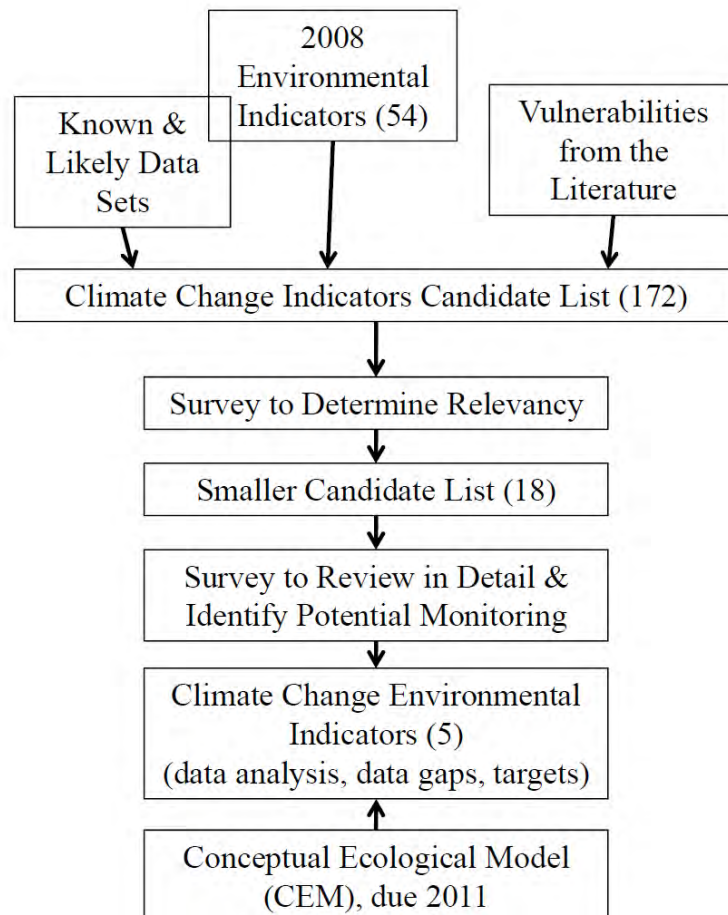


# Stewardship

Objectives of the CCMP include the CHNEP serving as a recognized resource to elected officials or their agents from local, state and federal government for policy advice. One of the actions under this is to build capacity for communities and their local leadership to mitigate and adapt to the effects of climate change through joint efforts. EPA contracted with ICF International on behalf of CHNEP to develop environmental indicators of climate change.

The Stewardship Gap priority problem is new to the CCMP as of 2008. Consequently, the development of the indicators of climate change required a slightly different process from the other indicators of this document. A candidate list was drawn from the 2008 Environmental Indicators, the 2009 Regional Vulnerability Assessment (derived from the literature), and known and likely data sets that might be relevant. These 172 candidates formed the first of two surveys where the respondents were asked to rate the relevancy of each candidate. The top ranked candidates (plus 2 additional candidates) formed a more detailed survey. Respondents were asked about known and needed monitoring programs, if existing data are detailed enough, if the candidate is responsive to climate change, if it is useful to managers and helpful for outreach and the relevance of the candidate. From the survey, 5 candidates were identified and modified. Available products were identified, data obtained and analyzed, data gaps identified and targets identified. This information is in the next few pages. In 2011, Conceptual Ecological Models will be developed and the climate change environmental indicators reviewed in the context of the model.

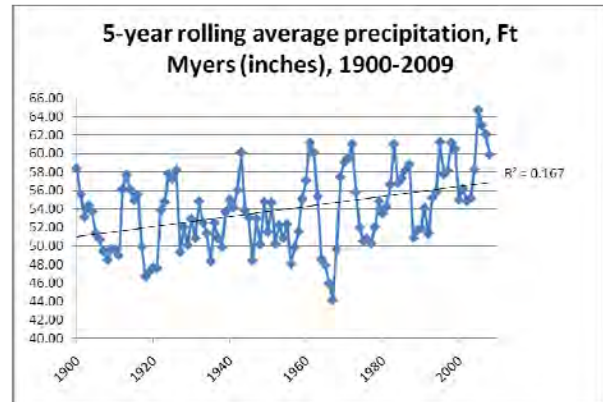
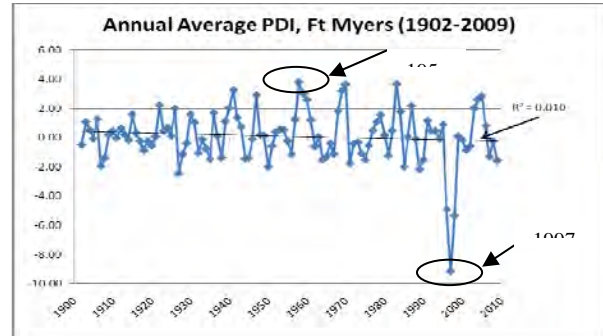


**SG-a:** Changes to precipitation trend/patterns, including extreme precipitation

**Summary:** Trends in precipitation can have a significant impact on managing natural systems. Periods of extreme drought can have adverse species and habitat impacts, such as insufficient flow to support submerged aquatic vegetation, fish and related food webs. Drought can also weaken terrestrial vegetation, decreasing resistance to pests and increasing the potential for wildfire. Identification of “extreme” precipitation events and monitoring trends in such events improves management choices.

