REstoration, COordination, VERification (RECOVER)

Southern Coastal Systems Hypothesis Clusters

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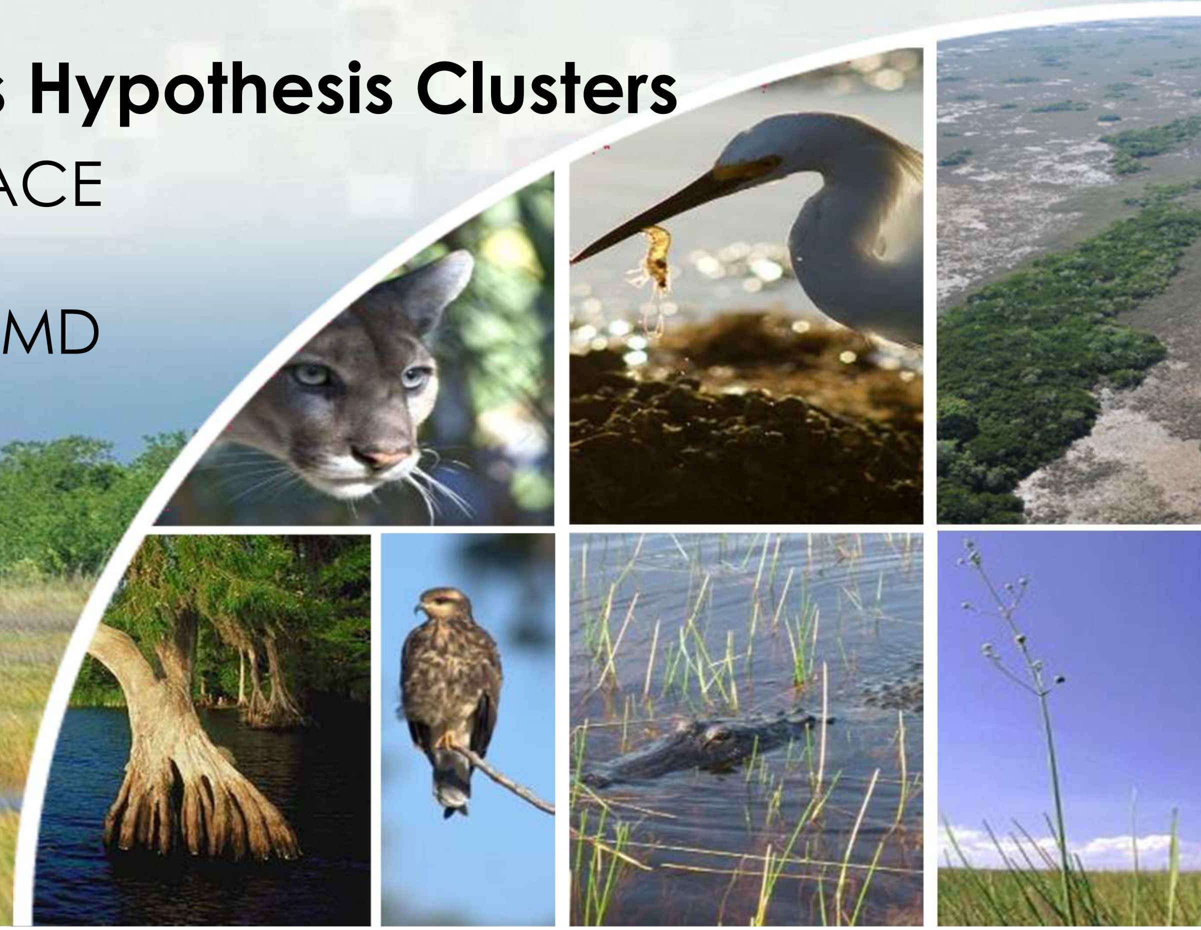
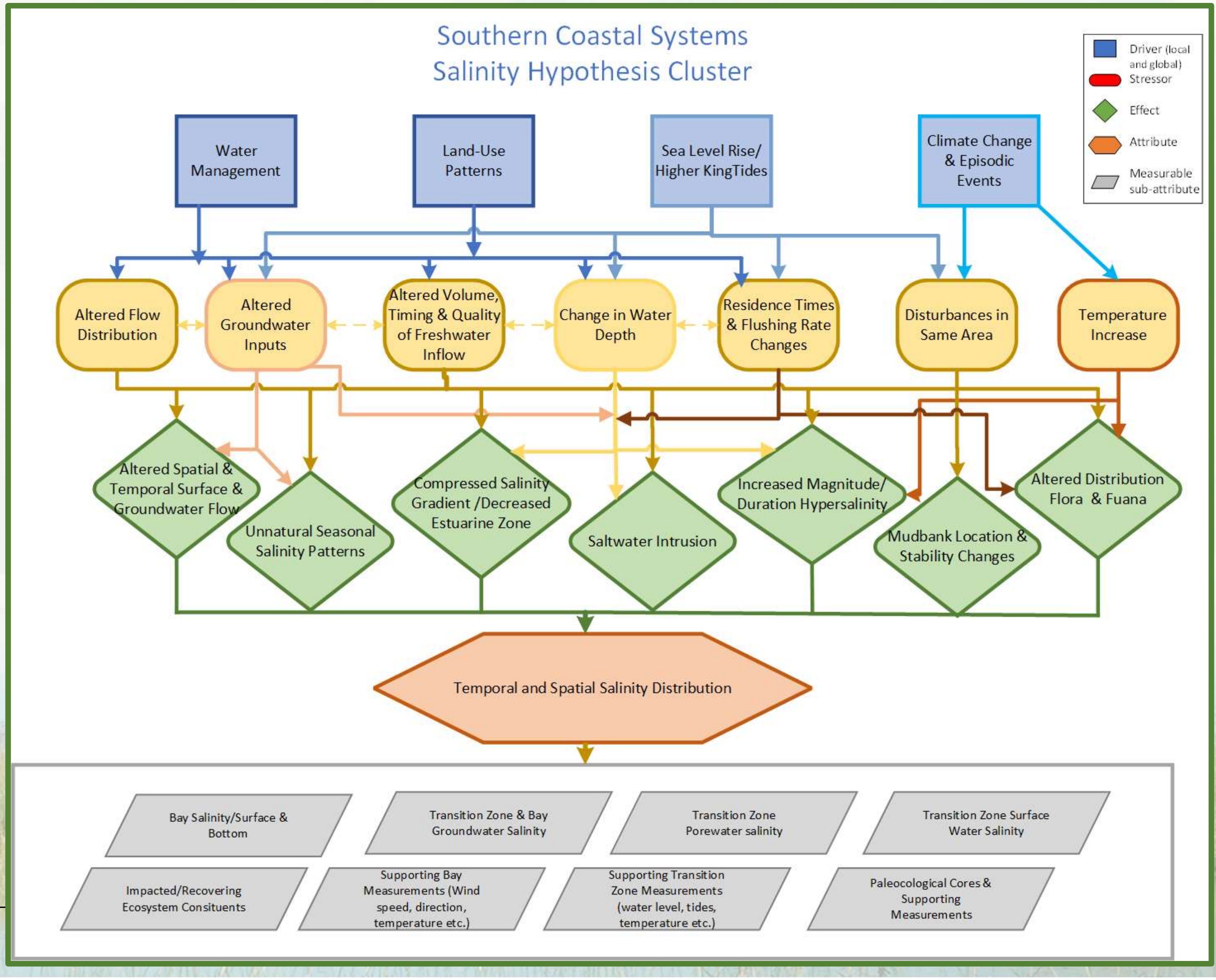


RECOVER Monitoring Workshop
July 19-20, 2023

SCS Salinity Hypothesis Cluster



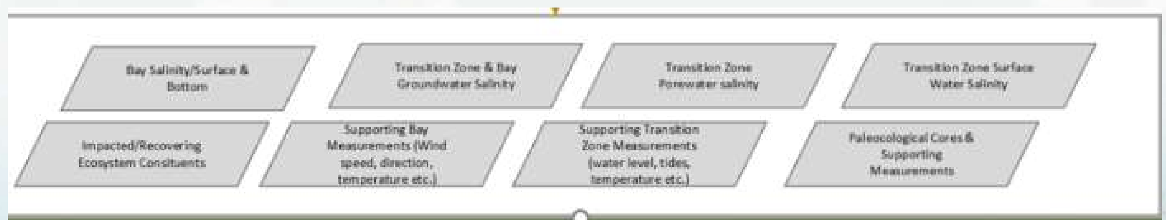
SCS Salinity Hypothesis Cluster Highlights

Working Hypotheses:

- Water Management: Flow redistributions will change salinity in coastal wetlands, mangroves, coastal waters. In areas where freshwater is increased, salinity will be reduced, and in areas where freshwater inflow is decreased, salinity will increase
- Land Use: This effect of land use is variable across the SCS but in general will have less effect than CERP implementation and CO2-driven climate change and sea-level rise in the long term.
- Sea Level Rise: Over a multi-decadal timescale, nearshore waters will experience greater exchange with oceanic marine waters as shallow banks and mangroves are inundated.
- Climate Change: An increase in temperature will increase evaporation which in turn will increase salinities, the effects will be enhanced in shallow areas and areas receiving limited freshwater inflow. Tropical storm disturbance may advance saltwater intrusion further inland, especially in areas with low elevations.

MAP Monitoring:

- Measurement of Temporal and Spatial Salinity and Supporting Measures



Key Uncertainty:

- Because of the low gradient and elevation of the coastal areas within the SCS, the overall resiliency of the SCS coastal environments and habitats to withstand sea level rise even with the increase in freshwater inflow is uncertain. The point at which additional freshwater will not be sufficient to overcome sea level rise and saltwater intrusion for the different regions of the SCS is not known.

SCS Salinity HC

Complete list of hypotheses for **Water Management and Land Use**:

Hypothesis 1. The implementation of restoration that affects freshwater delivery patterns will change salinity in coastal wetlands, mangrove, and estuarine waters within the SCS. In areas where freshwater is increased, salinity will be reduced, and in areas where freshwater inflow is decreased, salinity will increase.

Hypothesis 2. Restoring the distribution of freshwater flows to coastal wetlands will result in spatially and temporally diffuse surface and groundwater flow into the estuaries. This may produce a more natural salinity gradient from interior wetlands into the nearshore zone with a greater spatial extent of estuarine salinity zones and more gradual seasonal changes in salinity patterns (Swain and James, 2008).

