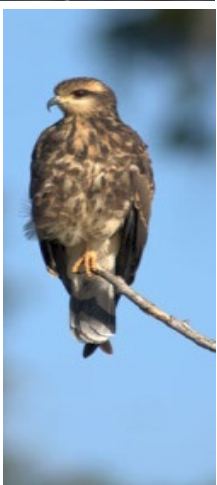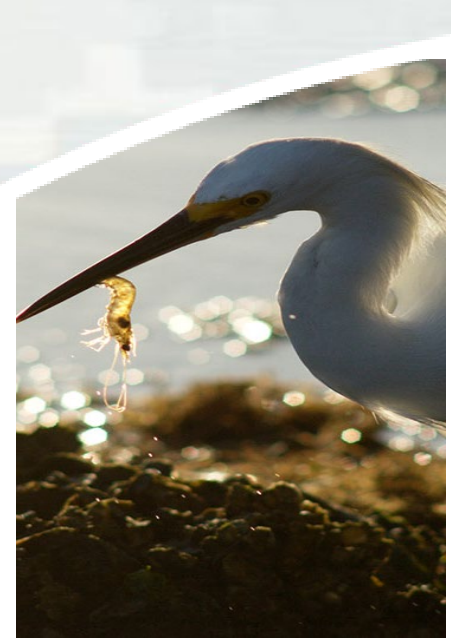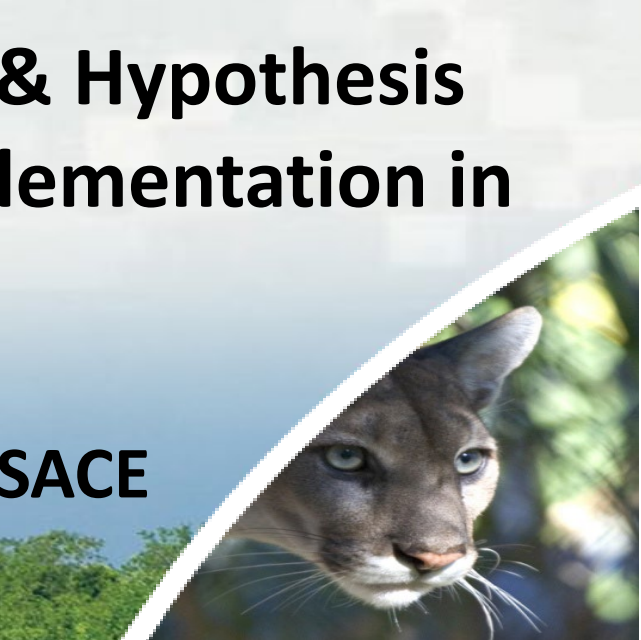# REstoration, COordination, VERification (RECOVER)

Conceptual Ecological Models & Hypothesis Clusters– Background and Implementation in the Southern Coastal Systems

Melody Hunt, NPS

Stephanie Verhulst, USACE

Southern Coastal Systems
Outline

- RECOVER
  - What is RECOVER?
  - RECOVER Science Strategy

- CEMs - Framework of CEMs

- SCS Regions
  - Example of CEM - Biscayne Bay

- Hypothesis Clusters
  - Example of Hypothesis Cluster – Water Quality

RECOVER

Multi-agency team of scientists, modelers, planners, and resource specialists

▪ Conducts scientific and technical evaluations

▪ Applies a system-wide perspective to the planning and implementation of CERP

▪ Communicates and coordinates science to ensure that CERP goals and purposes are achieved

Functions and Roles of RECOVER

- Ensures CERP implementation is guided by the best available science

- Three Major Missions:

  - **Assessment**: measuring performance of projects through research and monitoring

  - **Evaluation**: forecasting project performance through predictive modeling and performance measures

  - **Planning**: integrating RECOVER with planning and operation of the system
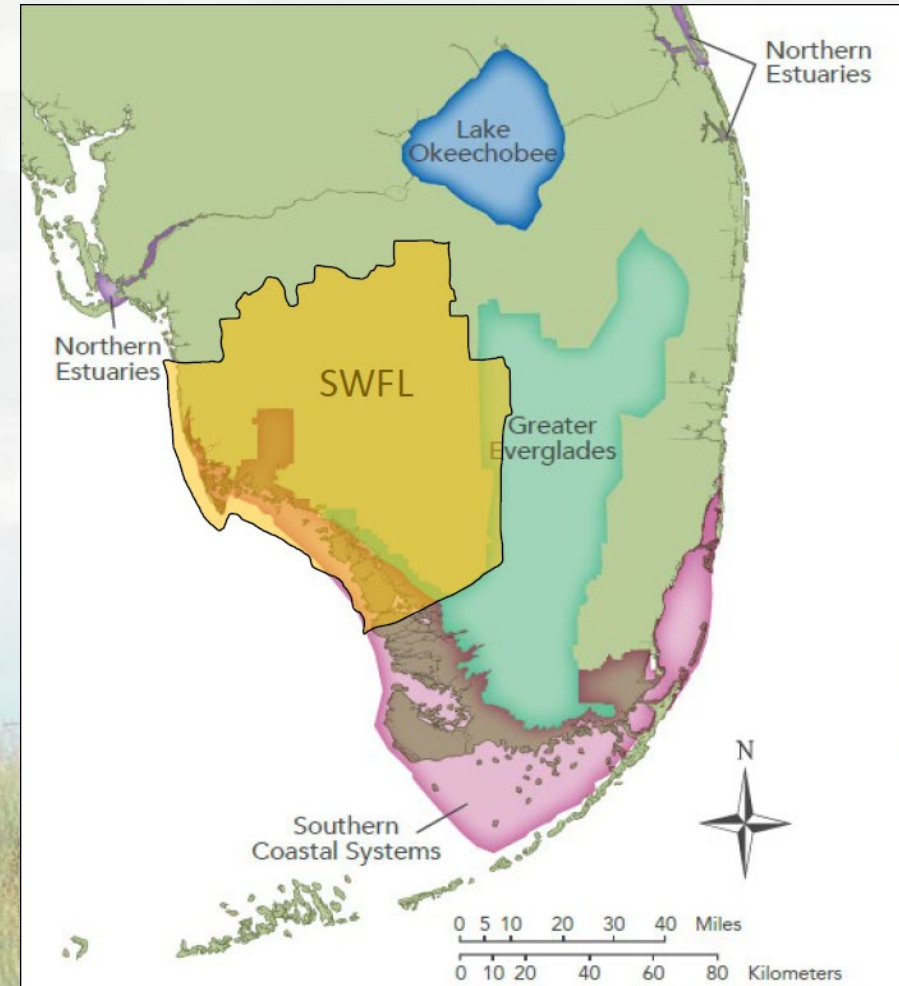
Assessing CERP Restoration Success

