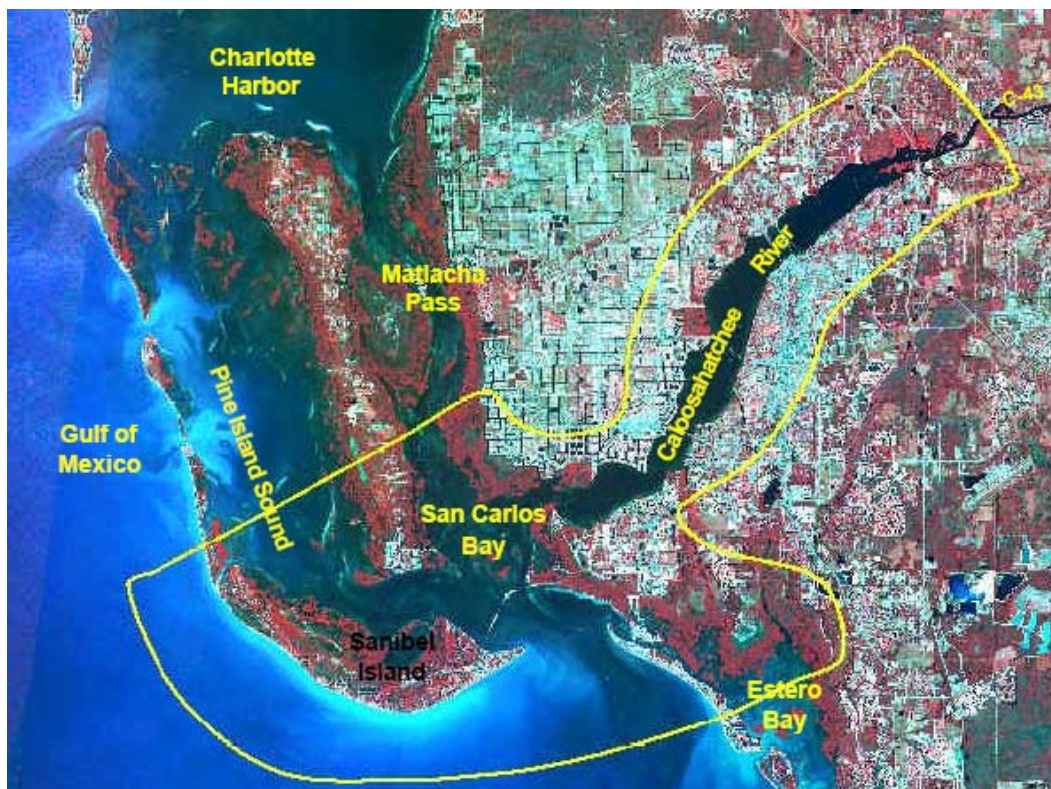


## 10.0 Northern Estuaries CERP-Specific Conceptual Models and Performance Measures

The Northern Estuaries region includes Caloosahatchee, St. Lucie and Loxahatchee Estuaries, and Lake Worth and Indian River Lagoons. Caloosahatchee Estuary is located on the Gulf Coast (**Figure 10-1**), while the other estuaries are located on the Atlantic Coast (**Figure 10-2**). The final draft of the *Monitoring and Assessment Plan (MAP), Part 2, 2006 Assessment Strategy for the MAP* (RECOVER 2006), referred to as the Assessment Strategy, presents four CERP-specific conceptual ecological models for Northern Estuaries. These models provide a visual description of causal pathways described in hypotheses clusters. Clusters reflect major attributes of estuarine systems expected to be affected by CERP: oyster, fish, submerged aquatic vegetation (SAV) and benthic infaunal community.