Hypothesis 3. The addition of freshwater inflow will modify groundwater heads, surface water slope and resulting discharges in the coastal zone, which will alter estuarine salinity patterns in areas throughout the SCS. Maintaining a higher water table in southeastern Miami - Dade County will provide additional groundwater flow into Southern Biscayne Bay. This is especially relevant in the late wet season months and throughout the dry season to allow estuarine conditions to persist more naturally for a longer duration.

Hypothesis 4. Increased freshwater heads in Taylor Slough will lower salinity in Northeastern Florida Bay (Dessu et al., 2018; Marshall, Wingard, and Pitts, 2014).

Hypothesis 5. Increased freshwater heads in Shark River Slough will lower salinity in western Florida Bay and Cape Sable (Marshall, Wingard, and Pitts 2014)

SCS Salinity HC

Complete list of hypotheses for **Water Management and Land Use** (cont.):

Hypothesis 6. The implementation of restoration in coastal wetlands that improves the natural timing of freshwater inflow will improve hydroperiods in the coastal wetlands and salinity conditions within adjacent nearshore areas.

Hypothesis 7. In Biscayne Bay, reducing high-volume point source discharges from canals will reduce damaging high frequency and high magnitude salinity fluctuations in the nearshore area.

Hypothesis 8. Restoring the quantity, timing, and distribution of fresh water to the coastal areas will decrease frequency and spatial extent of elevated and hyper-salinity events.

Hypothesis 9. Diversion of fresh water from the eastern panhandle & western Taylor Slough and maintaining a higher water table in the southern Everglades, may decrease the magnitude, duration, and spatial extent of elevated and hyper-salinity in north-central Florida Bay.

Hypothesis 10. In Biscayne Bay, freshwater inflow during the dry season and early and late wet season will decrease frequency and spatial extent of nearshore elevated and hyper-salinity.

Hypothesis 11. Increased freshwater inflow resulting from CERP activities will result in increased oxygen solubility of lower salinity water. As a result, *Thalassia* communities located further from the nearshore will experience decreased periods of sulfide poisoning and subsequent mortality events.

SCS Salinity HC

Complete list of hypotheses for **Sea-Level Rise**:

Hypothesis 12. Increased fresh water into groundwater will produce higher freshwater head gradient to help mitigate saltwater intrusion.

Hypothesis 13. Natural tidal creeks and sloughs can be a conduit for saltwater intrusion and the inland advancement of increased salinity under different conditions including: when freshwater inflow is low, during storm surge, as the result of sea level rise, and during droughts or extended dry periods which can enhance this process.

Hypothesis 14. Seawater that has advanced into the transition zone within Florida Bay and the Southwest Coast may become trapped in areas with low topography. Evaporation of this trapped seawater will lead to hyper-salinity in isolated basins.

Hypothesis 15. Nearshore estuarine waters will advance inland with sea level rise. Because of the low gradient in the SCS, at some point additional freshwater input will not be sufficient to overcome sea level rise and saltwater intrusion will occur.

Hypothesis 16. In Florida Bay the banks that separate the embayments will become less prominent due to sea level rise and change water turnover (or residence times) by increasing mixing with marine waters. This change may mediate and reduce the current level of hyper-salinity in the more isolated basins resulting in a more marine environment overall. In northeastern basins, this may also lead to a loss in estuarine gradients.

SCS Salinity HC

Complete list of hypotheses for **Sea-Level Rise** (cont.):

Hypothesis 17. Increased freshwater flow to coastal areas will counter saltwater intrusion due to sea level rise in some areas.

Hypothesis 18. In wetland transition zones increased freshwater inflow may result in longer hydroperiods and increased water depth in the transition zone due to concurrent sea level rise.

Hypothesis 19. In wetland transition zones increased freshwater inflow can create a freshwater lens over a saltier lens of water and may result in elevated porewater salinities due to concurrent sea level rise.

Hypothesis 20. Increased freshwater flow will enhance resiliency of the coastal vegetation, especially mangroves, thereby reducing potential for coastal transgression since the mangroves contribute to sediment accretion. In some regions of the world this process has been shown to allow the coast to keep up with SLR (at certain rates) (McKee, et al. 2007; Woodroffe, 2016).

Hypothesis 21. The location of water column stratification produced by surface waters of lower salinity than bottom waters will move further offshore.

Hypothesis 22. Over a multi decadal timescale, formerly brackish locations will transition to marine environments and formerly freshwater locations will transition to brackish environments.

SCS Salinity HC

Complete list of hypotheses for **Sea-Level Rise** (cont.):

Hypothesis 23. Increased freshwater flow to coastal areas will counter saltwater intrusion due to sea level rise in some areas.

Hypothesis 24. In wetland transition zones increased freshwater inflow may result in longer hydroperiods and increased water depth in the transition zone due to concurrent sea level rise.

Hypothesis 25. In wetland transition zones increased freshwater inflow can create a freshwater lens over a saltier lens of water and may result in elevated porewater salinities due to concurrent sea level rise.

Hypothesis 26. Increased freshwater flow will enhance resiliency of the coastal vegetation, especially mangroves, thereby reducing potential for coastal transgression since the mangroves contribute to sediment accretion. In some regions of the world this process has been shown to allow the coast to keep up with SLR (at certain rates) (McKee, et al. 2007; Woodroffe, 2016).

Hypothesis 27. The location of water column stratification produced by surface waters of lower salinity than bottom waters will move further offshore.

Hypothesis 28. Over a multi decadal timescale, formerly brackish locations will transition to marine environments and formerly freshwater locations will transition to brackish environments.

SCS Salinity HC

Complete list of hypotheses for **Climate Change**:

Hypothesis 29. An increase in temperature will increase evaporation which in turn will increase salinities, the effects of which will be enhanced in shallow areas and areas receiving limited freshwater inflow.

Hypothesis 30. The increased evaporation may offset the water level increase by SLR in Florida Bay and there will be little or no change in the mudbanks separating the embayments or change to water residence times.

Hypothesis 31. Offshore regions will behave and respond differently than the inshore regions.

Hypothesis 32. Tropical storm disturbance may advance saltwater intrusion further inland, especially in areas with low elevations. Saltwater from storm surges may stay pooled inland in low lying areas and may increase porewater salinities further inland resulting in changes in habitat and species distributions.

Hypothesis 33. Nearshore salinities will decrease over the longer time scale of CO_2–driven climate change.

SCS Salinity HC

Complete list of Uncertainties:

Uncertainty 1. Salinity is a key variable needed to predict physical and ecologic outcomes of CERP and is used as an to interpret ecologic monitoring and as an input to existing predictive. However, many of the programs from which salinity data are drawn for restoration support are not funded by the MAP. Thus, as monitoring programs institute changes (e.g., scope, location, frequency of monitoring), are discontinued, or are replaced by programs with different scope, objectives and/ or methods of sampling, assessments for restoration activities may be impacted.

Uncertainty 2. Several additional hydrologic parameters including rainfall, freshwater inflow, evaporation, SET, and water level are needed in order to interpret the information obtained by the salinity monitoring. As noted for the salinity monitoring above, as changes to MAP funded programs (e.g., scope, location, frequency of monitoring), are discontinued, or are replaced by programs with different scope, objectives and/ or methods of sampling, assessments for restoration activities may be impacted. Any changes to these supporting parameters may impact the ability to use and interpret the salinity data that is collected.

Uncertainty 3. Current estimates for the contribution of groundwater input with respect to the overall water budget are highly uncertain due to the lack of groundwater information data throughout the SCS. Given the known interconnectivity of surface and groundwater, this makes predictions on the impacts of restoration to groundwater also uncertain.

Uncertainty 4. Because of the low gradient and elevation of the coastal areas within the SCS, the overall resiliency of the SCS coastal environments and habitats to withstand sea level rise even with the increase in freshwater inflow is uncertain. The point at which additional freshwater will not be sufficient to overcome sea level rise and saltwater intrusion is not known.

SCS Salinity HC

Complete list of Uncertainties (cont.):

Uncertainty 5. Salinity is one factor that may result in floral and faunal shifts (e.g., changes in species composition and community structure) in the coastal ecosystems however, there are multiple stressors that can also cause shifts and there are inherent uncertainties in determining a direct causal – effect linkage between salinity and these changes. Often times the change is a result of a combination of stressors (e.g., storms, temperature changes, nutrient or biogeochemical influences and other environmental factors).

Uncertainty 6. Several additional hydrologic parameters including rainfall, freshwater inflow, evaporation, SET, and water level are needed in order to interpret the information obtained by the salinity monitoring. As noted for the salinity monitoring above, as changes to MAP funded programs (e.g., scope, location, frequency of monitoring), are discontinued, or are replaced by programs with different scope, objectives and/ or methods of sampling, assessments for restoration activities may be impacted. Any changes to these supporting parameters may impact the ability to use and interpret the salinity data that is collected.

Uncertainty 7. Predicting pre-drainage, current, future without project (including sea level rise) and restoration scenarios remains an uncertainty for the SCS in large part because multiple models must be coupled which produces error and compounds existing model limitations and inaccuracies.

Uncertainty 8. Future changes in population, water use, flood protection needs, and land-use changes are unknown and may have impacts on salinities in the southern coastal systems.