System-wide Science

- Organized around **Conceptual Ecological Models (CEMs) and hypotheses**
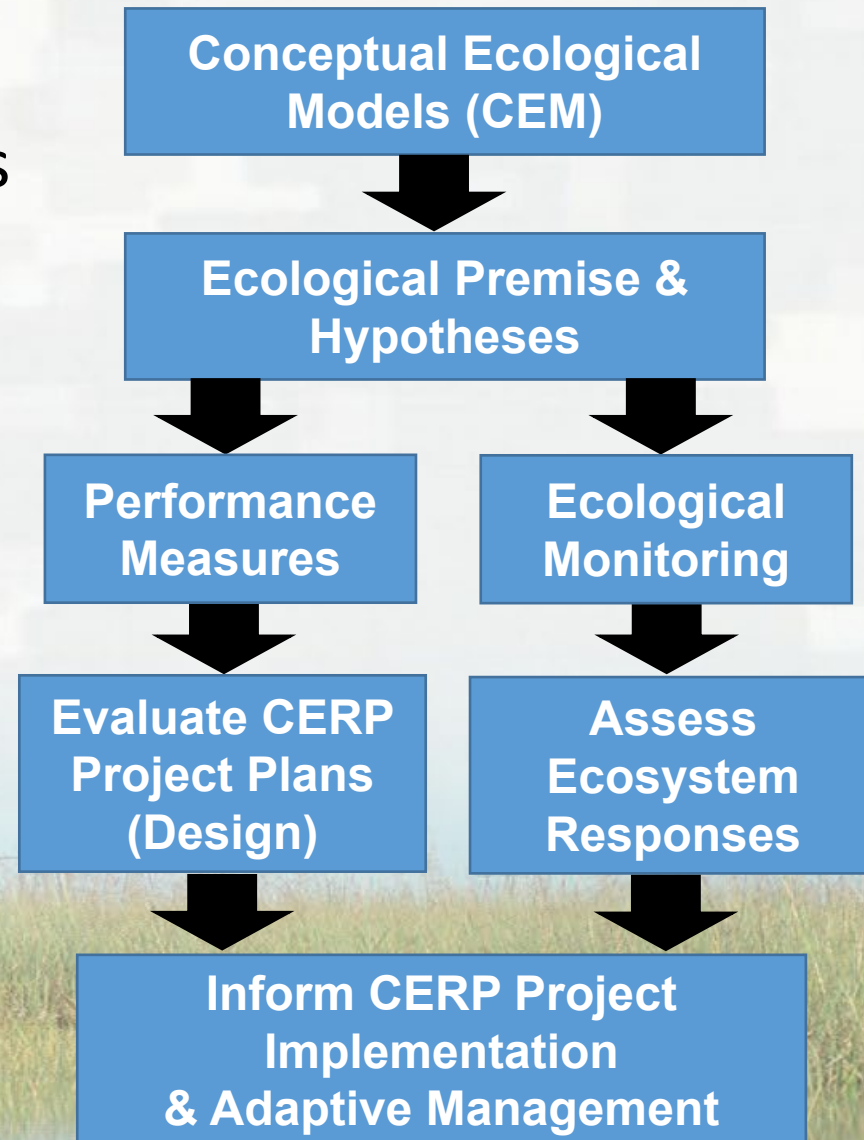- Establishment of **Monitoring and Assessment Plan (MAP)**

Regional landscape level

RECOVER's Science Strategy

- Framework to understand the ecological systems

- Establish baseline (pre-CERP) conditions and assess ecosystem response

- Develops organized structure to **evaluate** CERP project design and **inform** project implementation and **Adaptive Management**

Conceptual Ecological Models (CEM)

↓

Ecological Premise & Hypotheses

↓

Performance Measures → Ecological Monitoring

↓

Evaluate CERP Project Plans (Design) → Assess Ecosystem Responses

↓

Inform CERP Project Implementation & Adaptive Management

Agenda Item #6 RECOVER CEMs

RECOVER's Science Strategy

Conceptual Ecological Models

- Non-quantitative planning tools

- Describe ecological linkages

- Process to organize and communicate knowledge of the ecosystem

What is causing this system to change?

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┌─────────────────────────┐
│  Conceptual Ecological  │
│    Models (CEM)         │
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┌─────────────────────────┐
│  Ecological Premise &   │
│      Hypotheses         │
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┌───────────┐ ┌───────────┐
│Performance│ │Ecological │
│ Measures  │ │Monitoring │
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┌───────────┐ ┌───────────┐
│Evaluate   │ │  Assess   │
│CERP       │ │ Ecosystem │
│Project    │ │ Responses │
│Plans      │ │           │
│(Design)   │ │           │
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┌─────────────────────────┐
│  Inform CERP Project    │
│    Implementation       │
│  & Adaptive Management   │
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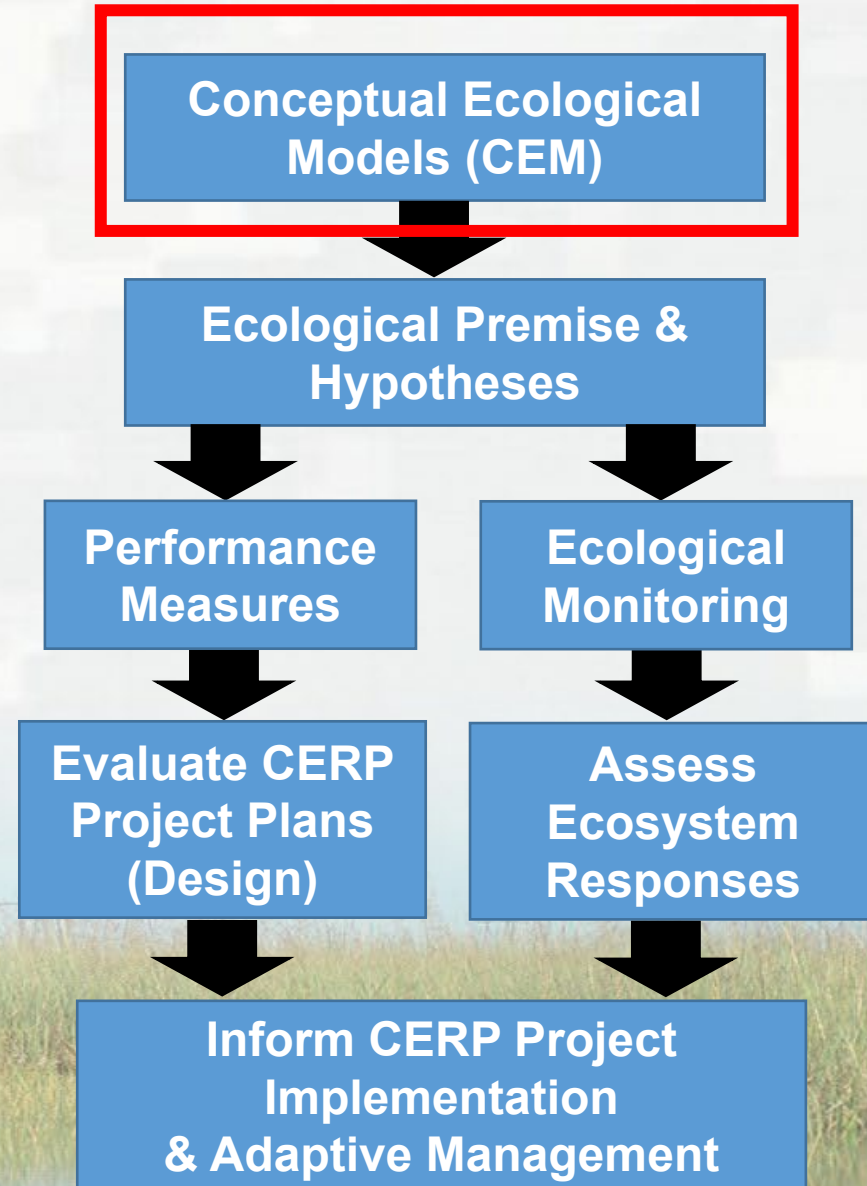
CEM Framework

DRIVERS

Drivers represent any type of **physical or biological force** that can significantly influence a natural system.