The following sections briefly summarize descriptive text for hypotheses clusters and present conceptual ecological model diagrams along with how performance measures relate to them. Application of performance measures during evaluation (planning) and assessment processes, including the hypothesis-based approach, are discussed in more detail in Section 2. Full discussions of hypotheses clusters from the draft Assessment Strategy can be accessed from the CERP System-wide Performance Measures web page: [http://www.evergladesplan.org/pm/recover/recover\\_docs/et/060507\\_pm\\_report/hypothesis\\_clusters\\_ne.pdf](http://www.evergladesplan.org/pm/recover/recover_docs/et/060507_pm_report/hypothesis_clusters_ne.pdf).



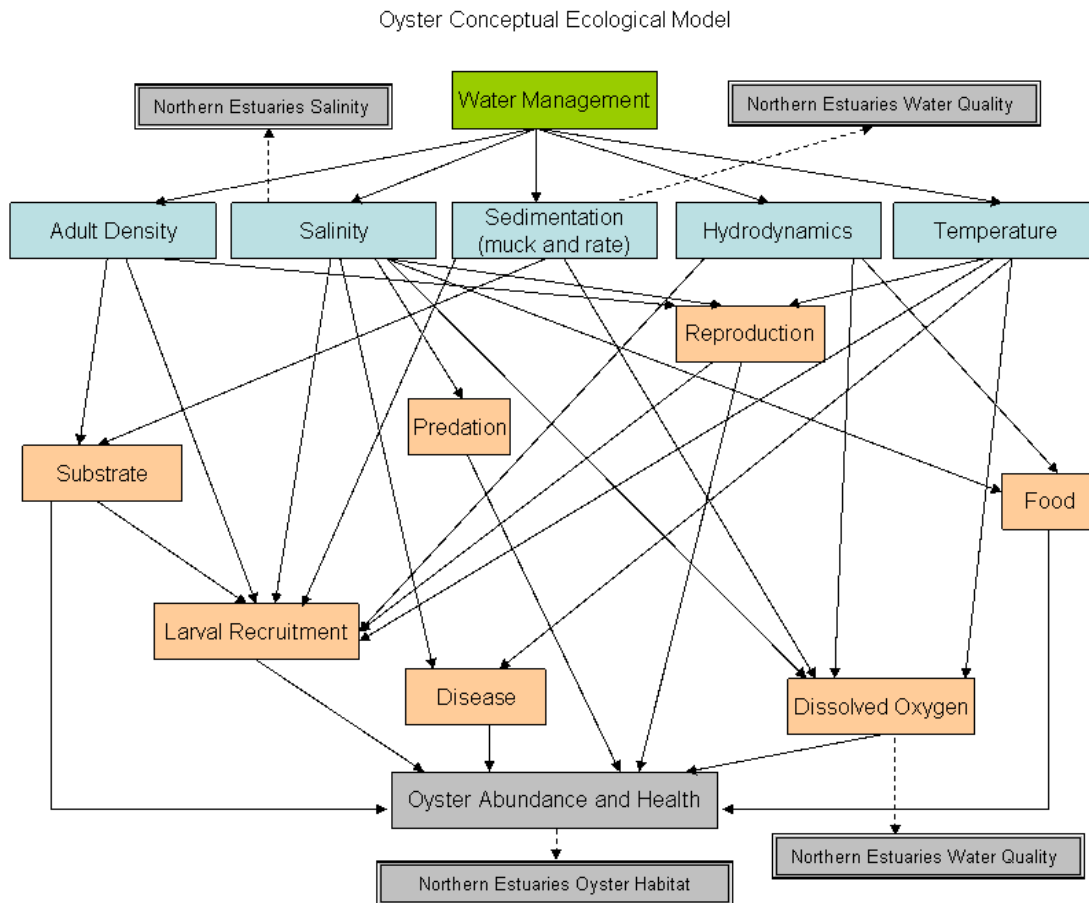
**Figure 10-1. Northern Estuaries Module boundary along the Gulf Coast**



Figure 10-2. Northern Estuaries Module boundaries along the Atlantic Coast

## 10.2 Oyster

Reduction in oyster coverage within Northern Estuaries is largely due to altered freshwater inflow and changes in hydrodynamics resulting from water management practices (**Figure 10-3**). These changes have altered salinity and led to sedimentation. Water management practices release significant volumes of fresh water over a short period of time into estuaries resulting in a sudden drop in salinity. This sudden drop can lead to significant oyster mortality, decreased growth, reproduction and spat recruitment. Also, undesirable shifts in the estuarine salinity envelope can result in increased susceptibility to disease.