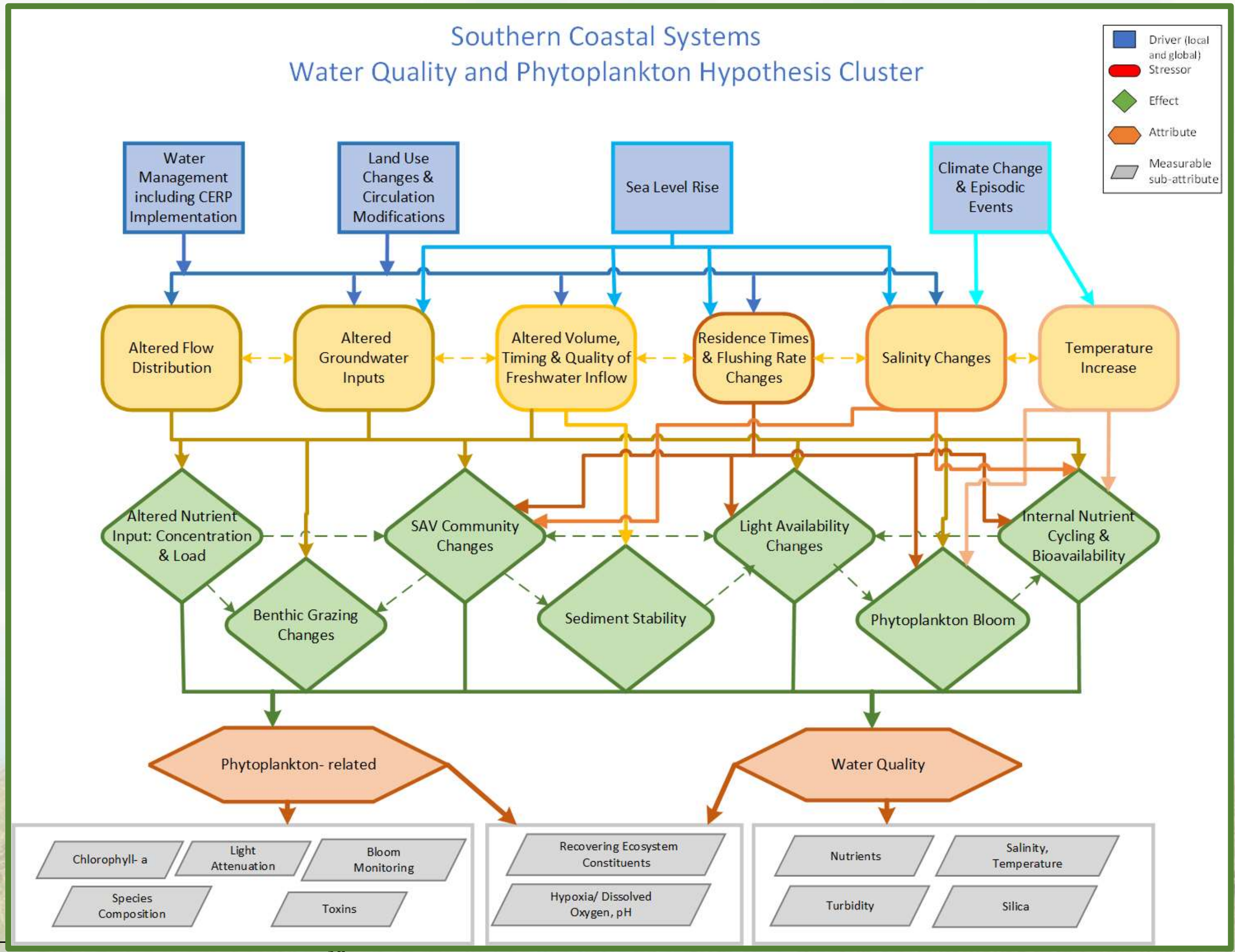
SCS Salinity HC

Complete list of Uncertainties (cont.):

Uncertainty 9. Predicting the future effects of sea level rise on the SCS are uncertain the rate of relative sea level rise is dependent on factors that fall outside the realm of CERP (Khan et al. 2017).

Uncertainty 10. Effects of climate change, severe storms and storm surge, and magnitude and timing of rainfall events may have positive or negative effects on restoration activities and are inherently uncertain within the SCS.

SCS Water Quality and Phytoplankton Hypothesis



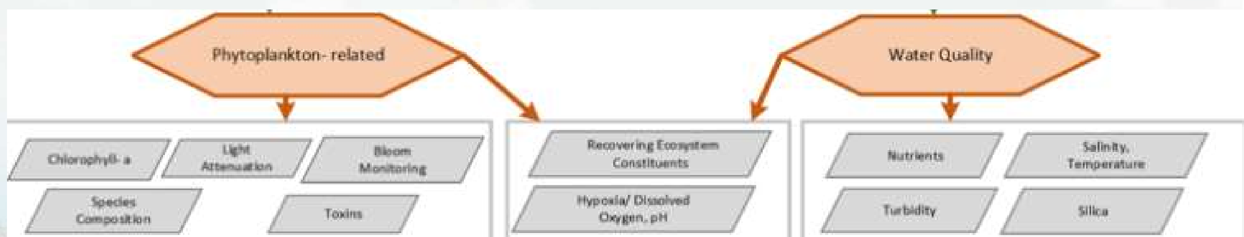
SCS Water Quality and Phytoplankton Hypothesis Cluster Highlights

Working Hypotheses:

- Water Management: Increased flow will increase in nutrient loading where nutrient reduction measures are not implemented. Phytoplankton species changes likely
- Land use: Direct effects highly variable throughout SCS mobilization of nutrients to coastal systems in some areas. Less effect than CERP alterations
- Sea Level Rise: Rising sea level will mobilize nutrients in vadose zone and cause peat collapse and transport to nearshore waters.
- Climate Change: Increase over longer timescales but episodic, more frequent storms can disturb nearshore environments and cause pulses of nutrients. Increase in temperature may produce phytoplankton shifts, increase blooms

MAP Monitoring:

- None, monitoring performed independently by various agencies



Key Uncertainties:

- Climate change and sea level rise
- Changes in phytoplankton communities
- Gaps in data and collection efforts
- ??Reef tract impacts? —per recent Coral Reef meeting

SCS Water Quality and Phytoplankton HC

Complete list of hypotheses for **Water Management – Nutrient Inputs and Cycling**:

Hypothesis 1. Restoring more natural, dispersed freshwater delivery through coastal wetlands and creeks will change the distribution and timing of nutrient inputs to coastal water bodies with an increase in nutrient loading to the nearshore environment where an increase of flow occurs.

Hypothesis 2. The bioavailability of nutrients will change depending on the type, concentration, and load of nutrients entering the system from the watershed as well as internal estuarine mechanisms resulting from CERP actions (*e.g.*, phosphorus limitation of dissolved organic matter decomposition).

Hypothesis 3. CERP Implementation will initially increase nutrient input and DOM to Florida Bay. The lack of flushing in some parts of the mangrove ecotone of the mangrove ecotone over the past several decades, particularly the lake systems connected to central Florida Bay has likely yielded a buildup of nutrients and organic matter. Over time, as freshwater input increases, the nutrients in the ecotone will lessen in concentration thus yielding less nutrient entering the estuaries.

Hypothesis 4. Changes in salinity and benthic habitat because of restoration will affect internal nutrient cycling rates (*e.g.*, nitrogen fixation and denitrification) and biogeochemical processes (*e.g.*, phosphate sorption).

Hypothesis 5. Changes in land use, altered landscapes, and enhanced cultural eutrophication with population growth will influence the magnitude of "effects" shown in the diagram - nutrient input, SAV community, sediment stability, light availability, blooms and internal nutrient cycling and bioavailability.

SCS Water Quality and Phytoplankton HC

Complete list of hypotheses for **Water Management – Nutrient Inputs and Cycling (cont.)**:

Hypothesis 6. The effects of stratification and circulation may be variable depending on the region. Higher freshwater flows may produce greater stratification in some areas and may decrease residence times and flush the system more rapidly in other areas.

Hypothesis 7. The nearshore light environment will change. The flooding of coastal wetlands will produce increased amounts of CDOM (colored dissolved organic matter) that will be transported into the nearshore environment decreasing light transmission and changing the spectral composition of the underwater light field. This change may result in changes in nearshore SAV distribution yielding more diversity and mixed beds.

SCS Water Quality and Phytoplankton HC

Complete list of hypotheses for **Water Management – Phytoplankton**:

Hypothesis 8. Increases in freshwater inflows to southern coastal systems will alter nutrient loads, which in turn will impact phytoplankton biomass and composition. The specific impacts will not only depend on the nature of the inflows (e.g., source, volume and timing of inflows, storm impacts, nutrient concentrations, CDOM, presence of high biomass of freshwater HABs), but also the structural and functional characteristics of the receiving water bodies (e.g., degree of restriction, morphology of the basins, biological communities present, nutrient limitations).

Hypothesis 9. Phytoplankton community composition (i.e., species) will change in the nearshore environment as a result of the changed nearshore salinity, light, and nutrient environments and respond relatively quickly to increased flow of freshwater. Community composition may change significantly with change in freshwater volume or change in nutrient concentrations or ratios. Following general phytoplankton ecology, greater relative amounts of allochthonous chlorophytes and cyanophytes transported from upstream freshwaters and into nearshore waters would be expected. Increased nutrient loading and silicate may promote the faster growing diatoms. Overall, an expansion of low-salinity phytoplankton communities and retreat of coastal oceanic communities is expected in areas that receive increased freshwater inflow.

Hypothesis 10. Unless nutrient reduction measures are implemented, nutrient input or loads may increase where freshwater inputs increase which have the potential to increase the occurrence of phytoplankton blooms.

Hypothesis 11. The measurement and evaluation of phytoplankton related parameters for bloom monitoring will aid in the capabilities to predict algal blooms and provide capability to link blooms to specific drivers.

SCS Water Quality and Phytoplankton HC

Complete list of hypotheses for **Water Management – Phytoplankton (cont.)**:

Hypothesis 12. Biomass of phytoplankton as measured with chlorophyll-a will increase with supply of nutrients, which may accompany higher flow or internal water body cycling of nutrients.

Hypothesis 13. Increased freshwater flows may decrease chlorophyll-a concentration, if nutrient levels remain the same, or are reduced through longer retention times in wetlands.

Hypothesis 14. Releases of nutrients into the water column from increased flows, volumes, loading or by changes to internal cycling such as disturbed sediment, habitat shifts (e.g., seagrass die-offs) or other internal nutrient cycling change may induce localized or even regional changes that create a shift in productivity from benthic to planktonic, and more frequent planktonic algal bloom conditions.

SCS Water Quality and Phytoplankton HC

Complete list of hypotheses for **Land Use**:

Hypothesis 15. Nutrient loading to northern Biscayne Bay will decrease, assuming flow does not increase and nutrient concentration decreases.

Hypothesis 16. Phytoplankton blooms in northern Biscayne Bay will decrease in severity and duration.

Hypothesis 17. Phytoplankton blooms, when they do occur will be comprised of previously blooming species because of long-term stores of viable resting spores deposited into the sediments during previous blooms.

Hypothesis 18. Unless reduction measures are taken nutrient inputs will increase to southern Biscayne Bay.

Hypothesis 19. Phytoplankton community composition in southern Biscayne Bay will change and shift from slower growing species to faster growing species.

Hypothesis 20. Alteration of the mobilization and release of nutrients from developed and agricultural areas, through nutrient uptake in treatment areas, and through changes in nutrient processing and retention in the Everglades will change the quantity and quality of nutrient inputs to the estuaries.

SCS Water Quality and Phytoplankton HC

Complete list of hypotheses for **Sea-Level Rise**:

Hypothesis 21. As sea level rises, contaminants in the soil and shallow groundwater from urban, agricultural, industrial, landfill or otherwise disturbed land uses adjacent to Biscayne Bay will enter the Bay and intensify water quality concerns and associated impacts. Changes in stratification, dissolved oxygen and phytoplankton composition may result from higher nutrient and other contaminant inputs.

Hypothesis 22. Shallow-water SAV communities may retreat inland with the rising sea, but upland urban areas with elevated and hardened shorelines or natural area buffer may prevent such retreat resulting in SAV loss which due to internal nutrients can trigger phytoplankton blooms.