STRESSORS

Stressors are **physical, chemical, and biological mechanisms** that cause change(s) in the ecosystem.
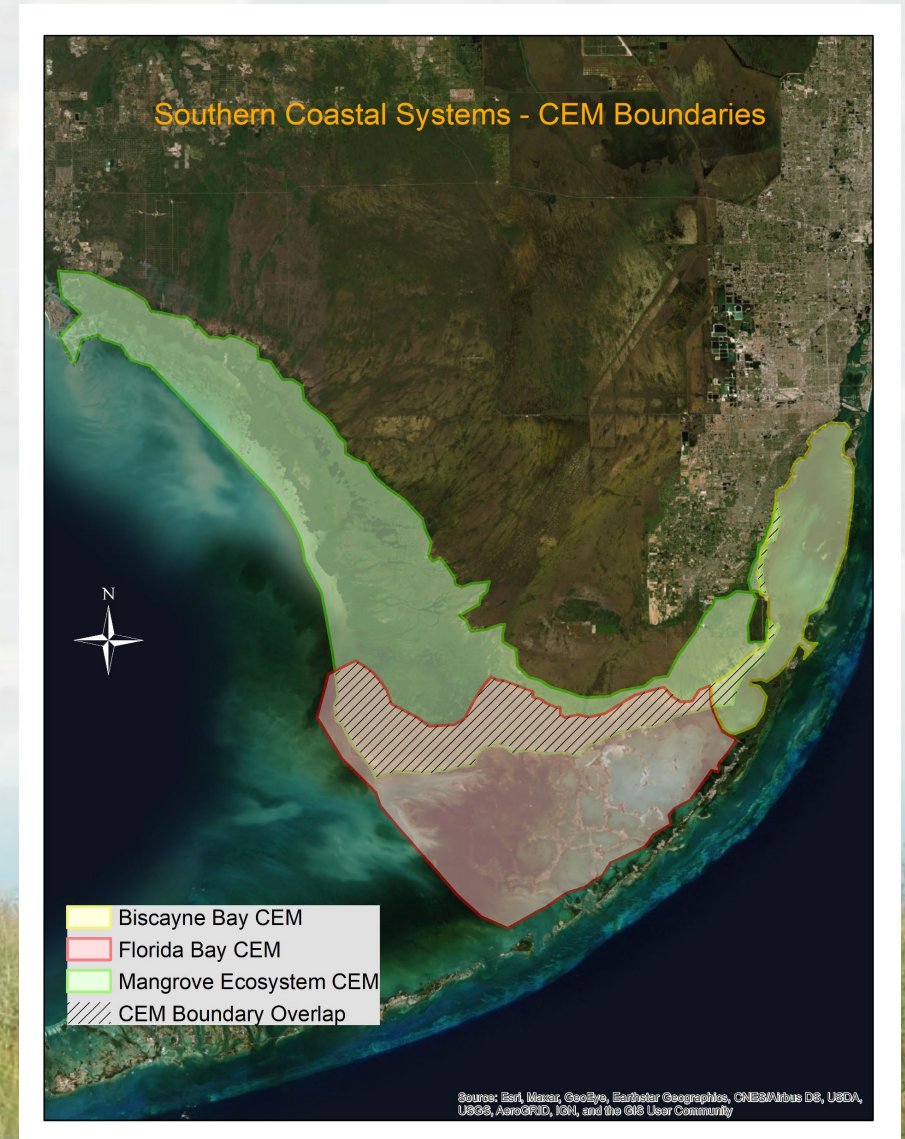
EFFECTS

Ecological effects are **physical, chemical, and biological responses** that are intrinsic to the ecological system and are triggered by stressors.

ATTRIBUTES

Attributes are a **parsimonious subset of ecosystem components** that are thought to be representative of overall ecological conditions of the system.
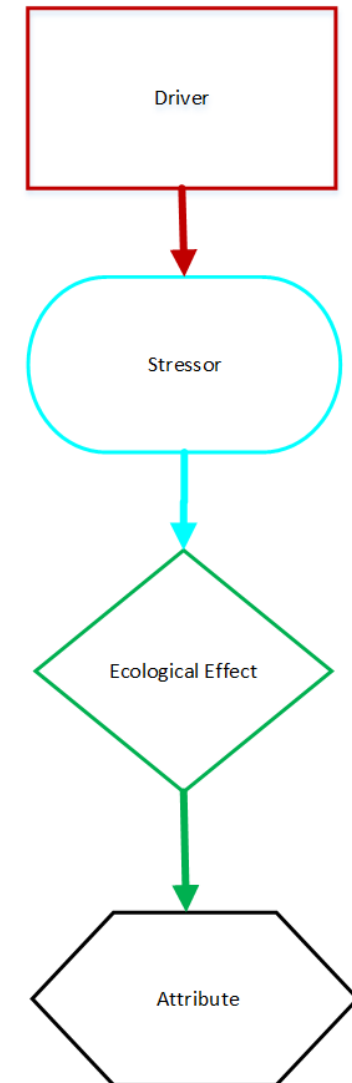
Southern Coastal Systems-Regions

- 3 different regions within SCS
  - Florida Bay Coastal Systems
  - *Biscayne Bay Coastal Systems*
  - Everglades Freshwater to Marine Ecotone
- All contain a mosaic of different habitats
- Geomorphological and other differences between regions
- Some regions overlap (mangroves)

Southern Coastal Systems - CEM Boundaries

Biscayne Bay CEM
Florida Bay CEM
Mangrove Ecosystem CEM
CEM Boundary Overlap

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

RECOVER
assessment
science
evaluation
integration

Agenda Item #6 RECOVER CEMs

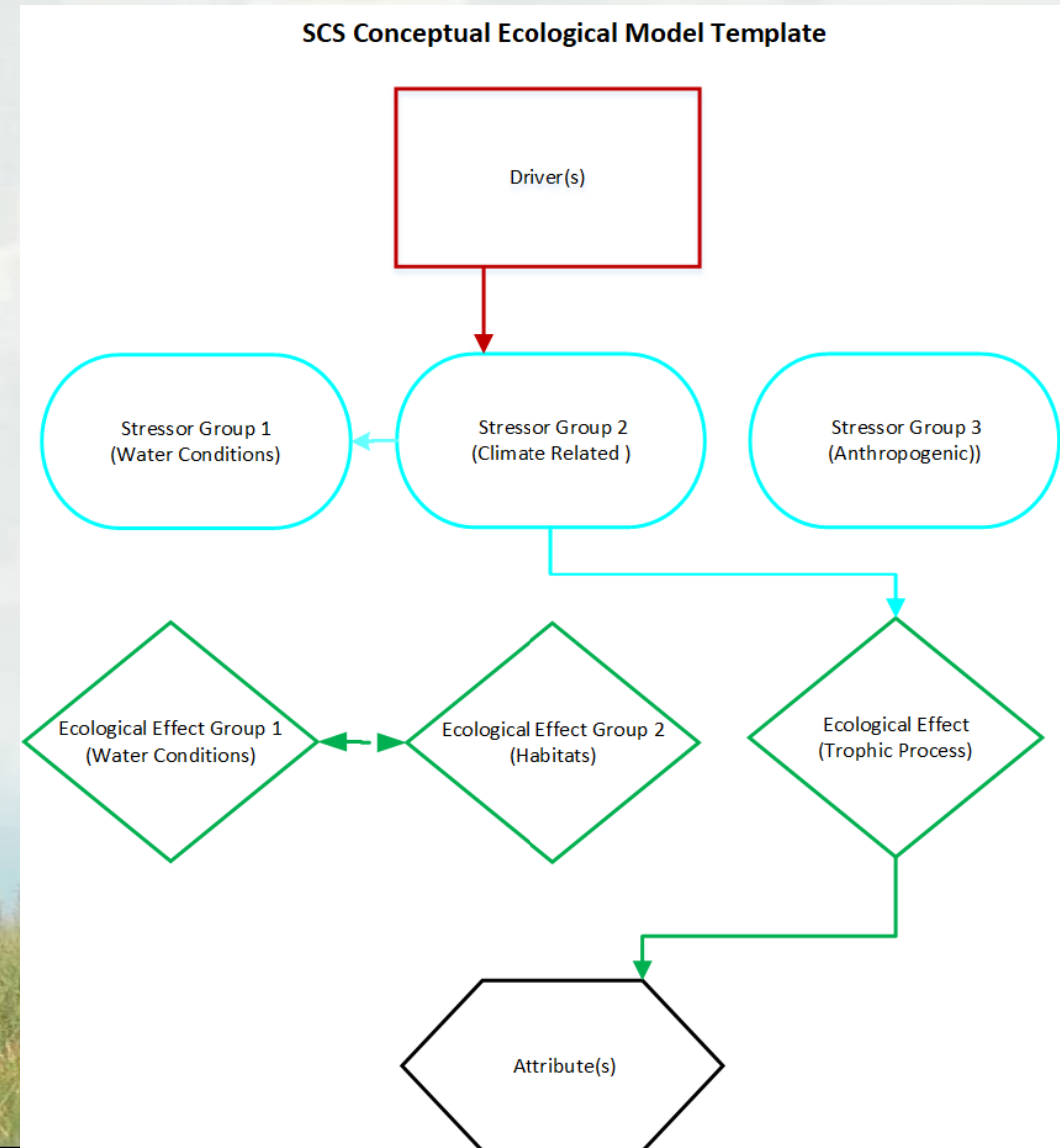# Southern Coastal Systems-Basic Elements

