Adapting Assessment Tools and Water Quality Criteria for a Changing Climate

UF Water Symposium

Session: Impacts of Climate Change and Climate Variability on Water Resources

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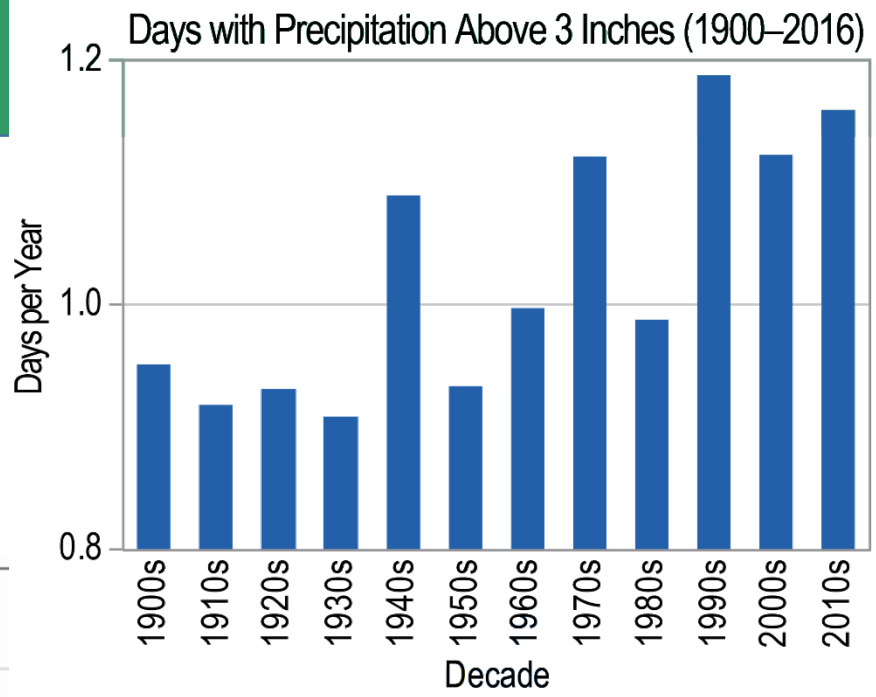
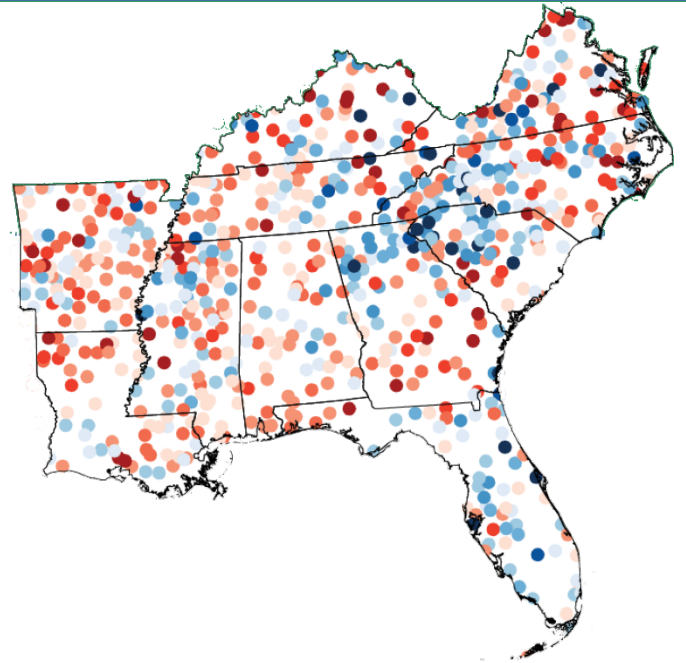
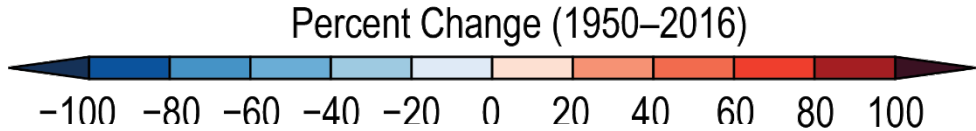
Overview

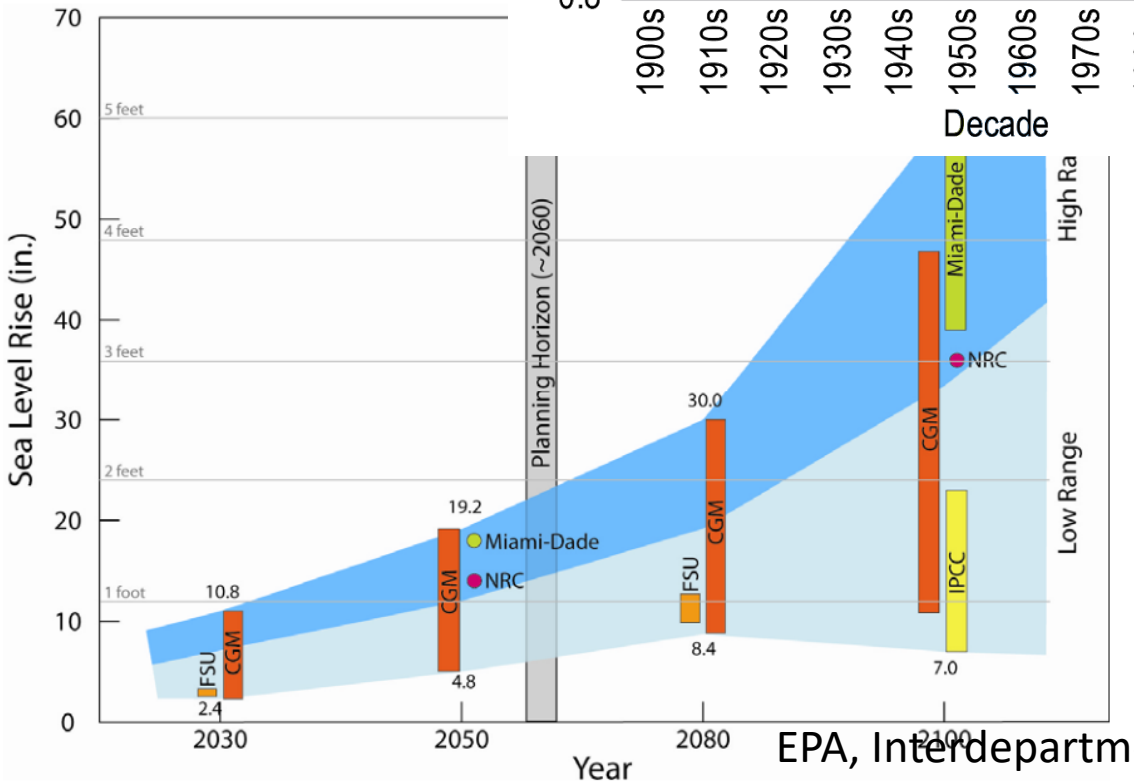
- Projected climate change effects in Florida
- Regulatory Implications for selected programs:
  - Total Daily Maximum Loads (TMDLs)
  - Municipal Separate Storm Sewer System (MS4)
  - Minimum Flows and Levels (MFLs)
  - Groundwater/Drinking Water program
  - Water Quality Criteria
  - Biological Assessment

FRYDENBORG eco LOGIC

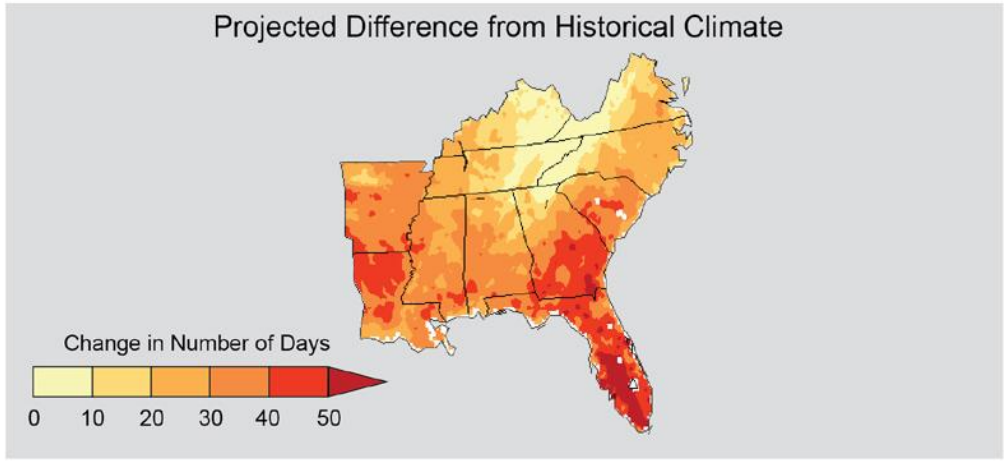








Projected Change in Number of Days Over 95°F



EPA, Interdepartmental Climate Change Group & Fourth National Climate Assessment

What is likely for Florida?