Hypothesis 23. The rising sea level will mobilize nutrients in the current vadose zone and transport these previously contained nutrients to nearshore waters.

Hypothesis 24. In basins throughout Florida Bay that have restricted flushing, greater water exchange and increased circulation will decrease water residence times reducing frequency of phytoplankton blooms in some areas.

Hypothesis 25. Peat collapse may occur where saltwater intrusion occurs with resulting release of nutrients to the coastal systems.

SCS Water Quality and Phytoplankton HC

Complete list of hypotheses for **Climate Change and Episodic Events**:

Hypothesis 26. Increased magnitude, frequency of storms events will cause increased pulses of nutrients from land with higher freshwater inputs. Increased magnitude, and frequency of storms events will cause an increase in disturbed sediments within the SCS, releasing nutrients in the water column and result in storm event related phytoplankton blooms.

Hypothesis 27. Increased magnitude, frequency of storms events will cause increased disturbance of habitats within the SCS (e.g., mangroves, seagrass beds) which over time release will nutrients into the water column and or alter biogeochemical cycling.

Hypothesis 28. An increase in water temperature will increase bloom frequency and or intensity and alter internal nutrient cycling, and bioavailability. This will be particularly evident in areas that are shallow, have restricted circulation, and/ or relatively small input of freshwater inflow.

Hypothesis 29. Altered wind patterns may cause stagnation and intensify blooms or may cause dispersal and decrease bloom impacts.

Hypothesis 30. Nearshore phytoplankton abundance will increase over the longer time scale of CO_2–driven climate change.

Hypothesis 31. Nearshore phytoplankton community composition may shift towards cyanobacteria that compete better at higher temperatures.

Hypothesis 32. Temporal variation measured over the course of years will increase in coastal ecosystems as systems are more frequently impacted and reset to early successional communities by effects of tropical storms and hurricanes.

SCS Water Quality and Phytoplankton HC

Complete list of **Uncertainties**:

Uncertainty 1. Change in water quality is measurable because most of the southern coastal systems study area have some existing non- MAP funded water quality monitoring data. Not so for changes in phytoplankton communities where the existing monitoring data is sparse and incomplete. The baseline phytoplankton community composition at the species level is unknown for many areas and numerous hypotheses suggest changes will occur.

Uncertainty 2. Most of the available information and study related to water quality conditions and algal bloom formations within the SCS is in Biscayne Bay and Florida Bay, where phosphorus limitation prevails. The downstream and receiving coastal areas of the Shark River have received less study and may be subject to nitrogen limitation or other significant differences from the other parts of the SCS.

Uncertainty 3. Data gaps in the monitoring can confound interpretation, which may undercut the ability to provide corrective adaptive management and maximize benefits in the future.

Uncertainty 4. Although there are several water quality models under development, none are currently in use or ready to aid resource management decisions or provide input to CERP planning or project decisions. The lack of an accurate and practical water quality model within the SCS limits predictive ability and the ability to link changes in the system to a specific driver or stressor.

Uncertainty 5. Understanding direct cause -effect relationships for predicting algal bloom formation including locations, origin, duration, and extent of events remains a challenge.

SCS Water Quality and Phytoplankton HC

Complete list of **Uncertainties**:

Uncertainty 6. Direct causal links between circulation and stratification and the interaction with increased freshwater flows are uncertain. Higher freshwater flows may produce greater stratification, or it may decrease residence times and flush the system more rapidly.

Uncertainty 7. Factors such as winds, currents, and sea level rise may have confounding and uncertain effects on the restoration efforts. For example, stagnant conditions can exacerbate blooms and intensify impacts. Conversely water circulations due to winds, current, or sea level rise may displace or disperse blooms and be beneficial in some instances.

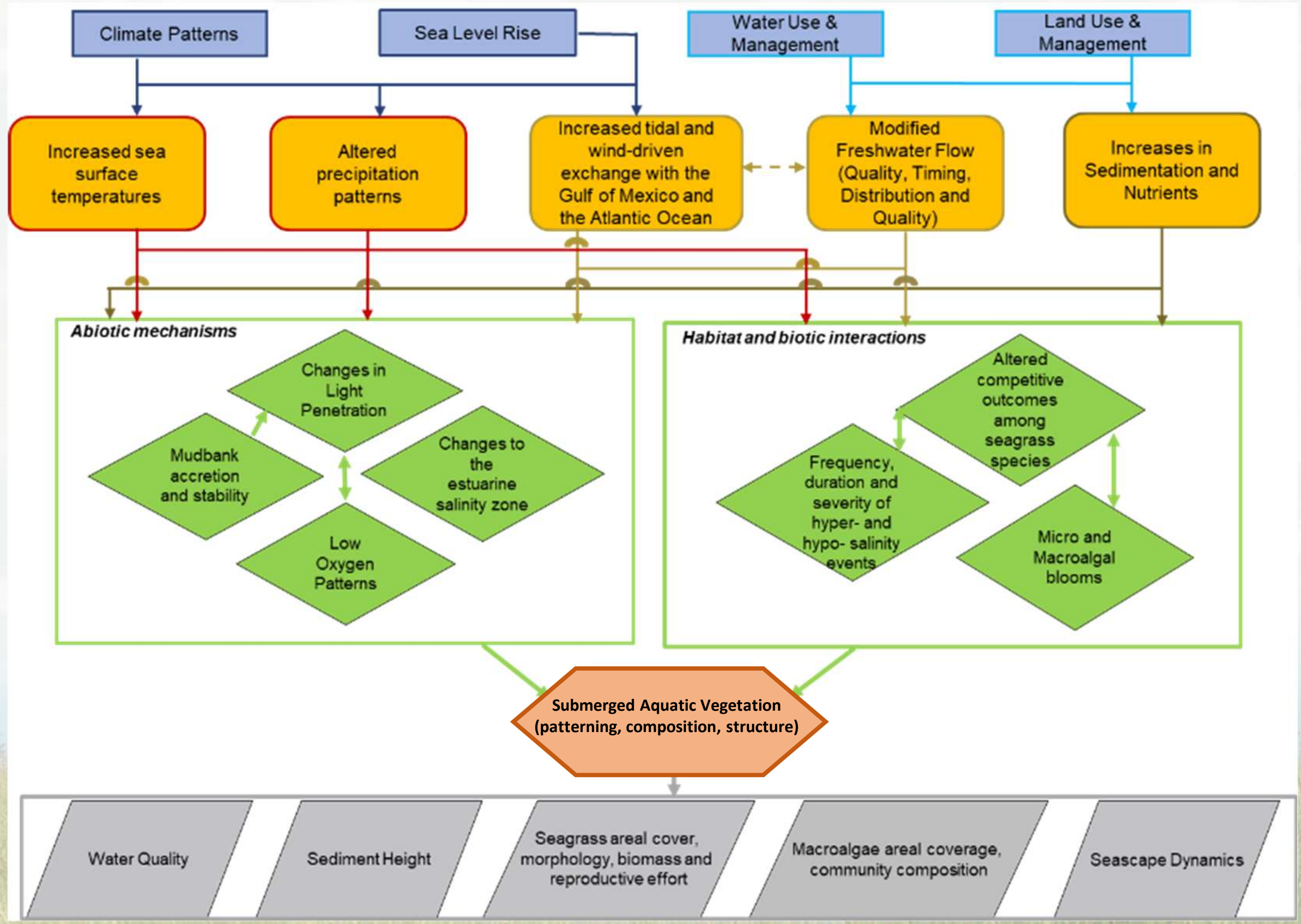
Uncertainty 8. The transport and potential effects of red tides and *Karenia brevis* to Florida Bay that originate outside of the SCS in Monroe County remain uncertain.

Uncertainty 9. Nutrient and contaminant inputs via groundwater within the SCS remain unquantified and effects or interaction such as nutrient sequestration potentials with benthic habitats such as seagrass remains uncertain.

Uncertainty 10. Climate change, sea level rise, episodic events (*e.g.*, tropical storms, droughts), and anthropogenic activities also confound data interpretation. The degree to which episodic changes such as storm intensity and or frequency, seawater surges, flooding or drought conditions will change in the future is uncertain.

Uncertainty 11. Many of these drivers produce dissimilar effects relative to each other and produce these effects over different time scales. Major uncertainties are the relative strengths of these drivers and how these relative strengths change over time scales from months to years to decades and beyond.

SCS Submerged Aquatic Vegetation Hypothesis Cluster



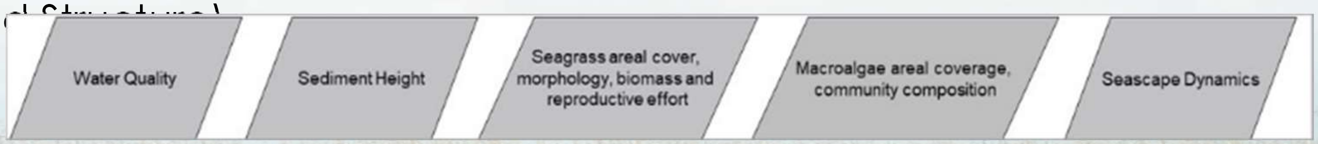
SCS Submerged Aquatic Vegetation HC

Themes of working hypotheses:

- **Water use**: Restoration of more natural freshwater releases through canals, spreader-canal features, wetland rehydration, and improvement of water delivery should promote beneficial salinity conditions, reduce sediment input, and decrease nutrient load to promote healthy and diverse SAV populations.
- **Climate Patterns:** Climate patterns will result in changes in sea surface temperatures, precipitation patterns, and SLR which in turn influences nutrient delivery (increased algal growth), frequency and intensity of drought conditions (hypersalinity), and dissolved oxygen levels (hypoxia and hydrogen sulfide).
- **Sea-level Rise:** SLR will eventually limit the restoration ability to deliver estuarine conditions in Florida Bay, outpace mud bank accretion, and increase connectivity between the Gulf of Mexico, Florida Bay, and the Atlantic Ocean.

MAP Monitoring:

- SAV (Patterning, Composition, and Structure)



Key Uncertainties:

- Climate patterns – thermal stress, salinity and nutrients, and cyanobacterial and macroalgal blooms
- SLR – mud bank accretion, sediment plumes, greater marine connectivity, and sufficient CERP flow
- Water and land management – seascape fragmentation, fluctuating flows, trophic use of seagrass beds, *Sargassum* impacts

SCS Submerged Aquatic Vegetation HC

Complete list of hypotheses:

Hypothesis 1. Climate change will result in increased sea surface temperatures and the risk of marine heat waves. Higher temperatures lower oxygen solubility and will increase the frequency, duration and intensity of hypoxic and anoxic events. Thermal stress will be exacerbated by dense seagrass beds and tall canopies (i.e., *T. testudinum* and *S. filiforme*).