**Figure 10-3. Oyster Conceptual Ecological Model with associated performance measures**

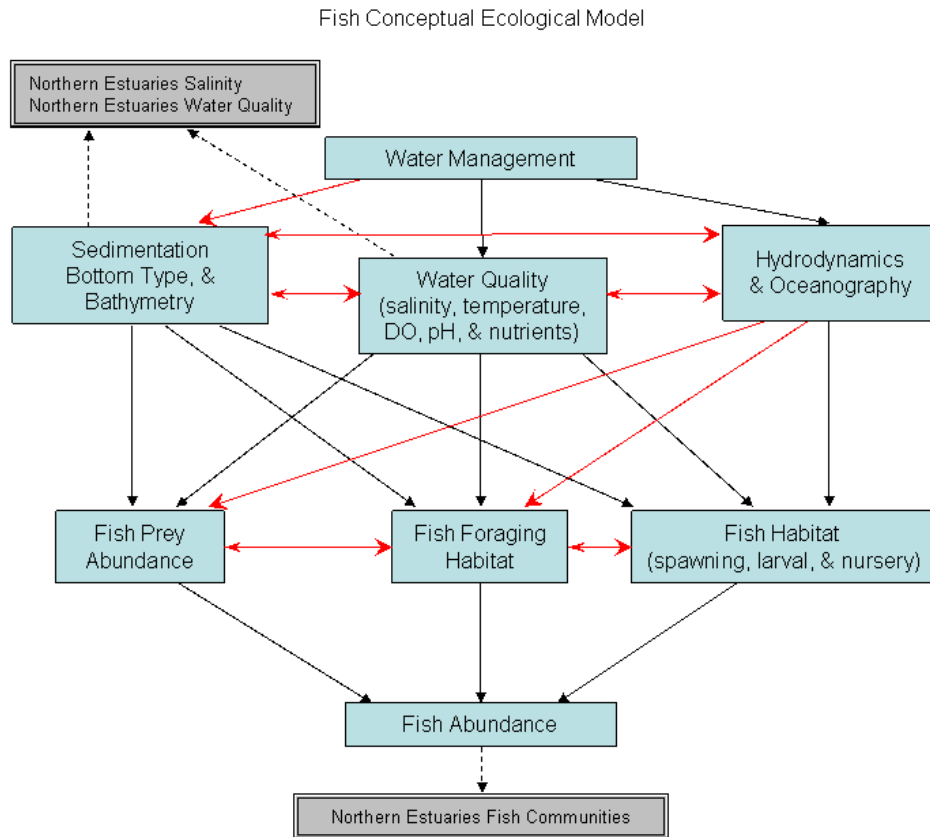
In addition to altering salinity, freshwater inflow carries sediments with silt, clay and high organic content and result in increased transport of floating aquatics, which then degrade and contribute to muck accumulation rate. Muck accumulation makes substrate unsuitable for oyster larval recruitment and growth. Deposition of sediment on oyster shells also makes them unsuitable for spat settlement. In addition, muck accumulation muck may also impact dissolved oxygen content making the area unsuitable for larval

settlement and growth. Suspended solids may clog adult oyster gills and interfere with filtering and respiration resulting in decreased growth and health.