- Drivers: Increasing greenhouse gases, air temperature, ambient water temperature, sea level rise
- Predicted changes include:
  - Ocean acidification
  - Greater evapotranspiration
  - Increased heavy rains , increased or decreased precipitation
  - Saltwater intrusion, estuary community shifts
  - Fewer freezes, warmer long-term weather
  - Warmer ambient water
  - Coral bleaching/disease
  - Changes in nutrient supply/cycling/food webs
  - Changes in distribution of native and invasive species

Total Maximum Daily Load (TMDL)

- TMDL is a mandatory program for restoring impaired waters
- TMDL identifies the maximum amount of a pollutant that a body of water can receive and still achieve water quality standards
- Point source and non-point source discharges subject to pollutant reductions

TMDL Example: Alachua Sink

- Alachua Sink determined to be impaired (excessive chlorophyll) due to nitrogen enrichment
- TMDL for total nitrogen of 40,380 lb/yr and 623 lb/yr, for MSWRF and KGS respectively. MS4 must reduce TN by 45%
- Upgrades to MSWRF
- 125 acre wetland created to achieve TMDL
- **If loading increases, wetland treatment must increase**

MS4 Permits

- **MS4 permits** authorize cities, counties, or other governmental entities to discharge storm-water collected by their storm systems to waters of the United States
- MS4 permits based on structural and non-structural best management practices demonstrated to reduce pollutants from **historic rainfall/loading rates**
- BMP effectiveness must be re-evaluated at new rain/loading patterns

Gainesville MS4s

- 125 acre wetland created to reduce nutrients, **any increase in MS4 loading would require additional treatment**

Minimum Flows and Levels (MFLs)

- Designed to protect aquatic systems from excessive water consumption by humans
  - Increasing demand from population growth, and likely less recharge (more runoff, less rainfall depending on season/location)
- **Each MFL represents a long-term water level and/or flow statistic that climate change influences**, composed of:
  - Water level or flow (how much / high)
  - Duration (how long)
  - Frequency (how often)

What is a Minimum Flow?

Low Flow Causing Harm?

Normal Flow

Variety of Goals for MFLs

- Climate change will affect ability to meet management goal differently
- Management goals include:
  - Recreation in and on the water;
  - Fish and wildlife habitats and the passage of fish;
  - Estuarine resources;
  - Transfer of detrital material;
  - Maintenance of freshwater storage and supply;
  - Aesthetic and scenic attributes;
  - Filtration and absorption of nutrients and other pollutants;
  - Sediment loads;
  - Water quality; and
  - Navigation.

Chapter 62-40.473, FAC

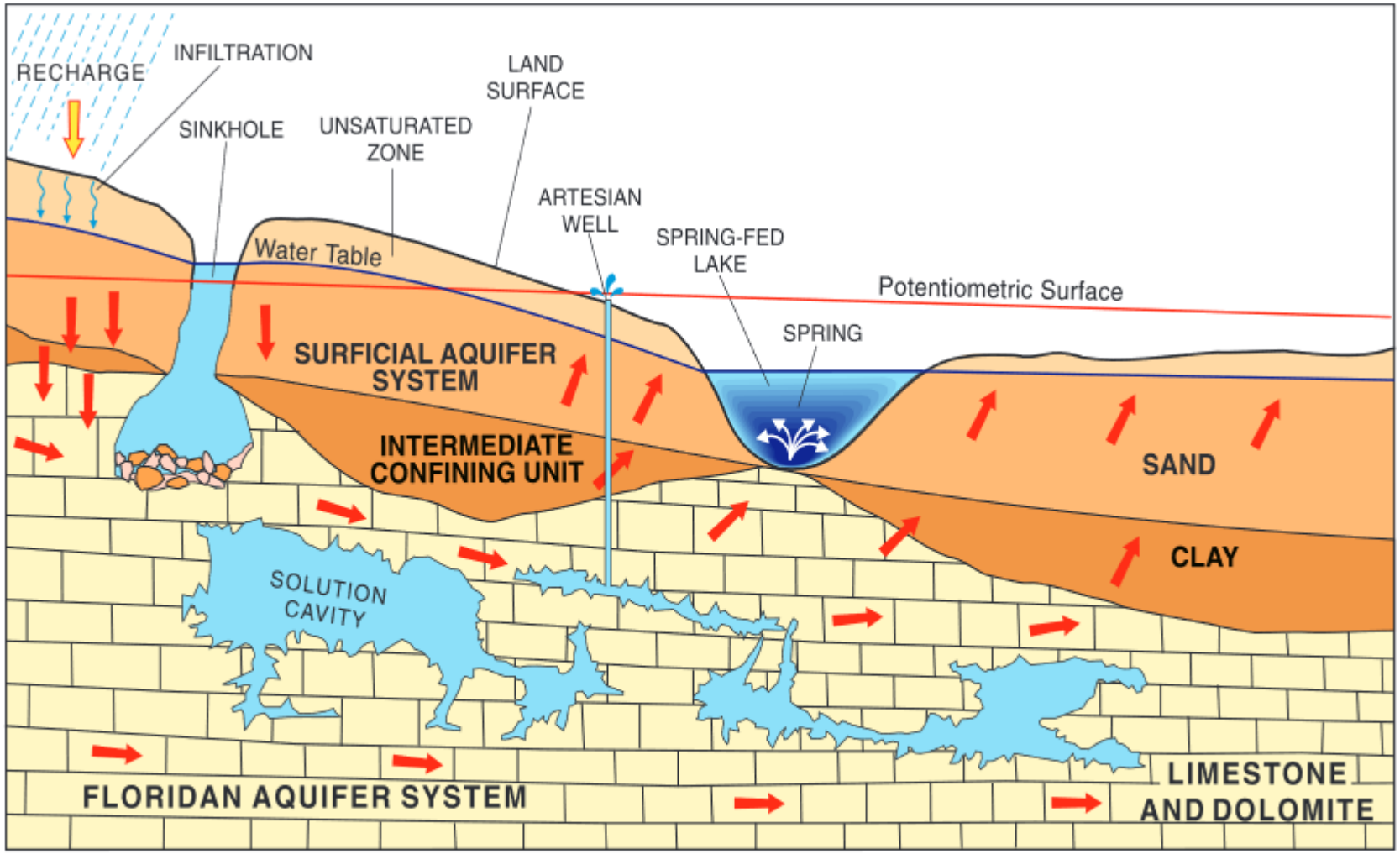
Volusia Blue

- MFL endpoint is manatee protection from cold temperatures
- Easier to achieve if warm