- Four Elements

  - **Drivers –** large spatial change

  - **Stressors** – focused

  - **Ecological Effects –** ecological system

  - **Attributes –** measurable

- Basic format used in original 2004-5 CEMs
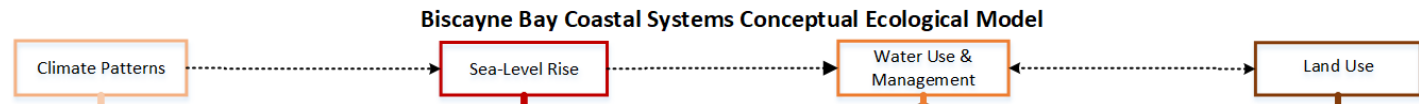

SCS Conceptual Ecological Model Template

Driver → Stressor → Ecological Effect → Attribute

Southern Coastal Systems-Grouped

- Grouped Elements (Stressors & Effects)

- Used in all 2023 revised CEMs

- Streamlined the diagrams


SCS Conceptual Ecological Model Template

Southern Coastal Systems-Biscayne Bay CEM

- 4 Drivers

- Same for all CEMs
  - Climate
 - Sea Level Rise
  - Water Use & Management
  - Land Use

Biscayne Bay Coastal Systems Conceptual Ecological Model

Climate Patterns ⇢ Sea-Level Rise ⇢ Water Use & Management ⇠⇢ Land Use

RECOVER
assessment
science
evaluation
integration

Southern Coastal Systems-Biscayne Bay CEM

- Grouped Stressors
  - Properties of Water
  - Climate
  - Anthropogenic

Biscayne Bay Coastal Systems Conceptual Ecological Model
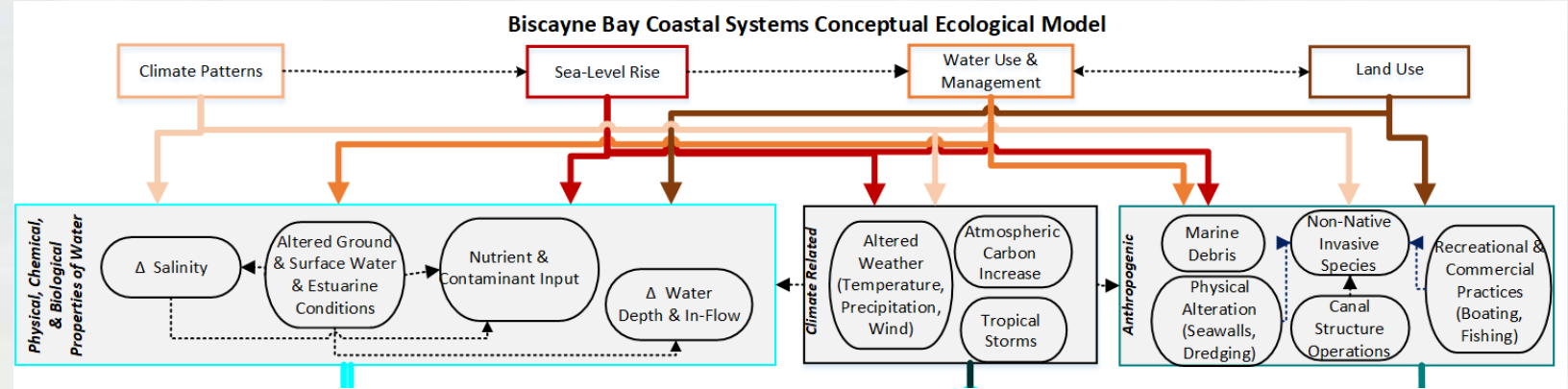
Southern Coastal Systems-Biscayne Bay CEM

- Grouped Effects
  - Water Quality/ Biogeochemistry
  - Habitat
  - Trophic Processes

