9.0 APPLICATION OF THE TECHNICAL ASSESSMENT GUIDANCE TO MODULES

The Module Groups have the primary responsibility for conducting CERP assessments. Consequently, acquainting the Module Groups with the assessment guidance process was an importance step to moving the guidance from concept and theory into actual practice. To accomplish this, the AT conducted a series of workshops with the Northern Estuaries, Greater Everglades, and Southern Estuaries Module Groups. The objectives of these workshops were to:

- Provide an overview of the Guidance process
- Explain the reporting requirements and schedules
- Review the current assessment hypotheses and relevancy to CERP
- Determine the basic types of data management resources needed to support the Module assessments
- Facilitate the communication and team-building process for each of the Modules.

The general format for these workshops included a review of the IAT guidance followed by a detailed examination of the MAP hypotheses. The current set of hypotheses are derived from the MAP and were subsequently re-examined to eliminate redundancy, identify opportunities to aggregate similar hypotheses, and ascertain whether the hypotheses remained valid and relevant to CERP restoration. Each Module Group selected an example hypothesis that represented a sub-model from the module CEM. This sub-model was then subjected to a detailed pathway analysis to identify the specific components and measures that were essential for assessing the status the hypothesis. Once the major components of the hypothesis were identified, the specific data needs were determined. This was followed by a preliminary data inventory to ascertain the need for MAP data, both MAP and non-MAP data, and/or data derived from specific experiments. Once completed, the Module Groups began the process of applying the Assessment Guidance.

Workshops provided a forum in which Module Groups convened as functioning units for conducting the CERP Assessments and developed a systematic strategy for the Module Groups to conduct MAP assessments using their own examples as the template. Initial assessment guidance for each Module is presented in the following sections and the following topics are addressed for each Module:

- Module background
- Monitoring project status
- Ecological models for specific hypothesis clusters
- Hypothesis cluster descriptions and graphics
- Sub-hypothesis descriptions where appropriate.

9.1 Northern Estuaries Module

9.1.1 Module Location Description and Background Information

The Northern Estuaries include the Caloosahatchee, St. Lucie, Loxahatchee, and Lake Worth Lagoon (Figures 9-1-1 and 9-1-2). Within Florida, nearly 70 percent of recreational and commercial fisheries species (i.e., oyster, pink shrimp, blue crab, gray snapper, red drum, snook, stripped mullet, and spotted sea trout) rely on estuaries for at least part of their life span. Major stressors currently impacting these estuaries include damaging freshwater inflows, degraded water quality, and habitat loss.

The Caloosahatchee Estuary is located on the southwest coast of Florida. Most of the freshwater flowing into the estuary comes from the Caloosahatchee River. Historically the Caloosahatchee River was a meandering system with numerous oxbows, flowing from its headwaters at Lake Hicpochee to the Gulf of Mexico (Figure 9-1-1). Activities that led to its degradation, beginning in the1890s, include channelization, connection to Lake Okeechobee, and construction of an extensive canal network associated with agricultural development in the watershed. The channelized portion of the Caloosahatchee River (C-43) the associated canal network have altered the timing, quantity, and direction of runoff in the watershed and led to abnormal salinity fluctuations. The tidally influenced portion of the estuary has been reduced by the operation of the S -79 control structure (Figure 9-1-2) which allows periodic large regulatory releases from Lake Okeechobee.

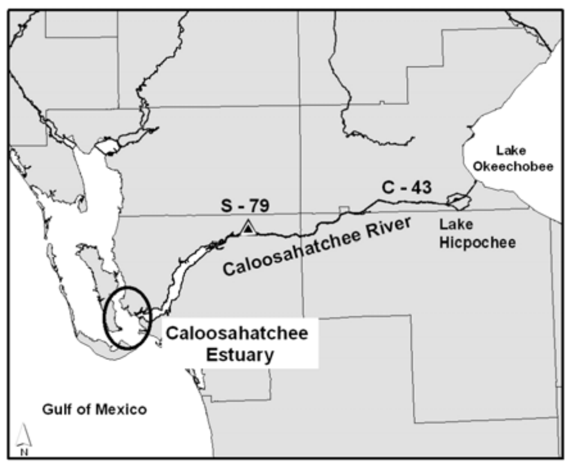

Figure 9-1-1: The Caloosahatchee estuary.

Prior to these impacts, the Caloosahatchee estuary was a highly productive system with an abundance of aquatic plants and animals. Today, the abundance, health, and functionality of these species have been greatly reduced. Submerged aquatic vegetation (SAV) and the eastern oyster (*Crassostrea virginica*), important components of the biological community, have been reduced from a widespread distribution to a sparse occurrence.

The St. Lucie Estuary (SLE), located on the southeast coast of Florida, flows into the Indian River Lagoon and the Atlantic Ocean. Historically, this estuary was a freshwater system influenced by ephemeral ocean inlets. When the St Lucie Inlet was permanently established in 1898, salinities increased and the system became estuarine, characterized by abundant mangroves, submerged oyster bars, and SAV.

Agricultural and urban drainage projects that began in the 1900s expanded the historic SLE watershed, to almost 775 square miles, almost three times its historic size. Major drainage canals constructed in the watershed include the C-23 and C-24 canals (Figure 9-2). The SLE is connected to Lake Okeechobee by the C-44 canal which is used for navigation and receives regulatory water releases from Lake Okeechobee. As a result, freshwater flow into the estuary tends to be excessive in the wet season and lower than normal in the dry season.