**Available Products:**

- Monitoring programs include the triennial water quality status and trends, long term rainfall/temperature stations at Bartow, Arcadia, and Fort Myers.
- Trends in drought can be tracked with the National Climatic Data Center’s (NCDC) North American Drought Monitor, using the *Palmer Drought Index* (PDI) or the *Standard Precipitation Index* (SPI). Monthly PDI and SPI data for Fort Myers (station ID 83186), dating to 1902 for both SPI and PDI, are available at: <http://www.ncdc.noaa.gov/oa/climate/monitoring/drought/nadm/indices.php>
- Daily precipitation and temperature records for all stations within Florida can be downloaded at: [http://www.coaps.fsu.edu/pub/griffin/SECO/OP/SECC\\_data/ascii/](http://www.coaps.fsu.edu/pub/griffin/SECO/OP/SECC_data/ascii/) or <http://cdiac.ornl.gov/epubs/ndp/ushcn/access.html> (this site also provides monthly and annual precipitation totals).



**Gaps:**

Identify standard methods for measuring extreme precipitation generally accepted by Florida’s water managers to employ. If monitoring this indicator reveals that extreme events are increasing, CHNEP could consider additional management actions such as:

1. Continually monitoring to determine the relationship between heavy precipitation events and estuary health; and
2. Considering adaptive measures to offset any observed negative impacts of increasing nutrient concentrations and other pollutants in the estuary system.

**Targets:**

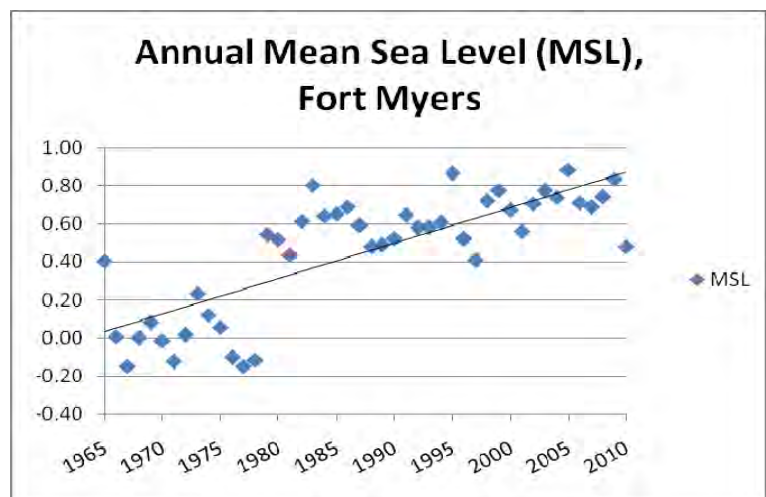
- Rolling 5-year average of 50 inches of rainfall per year (including the Bartow, Arcadia and Fort Myers stations).
- Annual number of events exceeding the 95<sup>th</sup> percentile (0.42 inches) on a monthly and annual basis.

## SG-b: Sea-level rise

**Summary:** Relative sea-level rise, which includes contributions from absolute global sea level increases, as well as local subsidence, is already observed to be increasing in the CHNEP area. The rise pre-dates anthropogenic contributions, with geologic records indicating that sea level in the CHNEP area has been rising for at least the past 6,000 years. Projections of sea level for the 21<sup>st</sup> century indicate the rate of rise will also continue to increase. Relative sea level for CHNEP is projected to be between 7 and 45 inches from 2000 to 2100.<sup>1</sup> Some of the threats to the CHNEP system associated with sea-level rise include saltwater intrusion of the water table and also of surface waters that are currently fresh or brackish. Higher salinity increases mortality of freshwater-dependent vegetation and animals. Higher baseline sea level also exacerbates the threats of storm surge from severe coastal storms. These threats include significant coastal erosion and inundation of terrestrial and freshwater habitats.