Biscayne Bay Coastal Systems Conceptual Ecological Model
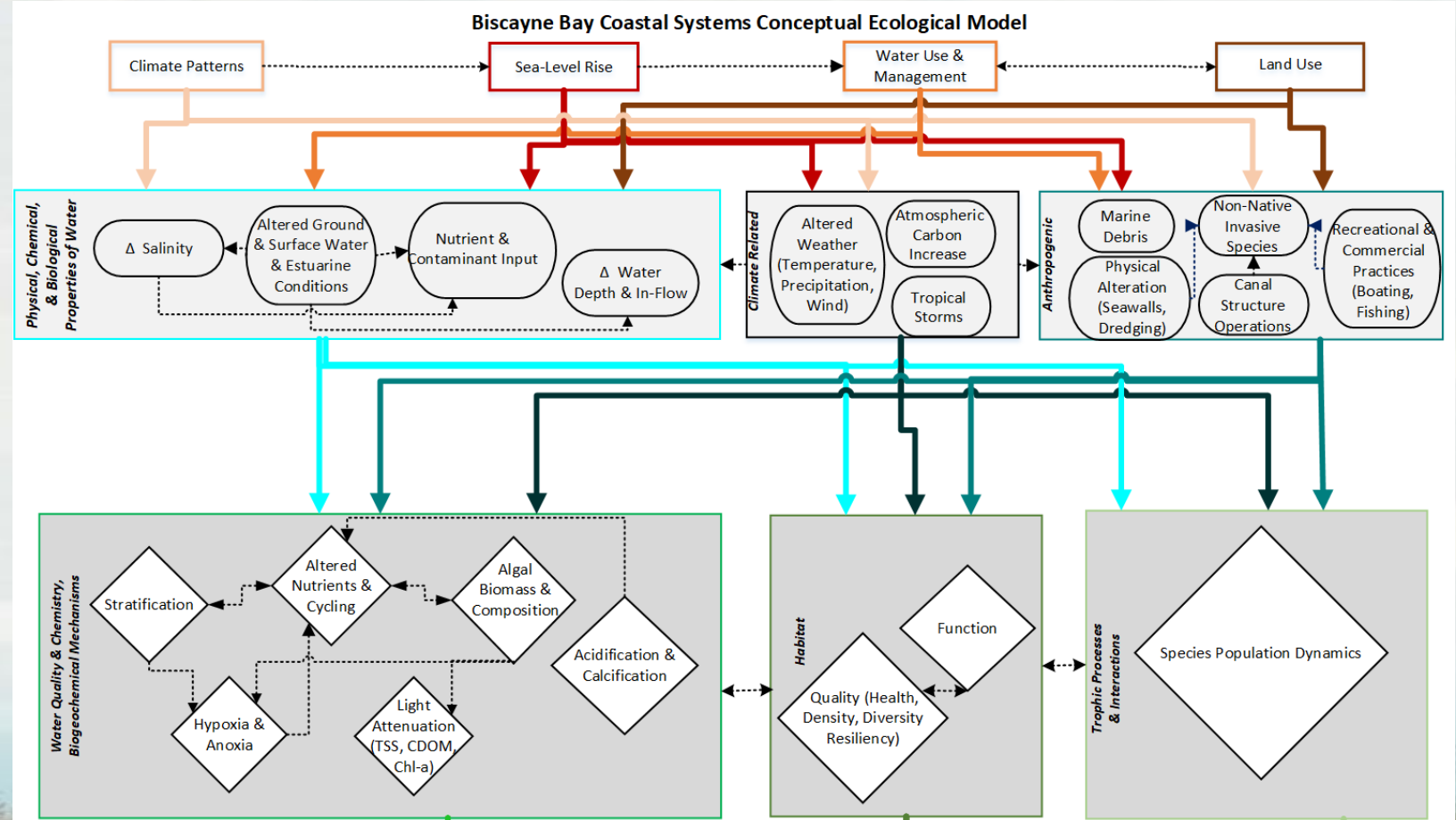
Southern Coastal Systems-Biscayne Bay CEM

- Attributes
- Measurable

Biscayne Bay Coastal Systems Conceptual Ecological Model
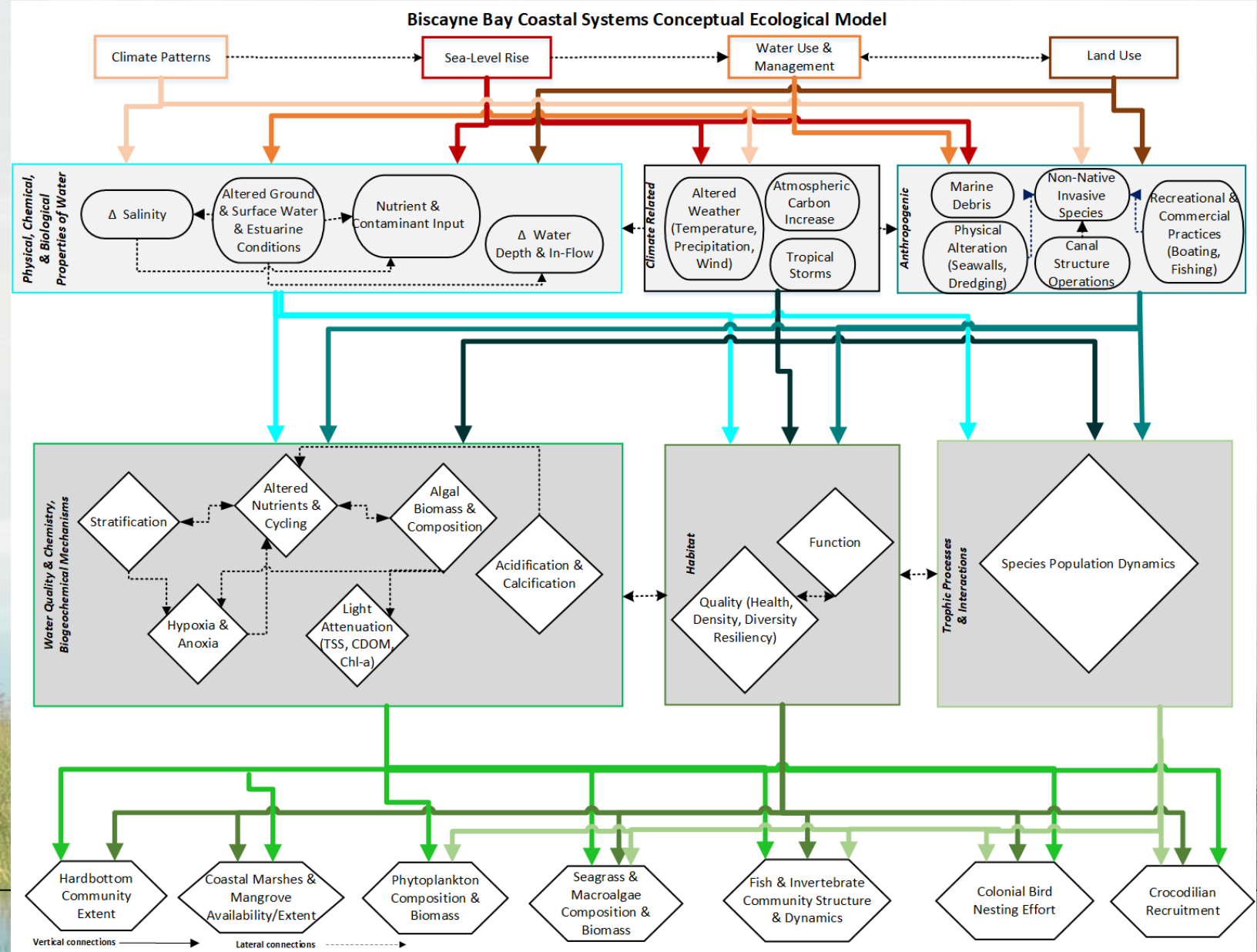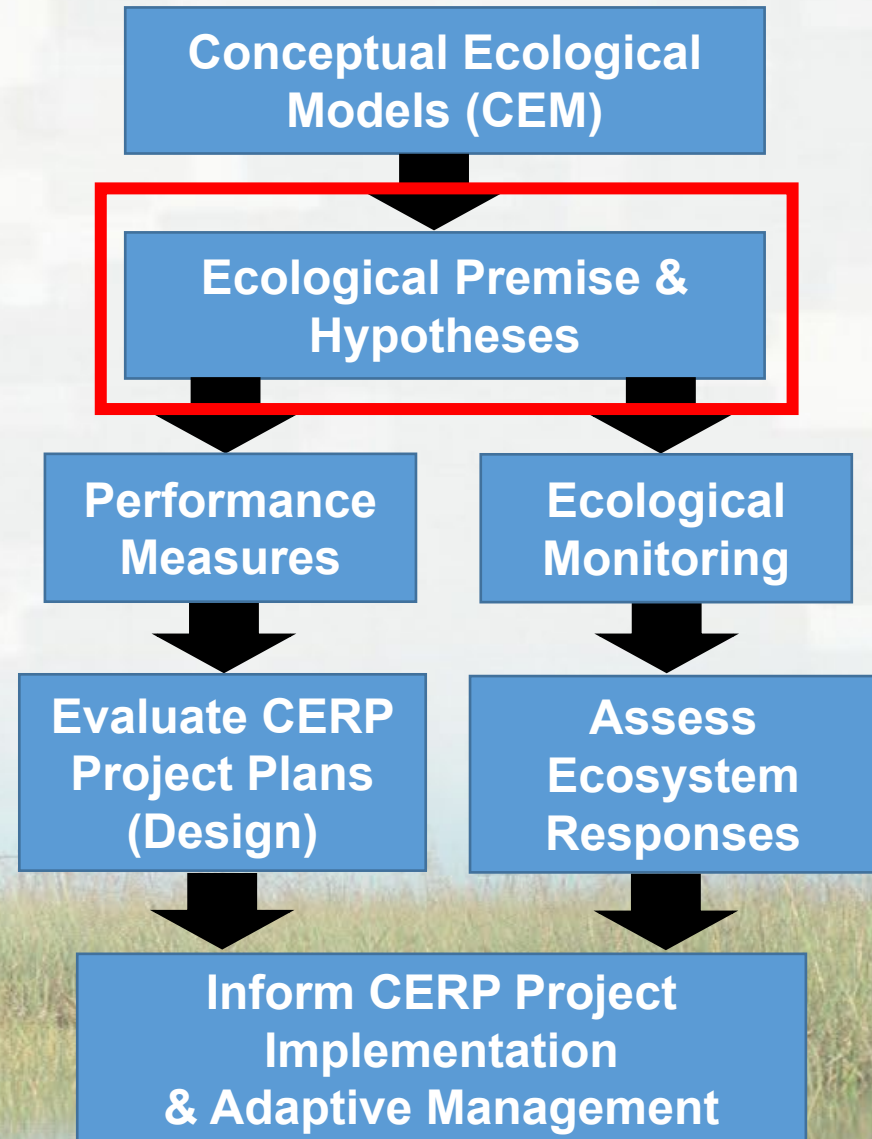
RECOVER Science Strategy