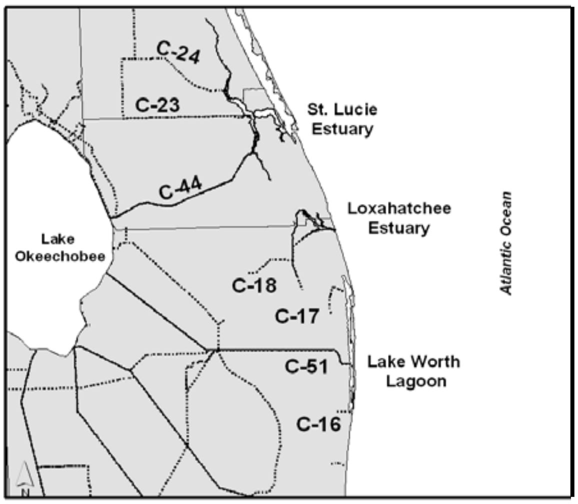

Figure 9-1-2: The St. Lucie, Loxahatchee, and Lake Worth Lagoon estuaries.

Thick deposits of mucky silt that cover large portions of the bottom of the SLE are unsuitable for SAV and oysters. These sediments also become resuspended by wind, current and boat traffic resulting in diminished light penetration in the water column and decreased light availability for SAV.

The Loxahatchee River is located on the southeast coast of Florida. The Loxahatchee Basin has been extensively altered by construction of canals, channelization of natural waterways, drainage and/or impoundment of wetlands, and stabilization of the Jupiter Inlet.

Construction of the C-18 canal disconnected the Northwest Fork from its headwaters Loxahatchee Slough (Figure 9-1-2). This has resulted in periodic shortages of water for the Northwest Fork and increased flows into the Southwest Fork during storm events. Saltwater intrusion upstream into the Northwest Fork has resulted in the loss of six river miles of cypress swamp and freshwater swamp and floodplain vegetation. The extent of oysters and seagrass beds is limited to smaller areas than they were historically.

Lake Worth Lagoon, located on the southeast coast of Florida, was historically a freshwater lake and receiving water from wetlands along its western edge. Creation of permanent inlets to the lagoon increased the tidal influence and the lake sifted to an estuarine lagoon. Cumulative impacts of human activities over the past 100 years have also altered the regionally important natural resources associated with the previously freshwater system. Changes affecting the hydrology include construction of major drainage canals (C-51, C-17, and C-16), shoreline bulkheads, a causeway, channels, and port development (Figure 9-1-2). Freshwater discharges from the C-51 canal produce excessive periodic releases of fresh water that adversely impact estuarine biological communities as well. A limited numbers of oysters remain in the lagoon and SAV populations are unhealthy and reduced in number.

Consequently, the three hypotheses clusters addressed in this section are:

- Oysters
- Fish
- Submerged aquatic vegetation (SAV)

9.1.2 Status of Monitoring Program in the Northern Estuaries

The table presented here is a list of existing monitoring program and components and their status in the northern estuaries.

Table 9-1-1: Monitoring Components and Key Uncertainties and Supporting Research for the Northern Estuaries.

Monitoring Components	MAP Section	STATUS
Salinity Monitoring Network	3.3.3.1	On-going
Water Quality and Phytoplankton Monitoring Network	3.3.3.2	Partially implemented
SAV Mapping from Aerial Photography	3.3.3.3	Underway in all but LWL
SAV Monitoring for Caloosahatchee Estuary	3.3.3.4	
SAV Transects/Visual Surveys for St. Lucie Estuary/Indian River Lagoon, Lake Worth Lagoon, and Loxahatchee River Estuary	3.3.3.5	
Oyster Monitoring Network	3.3.3.6	Underway
Juvenile Fish Community Monitoring Network (Caloosahatchee Estuary, St. Lucie Estuary/Indian River Lagoon)	3.3.3.7	Underway in Caloosahatchee, Pilot project underway in SLE/IRL with proposed FY06 start
Benthic Macroinvertebrate Monitoring (St. Lucie Estuary, Loxahatchee River Estuary)	3.3.3.8	Underway in SLE/IRL, planned FY06 start in Loxahatchee
Key Uncertainties and Supporting Research		
Reconnaissance Study of Caloosahatchee	3.3.4.1	Complete
Fish Health and Pathology in the St. Lucie Estuary	3.3.4.2	Underway
Bottlenose Dolphin Health Assessment in St. Lucie Estuary	3.3.4.3	No proposed start date
Manatee Abundance and Distribution Relative to Changes in Freshwater Flows and Seagrass Distribution as a Result of Implementation of CERP Projects	3.3.4.4	No proposed start date

9.1.3 Oyster Conceptual Ecological Model

The model below summarizes environmental interactions that are known to effect oyster health and abundance. Many of these parameters are currently being monitored and will be used in the assessment process based on the hypotheses listed below.