Hypothesis 2. Climate induced changes in precipitation patterns, restored freshwater flows, and SLR will increase nutrient delivery to Florida and Biscayne Bays. This will enhance benthic macrophyte growth and productivity, particularly for interior basins and those with high residence times; however, excess nutrients will promote epiphytic and macroalgal blooms (e.g., *Ulva* and *Anadyomene*) that can compete for SAV and alter benthic community structure.

Hypothesis 3. Climate change will result in increased frequency and severity of drought conditions in South Florida, resulting in hyper salinity (>45) events in Florida and Biscayne Bays. These events will lower water column oxygen availability and affect seagrass respiration and survival. Extreme or prolonged droughts will result in large-scale seagrass mortality events (i.e., die-off) driven by hydrogen sulfide intrusion.

Hypothesis 4. Sea level rise will eventually limit the ability of restoration to deliver estuarine conditions southward to Florida Bay proper. Greater mixing with the Gulf of Mexico will increase phosphorus delivery and push more marine conditions northward toward the mangrove ecotone. This will result in changes to the distribution of benthic macrophytes across the current salinity gradient. For example, *Syringodium filiforme* will expand eastward, westward, and northward into Lower and Central Florida Bay; *Thalassia testudinum* will migrate northward, replacing *Halodule wrightii* in some coastal basins; and *Ruppia maritima* will be displaced further up estuary, where freshwater inputs are greatest.

SCS Submerged Aquatic Vegetation HC

Complete list of hypotheses:

Hypothesis 5. Sea level rise will increase connectivity between Florida Bay, the Gulf of Mexico, and the Atlantic Ocean. Reduced residence times within the bay will lessen the impact of sediment resuspension events and cyanobacterial blooms. Increased light availability, increased water depth and stabilized salinities will advantage *S. filiforme* in southern Florida Bay and *T. testudinum* in northern Florida Bay.

Hypothesis 6. CERP flows in Taylor and Shark River Sloughs will decrease salinities in northeastern and western Florida Bay, respectively. This will result in the extension of estuarine salinity zones and the return of more moderate seasonal salinity cycles to Florida and Biscayne Bays. In response, *T. testudinum* monocultures will transition to mixed-species meadows (*T. testudinum* and/or *S. filiforme* and *H. wrightii*) and *H. wrightii* and/or *Ruppia maritima*). In coastal basins, and proximate to point sources of freshwater discharge, there will be increases in oligohaline genera like *Chara* and *Utricularia*.

Hypothesis 7. Mixed-species meadows will be more resilient to disturbances such as tropical weather systems, salinity extremes (i.e., drought) and fluctuations (i.e., rainfall and run-off), sediment resuspension events, and cyanobacterial blooms.

Hypothesis 8. Mixed-species meadows will result in greater secondary production.

Hypothesis 9. The Great Atlantic *Sargassum* Belt will continue to be an annual source of holopelagic *Sargassum* to Florida Bay and Biscayne Bay, with peak abundance in June and July. Once in shallow water, drift algal mats will shade and smother benthic macrophyte communities, and decomposing macroalgae will result in low dissolved oxygen and high sulfide concentrations, causing localized seagrass mortality.

SCS Submerged Aquatic Vegetation HC

Complete list of uncertainties (grouped by driver):

Climate Patterns

Uncertainty 1. How will thermal stress affect resilience of *T. testudinum* and *S. filiforme* meadows, including basal reproductive effort?

Uncertainty 2. How will thermal stress influence recovery and community succession within previously dominated seagrass meadows (will macroalgal dominance be transient or a more permanent phase shift)?

Uncertainty 3. How will recurrent and persistent cyanobacterial blooms and resuspended sediment events (i.e., shading) interact with increased nutrient availability and temperatures to alter competitive outcomes among seagrass species and macroalgal species?

Uncertainty 4. How will changes in salinity and nutrients influence the frequency and intensity of macroalgal blooms and foster species replacements?

SCS Submerged Aquatic Vegetation HC

Complete list of uncertainties (grouped by driver):

Sea-level Rise

Uncertainty 5. Will mud bank accretion continue to keep pace with SLR?

Uncertainty 6. What will release from P-limitation and more stable marine conditions mean for competitive outcomes between *H. wrightii, S. filiforme,* and *T. testidinum*?

Uncertainty 7. What are the drivers of the persistent sediment plume in western Florida Bay (e.g., SLR, peat collapse, Raulerson Brothers Canal)? How does the plume interact with cyanobacterial blooms in west-central Florida Bay? And how will both affect seagrass community trajectory?

Uncertainty 8. How will increase exchange with the Gulf of Mexico and Atlantic affect the frequency, intensity, and duration of cyanobacterial blooms in Florida Bay?

Uncertainty 9. Will greater connectivity with the Gulf of Mexico and Atlantic and more benign conditions in Florida Bay proper result in greater species introductions? How will benthic macrophyte communities be affected by species such as *Halophila stipulacea*?

Uncertainty 10. How effective will CERP flows be at counterbalancing drought conditions and resultant hyper salinity in western Florida Bay and Central and Southern Biscayne Bay?

Uncertainty 11. What does mangrove and freshwater wetland peat collapse and hurricane damage mean for nutrient flux to SAV communities in Florida Bay?

SCS Submerged Aquatic Vegetation HC

Complete list of uncertainties (grouped by driver):

Water Use and Land Management

Uncertainty 12. Will CERP flows and altered precipitation patterns combine to cause rapid drops in nearshore salinity? If so, will there be decreases in benthic macrophyte abundance or changes in meadow composition and configuration (i.e., seascape fragmentation)?

Uncertainty 13. Will potential seascape fragmentation necessitate changes in monitoring methods or require remote sensing approaches to capture changing landscape patterns?

Uncertainty 14. Will periods of hypo salinity stress lead to increases in *Labyrinthula* disease in northern *T. testudinum* beds?

Uncertainty 15. Will reduced salinities in the coastal estuaries result in increased manatee abundance and/or grazing pressure? How will shifts to mixed-species meadows affect herbivory generally?

Uncertainty 16. How will changing precipitation patterns and CERP flows alter groundwater dynamics in Florida Bay and Biscayne Bay?

Uncertainty 17. CERP flows will result in salinity regimes that maintain seagrass communities at a mid-successional state. Species diversity will confer resilience by providing a broader community-wide tolerance range for physical and physiological stressors such as light availability, storm disturbance, salinity, exotic species invasion, herbivory, and disease?

SCS Submerged Aquatic Vegetation HC

Complete list of uncertainties (grouped by driver):

Water Use and Land Management (cont.)

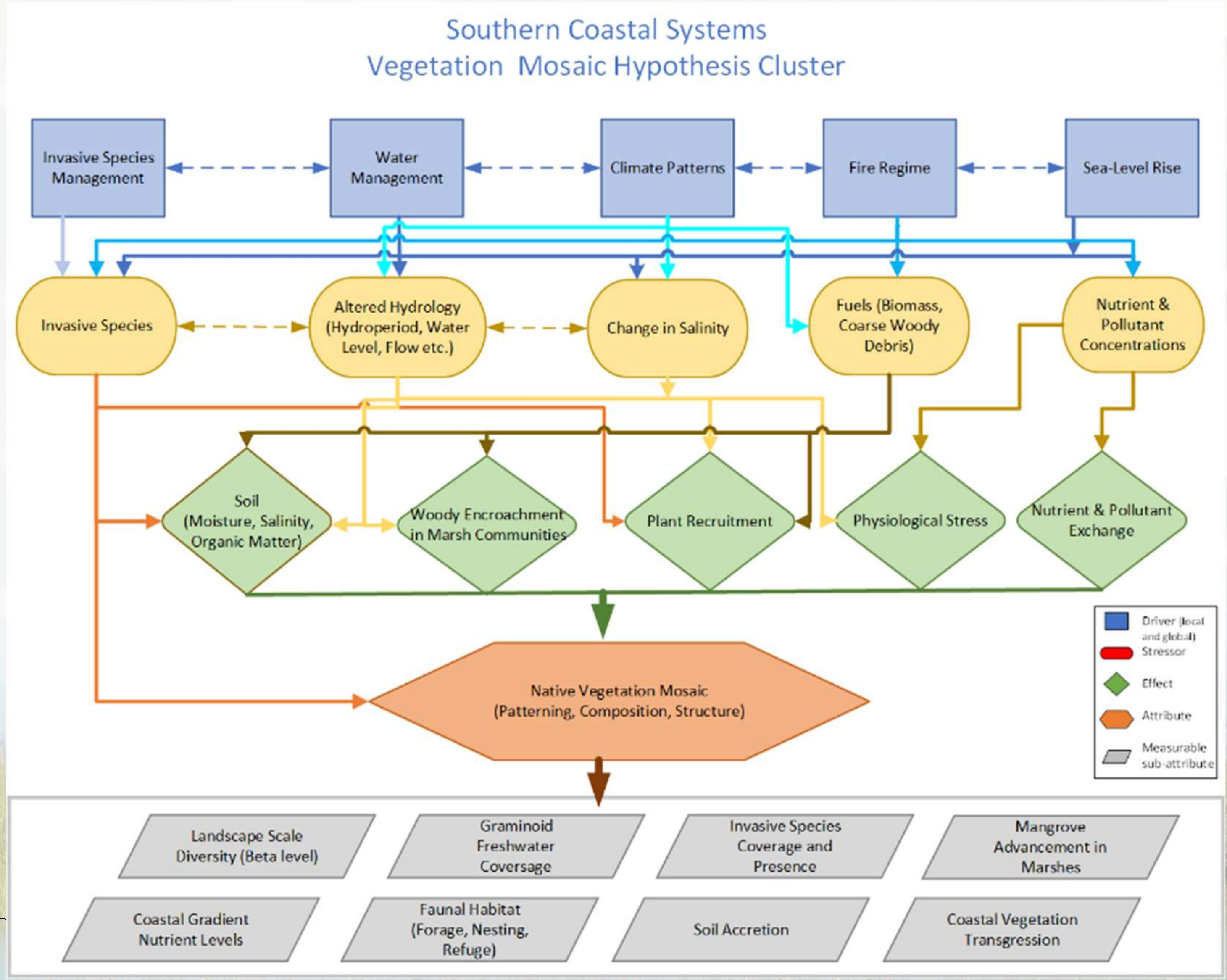
Uncertainty 18. What will be the habitat value of mixed-species meadows for recreational fish species?