The Northern Estuaries Water Quality performance measure addresses water quality, including sedimentation and dissolved oxygen. A performance measure has been developed to track oyster habitat during and following CERP implementation

### 10.3 Fish

Fish communities within Northern Estuaries are negatively affected by changes in natural salinity regimes and sedimentation composition and rate as a result of water management practices (**Figure 10-4**). Timing and severity of salinity fluctuations affects reproduction and growth of fish and availability of habitat. Natural healthy soft sediments support diverse estuarine fish communities because benthic animal communities that thrive in soft sediments are a food source and provide habitat for estuarine fish. Healthy oyster bed habitat is essential for survival of oyster dwelling fish and, as discussed in the previous section, muck does not support oysters. SAV communities that serve as fish habitat are also affected by salinity regime.



**Figure 10-4. Fish Conceptual Ecological Model with associated performance measures**

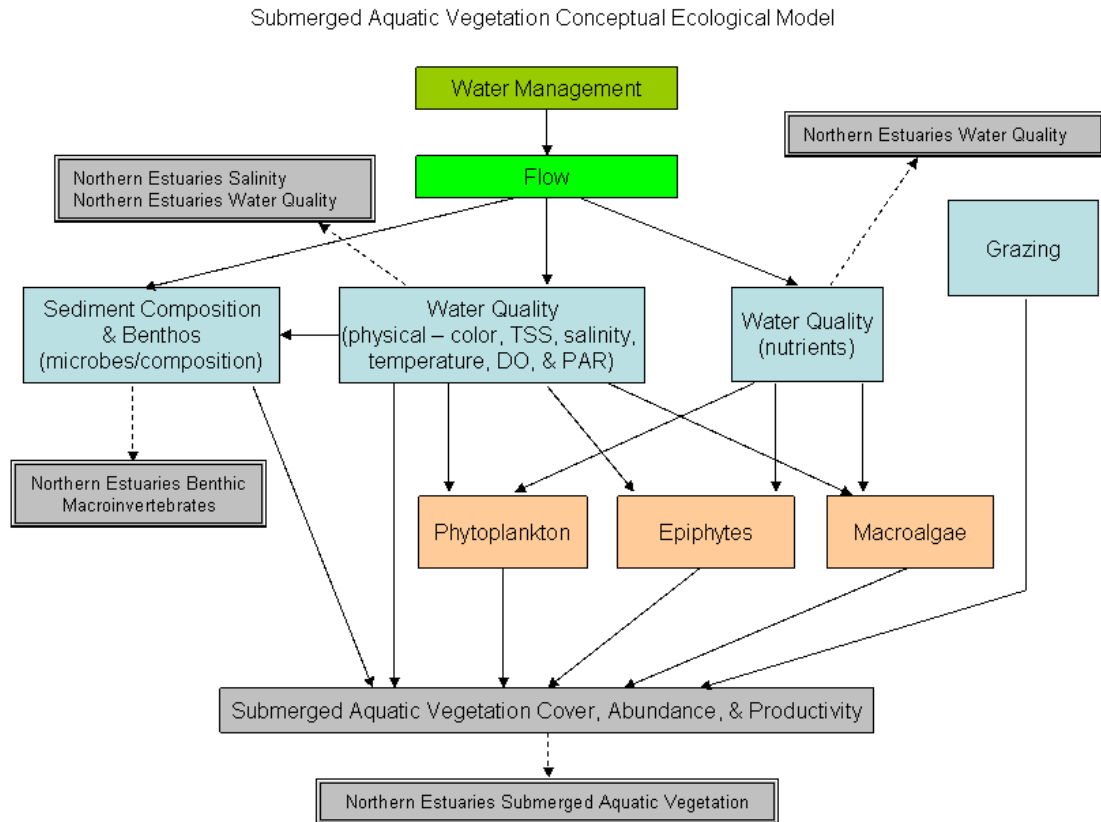
Hydrodynamics and oceanography also affect fish habitat. Sediment deposition and distribution is directly associated with stream configuration and topography, flow dynamics, water depth, and stream bank location and proximity, thus directly influencing fish species associated with shallow marginal sediment deposits.