Hypothesis Clusters

- Address the integration of stressor-response relationships of the system

- Provide refinement in types and numbers of performance measures and metrics
  - ► Linked to monitoring components

- Identify monitoring/research needs and plan the design of restoration programs

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│ Conceptual Ecological   │
│    Models (CEM)         │
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│ Ecological Premise &    │
│    Hypotheses           │
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│Evaluate   │  │  Assess   │
│CERP       │  │Ecosystem  │
│Project    │  │Responses  │
│Plans      │  │           │
│(Design)   │  │           │
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│ Inform CERP Project     │
│ Implementation          │
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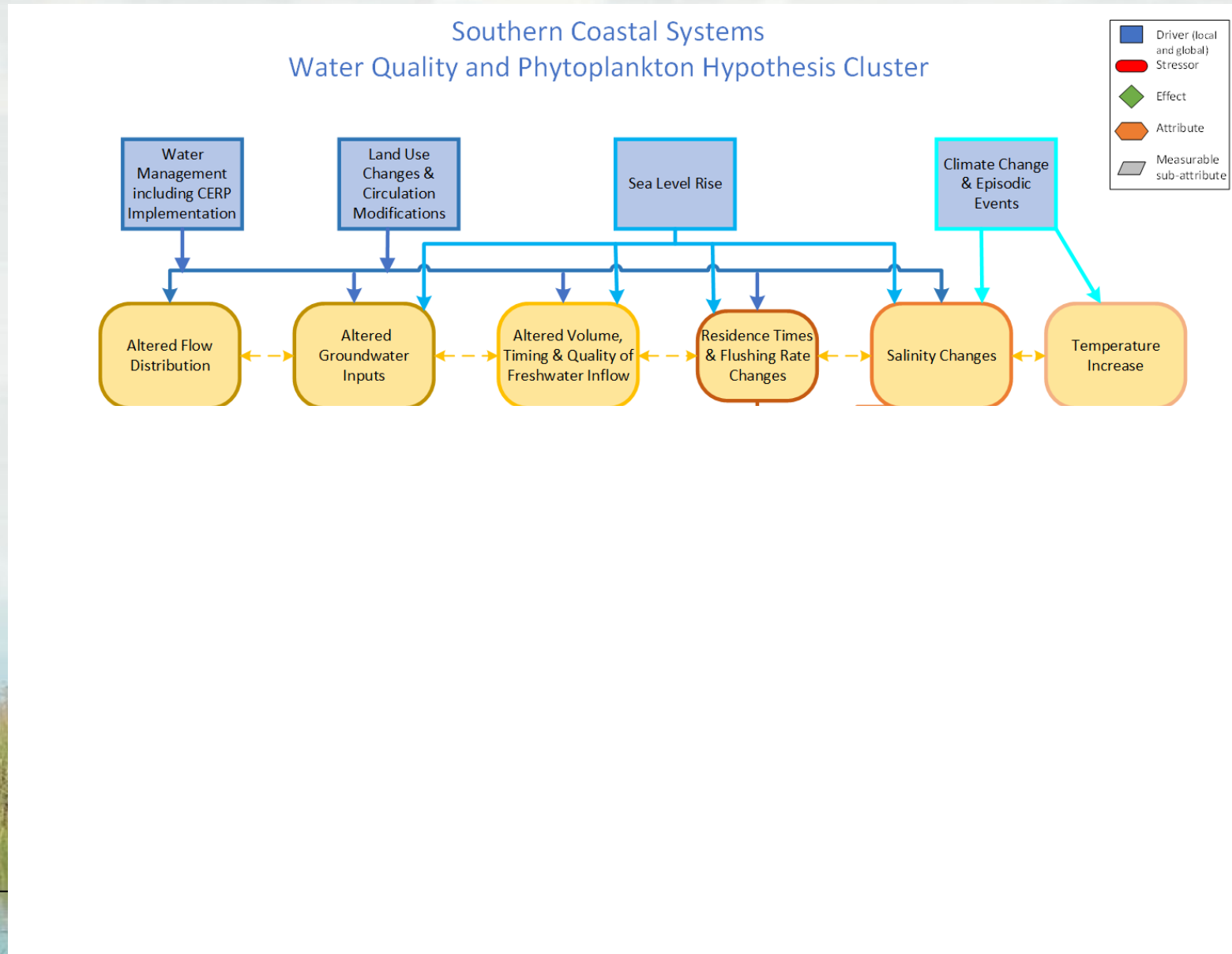
Southern Coastal Systems-Hypothesis Clusters

- Created with Subject Matter Experts (SMEs)

- Same format as CEMs- uses Basic Format (Non-Grouped)