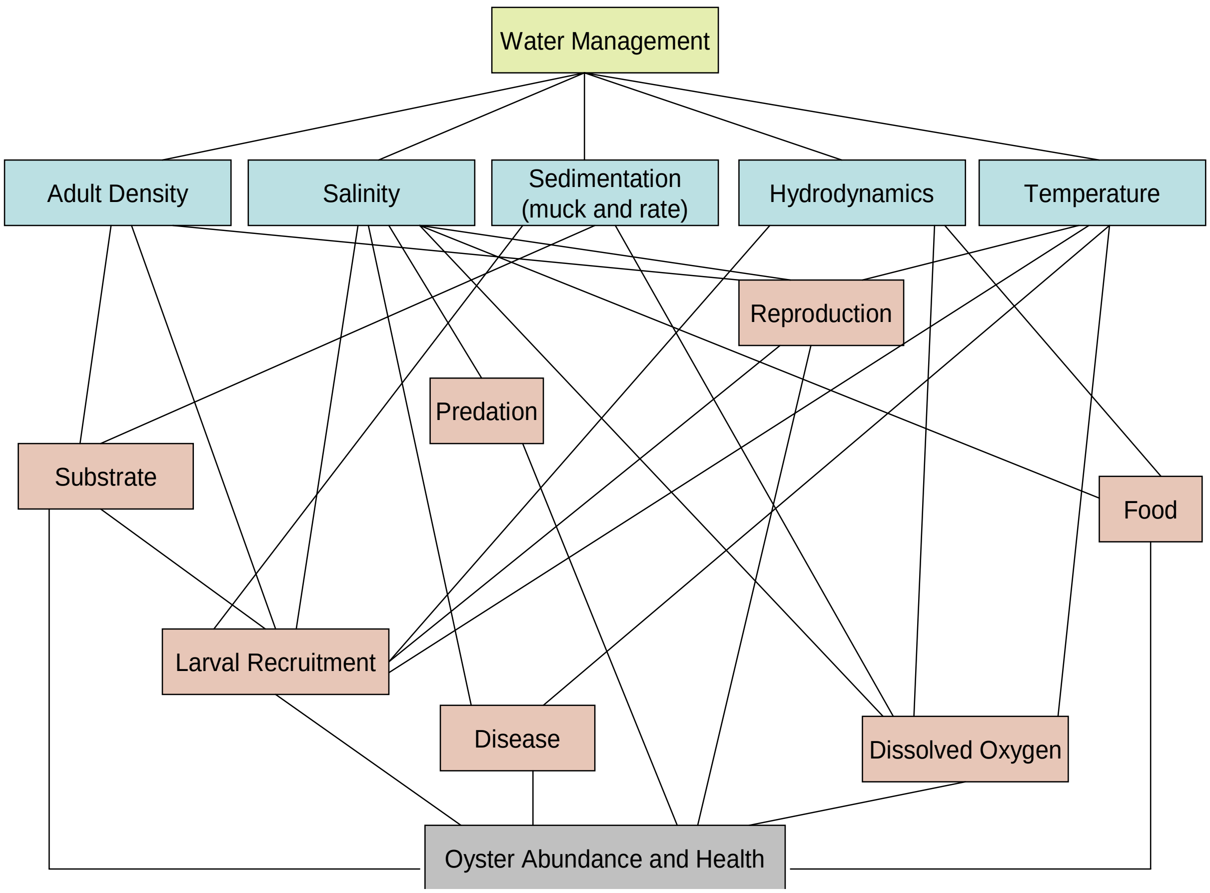

Figure 9-1-3: Oyster Conceptual Ecological Model

9.1.4 Oyster Hypotheses

Hypothesis 1
Undesirable shifts in the estuarine salinity envelope result in decreased survival, reproduction, spat recruitment, growth and increased susceptibility to predation and diseases such as *Perkinsus marinus* (DERMO) and *Haplosporidium nelsoni* (MSX) in the southeast estuaries oysters.

Rationale: Large rainfall events and subsequent watershed run-off, or large volume releases from Lake Okeechobee cause large volumes of freshwater over a short period of time to enter the estuary causing a sudden drop in salinity. This sudden drop can lead to significant mortality in the oyster population, changes in food type and availability and decreased growth, reproduction, and spat recruitment. Extreme droughts can also negatively impact oysters by making them prone to disease and predation.

Hypothesis 2
Accumulation of muck (high organic content depositional matter) on available substrate or nearby areas will make substrate unsuitable for oyster larval settlement and thus recruitment and growth of larval oysters. In addition, accumulation of muck may also impact the dissolved oxygen content making the area / substrate unsuitable for larval settlement and growth.

Rationale: Oyster recruitment is negatively effected by the accumulation of mucky sediments in the estuary. Muck is unsuitable substrate for spat settlement. Areas that once contained sand and/or shell have been covered by these very soft, unconsolidated sediments. Freshwater inflow carries sediments with silt, clay and high organic content. Freshwater inflow from canals can also result in an increase in the transport of floating aquatics, which then degrade and contribute to the rate of muck accumulation.

Hypothesis 3
Increased sediment loads in the water column impair respiration and feeding of oysters resulting in decreased growth and condition index or reproductive health of oysters. In addition, sediment accumulation on oyster shell negatively affects spat recruitment.

Rationale: Oyster populations are affected by increased sediment loads resulting from alterations to the natural hydrology. Adult oysters have effective morphological adaptations for feeding in much higher levels of suspended solids than are usually encountered under normal conditions. Oysters from relatively turbid estuaries appear to be capable of feeding at total suspended solid concentrations as high as 0.4 g/l but significantly reduce their pumping rates at concentrations as low as 0.1 g/l. Suspended solids may clog gills and interfere with filtering and respiration of oysters. Deposition of sediment on oyster shells also makes them unsuitable for spat settlement.

Hypothesis 4
Increase in oyster reef coverage will enhance secondary habitat for other estuarine species resulting in increased diversity and abundance.