### Available Products:

- Raw data and graphs of locally-measured sea level trends in Fort Myers are available through the National Oceanic and Atmospheric Administration (NOAA) *Tides and Currents* website. Mean monthly sea level data are available for 1965 to present. From the monthly data, annual and decadal trends have been identified. Local data (for station 8725520 in Fort Myers) is available at:



Local data (for station 8725520 in Fort Myers) is available at:

[http://tidesandcurrents.noaa.gov/station\\_retrieve.shtml?type=Historic+Tide+Data](http://tidesandcurrents.noaa.gov/station_retrieve.shtml?type=Historic+Tide+Data). The graph below presents annual mean sea level at NOAA's Fort Myers station.

### Gaps:

- Further investigation of how sea-level rise may affect ecosystem processes and identify management priorities.
- Develop better models of sea-level rise curves.

### Targets:

- Relative sea-level rise at 1 inch per decade (plus or minus ½ inch).

<sup>1</sup> CHNEP 2010. Charlotte Harbor Regional Climate Change Vulnerability Assessment.

## SG-c: Water Temperature

**Summary:** Increases in water temperature affect estuarine organisms directly based on species' thermal tolerances and indirectly because warm water holds less dissolved oxygen (DO). Northward shifts in the distributions of mobile species can be expected as sea surface temperatures (SSTs) increase, while sessile organisms will experience physiological stress and ultimately mortality as thermal tolerances are exceeded. Harmful algal blooms (HABs) are triggered by excessive nutrient loadings combined with elevated water temperatures, contributing to declines in DO when the algal biomass decays.

### Available Products:

SST data can be used to detect warming trends or to compute temperature anomalies (deviations from annual means). Sources for SST data include:

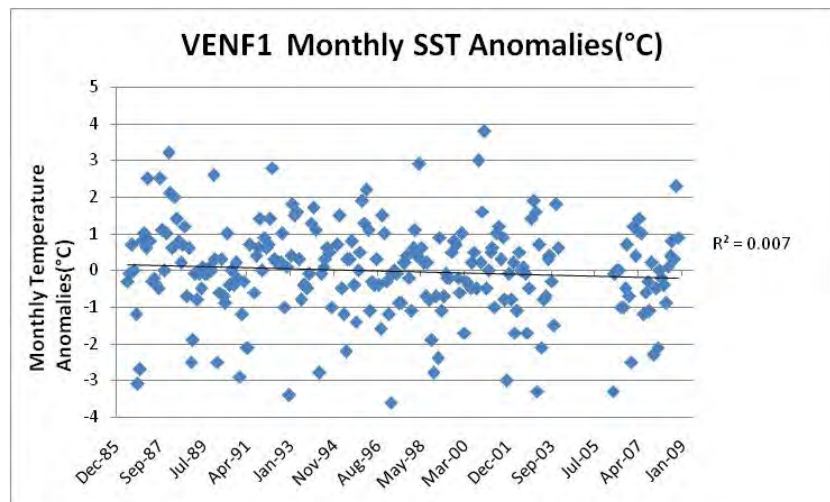
- The National Data Buoy Center (NDBC) – <http://www.ndbc.noaa.gov> - has meteorological data, including sea surface temperature data, for NOS Station FMRFI – 8725520 - Ft. Myers, National Data Buoy Center Station VENF1 – Venice, and University of South Florida Station BGCF1 – Big Carlos Pass Data can be downloaded or viewed online.
- The Charlotte Harbor Estuaries Volunteer Water Quality Monitoring Network (CHEVWQMN) collects monthly water temperature data in the Lemon Bay, Gasparilla Sound, Charlotte Harbor, Pine Island Sound, Matlacha Pass, San Carlos Bay and Estero Bay estuaries. The data are available online at: <http://www.dep.state.fl.us/COASTAL/SITES/charlotte/volunteer/waterquality.htm>.

### Gaps:

- CHEVWQMN water temperature data for 1996-2008 were collected with thermometers, but from 2009 on the data have been collected with probes. The correction factors needed to compare future temperature data to past years to look for significant temperature changes are currently under development by FDEP CHAPs.
- Temperature data are collected regularly at buoys off Fort Myers, Venice and Big Carlos Pass, but are only available for the past decade. Because some warming has already occurred, these data may not be good indicators of water temperatures from a pre-development perspective. If the data continue to be collected, however, analysis of temperature trends will be possible.

### Targets:

- No trends in National Data Buoy Center Station VENF1 Anomalies.



## SG-d: Phenology

**Summary:** There is increasing evidence that this change is altering the timing of key phenological (biological cycle) events in many plant and animal species. Changes in the timing of insect emergence, plant flowering, bird migrations and other phenological events can disrupt ecosystems in a number of important ways. For example, ecological mismatches can occur, such as when migratory birds arrive at their breeding grounds before insect food sources are available.