Uncertainty 19. Will mixed-species meadows differ in forage quality for mega-herbivores such as sea turtles and manatees?

Uncertainty 20. How much *Sargassum* will be delivered to South Florida annually? How variable will it be inter-annually? What exotic species and potential pathogens will be introduced? And what will be the long-term effects of this nutrient source on the seagrass ecosystems of Florida Bay and Biscayne Bay?

Uncertainty 21. Will *Sargassum* landings create localized anoxic conditions leading to mortality of SAV and associated fauna, especially in mangrove-lined shorelines?

SCS Native Vegetation Mosaic Hypothesis Cluster



SCS Native Vegetation Mosaic HC

Themes of working hypotheses:

- **<u>Water management</u>:** Restoration of natural flows and water regimes will reestablish and maintain native vegetation communities and salinity gradients.
- **<u>Climate patterns, water management, and land management</u>:** Hydrologic patterns and fire management will reduce fuel build-up which will reduce the intensity of fires that damage soil conditions.
- **<u>Invasive species</u>:** Restoration of natural flow and water patterns will decrease invasive floral species and promote native plant species coverage and diversity.

MAP Monitoring:

- Native Vegetation (Patterning, Composition, and Structure)

Key Uncertainties:

- Climate change and sea-level rise
- Management Activities
- Natural fire regimes and vegetation to support fire
- Exotic species and nuisance species colonization

SCS Native Vegetation Mosaic HC

Complete list of hypotheses:

Hypothesis 1. Water regime (depth and periodicity) created in each habitat unit, or vegetation mosaic listed above, maintains the community or moves it to a more desired state represented by pre-drainage natural characteristics.

- Indicative community attributes:
  - Growth and survival of target species
  - Recruitment of target species
  - Usage by targeted wildlife species
  - Minimum of invasive non-native species

Hypothesis 2. Water management methods aimed at restoring pre-drainage (natural) hydrologic conditions (depth and periodicity) for coastal wetlands will likely slow the landward transgression of the white zone and mangroves.

Hypothesis 3. By restoring natural water flow and hydroperiods into the coastal vegetation mosaics, soil accretion rates will increase, potentially forestalling the adverse effects of sea-level rise on coastal wetlands.

Hypothesis 4. In sawgrass dominated communities or other vegetation capable of carrying fire, periodic prescribed burning will minimize colonization by mangroves, invasive non-native species, and woody plant encroachment.

SCS Native Vegetation Mosaic HC

Complete list of hypotheses:

Hypothesis 5. Hydrologic patterns and fire management will reduce the build-up of fuels (biomass and woody debris) that can lead to intense fires that burn peat, remove carbon, and sterilize the soils. Changes in soil conditions can shift plant community composition and structure to a different vegetation mosaic and landscape patterning.

Hypothesis 6. The establishment, extent, and distribution of invasive species, like Old World climbing fern, Brazilian pepper, and Australian pine will decrease within the Southern Coastal System which would allow for native plant recruitment, distribution, and community structure.

Hypothesis 7. Landscape scale floral and faunal diversity and species composition would be maintained and enhanced with the restoration of freshwater flow that will reestablish a coastal salinity gradient.

Hypothesis 8. Increased freshwater flow and water levels will maintain the natural mosaic patterning of plant assemblages across physical, ecological, and environmental gradients across the Southern Coastal System.

Hypothesis 9. Increase in freshwater flow will likely result in reduced TP concentration, salinity and saltwater intrusion, and cattail distribution and dominance along the coastal gradient.

SCS Native Vegetation Mosaic HC

Complete list of Uncertainties:

Uncertainty 1. How will periodic drought affect water management decisions and the salinity gradient along the coastal Everglades and ultimately the vegetation mosaic?

Uncertainty 2. Given that plant communities are unlikely to be restored to pre-drainage conditions, will hydrologic restoration result in patterning of a vegetation mosaic with landscape scale diversity?

Uncertainty 3. Will hydrologic restoration impact soil accretion and allow for the natural coastal mosaic of vegetation communities to persist as sea level rises?

Uncertainty 4. Will native vegetation return following hydrologic restoration and natural fire regime, or will active management be required to control reestablishment of invasive and allow natives to recolonize?

Uncertainty 5. How will frequency and intensity of perturbation events (fires, freezes, storms) affect native plant communities?

Uncertainty 6. Will restored hydrology reverse the landward transgression of mangroves?

SCS Native Vegetation Mosaic HC

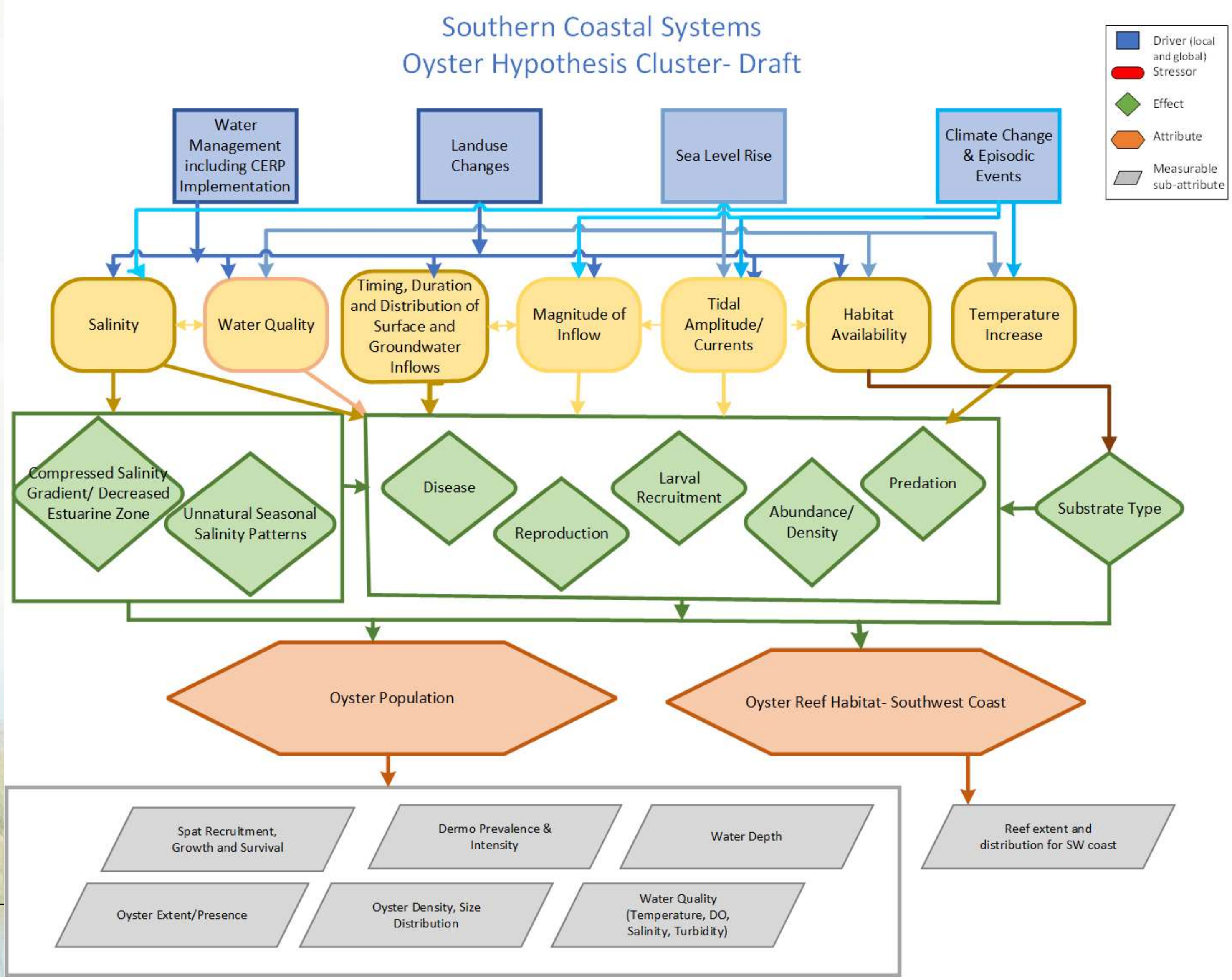
Complete list of Uncertainties (cont.):

Uncertainty 7. Is the amount of fresh water available sufficient to offset the impacts of SLR? Will increased freshwater flows offset saltwater intrusion into interior freshwater marshes? Will restored freshwater flows and SLR result in ponding and transition to open water habitat?

Uncertainty 8. Will restored freshwater flows increase sawgrass biomass, density, and distribution which will allow for fires to regulate wood plant encroachment, specifically mangroves?

Uncertainty 9. Will restored freshwater flows result in the reduction of nuisance species like cattails, willow, and other disturbance-colonizing species?

SCS Oyster Hypothesis Cluster

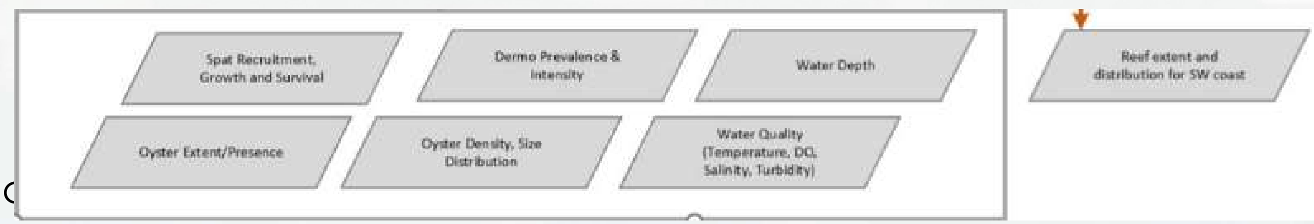


SCS Oyster HC

Themes of Working hypotheses:

- **Altered freshwater flow into coastal estuaries from climate change** may result in salinities outside optimal levels for oysters causing physiological stress, widespread mortality, and increased disease and predation rates.
- **Large inflows of freshwater** physically flush larvae out of the estuaries.
- **Suitable habitat quality and substrate type** will increase larval settlement success and encourage sustainable oyster populations.

- **MAP Monitoring:**
  - Oyster population
  - Oyster reef habitat (Southwest c



- **Key Uncertainties:**
  - Larval availability and connectivity for sustaining populations
  - Substrate availability and suitability in SCS
  - Resilience and ability of oysters to recover after a damaging event
  - Impact of reduced "year classes" on oyster populations (decreased oyster life span, survival)
  - Impact of climate change and SLR on distribution and health of oyster populations

SCS Oyster HC

Complete list of hypotheses:

Hypothesis 1. Heavy rainfall and large volumes of freshwater entering the estuaries rapidly decrease salinities below optimal levels for oysters, causing physiological stress and widespread mortality.