Rationale: Oysters are natural components of South Florida estuaries and were documented to be abundant in the system. Although currently less abundant, they continue to be important. Reduction in oyster coverage was largely due to altered freshwater inflow, shell mining, and changes in hydrodynamics. This decrease has resulted in a loss of oyster reef community and the estuarine species that use this habitat.

9.1.5 Fish Conceptual Ecological Model

The model below summarizes environmental interactions that are known to effect fish abundance. Many of these parameters are currently being monitored and will be used in the assessment process based on the hypotheses listed below.

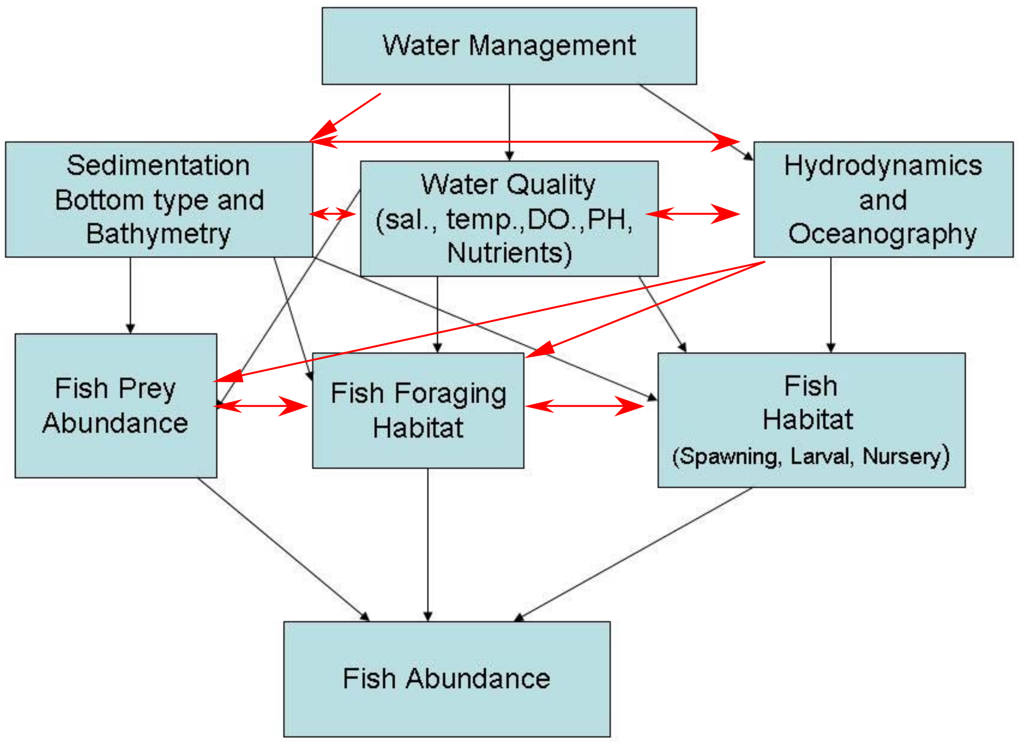

Figure 9-1-4: Fish Conceptual Ecological Model

9.1.6 Fish Hypotheses

The fish model ranks water quality parameter hypotheses in order based on their importance and value to fish physiology in a subtropical/tropical setting. This ranking is based on research results in northern estuary seagrass, mangrove and freshwater tributary studies. Relevant parameters are ranked as follows: 1- Dissolved oxygen; 2- Nutrients; 3 - Salinity; 4 - pH; 5 - Temperature.

Hypothesis 1
Dissolved oxygen levels within the northern estuaries will directly influence fish population dynamics within these estuaries.

Rationale: Dissolved oxygen. Tropical/subtropical systems are warm thus reducing the oxygen carrying capacity of water. Warm water systems often have high productivity if sufficient nutrients are present, thus often eutrophicating aquatic systems, increasing BOD. Since prolonged extreme (< 18 C) cold water periods are rare, particularly in the St. Lucie River system, primary production and detrital production occurs year round. This environmental condition is common throughout the world tropics. For this reason the indigenous tropical fish community shows physiological adaptations to low DO conditions. For instance: tarpon, gar, and mudfish are obligate air breathers; snook, bigmouth sleepers, fat sleepers, crested gobies, rivulus, mosquitofish, and tropical mullet species are facultative air breathers and surface water sippers, all capable of withstanding DO levels as low as 1.0 ppm or lower. Most temperate to warm temperate fishes, spotted seatrout, red drum, black drum, sand seatrout, and Atlantic toadfish apparently do not have the capability to withstand low oxygen conditions. This complex scenario with a complex indigenous fish fauna means that our studies of water quality impacts on fish populations will have to be examined at the species level.

Hypothesis 2

Nutrient concentrations in the Northern Estuaries are directly associated with fish health and mortality in these estuaries.

Rationale: Nutrients. It is apparent from resent observations over the past 30 yrs that plankton and harmful algal blooms (HABs) fed by nutrient loading have had substantial impacts on fish health and survival in the northern estuaries. The list of impacted species continues to grow annually to the point that no species can be left out of this analysis. Initially 1970's observations indicated that mullet were most likely to be impacted by HABs. We assume that nutrient levels, water turbulence and sediment resuspension produce conditions that are favorable for algal blooms. Nutrient levels can have substantial impact on HAB production and primary production levels in general, thus increase BOD/system eutrophication and decrease dissolved oxygen.

Hypothesis 3

Rapid and substantial water salinity changes as a result of water management and at levels not typically observed under natural dry season conditions will have a significant deleterious effect on stenohaline fish egg/larval, juvenile survival at northern estuary spawning and nursery sites.