Groundwater/Drinking Water program

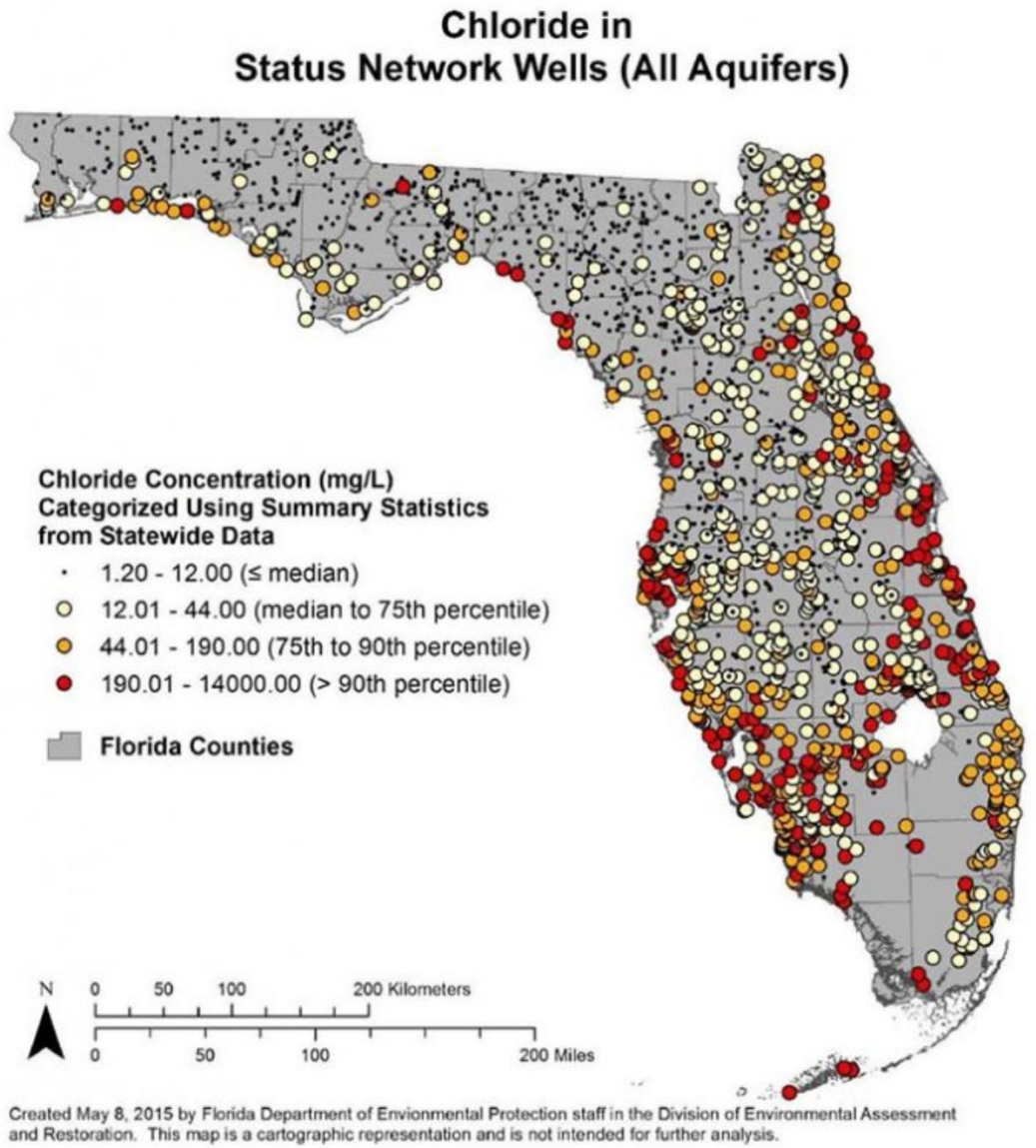
- ~80% of Florida's drinking water is groundwater
- The Groundwater/Drinking Water program is designed to assure the water Floridians consume meets critical drinking water criteria
- Primary Standards (e.g., many contaminants, carcinogens)
- Secondary Standards (e.g., chloride, 250 mg/L)

Florida's Hydrogeology (USGS)



Florida's extremely porous karst geology makes installing barriers to rising sea levels impossible

Chloride Levels Getting Higher



- Chloride is rising significantly in Florida's aquifers, which will be **exacerbated by increased sea level rise**
- Implications for surface water consumption, inter-basin transfers (surface instead of ground)

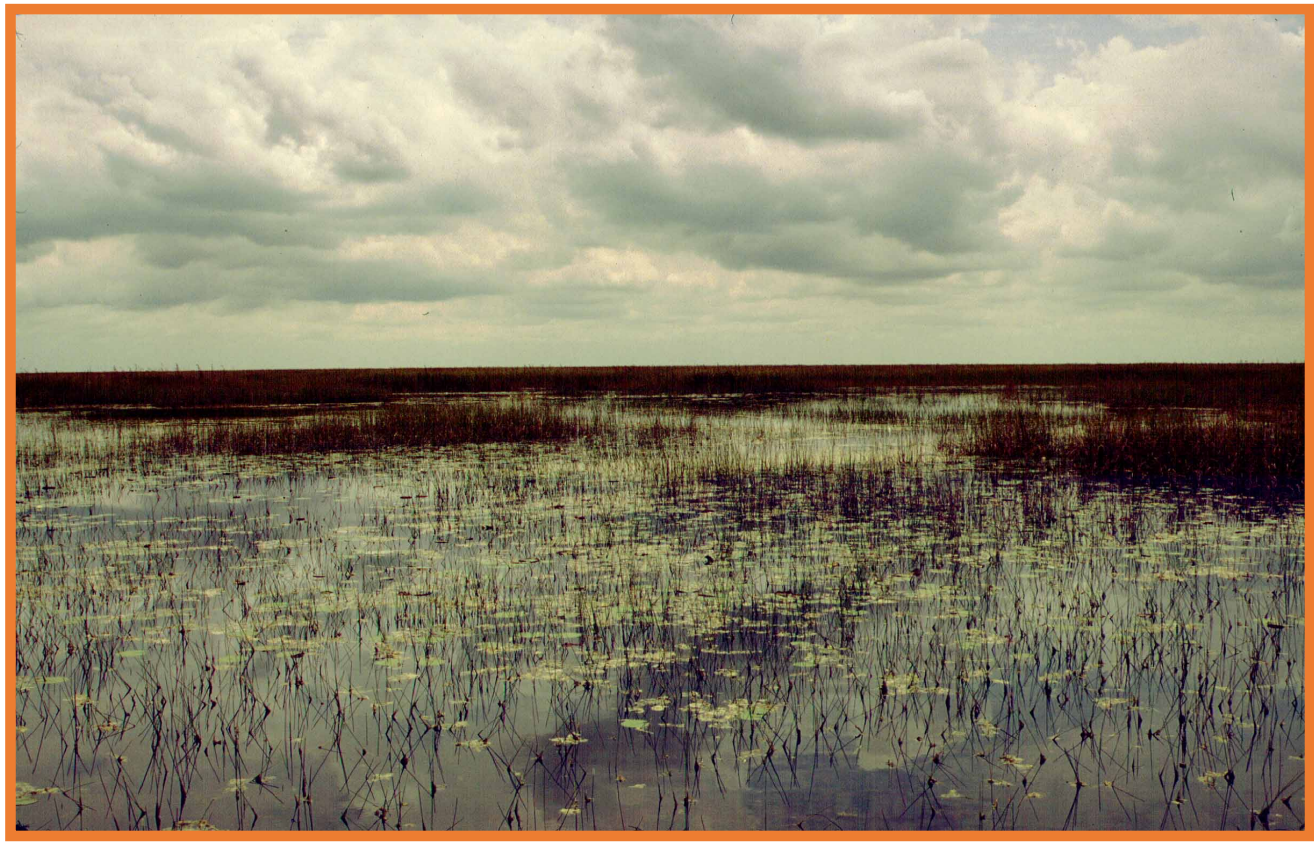
Rick Copeland, FDEP

Water Quality Criteria

- Narrative or numeric standards designed to maintain waterbody designated uses, generally supporting healthy, well balanced aquatic communities and recreation in and on the water
- Most criteria are derived in laboratory toxicity tests, but some are based on **“background” conditions:**
  - Specific conductance
  - pH
  - Transparency
  - Turbidity
  - Chloride

