


Framework for Ecological Risk Assessment

(EPA 1992, 1998)



Problem Formulation



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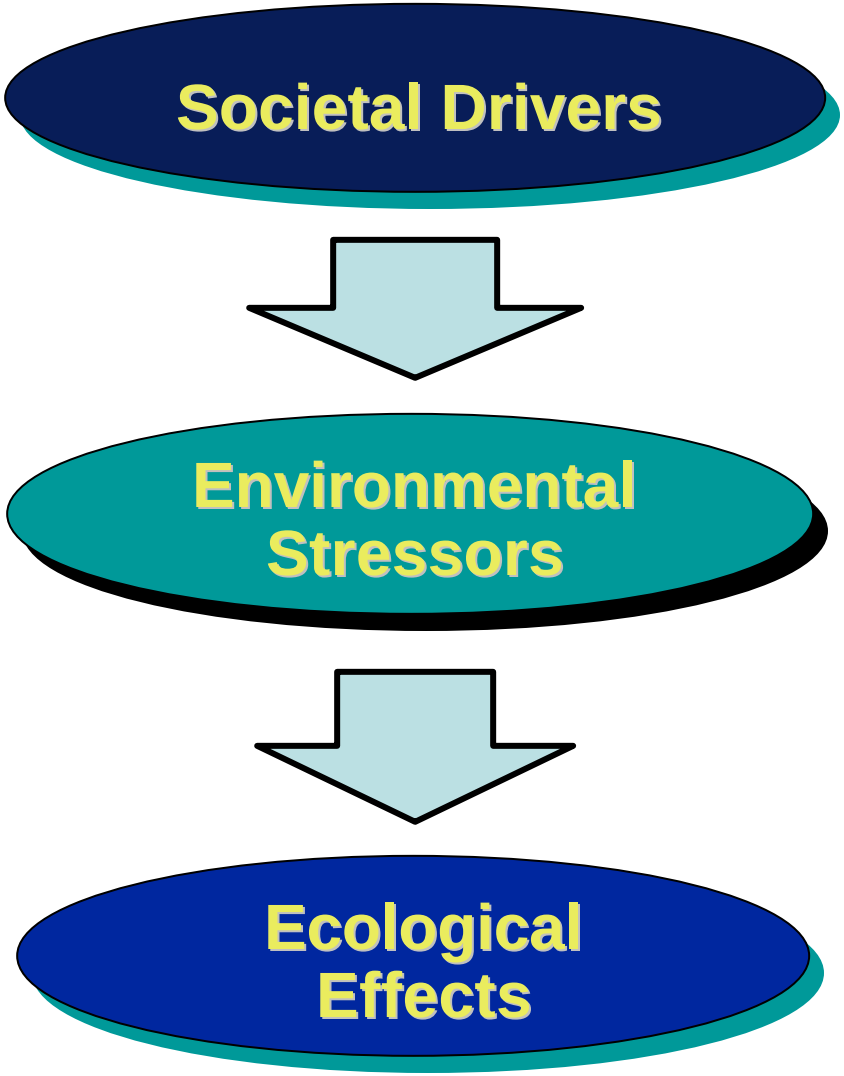
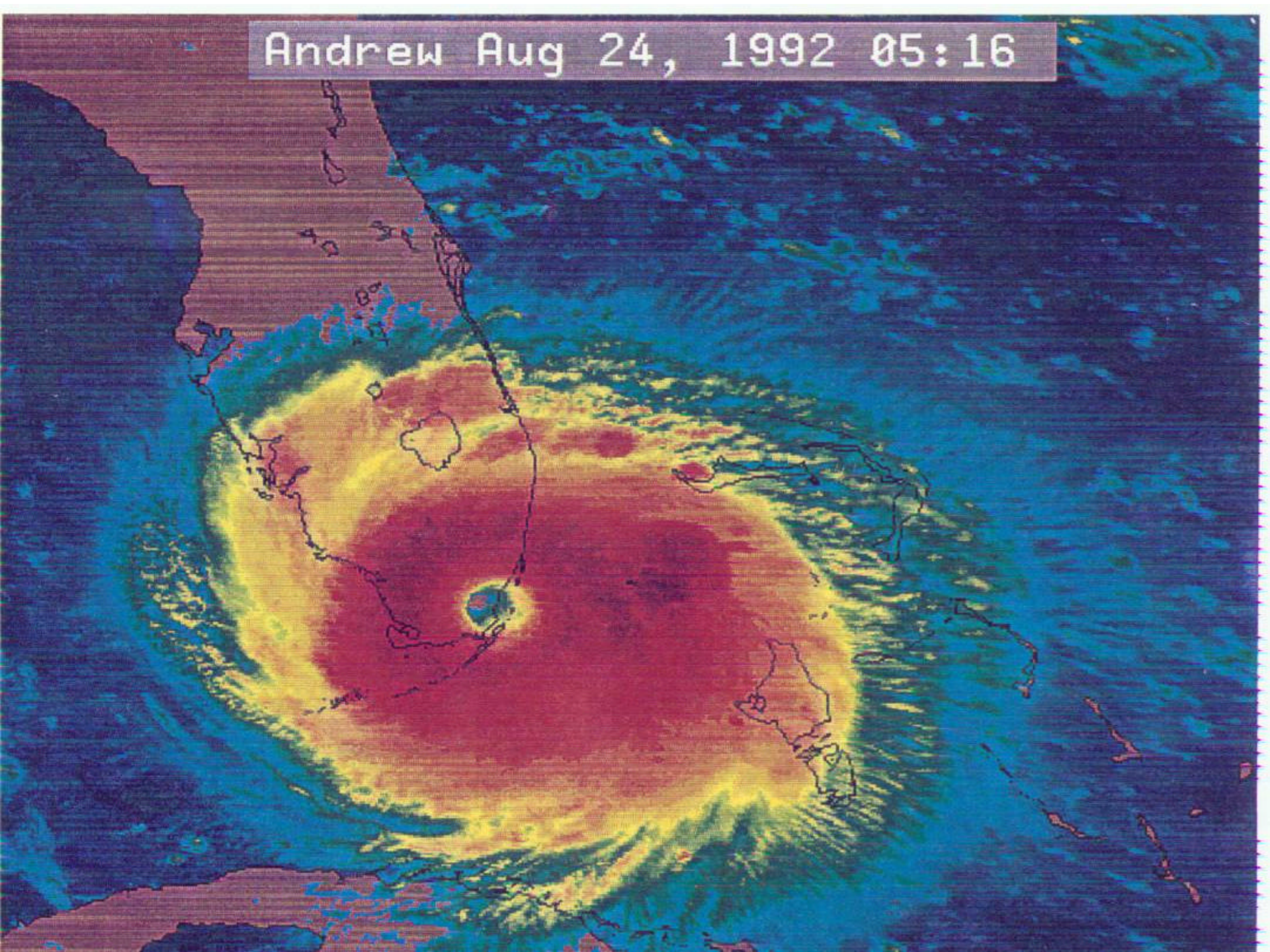


Stressors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