Rationale: Salinity. Since larval fish and eggs require specific salinity conditions for survival and fish spawning sites are located within the Northern Estuaries. There is a direct relationship between freshwater flow and quantity, ambient salinities, and potential egg/larval survival. There is a very species rich resident and migratory fish fauna that is distinctly marine, particularly on the Florida east coast, which is very sensitive to salinity change as larvae, juveniles and adults. Stenohaline larval stages and species use of the northern estuaries is directly associated with ambient water quality with salinity thought to be the most relevant. In contrast, many euryhaline members of the indigenous estuarine fish fauna of south Florida are notorious for not being reliant on specific salinity patterns. They have the capability as juveniles and adults, but not necessarily as eggs and larvae, to enter freshwater tributaries from the Ocean or Gulf with little or no acclimation. Species that show this marine-freshwater migratory pattern are snook, tarpon, bull sharks, sheepshead, striped mullet, various gobies and gray snapper.

Hypothesis 4
Maintenance of water pH levels above 5.0, and near neutral, 7 - 8.0 in the Northern Estuaries is beneficial to fish survival, health and mortality in these estuaries.

Rationale: pH: There is little information on pH effects on Florida fish physiology other than major fish mortalities documented in association with phosphate-gypsum storage mound leaks into the Peace River and Alafia River in recent decades. Extremely low pH levels (< 3.0) are lethal. We do not believe pH will be a problem in the northern estuaries. Florida freshwater tributaries typically contain large enough concentrations of carbonates that the water appears to be buffered. Sulfides in mangrove swamps and backwater sloughs may reduce both DO and pH in localized areas.

Hypothesis 5
Water management impacts on ambient water temperature do not show a direct correlation with fish population dynamics, life history, survival and mortality in the northern estuaries.

Rationale: Temperature: Since there is apparently very little ambient water temperature change in the northern estuaries associated with water management, water temperature is predicted to not be of much concern. However, it is recognized that there is a very distinct biogeographic difference between the Gulf and Atlantic estuarine fish faunas principally due to very different ambient water temperature regimes and ocean current patterns associated with both coastal systems (Caloosahatchee River/Charlotte Harbor: @ 250 fish species versus St. Lucie River/Indian River Lagoon: @ 500 fish species). Because of this, a stenothermic tropical fish fauna is found in the St. Lucie ecosystem that is not present in the Caloosahatchee ecosystem. Due to the endemism of these species within the St. Lucie/Indian River Lagoon systems relative to the United States as a whole, many of these east coast fish species have been of concern for listing as rare, endangered and threatened species by regional and national biologists over the past 30 years.

Hypothesis 6
Water flow rates and volumes within the St. Lucie and Caloosahatchee estuaries have a direct influence on fish population dynamics, distribution and migration within these estuaries.

Rationale: Arrows have been added from the “Hydrodynamics and Oceanography” box in the Fish Conceptual Ecological Model box connecting these physical conditions to the “Fish Prey” and “Fish Foraging” boxes as hydrodynamics and oceanography (water level, bathymetry, tides, winds, current flow rates) have direct influence on fish population dynamics, distribution, migration and survival. This is particularly true for fish eggs and larvae.

Hypothesis 7
Changes in the salinity envelope in the northern estuaries will not have a detrimental effect if they mimic natural climatically driven salinity regimes (e.g., wet season vs. dry season), and if salinity shifts are more gradual and extreme rapid changes are avoided.

Rationale: Estuarine populations of stenohaline fishes are most sensitive to atypical salinity regimes as either larvae (spotted seatrout), juveniles (tropical reef fish: yellowtail, lane and mutton snapper) or adults (spawning spotted seatrout and common snook). Therefore the timing and severity of salinity fluctuations becomes an important factor in reproduction and growth. Euryhaline fish populations that often associate with oligohaline habitats show a positive association with increased freshwater flows relative to food availability (e.g., feeding adult common snook).

Hypothesis 8
Soft sediments that occur naturally in estuarine systems support healthy estuarine fish communities while excessive anthropogenically accelerated accumulations of anoxic muck can have a negative influence on the community.

Rationale: Soft sediment (mud) fish communities have a positive association with healthy fine sediments, mud and their benthic animal communities as a food source (primarily gerreids, mugilids and engraulids) and habitat source (gobioid fishes). Benthic soft sediment invertebrate communities support the largest biomass component of indigenous St. Lucie/Loxahatchee River fish communities. In contrast, abiotic fine sediments ("muck") do not support this same soft sediment (mud) fish community and can create a bottom devoid of life often accompanied by anoxic conditions.

Hypothesis 9
Riverine and estuarine sediment composition and dynamics dictates recruitment success in centropomids, gerreids, and gobioids dependent on the northern estuaries.

Rationale: Sediment deposition and distribution is directly associated with stream configuration (e.g., meander vs. straightened) and topography, flow dynamics, water depth and stream bank location and proximity, thus directly influencing the population status of fish species that associate with shallow marginal sediment deposits (centropomids, gerreids, and gobioids).

Hypothesis 10
Health oyster bed habitat is essential for the survival of oyster reef dwelling fish. Population dynamics in *Gobiosoma bosc* (Gobiidae) is influenced by: (1) oyster reef structure; (2) live vs. dead oyster reef structure; (3) age and degradation/deterioration of oyster reef systems.