- Topics in SCS– mostly from CEM Effects

  - *Water Quality & Phytoplankton*

  - Salinity

  - Submerged Aquation Vegetation

  - Native Vegetation Mosaic

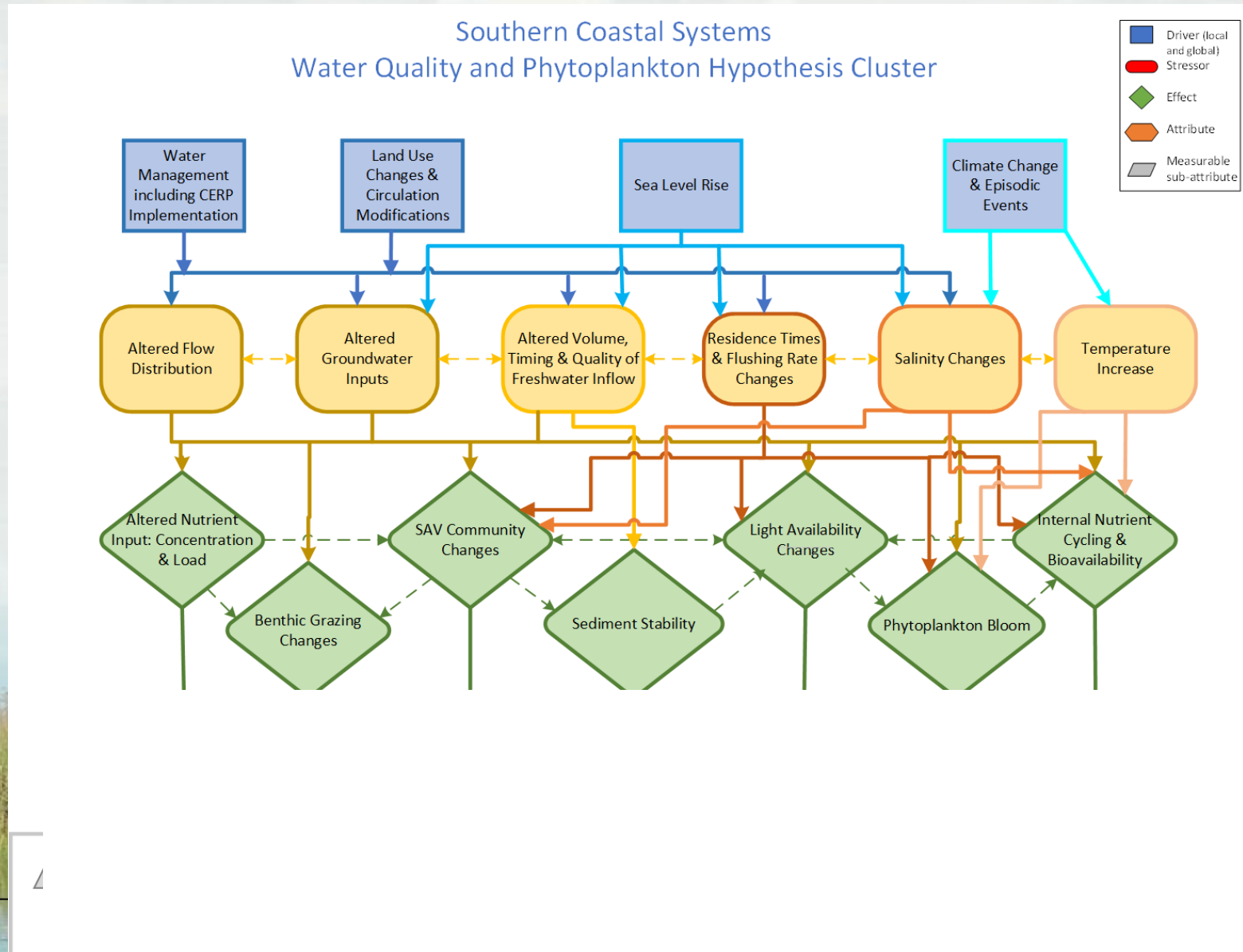 - Estuarine Nursery Habitat

  - Predator-Prey Interactions

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Southern Coastal Systems-Hypothesis Cluster

- SCS Water Quality & Phytoplankton

- Same Drivers as CEMs

- Non-Grouped

Southern Coastal Systems- Hypothesis Cluster

- SCS Water Quality & Phytoplankton

- Same Drivers as CEMs

- Non-Grouped

- Specify stressors, effects

Southern Coastal Systems-Hypothesis Cluster

- SCS Water Quality & Phytoplankton

- Same Drivers as CEMs

- Non-Grouped

- Specify stressors, effects and attributes
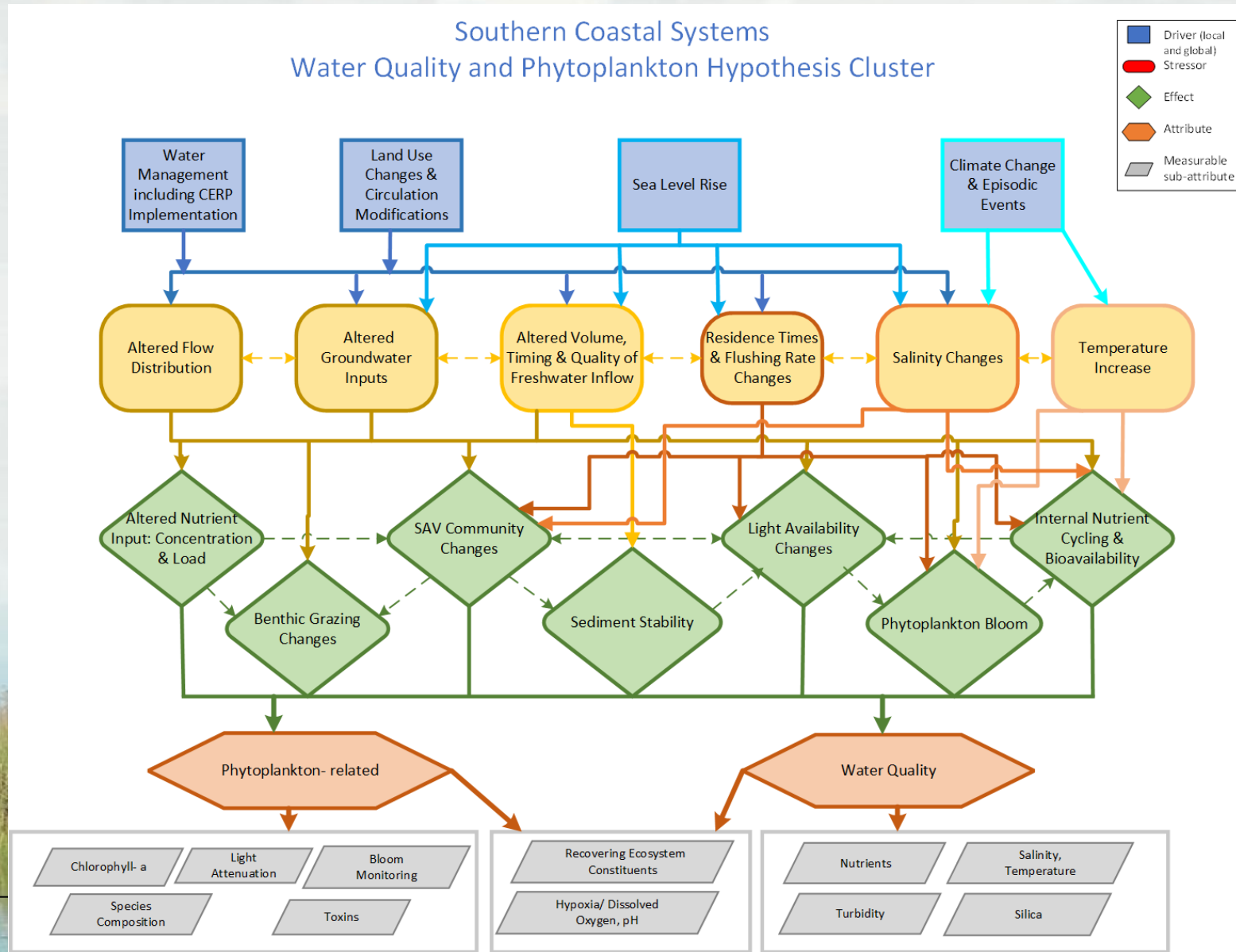
Conceptual Ecological Models and Hypothesis Clusters