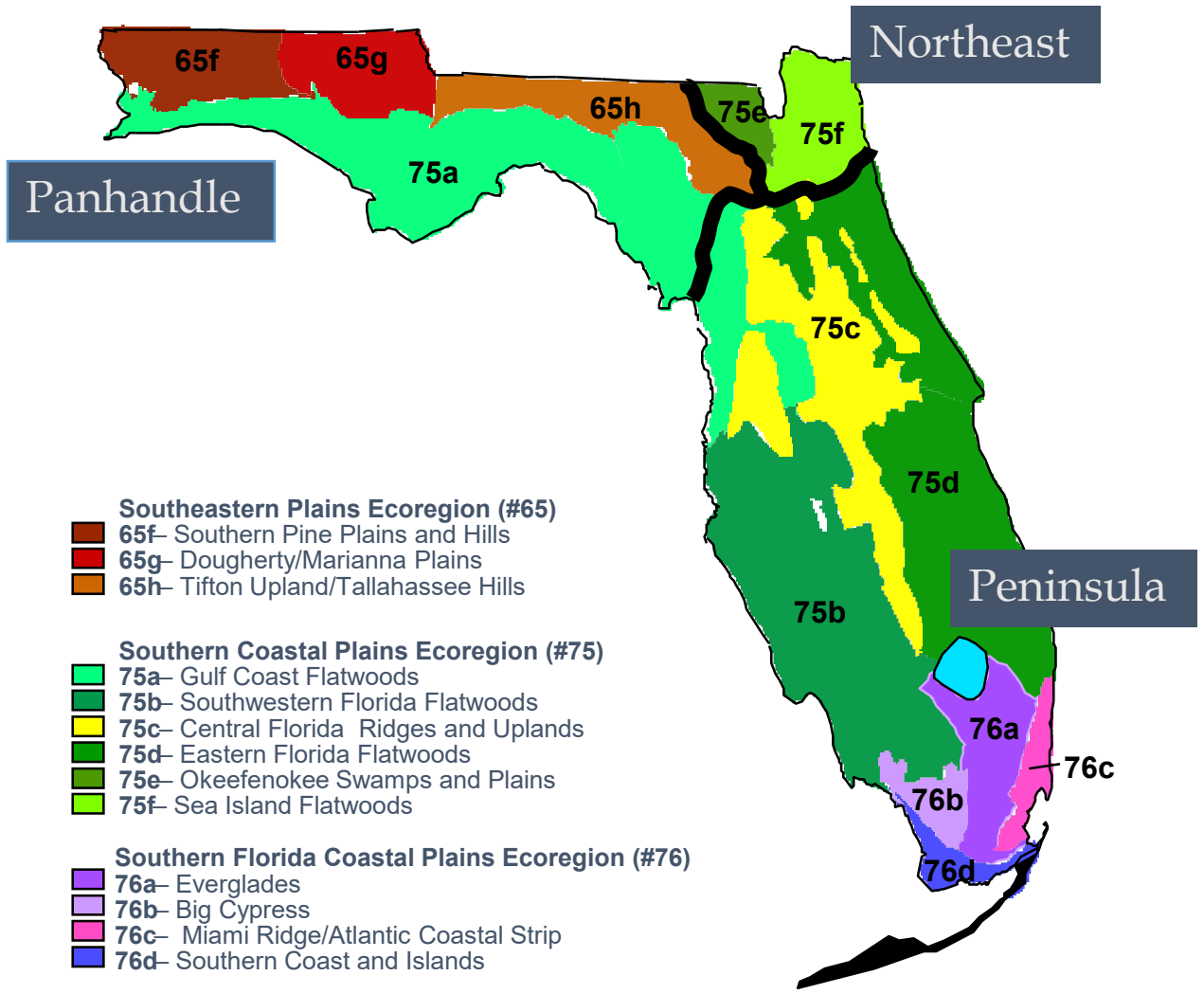
Chloride Example

- Shall not be increased **more than 10% above normal background**. Normal daily and seasonal fluctuations shall be maintained.
- If Everglades chloride begins to increase by >10% due to sea level rise, how can this be mitigated?
- Mangrove forest develop – new background condition?



Biological Assessment

- FDEP has developed biological assessment tools for Stream Condition Index, BioRecon, Lake Vegetation Index, Linear Vegetation Survey, and Rapid Periphyton Survey
- Biological expectations separated by **regional reference conditions**
- When reference conditions change, tools must be adapted



2016 Algal Bloom in St. Lucie Estuary

Microcystis, A Freshwater Alga That Can Produce Toxins, Thrives in Warm Water

Estuary Numeric Nutrient Criteria

- Based on "**maintain healthy existing conditions**", BUT:
- Increased flows to estuaries likely to increase nutrient delivery and eutrophication (Easterling et al 2000; Alber 2002;Peterson et al 2008)
- Major spatial shifts in wetland communities, including invasions of exotic species, likely (Dahdouh-Guebas et al 2005)
- **More wet years than baseline, more NNC failures**

Conclusion

Climate change will significantly affect regulatory program effectiveness, will stress municipalities/dischargers seeking to comply with law