Hypothesis 2. Large inflows of freshwater to the estuaries inhibit larval settlement by physically flushing the pelagic larvae out of the estuaries.

Hypothesis 3. Reduced freshwater inputs to the estuaries during the dry season or drought periods increase salinities above optimal levels for oysters, causing physiological stress and increased disease and predation rates.

Hypothesis 4. Suitable habitat quality and substrate type will increase larval settlement success and encourage sustainable oyster populations.

SCS Oyster HC

Complete list of Uncertainties:

Uncertainty 1. Groundwater effects: Do oysters (*Crassostrea virginica*) occur where this is consistent freshwater such that salinity remains in their preferred zone and limits oyster predators and oyster diseases? The location of fresh or lower salinity upwellings is not generally known beyond a dozen or so locations in South Biscayne Bay in the CERP Biscayne Bay Southern Everglades Ecosystem Restoration (BBSEER)/Biscayne Bay Coastal Wetlands (BBCW) footprint. The co-location and use of these groundwater openings/upwellings as well as lower salinity areas by oysters is not well understood for Biscayne Bay.

- What is the location and relationship of the presence of low salinity groundwater outfalls and the co-occurrence of oysters.
- What is the persistence of oysters at these locations vs other more dispersed locations in the Bay.

Uncertainty 2. Oyster Bars: The persistence of oysters in relation to hardbottom oyster 'set' habitat.

- Is there a need to re-establish oyster habitat in general or does it exist and what is the extent of its use?
- Is there a need to locate oyster cultch material or create artificial oyster bar habitat or is there adequate existing non-oyster bar habitat for set?

Uncertainty 3. Breeding: When is the peak and shoulder breeding seasons in Central/South Biscayne Bay?

SCS Oyster HC

Complete list of Uncertainties (cont.):

Uncertainty 4. Impacts of temperature on oyster survival:

- Are the canals and canal input near enough the same ambient temperature as the downstream receiving water so that temperature of inflow has a minimal effect on oyster survival.
- Does canal inflow to Biscayne Bay in the wet season (hottest climatically) affect oyster spawn/spat set or adult oysters?

Uncertainty 5. Larval availability and connectivity for sustaining populations (endogenous vs. exogenous sources)

Uncertainty 6. Substrate availability for larval settlement indicated through acoustic mapping and substrate classification efforts are uncertain in the SCS as efforts have not been made in recent years

Uncertainty 7. Persistence of suitable settlement substrate after repeated mortality events

Uncertainty 8. Resilience and ability of oysters to recover after a damaging event (e.g., will there be an exogenous larval source for recovery after a mortality event)

Uncertainty 9. Impact of reduced "year classes" on oyster populations (decreased oyster life span due to disease and damaging water quality)

SCS Oyster HC

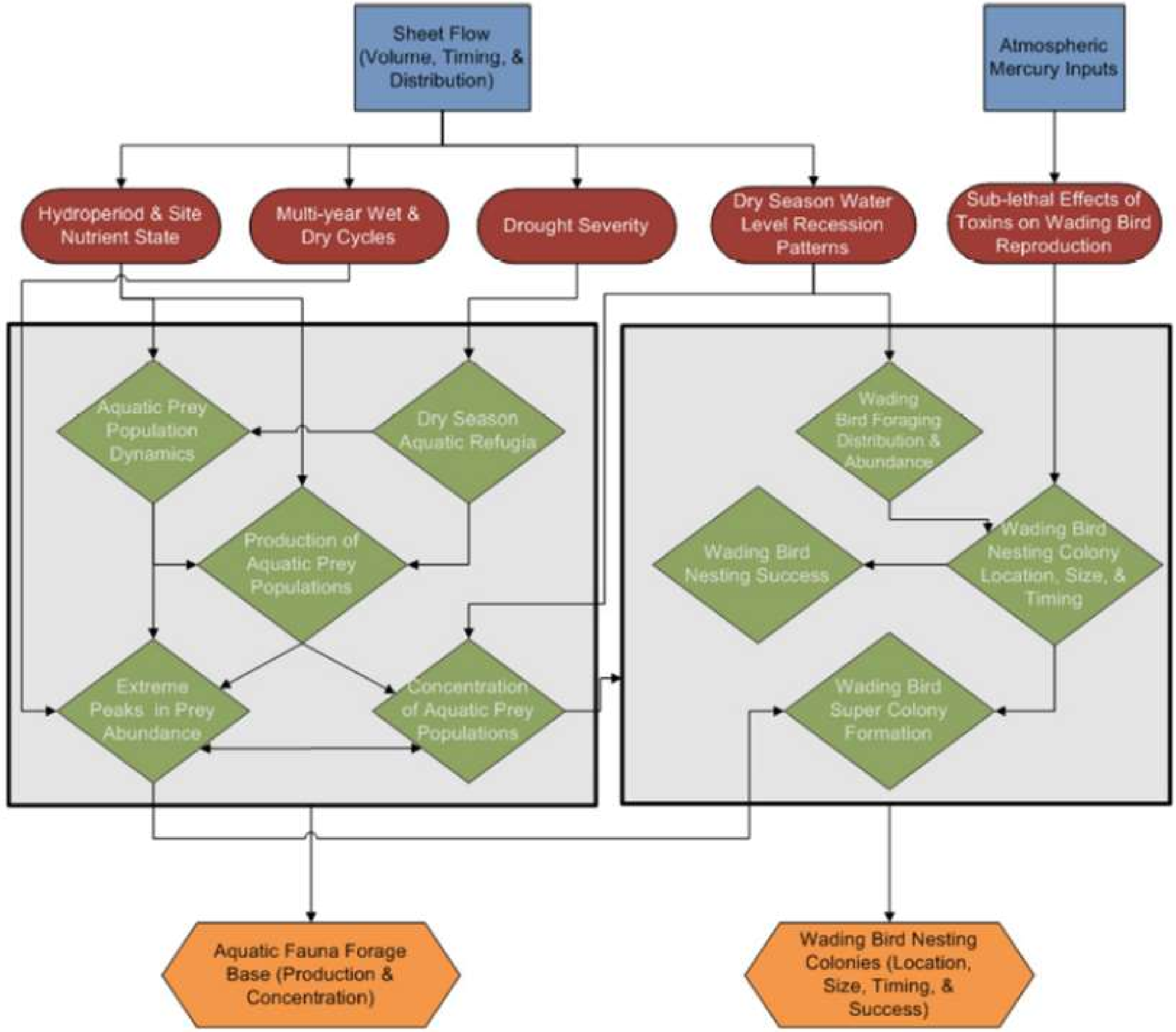
Complete list of Uncertainties (cont.):

Uncertainty 10. Impact of weaker and more porous shells on longevity of oyster and oyster population

Uncertainty 11. Impact of increased water temperature/reduced seasonality on physiological health of oysters

Uncertainty 12. Impact of sea level rise on distribution and health of oyster populations

SCS Predator-Prey Interactions (Trophic Interactions) Hypothesis Cluster



SCS Predator-Prey (Trophic Interactions) HC

Themes of Working hypotheses:

- **Hydrological conditions (i.e., hydroperiod and water depth), salinity, and wet season population densities and dry season concentrations** of marsh fishes, crayfishes, and other aquatic organisms influence wading bird foraging success.
- Many aspects of spawning, larval movement and development, juvenile growth and predation have been directly linked to **the magnitude and timing of freshwater inflow inundation of short hydroperiod wetlands, fish biomass production during the preceding wet season, and the incidence of environmental disturbances**.
- **MAP Monitoring:**
  - Crocodilians
  - Roseate spoonbills
  - Coastal wading bird colonies
  - Fishes
- **Key Uncertainties:**
  - Effects of climate change on marine end members
  - Effects of invasive fish species on diversity and trophic structure of native prey fish communities
  - Patterns of accumulation and biomagnification of mercury, pesticides, and pharmaceuticals in coastal and estuarine fishes
  - The spatial extent of oligohaline habitat needed to maximize production and survival of indicator fish species

SCS Predator-Prey (Trophic Interactions) HC

Complete list of hypotheses:

Hypothesis 1. Wading bird foraging success would improve as prey biomass increases with the restoration of more extensive wetlands including short hydroperiod wetlands and more natural dry season water table recession rates (Botson et. al., 2016). Restoration may remove subsidy, but increase suitability of estuary to allow sustained spillover of higher marsh production.

Hypothesis 2. American alligator and crocodile growth rates, survival, relative density, body condition, and nesting would improve with the restoration of freshwater flows and more extensive wetlands including short hydroperiod wetlands and more natural dry season water table recession rates.

Hypothesis 3. The wet season density and size structure of aquatic prey organisms are directly related to the time since the last dry-down and the length of time the marsh was dry. Aquatic prey populations are also affected by site nutrient status. Responses are non-linear and species specific.

Hypothesis 4. Prolonged inundation in marshes resulting from restoration will have a positive effect on prey densities and biomass resulting in greater marsh production, including for sunfishes (with relatively high caloric content relative to other estuarine prey), that are known to be a critical food source for both fish and avian predators. Small ‘prey-base’ fishes (<10 cm TL) utilize the expansive ephemeral wetlands (i.e., upper mangle) during wet periods, and are concentrated into deeper creeks when these wetlands became dry. Densities of these fishes increase on the upper mangrove with increased flooding (hydroperiod), and greater densities of larger species are observed in the creeks when hydroperiods exceeded 240 days.

SCS Predator-Prey (Trophic Interactions) HC

Complete list of hypotheses (cont.):

Hypothesis 5. Lower salinities resulting from restoration will increase habitat suitability for freshwater prey species in the ecotone or currently oligohaline and mesohaline zones, increasing in situ prey production in ecotonal habitats. Climate change will counteract these effects by increasing salinity regimes with sea level rise.

Hypothesis 6. The concentration of aquatic prey organisms into high-density patches where wading birds can feed effectively is controlled by the rate of dry season water level recession interacting with local topography and habitat heterogeneity.

Hypothesis 7. Unusually large aggregations of nesting wading birds (super colonies) consisting mostly of white ibis form after periods of drought in natural multi-year wet and dry cycles. The drought periods appear to cue pulses of production of prey organisms. The mechanisms by which these pulses are organized are poorly understood. Crayfish population surges, predatory fish population decline, and nutrient dynamics are likely involved.