Rationale: *Gobiosoma bosc* plays a major trophic role in northern estuaries due to its numerical dominance of riverine ichthyoplankton and as the major vertebrate species directly associated with oyster reefs as critical habitat, feeding and spawning sites.

G*obiosoma bosc* is a major prey item for planktivorous fishes, chaetognaths, ctenophora, and as an adult prey for juvenile gray snapper *Lutjanus griseus*.

Hypothesis 11

Populations of juvenile reef fish (lutjanids, serranids, scorpeanids, gobiids, blenniids and labrisomids) that are dependent on estuarine seagrass and nearshore hardbottom show a positive relationship with salinity, ex. higher densities at higher salinities,

Rationale: Spawning populations of seagrass and reef associated marine/ mesohaline/ polyhaline fish species are most affected by atypical (aseasonal) reduced salinities during their spawning period. Life history, growth and mortality of marine/ mesohaline/ polyhaline seasgrass/reef associated fish species are negatively influenced by atypical and/or aseasonal reduced salinities which occur both from the overly ditched and drained watershed as well as from Lake Okeechobee discharges.

Hypothesis 12

Healthy freshwater emergent herbaceous vegetation is directly related to oligohaline fish populations.

Rationale: Population dynamics, distribution and survival in syngnathids (opossum pipefish, *Microphis brachyurus lineatus*), eleotrids (fat sleeper, *Dormitator maculatus*; spinycheek sleeper, *Eleotris pisonis*), poeciliids and centrarchids are influenced by freshwater emergent vegetation species distribution quantity and vegetative structure. The ability to obtain and maintain a healthy freshwater emergent vegetation zone depends on being able to avoid large fluxuations in salinity in the riverine portions that feed into the main estuary.

9.1.7 Submerged Aquatic Vegetation Conceptual Model

The model below summarizes environmental interactions that are known to affect the cover, abundance and productivity of submerged aquatic vegetation. Many of these parameters are currently being monitored and will be used in the assessment process based on the hypotheses listed below.

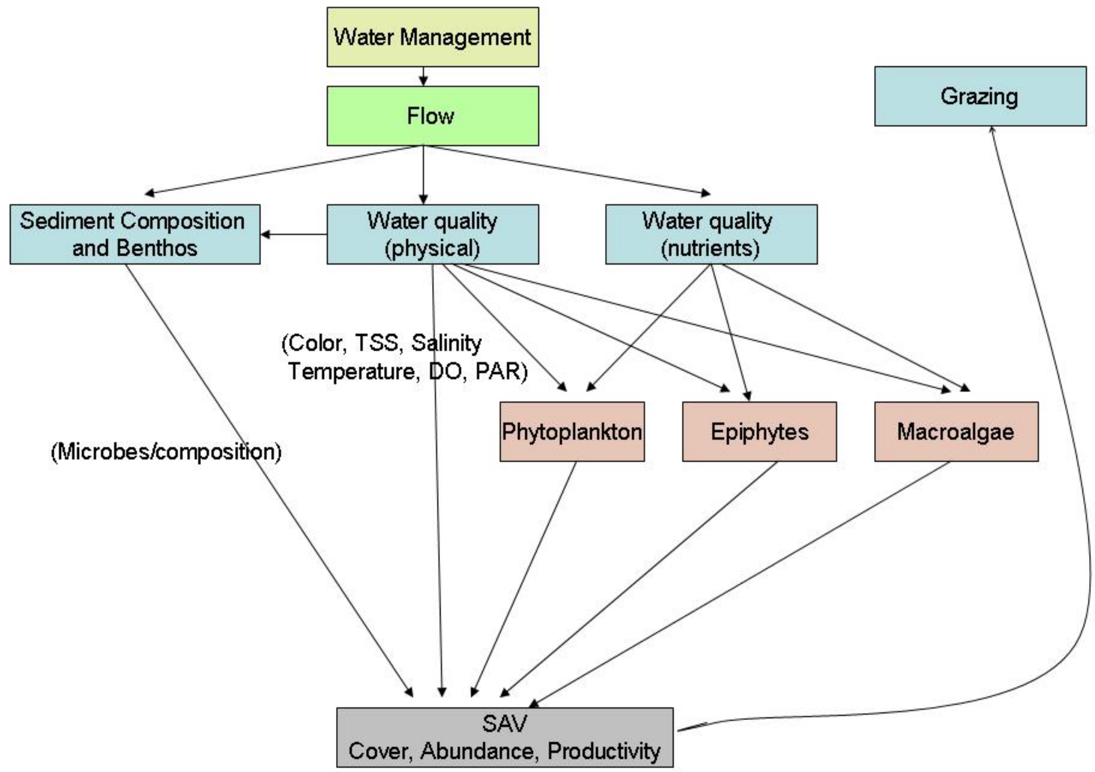

Figure 9-1-5: Submerged Aquatic Vegetation Conceptual Ecological Model

9.1.8 SAV Hypotheses

Hypothesis 1
Extreme fluctuations in estuarine salinity resulting from hydrologic alterations, water management practices, and sea level rise have had a negative effect on SAV function and have resulted in large decreases in spatial extent of SAV in the Northern Estuaries.

Rationale: Species composition and density of SAV communities are directly linked to the mean salinity and the variation around the mean at any given location. In the upper estuary, the naturally occurring submerged grass species, *Vallisneria americana,* will not survive prolonged periods of elevated salinity that occur as a result of manipulated freshwater flow. *Halodule wrightii* persists in areas with high variation in salinity. *Thalassia testudinum* and *Syringodium filiforme* will not tolerate prolonged periods of reduced salinity as a result of freshwater discharges from the local basin or Lake Okeechobee, and persist in areas with relatively low variation in salinity.