- Diagrams illustrate interactions and elements in a simplistic way

- Detailed narrative necessary to support each element and interaction

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RECOVER
assessment
science
evaluation
integration
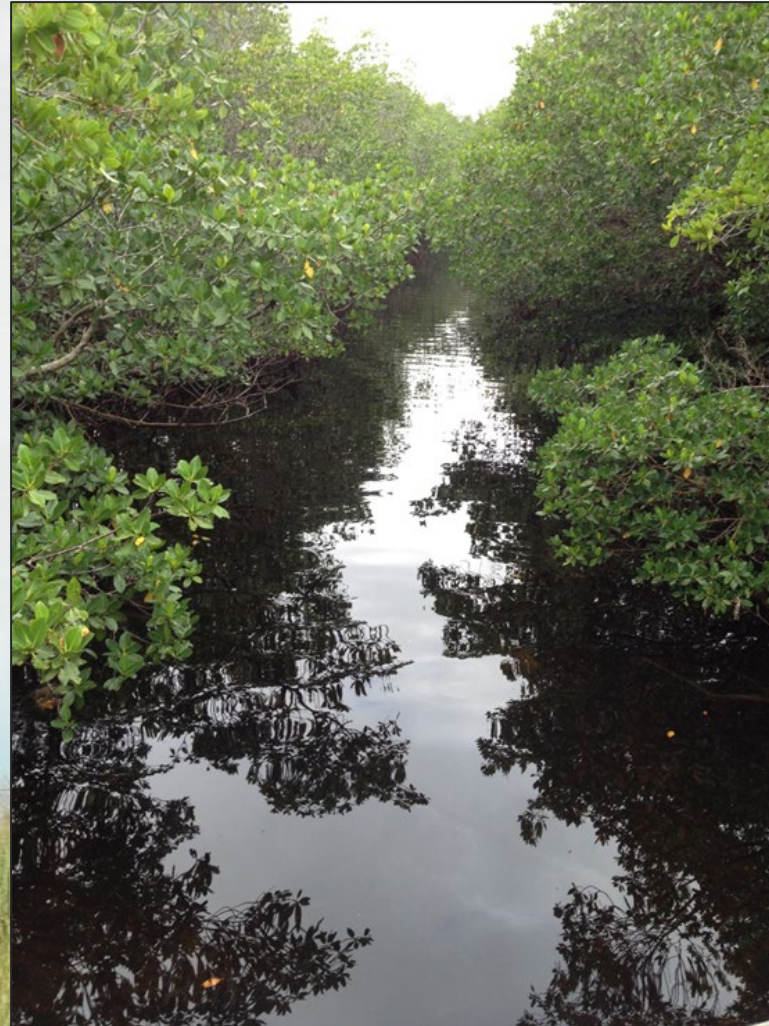
Changes in Science and Knowledge
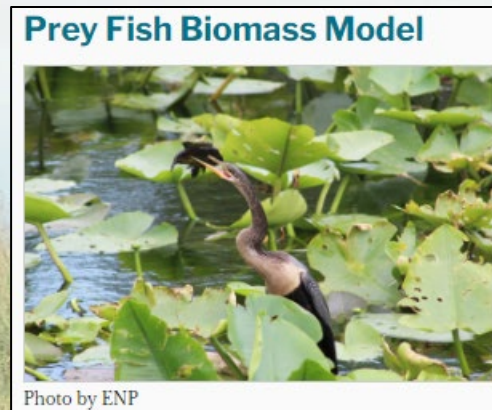
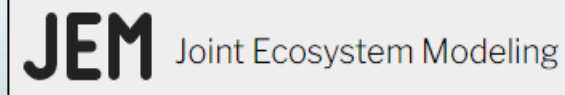Periodic updates necessary for CEMs and HCs

- Team of subject-matter experts

- Evaluate current knowledge
    - Changes occurring in the systems – natural and anthropogenic

- Develop guiding questions for hypothesis cluster

- Evaluate established hypotheses and key uncertainties
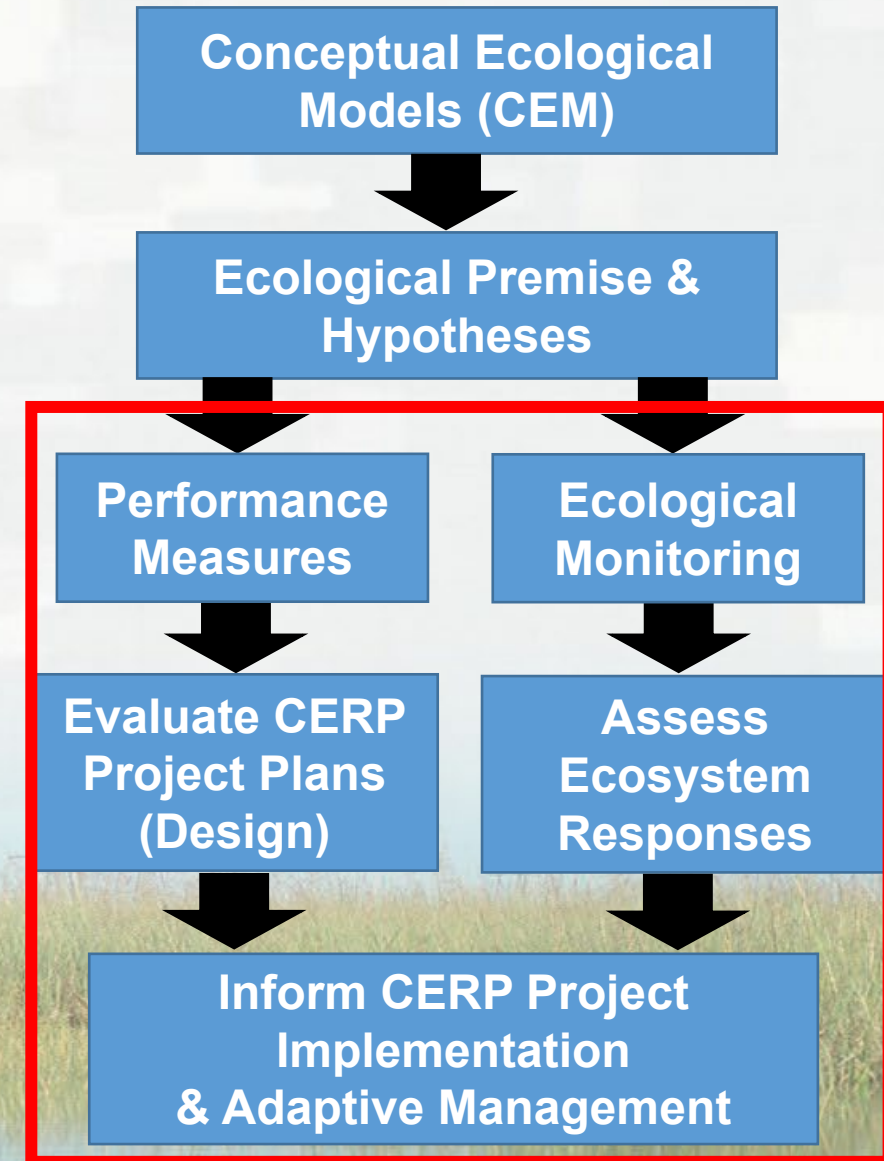
Thank you

Southern Coastal Systems Regional Coordinators:

Stephanie Verhulst – USACE
Stephanie.A.Verhulst@usace.army.mil

Melody Hunt – NPS
Melody_Hunt@nps.gov

Carlos Coronado – SFWMD
ccoron@sfwmd.gov

Agenda Item #6 RECOVER CEMs