SCS Predator-Prey (Trophic Interactions) HC

Complete list of hypotheses (cont.):

Hypothesis 8. Successful nesting of roseate spoonbills on the northern boundary of Florida Bay requires a well-timed drying front progressing along the coastal wetland landscape between November and April. This drying front provides a reliable source of prey needed for nesting success. Water depths must drop to at least 12.5 centimeters as the dry season progresses in order to meet the spoonbill's depth threshold for effective foraging on concentrated populations of small fishes and other aquatic prey organisms. Years of low spoonbill nesting success occur when the drying front is abbreviated by too wet or dry conditions, or when water levels rise, rather than recede, during periods of the dry season (water level reversals). Another factor contributing to spoonbill nesting success is the buildup of prey populations of small marsh fishes during the wet season. Prey populations of marsh fishes that are available for concentration during the dry season are directly correlated to the duration of hydroperiod and inversely correlated to salinity.

Hypothesis 9. Increased flows to the coast will have benefits for predators that are mediated by greater marsh prey abundance, biomass, quality (energetic content) and broader spatial availability (due to lower salinities) in estuarine areas. These beneficial effects to predators include greater abundance and body condition, a broader distribution (for species that are salinity-limited, e.g., Florida largemouth bass, American alligators), and a greater frequency and/or higher success of reproduction. Climate change will counteract these effects by increasing salinity regimes and preventing these trophic benefits to predators.

Hypothesis 10. Increase restoration flows will increase hydrological connectivity and lessens constraints on predator movement and distribution, allowing consumers to better track production across the landscape and resulting in enhanced food web coupling across the landscape.

SCS Predator-Prey (Trophic Interactions) HC

Complete list of Uncertainties (cont.):

Uncertainty 1. Will the productivity benefits of climate change (higher nutrient inputs on marine end member) counteract some of the negative effects of increased salinity?

Uncertainty 2. Factors that govern marine prey production in Florida Bay are poorly understood, but hypersalinity and seagrass loss and seagrass diversity loss should play a role.

Uncertainty 3. Loss and/or alteration of habitat and nutrient pollution are adversely impacting fish and other aquatic fauna (i.e., blue crabs) populations and communities (Valiela et al. 2001; Faunce and Serafy 2006; Orth et al. 2006). Acute and chronic stressors (algal blooms, low dissolved oxygen, and hurricanes and other extreme weather event) occur in coastal ecosystems, but a comprehensive understanding of the long-term impacts of these, and the magnitude of their impacts on fish communities, is still lacking (Connell 1997; Cole and Monz 2003; Matich et. al., 2020). More work is needed to understand how some fish guilds benefit, while others are adversely impacted. For example, alterations of water column and benthic habitat can enable invasive species to outcompete native species (Dukes and Mooney 1999; Orth et al. 2006; Lewis et. al., 2020). Furthermore, within estuarine fish communities some guilds can benefit from an algal bloom, while abundances of others are negatively impacted (Gannon et. al., 2009). Fish monitoring alongside restoration projects will provide the means to understand how fish are responding.

Uncertainty 4. It is well established that invasive fish species introductions generally have undesirable impacts on ecosystems; however, the effects of these introductions on diversity and trophic structure is not well understood. Baseline biological and physical data are generally lacking on native and non-native species prior to non-native species introductions, thus making it difficult to distinguish effects of introduction from normal biological variability and to determine the effect on native species (Pintar et. al., 2023).

SCS Predator-Prey (Trophic Interactions) HC

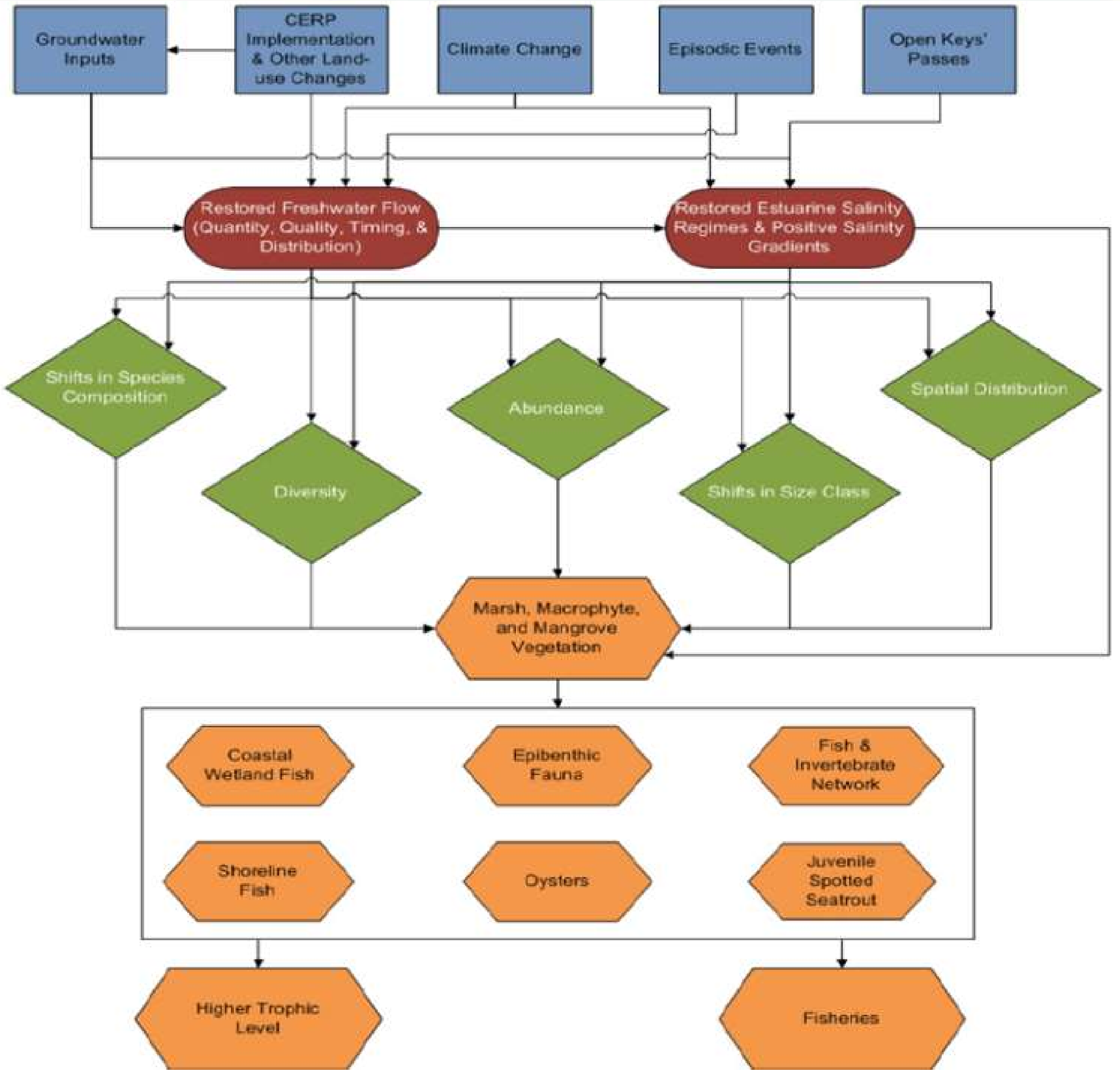
Complete list of Uncertainties (cont.):

Uncertainty 5. Patterns of accumulation and biomagnification of mercury, pesticides, and pharmaceuticals in coastal and estuarine fishes are of great concern in South Florida. There remain uncertainties surrounding mercury and other toxicant resuspension, methylmercury production and uptake by fishes following restoration efforts. Mercury sources, bioaccumulation, and biomagnification continue to be a fundamental concern because of the massive collaborative restoration program in South Florida (CERP) being undertaken by SFWMD and USACE that will alter the quantity, quality, timing and distribution of water delivered to coastal estuaries and bays. There is potential that these restoration efforts and resulting changes to water flows could exacerbate and further expand the biomagnification of mercury, pesticides, and other toxicants from the freshwater Everglades.

Uncertainty 6. Seagrasses, oyster reefs, mangroves, and salt marshes are critical coastal habitats that support high densities of juvenile fish and invertebrates. However, efforts to quantify these relationships are limited, and uncertainty remains as to which species are enhanced through these nursery habitats, and to what degree.

Uncertainty 7. Maintenance and restoration of oligohaline/mesohaline zones of coastal rivers is an important goal for restoration of the SCS. Water management operations need to therefore maintain adequate salinity by establishing and maintaining a healthy baseflow during the dry season and in droughts to promote a healthy fish assemblage and ecosystem. Where the oligohaline zone has been reduced in size and volume there have been reductions of native estuarine and resident species. For example, the distribution of opossum pipefish, snooks, sleepers, and selected gobies are known to be limited to freshwater and oligohaline portions of rivers. However, the spatial extent of oligohaline habitat needed to maximize production and survival of these indicator species is still unknown.

SCS Estuarine Nursery Habitat Hypothesis Cluster



SCS Estuarine Nursery Habitat HC

Working Hypotheses:

Hypothesis 1. Restoration would increase the length of shoreline receiving freshwater, expand the spatial extent of desirable salinities, and reduce salinity fluctuation to a range and frequency characteristic of natural estuarine conditions, thereby increasing the area of optimum habitat for many species. As a result, these changes will expand local distribution, increase abundance, and allow a richer species assemblage of estuarine species.

Hypothesis 2. Restoration would reduce the intensity, duration, and spatial extent of hypersaline conditions, thereby increasing the area of optimum habitat for nearshore fish and invertebrates.

Hypothesis 3. Anticipated changes in fish community structure in response to increasing the area of optimum habitat include an increase in the utilization of mangrove shorelines by euryhaline species such as gray snapper and snook, while the use by stenohaline marine species would decrease. There should be occasional observations of species associated with both fresh and brackish conditions.

Hypothesis 4. Restoration would increase the area covered by patchy or heterogeneous seagrass habitat, thereby increasing the area of optimum habitat for seagrass-associated fish and invertebrate species.

Hypothesis 5. Restoration would reestablish sheet flow to the coast that would rehydrate coastal marshes and recreate habitat for freshwater fish and other prey for utilization by wading birds and other high trophic level species.

MAP Monitoring:

- Marsh, Macrophyte, and Mangrove Vegetation
    - Coastal wetland fish
    - Shoreline fish
    - Epibenthic fauna
    - Oysters
    - Fish & invertebrate network
    - Juvenile spotted seatrout

SCS Estuarine Nursery Habitat HC

Key Uncertainties:

Uncertainty 1. Ability/validity of extending to restored systems inferences based on impacted systems when they may be fundamentally different.

Uncertainty 2. Present observations may be an artifact of an unknown or unsampled factor.

Uncertainty 3. Oversimplification of current habitat suitability