Must plan now

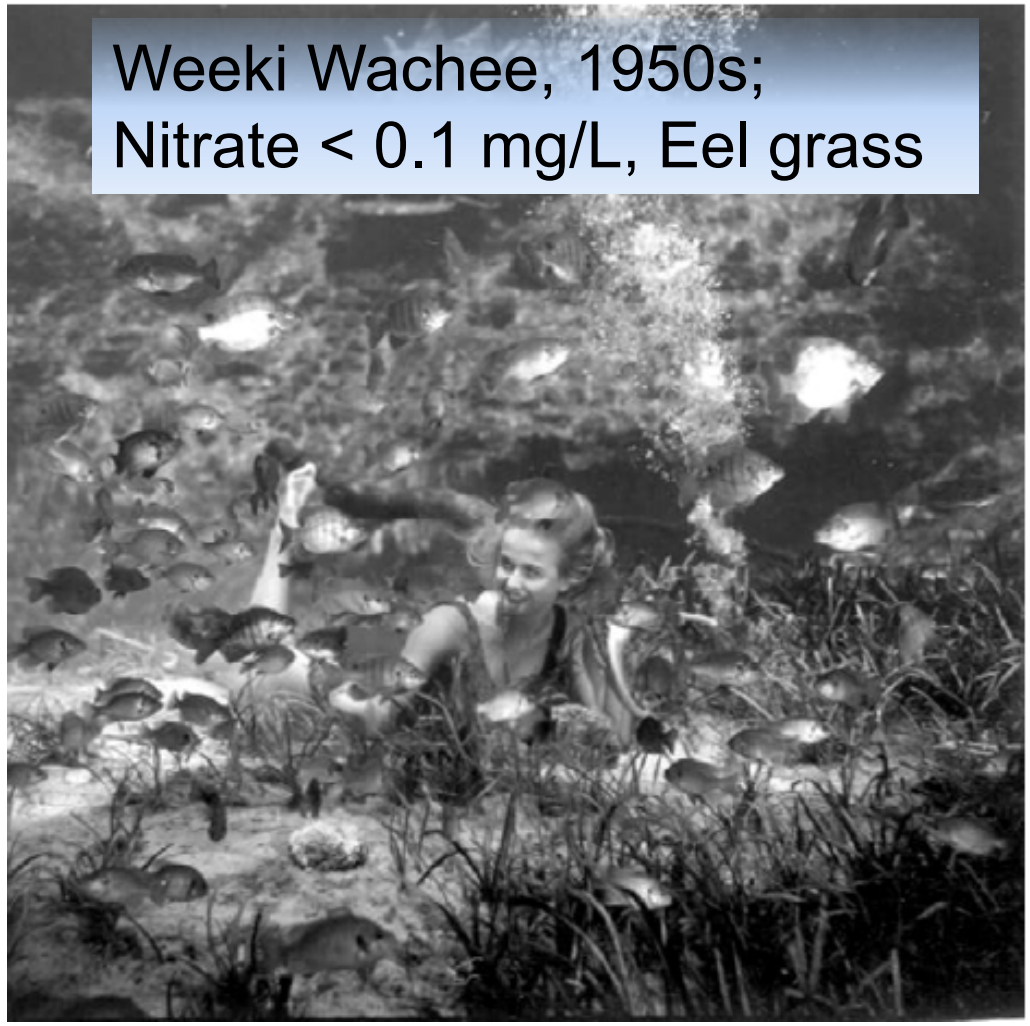
Questions? www.frecologic.com

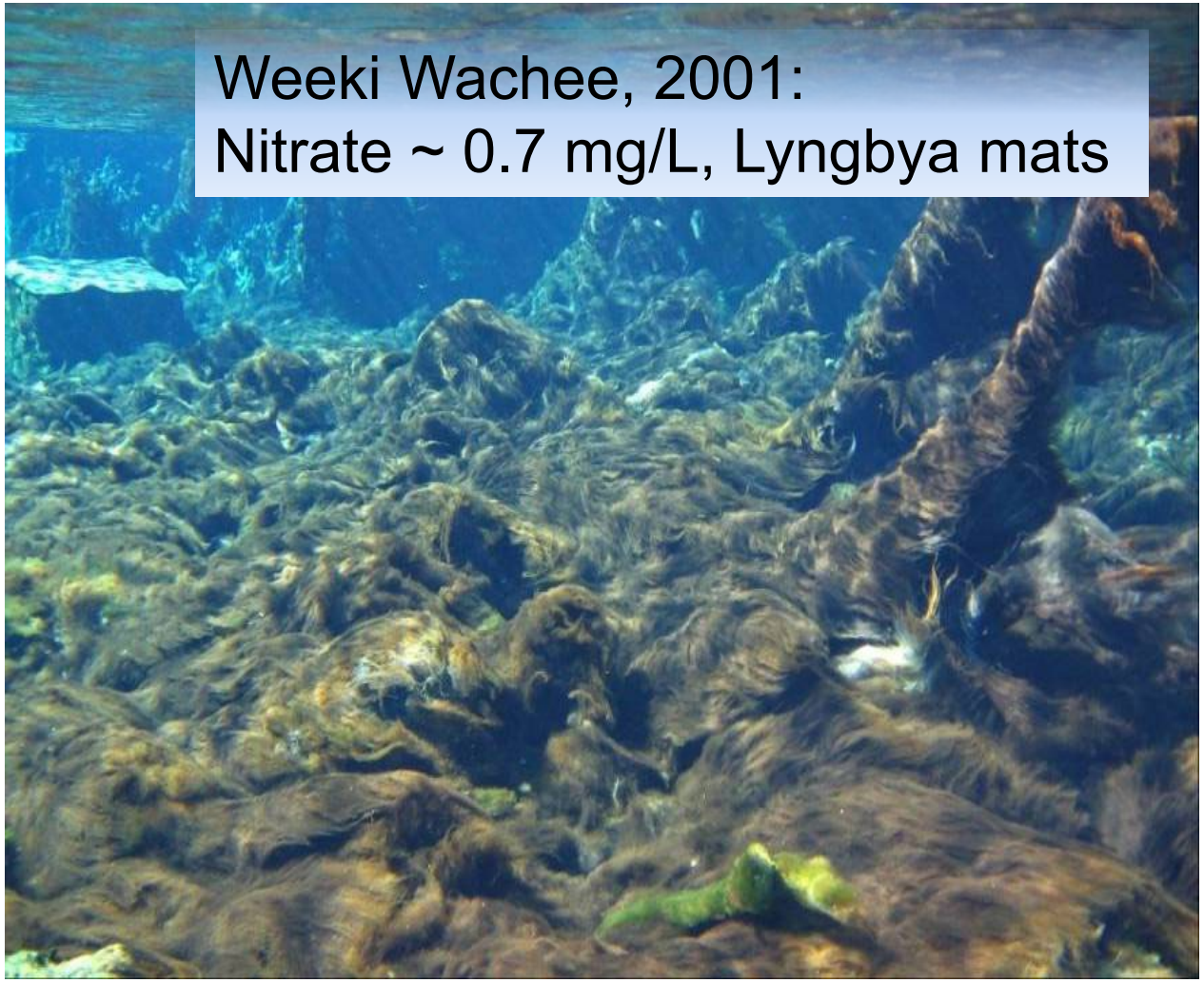
ideas

- Development of assessment tools, particularly for assessments of biological community status and trends, for rapid assessments of natural resources, and for evaluation of management efforts

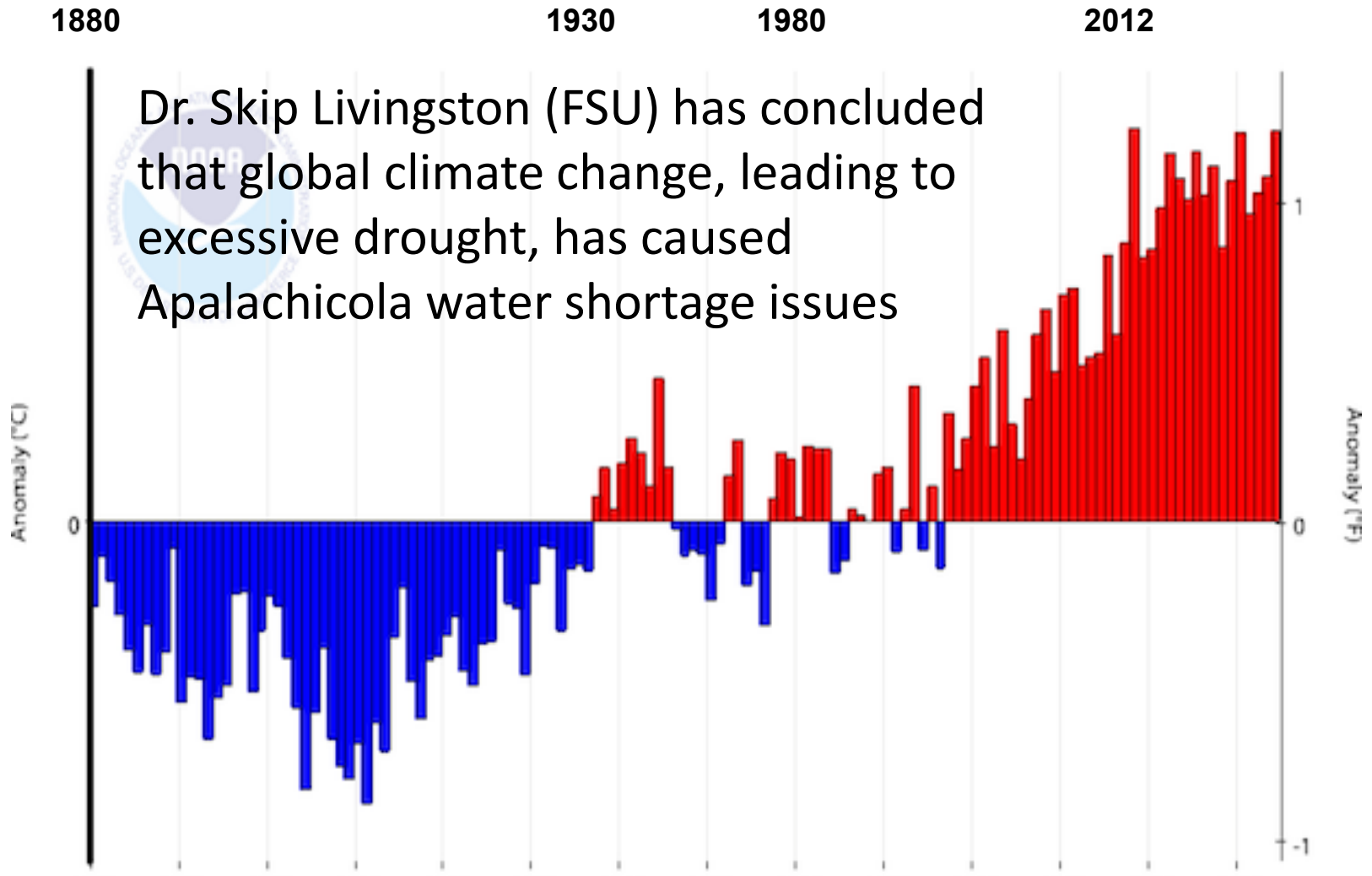
Springs and Water Quality

- Nitrate water quality criterion of 0.35 mg/L required for spring vents



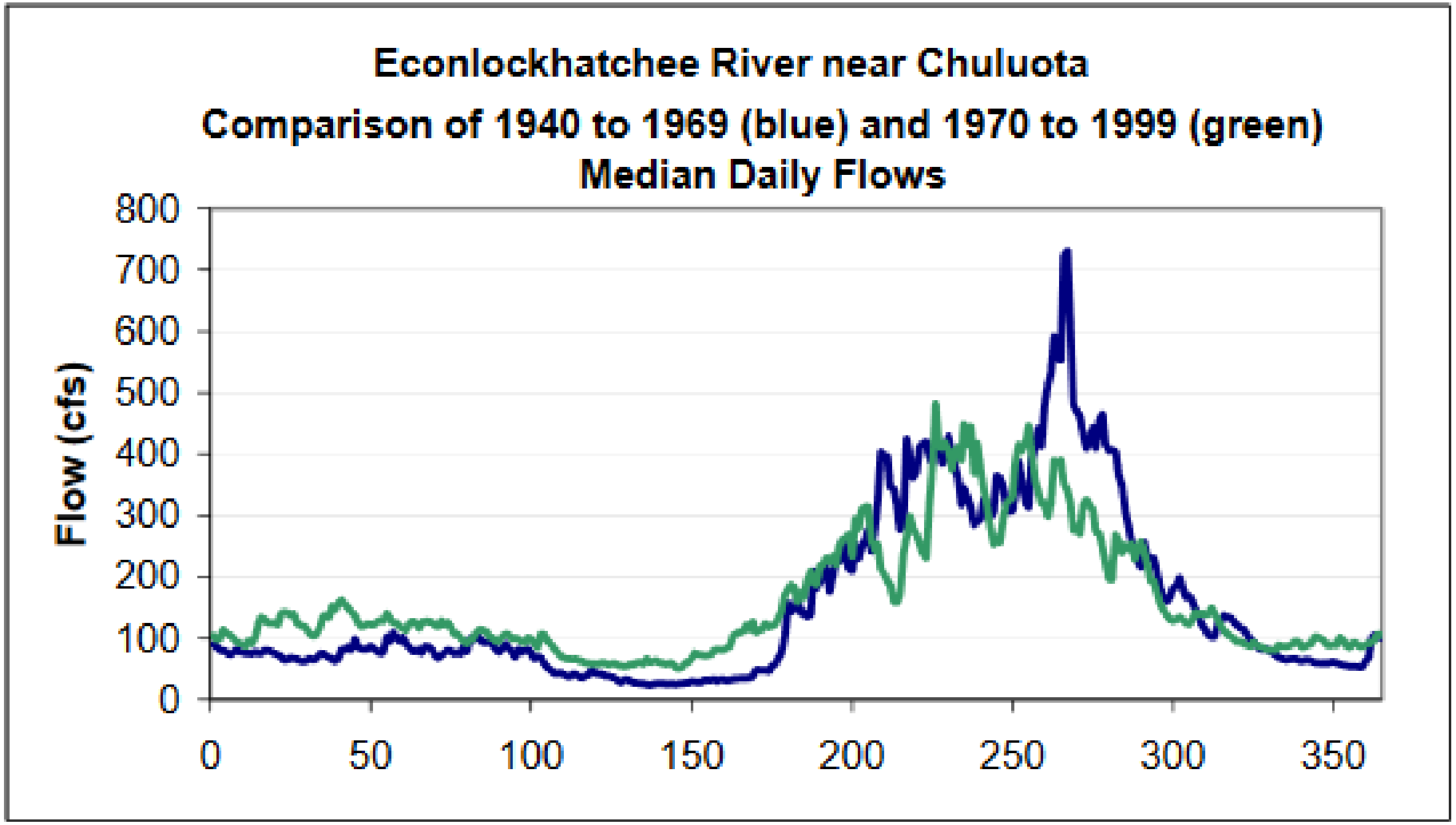


Global Land and Ocean Temperature Anomalies (NOAA)