CERP implementation should result in more natural freshwater flows to Northern Estuaries, resulting in fewer fluctuations in salinity and less muck accumulation, which is expected to benefit fish communities. Performance measures have been developed to measure response of salinity and water quality (including sedimentation) stressors and the fish community attribute to CERP implementation.

#### **10.4 Submerged Aquatic Vegetation**

Water management practices have altered natural flow of fresh water into Northern Estuaries (**Figure 10-5**) resulting in changes to salinity regimes, sediment composition, and water quality, which negatively affect SAV. Extreme fluctuations in estuarine salinity have resulted in large decreases in spatial extent and changes in SAV species composition. Large deposits of muck have displaced normal sandy substrate and altered sediment characteristics contributing to decreased extent of SAV beds. Increased nutrients, dissolved organic matter, and turbidity increase phytoplankton levels and water color, which decreases the amount of light that penetrates the water column, decreasing photosynthetically-active radiation (PAR) at SAV blades. PAR is further reduced by increased epiphyte growth caused by increased nutrient availability and/or decreased grazing pressure.

CERP implementation is expected to provide more natural freshwater flows to Northern Estuaries, reducing stresses caused by changes to salinity regime, water quality and water clarity that are negatively affecting SAV. Performance measures have been developed for salinity and water quality stressors. Water quality indicators include water clarity and nutrient loads and concentrations. A SAV performance measure has also been developed. These performance measures will track response of these stressors and attribute to CERP implementation.