Hypothesis 2
Large deposits of organic, fine silt, and clay materials, i.e., muck, have displaced normal sandy substrate in the Northern Estuaries, thereby contributing to the decrease in extent of SAV beds.

Rationale: Sediment characteristics (e.g. nutrients, oxygen, microbial communities) are important to SAV survival; these characteristics will be altered by the increased deposition of fine silts and organic matter. Fast growing SAV (e.g. *Halodule wrightii*) requires higher nutrient levels in the sediment, than slower growing forms (e.g. *Thalassia testudinum*). Anoxic sediment will lead to sulphide intrusion in SAV rhizomes leading to die-back. Microbial communities are important to the biochemical reactions occurring around the SAV rhizomes.

Hypothesis 3
Input of increased levels of nutrients, dissolved organic matter and turbidity affect SAV abundance and health by increasing phytoplankton levels and water color, which in turn decreases the amount of light that penetrates the water column to become available to SAV.

Rationale: Sediment loads (turbidity), color and chlorophyll increase light attenuation which is directly correlated to decreased depth distribution and shoot density of SAV. Seagrasses require more light than macro-algae or phytoplankton, therefore decreased light (increased light attenuation) will reduce the ability of seagrass to compete with these other species. *Halodule wrightii* and *Syringodium filiforme* require less light than *Thalassia testudinum*, therefore a prolonged increase in light attenuation will lead to a shift in species composition. Sulphide toxicity occurs as a result of increased light attenuation and a decreased ability for plants to photosynthesize and oxygenate the sediments surrounding the rhizomes.

Hypothesis 4
Negative changes in SAV community structure and function along with changes in the natural salinity regime have resulted in a decrease in larval and adult fish recruitment in the Northern Estuaries.

Rationale: There is a quantifiable relationship between fish and seagrass habitat that is influenced by ambient salinity regimes. Estuarine seagrass and nearshore hardbottom dependent populations of juvenile tropical reef fish (lutjanids, serranids, scorpeanids, gobiids, blenniids and labrisomids) show a positive relationship with salinity, e.g. higher densities at higher salinities. Extreme and rapid salinity fluctuations degrade SAV habitat that many estuarine dependant fish rely on for spawning, nursery and foraging habitat.

Hypothesis 5
Increased epiphyte growth can be caused by both increases in available nutrients that accelerate growth and/or a decrease in grazing pressure.

Rationale: SAV losses have been associated with over-enrichment of estuarine waters, which stimulates growth of epiphytes, resulting in reduction of photosynthetically active radiation (PAR) at the SAV blades. Herbivorous grazing on epiphytes can partially relieve SAV growth inhibition at moderate nutrient loading rates but does not seem to significantly alter plant response at higher nutrient levels.

9.1.9 Benthic Infaunal Community Conceptual Ecological Model

The model below summarizes environmental interactions that are known to effect benthic community structure. Many of these parameters are currently being monitored and will be used in the assessment process based on the hypotheses listed below.

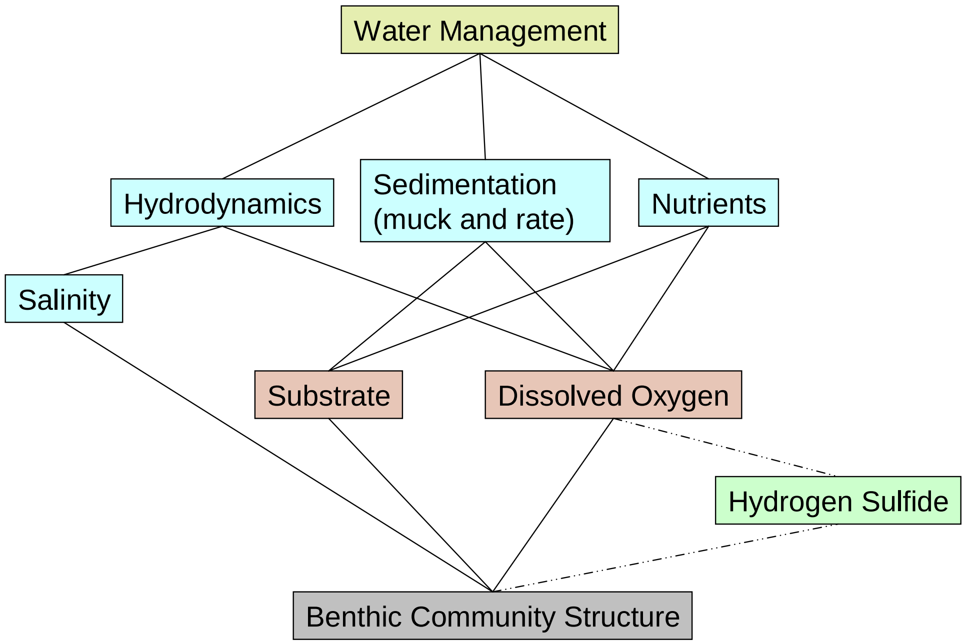

Figure 9-1-6: Benthic Infaunal Community Conceptual Ecological Model

9.1.10 Benthic Infaunal Community Hypotheses

Hypothesis 1
Irregular and extreme shifts in salinity in the St. Lucie Estuary prevent the establishment of a natural healthy estuarine infaunal community

***Rationale*:** In contrast to a natural estuary where the riverine input is relatively stable, and/or relatively predictable, throughout the year, resulting in a wedge-shape bottom layer of higher salinity (strong pycnocline), the irregular and massive freshwater releases from the primary SFWMD canals which drain the estuary's expanded basin and regulatory releases from Lake Okeechobee to both the Caloosahatchee and St. Lucie Estuaries lead to sudden and dramatic drops in salinity in the entire water column. These unstable conditions prevent the establishment of a diverse and healthy estuarine benthic infaunal community (a very important food source for many fish and bird species). Benthic animals are directly or indirectly involved in most physical and chemical processes that occur in estuaries, processes that will be disturbed by these salinity changes.