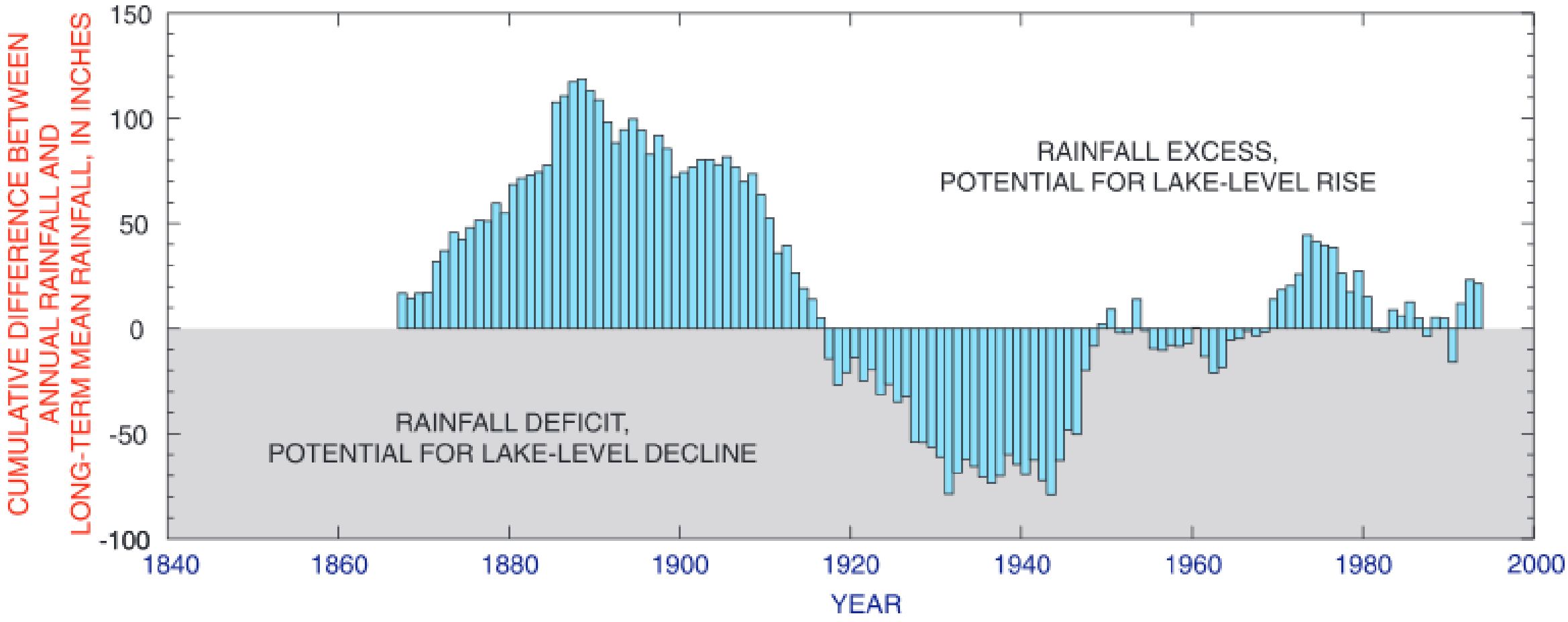


Atlantic Multi-Decadal Oscillation and Flows

(SWFWMD)



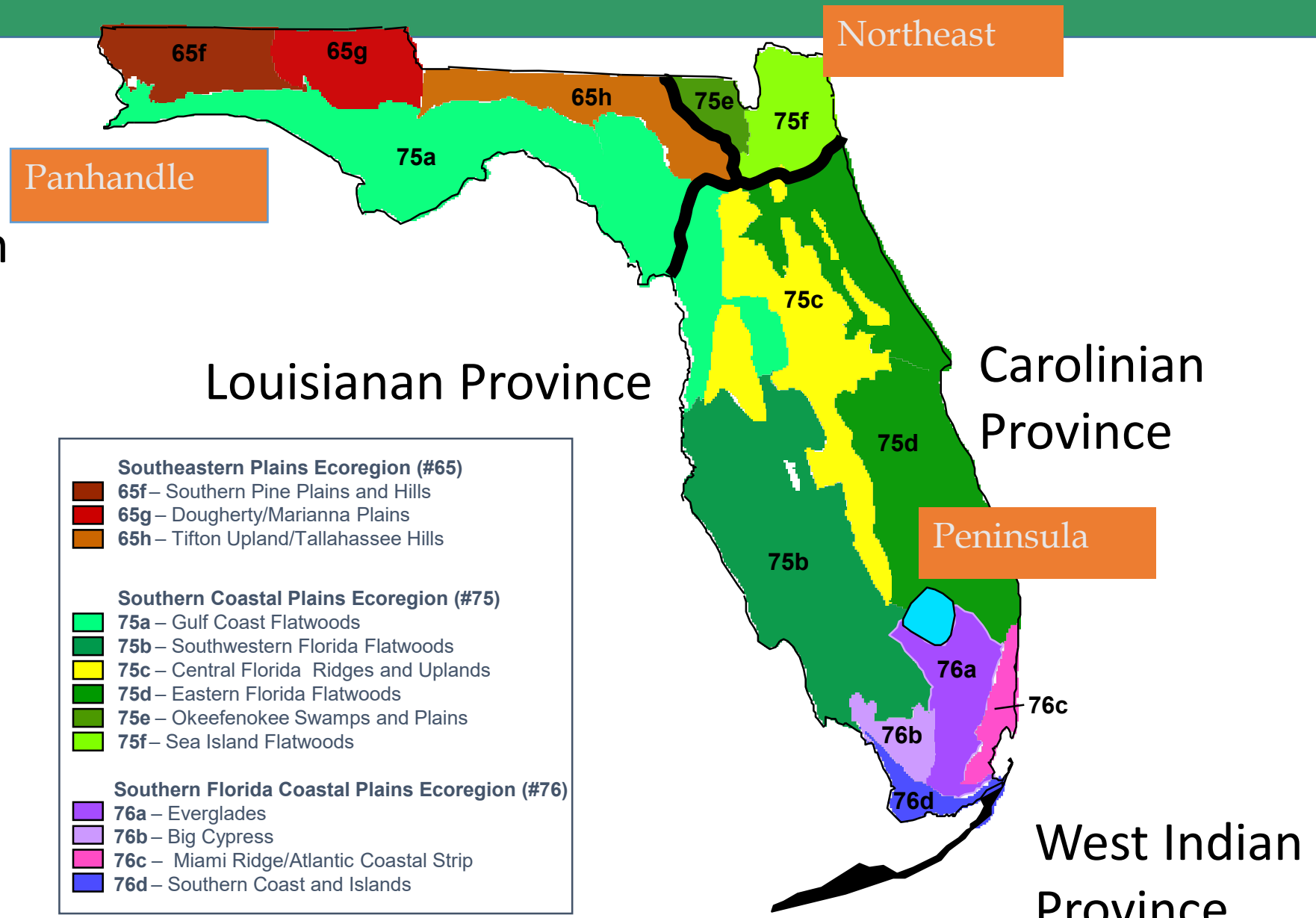
Excess vs. Deficit Rainfall and Lake Levels (USGS)



Ecological Regions/Geography

All categories influenced by geographic region (ecoregion or physiographic province):