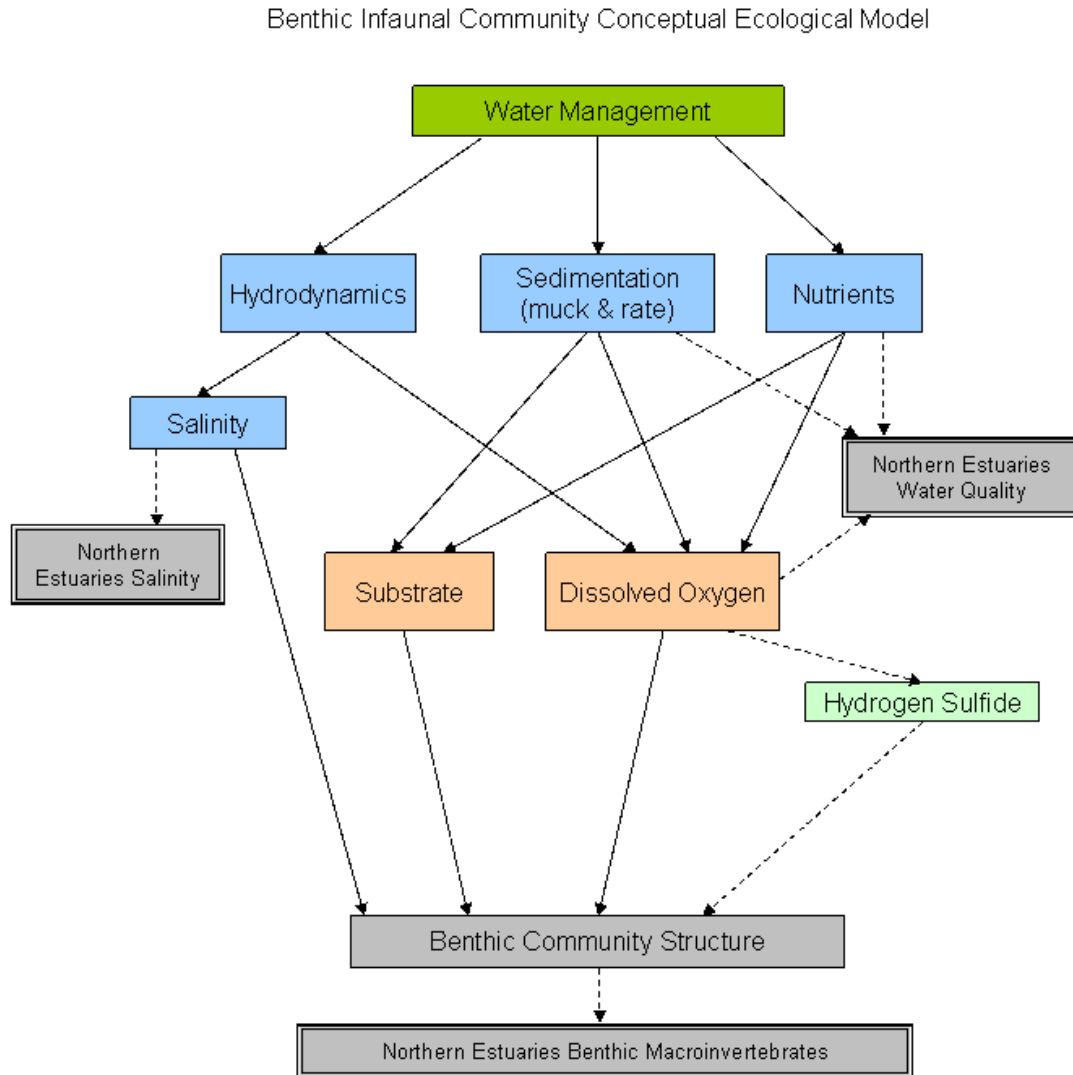


**Figure 10-5. SAV Conceptual Ecological Model with associated performance measures**

### 10.5 Benthic Infaunal Community

Benthic animals are directly or indirectly involved in most physical and chemical processes that occur in estuaries and are a very important food source for many fish and bird species. Northern Estuaries benthic communities have been negatively affected by alterations in salinity regimes, sedimentation type and rate, and dissolved oxygen levels caused by water management practices (**Figure 10-6**). Regulatory releases from Lake Okeechobee lead to sudden and dramatic drops in salinity, preventing establishment of a diverse and healthy estuarine benthic infaunal community. These releases result in wide-scale deposition of muck, which inhibits infaunal species establishment. Also, widespread muck deposition has depressed dissolved oxygen concentrations and increased sulfide concentrations. Such hypoxic, anoxic and/or toxic conditions result in mortality of benthic communities and prevent larval recruitment.

CERP implementation is expected to provide more natural freshwater flows to Northern Estuaries, reducing stresses caused by changes to salinity regime, sedimentation and dissolved oxygen levels that are negatively affecting benthic communities. Performance measures have been developed for salinity, water quality (including sedimentation and dissolved oxygen levels) and benthic macroinvertebrates.



**Figure 10-6. Benthic Infaunal Community Conceptual Ecological Model with associated performance measures**

### 10.6 Northern Estuaries Performance Measures

CERP System-wide performance measures that relate to Northern Estuaries are as follows:

- Northern Estuaries Salinity
- Northern Estuaries Water Quality
- Northern Estuaries Oyster Habitat
- Northern Estuaries Benthic Macroinvertebrates

- Northern Estuaries Submerged Aquatic Vegetation
- Northern Estuaries Fish Communities

Documentation sheets can be accessed from the Northern Estuaries Performance Measure web page: [http://www.evergladesplan.org/pm/recover/perf\\_ne.aspx](http://www.evergladesplan.org/pm/recover/perf_ne.aspx).

## 10.7 References

RECOVER. 2006. Monitoring and Assessment Plan (MAP), Part 2, 2006 Assessment Strategy for the MAP, Final Draft. Restoration Coordination and Verification Program, c/o United States Army Corps of Engineers, Jacksonville District, Jacksonville, FL, and South Florida Water Management District, West Palm Beach, FL. December 2006.  
[http://www.evergladesplan.org/pm/recover/recover\\_map.aspx](http://www.evergladesplan.org/pm/recover/recover_map.aspx)