Hypothesis 2
The anthropogenically exacerbated accumulation of soft unconsolidated and strongly reducing sediments in the estuary inhibits the establishment of infaunal species resulting in an impoverished community characterized by low diversity and density.

***Rationale*:** Abiotic factors, such as sediment grain size and quality determine broad-scale benthic community patterns. Fine sediment deposits are a typical characteristic feature of most estuaries; however, wide scale predominance of fine sediments at the expense of other typical estuarine sediment types, as is present in the St. Lucie estuary, constitutes a patently man-induced geologic imbalance that is necessarily reflected in both the benthic community and the higher trophic level species which rely on the benthos.

Hypothesis 3
The frequent re-suspension of fine sediments in the St. Lucie Estuary severely impacts certain infaunal species important for the ecosystem stability.

***Rationale*:** Suspension feeders, such as many bivalves tend to predominate in sandier sediments. They feed and eliminate wastes by either pumping water through their burrows, where it is filtered out and pumped out, or by extending feeding structures above the bottom through which water is pumped and filtered. The increase in suspended sediments likely clogs the filtering apparatus of the suspension feeders, resulting in a community dominated by deposit feeders, i.e., a community not in balance among functional groups.

Hypothesis 4
Low oxygen concentrations, and at times significant concentrations of H_2S in the waters adjacent the bottom sediments often occurs resulting in mass mortality and prevents the settling of larvae, adversely affecting the infaunal communities.

***Rationale*:** As a result of the widespread deposition of typically strongly reducing fine unconsolidated sediments, bottom waters are likely to exhibit depressed oxygen concentrations, and in some events contain significant quantity of sulfide from decomposition processes occurring in the sediment. Such conditions may likely be extensive on occasions when temperatures are higher (during the summer) or when wind induced mixing is low. Low oxygen concentrations have also been associated with freshwater discharge (Stanley and Nixon 1992). Such hypoxic, anoxic, and/or toxic conditions result in mortality of the sessile benthic communities, which may be followed by a rapid establishment of opportunistic species. Overall these conditions result in a severe disturbance of the entire estuarine ecosystem.

Hypothesis 5
Increases in nutrient concentrations may directly or indirectly seriously impact benthic abundance, biomass, diversity and species composition.

Rationale: All benthic heterotrophs regenerate nutrients that can stimulate primary production. This primary production may be beneficial for some benthic animals (e.g. suspension feeders), but a high primary production caused by nutrient increases can often lead to lower oxygen concentrations near, and at the bottom. This may be devastating to a large number of infaunal species, and lead to higher relative abundances of species tolerant to low oxygen levels. This community will also usually wind up dominated by a few opportunistic (r-strategists) species. These species usually occur in large numbers, but with a very low diversity, and may impact other species (fish, large invertebrates) that are dependent on a diverse bottom community as the food source.

9.2 Greater Everglades Wetlands Module

9.2.1 Module Location Description and Background Information

The remaining portion of the Greater Everglades Wetlands includes a mosaic of inter-connected freshwater wetlands and estuaries (Figure 9.2.1). A ridge and slough system of patterned, freshwater peatlands extends throughout the Water Conservation Areas (WCAs) into Shark River Slough in Everglades National Park. The ridge and slough wetlands drain into tidal rivers that flow through mangrove estuaries into the Gulf of Mexico. Higher elevation wetlands that are characterized by marl substrates and exposed limestone bedrock flank either side of Shark River Slough. The marl prairies and rocky glades to the east of Shark River Slough include the drainage basin for Taylor Slough, which flows through an estuary of dwarf mangrove forests into northeast Florida Bay. The Everglades marshes merge with the forested wetlands of Big Cypress National Preserve to the west of WCA 3 and Everglades National Park. Also included in the Greater Everglades Wetlands are the Lake Okeechobee littoral zone and the hydric pinelands and seasonal wetlands of the J.W. Corbett/Pal Mar Wildlife Management Area.

The Greater Everglades Wetlands Module combines four conceptual ecological models:

1) Everglades Ridge and Slough
2) Everglades Southern Marl Prairies including the Taylor Slough basin
3) Everglades Mangrove Estuaries including the mangrove estuaries of Florida Bay and the Gulf of Mexico westward to Lostman's River
4) Big Cypress Basin eastern portions that will be influenced by the CERP

Major stressors currently impacting Greater Everglades Wetlands include disruption of sheet flow and associated hydropatterns, sea level rise, nutrient inputs and eutrophication, and non-native plants and animals. The Greater Everglades Wetlands Module includes five clusters of interrelated hypotheses:

- Integrated Hydrology And Water Quality
- Coastal Transgression, Tidal Channel Characteristics, Salinity Gradients, and Mangrove Forest Productivity
- Wetland Landscape and Plant Community Dynamics
- Predator-Prey Interactions of Wading Birds and Aquatic Fauna Forage Base