- Terrestrial
- Wetland
- Aquatic Freshwater
- Marine

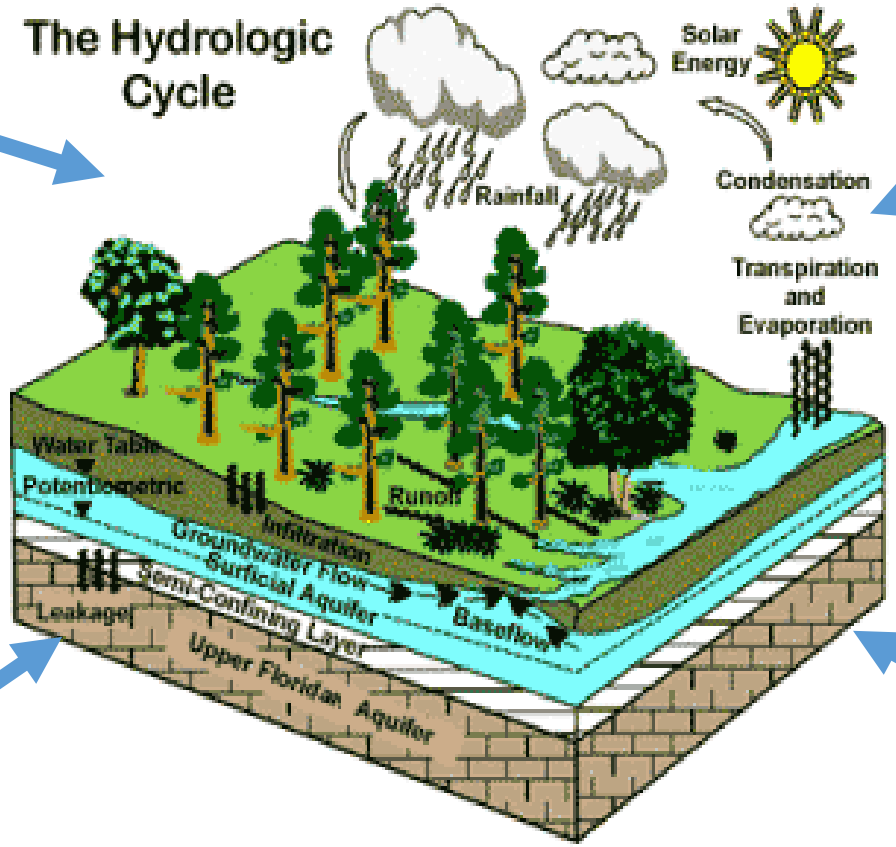


Aquatic Eco-systems

Morphology: Physical Configuration

Aquatic Habitat Structure: System Dependent

Organism Recruitment: Food Webs



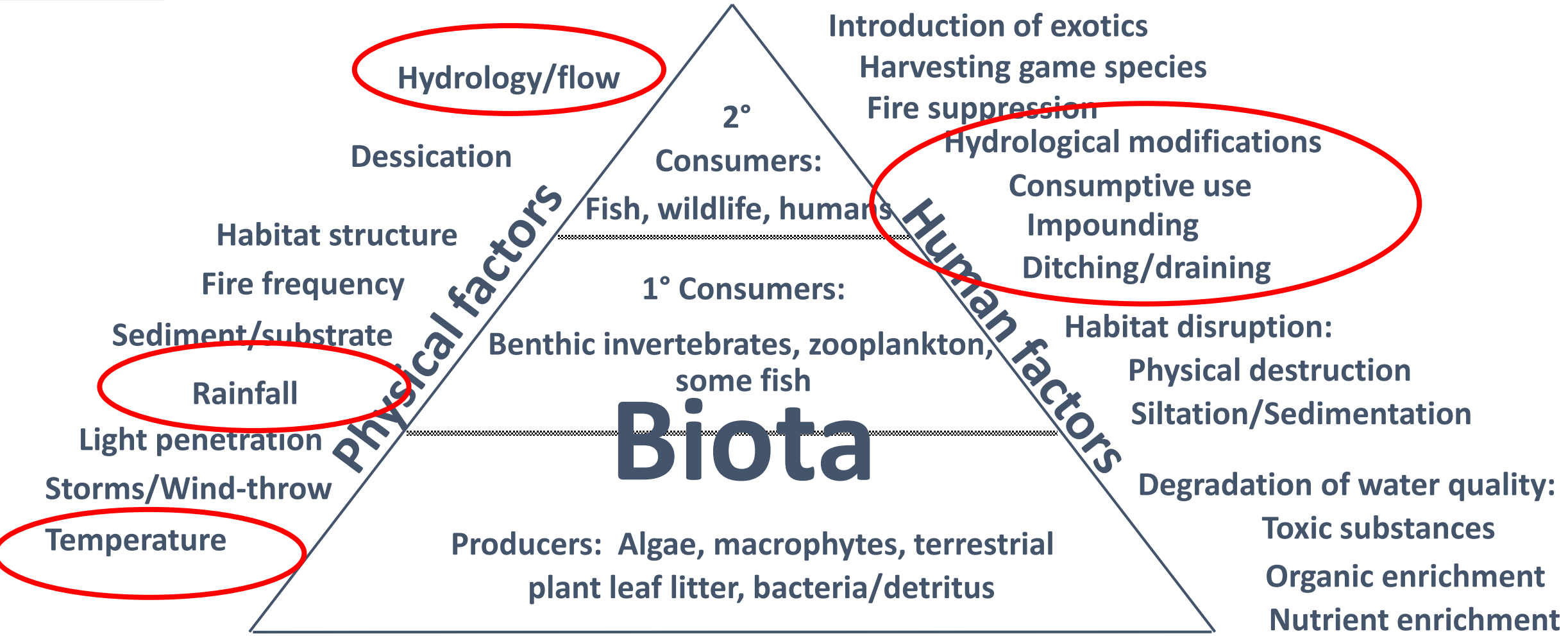
Ecosystem

Hydrology Timing, Frequency, Duration of Freshwater Inputs

Water Quality: Transparency, Nutrients, etc.

Littoral/Riparian Buffer: Plant Community Type

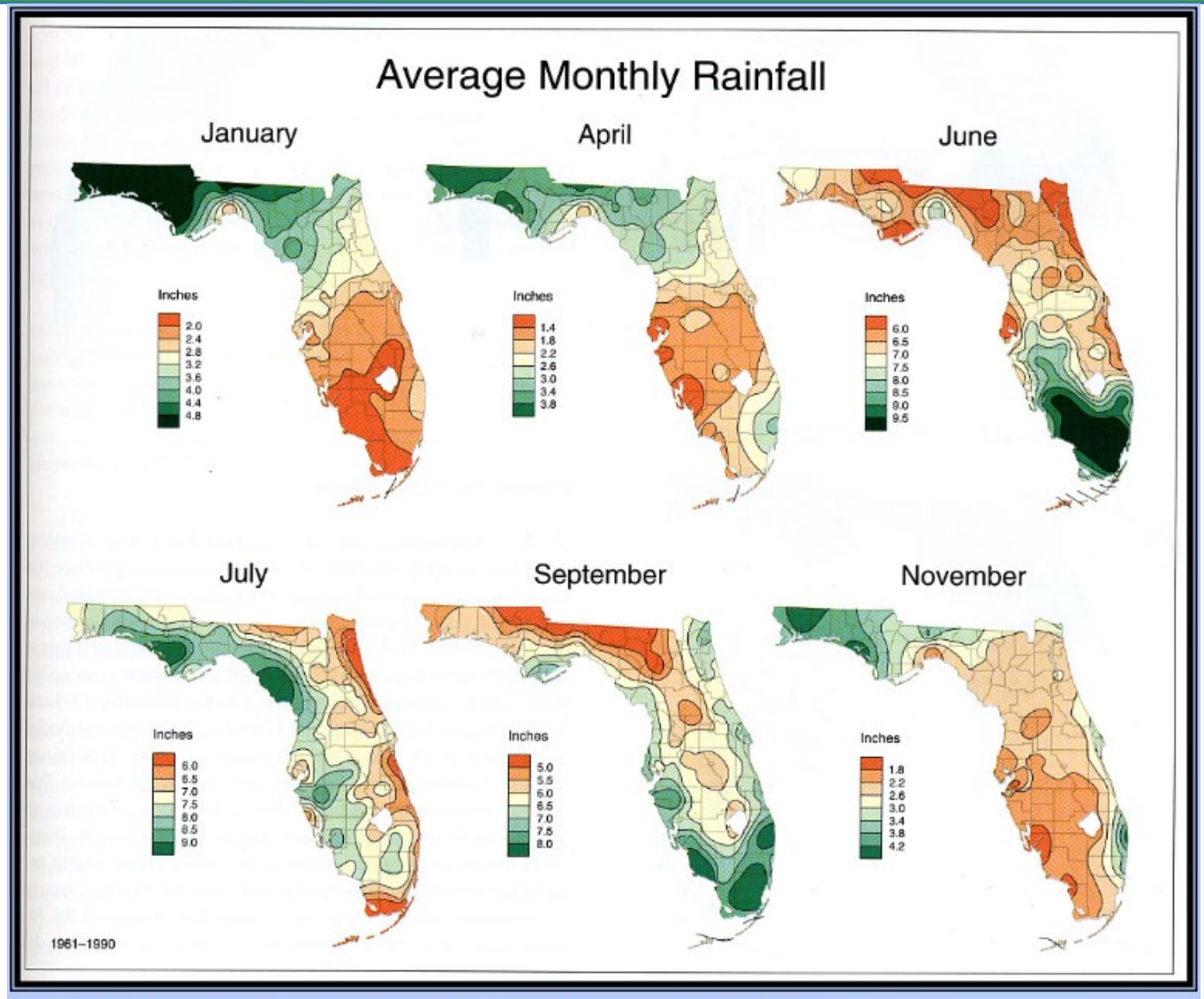
Factors Affecting Biological Communities