### Available Products:

- The only source of long-term phenologic data found in the CHNEP study area relates to citrus research. Dr. L. Gene Albrigo, Citrus Research & Education Center, Lake Alfred, FL, [albrigo@crec.ifas.ufl.edu](mailto:albrigo@crec.ifas.ufl.edu) maintains over 50 years of citrus flowering and modeling data<sup>2</sup>. Valiente and Albrigo (2000) analyzed days to full bloom in relation to temperatures over the period 1960-2000 and found they could predict citrus tree flowering. Floral organ differentiation is initiated after 650 cumulative hours under 19° C (66° F). Preliminary regression analyses of the modeled data suggest floral organ differentiation is occurring 1 day later for every 3 years of record. Live oaks flower about a week before citrus. The Live Oak Phenology Network can be found at: <http://www.cbs.umn.edu/cavender/LOPnet/>.
- The USA National Phenology Network (USA-NPN) (<http://usanpn.org>) is a data source.
- Sightings in state parks in CHNEP are available in spreadsheet format from Terry Hingtgen, Environmental Specialist, District 4, Florida Park Service, Department of Environmental Protection, 1843 South Tamiami Trail, Osprey, Florida, 34229, (941) 486-2051.
- The Cornell Ornithology Lab Ebird website <http://ebird.org/ebird/eBirdReports?cmd=Start> has counts by amateur birders by species and location.
- A Florida Phenology Network is being organized by George Kish (U.S. Geological Survey), Will Sheftall (University of Florida Extension), Anna Farmer (Florida Fish and Wildlife Conservation Commission), and Joseph Reinman (U.S. Fish and Wildlife Service). A workshop for developing protocols, species lists, data portals, and a strategy for building a Florida-wide network was held in Gainesville in May 2009. George Kirsch is also the coordinator for the Southeast Regional Phenology Network. Both networks are part of the USA-UPN. Mr. Kish has offered to provide training to CHNEP volunteers.

### Gaps:

Long-term monitoring of natural phenologic data in the CHNEP study area.

### Targets:

- No further delay in citrus floral organ differentiation.

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<sup>2</sup> Valiente, J. I., and L.G. Albrigo. 2002. Modeling flowering date of sweet orange trees in central Florida based on historical weather. *Proc. Intl. Soc. Citriculture*, pages 296-299.

## SG-e: Habitat Migration

**Summary:** Landward migration of seagrass and salt marsh habitats has been documented in the CHNEP study area.

### Available Products:

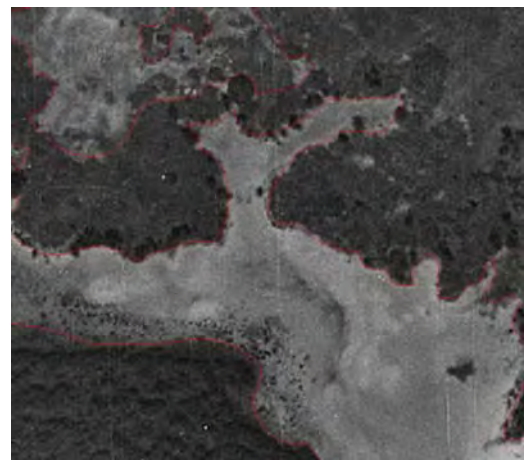
- “Implications of Sea Level Rise to Seagrasses in Charlotte Harbor National Estuary Program,” Ott, 2009, demonstrated landward migration of sea grasses between 1950 and 1999. 1950 maps were developed for CHNEP by PhotoScience and were compared to 1999 Water Management District seagrass maps.
- “Climate Change Vulnerability Assessment and Adaptation Opportunities for Salt Marsh Types in Southwest Florida” is in preparation by the Southwest Florida Regional planning Council. Initial findings demonstrate landward migration of some marsh types in some areas.

### Gaps:

- Completion of salt marsh study, including analysis of rate of migration.

### Targets:

- As determined in salt marsh study and verified by seagrass data.



**EPA Governmental Performance and Results Act (GPRA)  
Matrix, Indicator Report**

**NEP NAME: Charlotte Harbor National Estuary Program**

Indicator	In Use or Under Development?	CCMP Objective	Type of Monitoring for Each In Use" Indicator	Entity Conducting/ Funding Monitoring	Parameters Being Monitored	Question the Indicator Will Help Answer
19. Climate Change	Under Development.	<b>SG-2:</b> By 2010, the CHNEP will serve as a recognized resource to elected officials or their agents from local, state and federal government for policy advice.	1. Rainfall 2. Sea Level 3. Water Quality 4. Citrus modeling 5. Aerial photographs	1. Climate Center 2. NOAA 3. Many Agencies 4. IFAS 4. CHNEP contracts	1. Rainfall 2. Sea Level 3. Water Temperature 4. Phenology 5. Habitat Migration	1. Is climate changing? 2. Are ecosystems changing in response?