Water quality factors

Conductivity/Salinity pH Major ions Dissolved Oxygen Organic carbon Nutrients

Average Monthly Rainfall

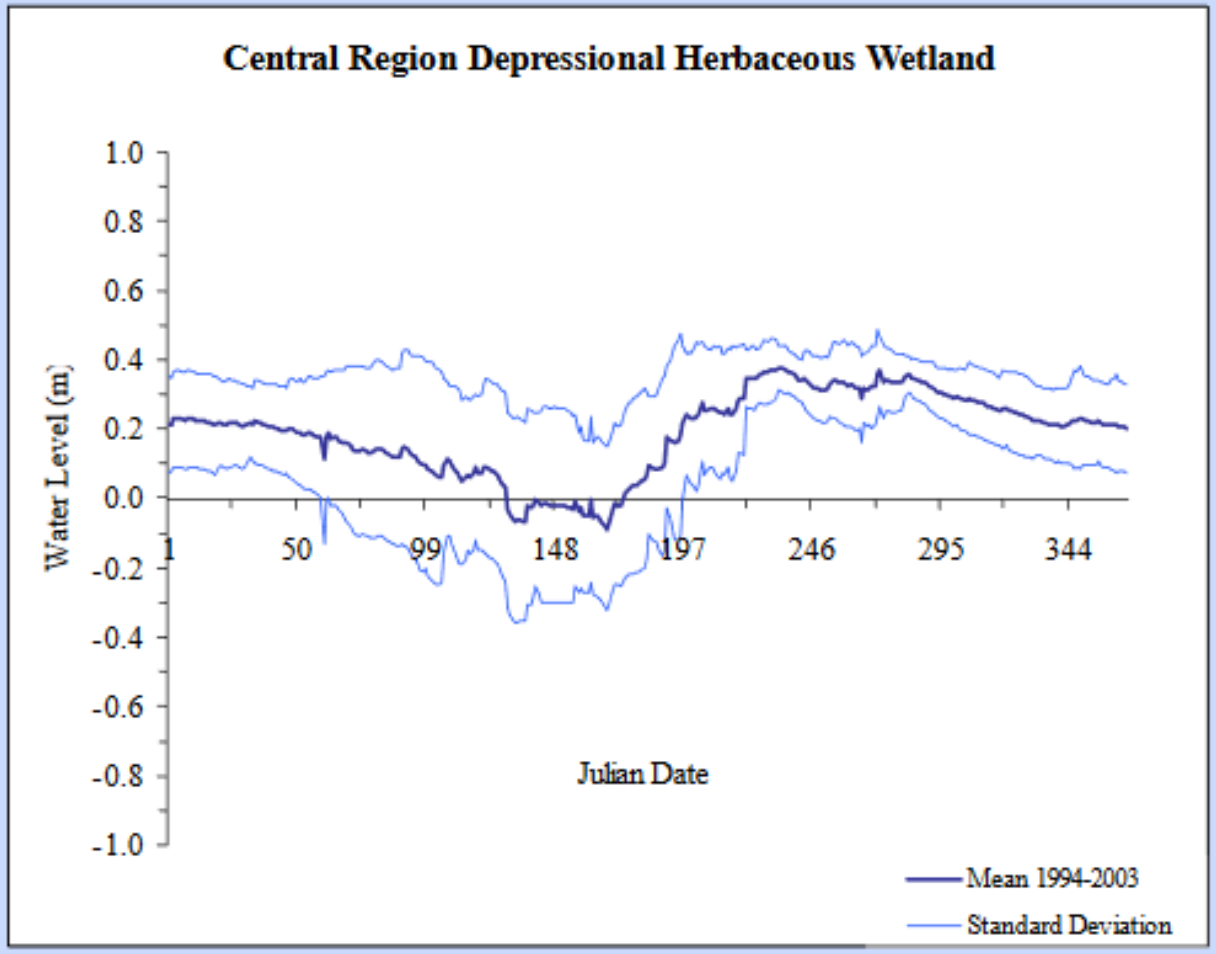


From: Fernald, E.A. and E.D. Purdum (eds). 1998. Water Resources Atlas of Florida.

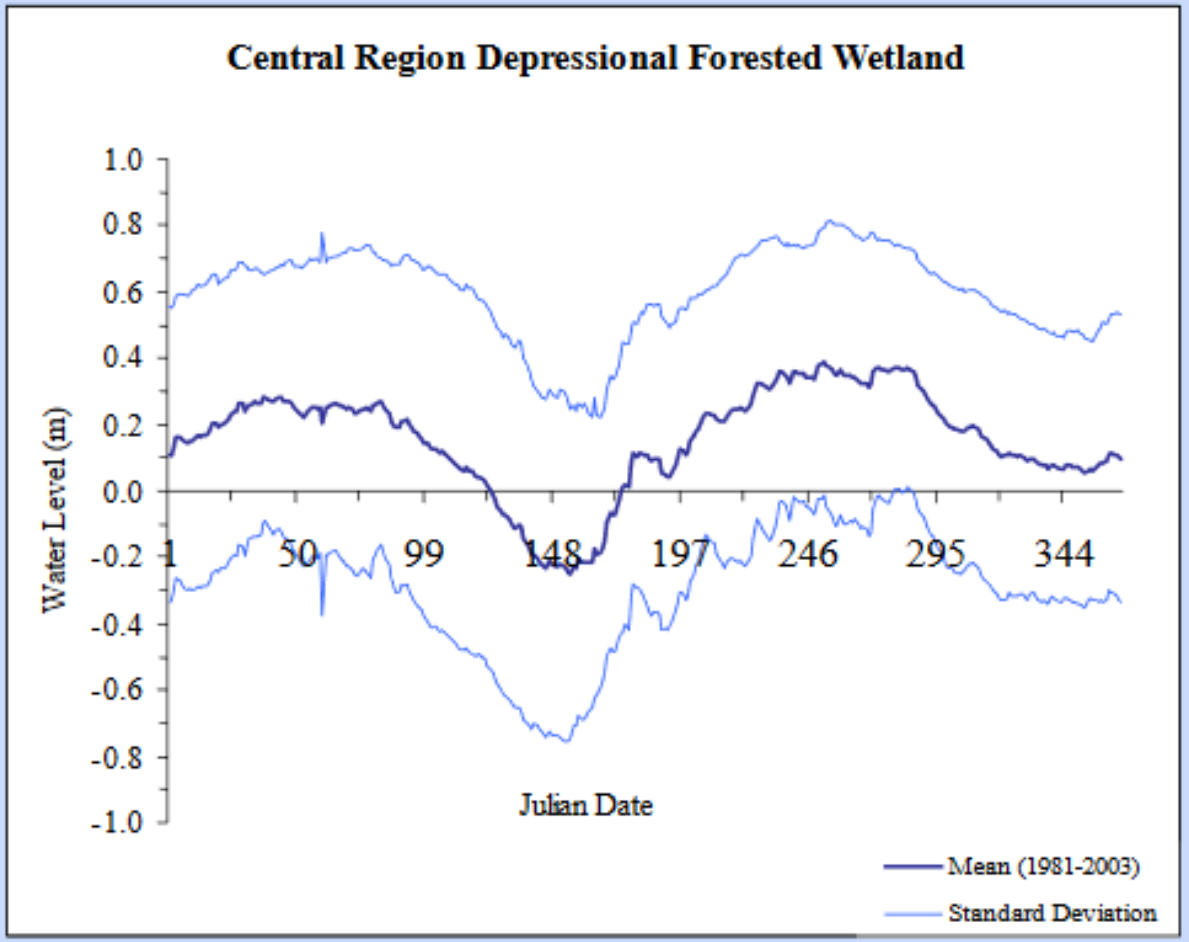
Typical Hydroperiods (FNAI, 1990):

System	Inundation Days Per Year
Wet flatwoods	30-90 days/yr
Wetland hardwood forests	60 days/yr
Wet prairie	50-100 days/yr
Basin marshes	200 days/yr
Isolated cypress domes	200-300 days/yr
Floodplain swamps	300 days/yr

Expected Wetland Levels



Data from SWFWMD 1994-2003.



Data from SWFWMD 1981-2003.

Wet and Dry Season: Cypress Dome

Moss collars and lichen lines on a cypress trunk. (KCR)

Moss collars, lichen lines, and water marks on cypress trees during low water levels. (KCR)

River Hydrographs: Panhandle vs Peninsula (SWFWMD)