Florida Department of Environmental Protection

Big Bend Model

Wayne Magley
Watershed Evaluation and TMDL Section
FDEP

March 7, 2016

BACKGROUND

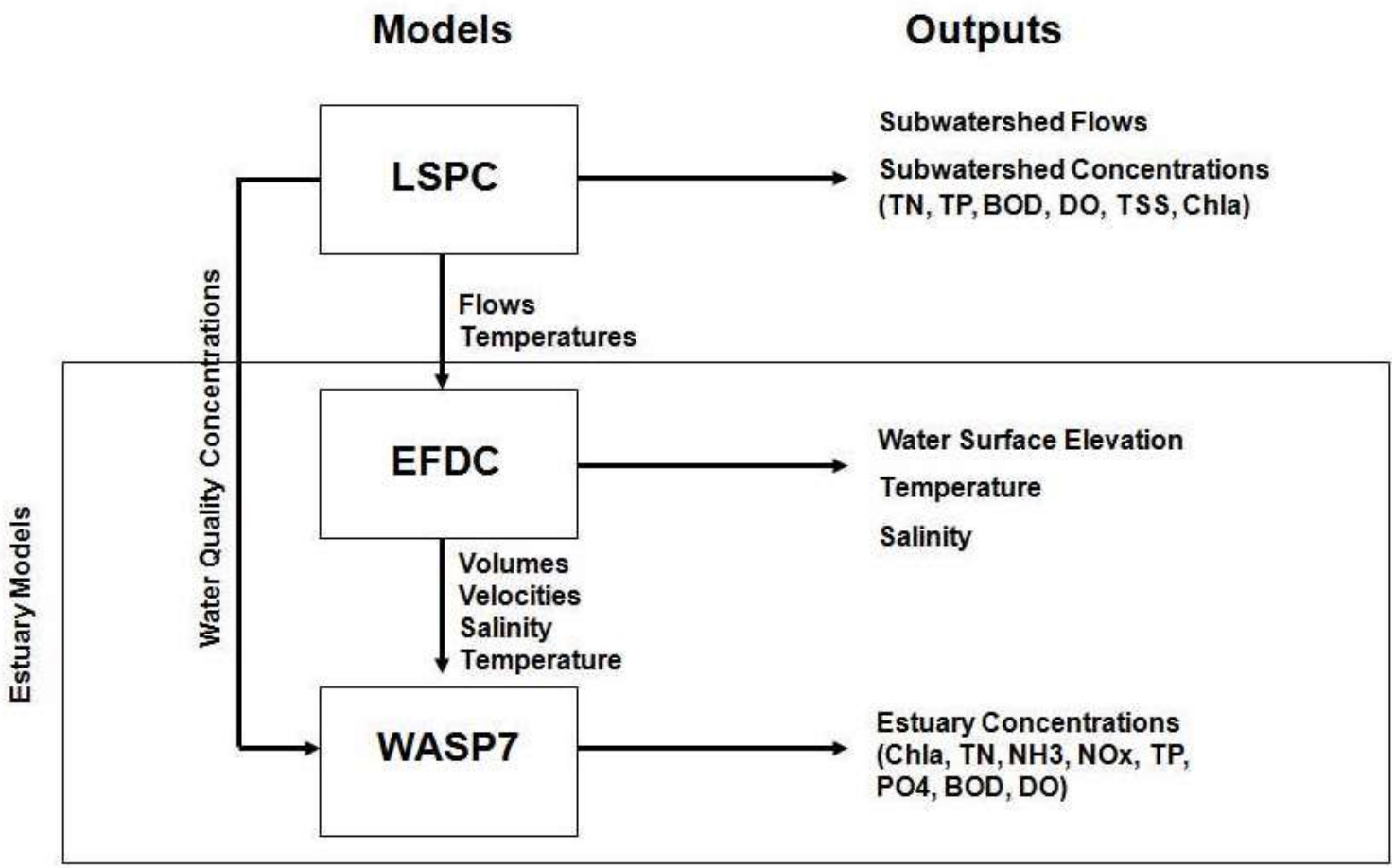
- As outlined in the EPA November 30, 2012 document "Methods and Approaches for Deriving Numeric Criteria for Nitrogen/Phosphorus Pollution in Florida's Estuaries, Coastal Waters, and Southern Inland Flowing Waters," the application of water quality simulation models was one of the approaches used by EPA to develop Numeric Nutrient Criteria (NNC).
- Tetra Tech, Inc. was contracted by EPA to setup and calibrate a series of linked watershed and estuarine models for Florida estuaries.
- These models link causal variables such as Total Nitrogen (TN) and Total Phosphorus (TP) to ecological indicators such as chlorophyll *a* (chla) and water clarity, and establish protective nutrient levels based on specific biological assessment endpoints.

Watershed and Estuary Models

- Watershed Model - Loading Simulation Program in C++ (LSPC)
- Estuary Model
  - Hydrodynamics - Environmental Fluid Dynamics Code (EFDC)
  - Water Quality - Water Quality Analysis Simulation Program (WASP)

EPA WATERSHED AND ESTUARY MODEL LINKAGE

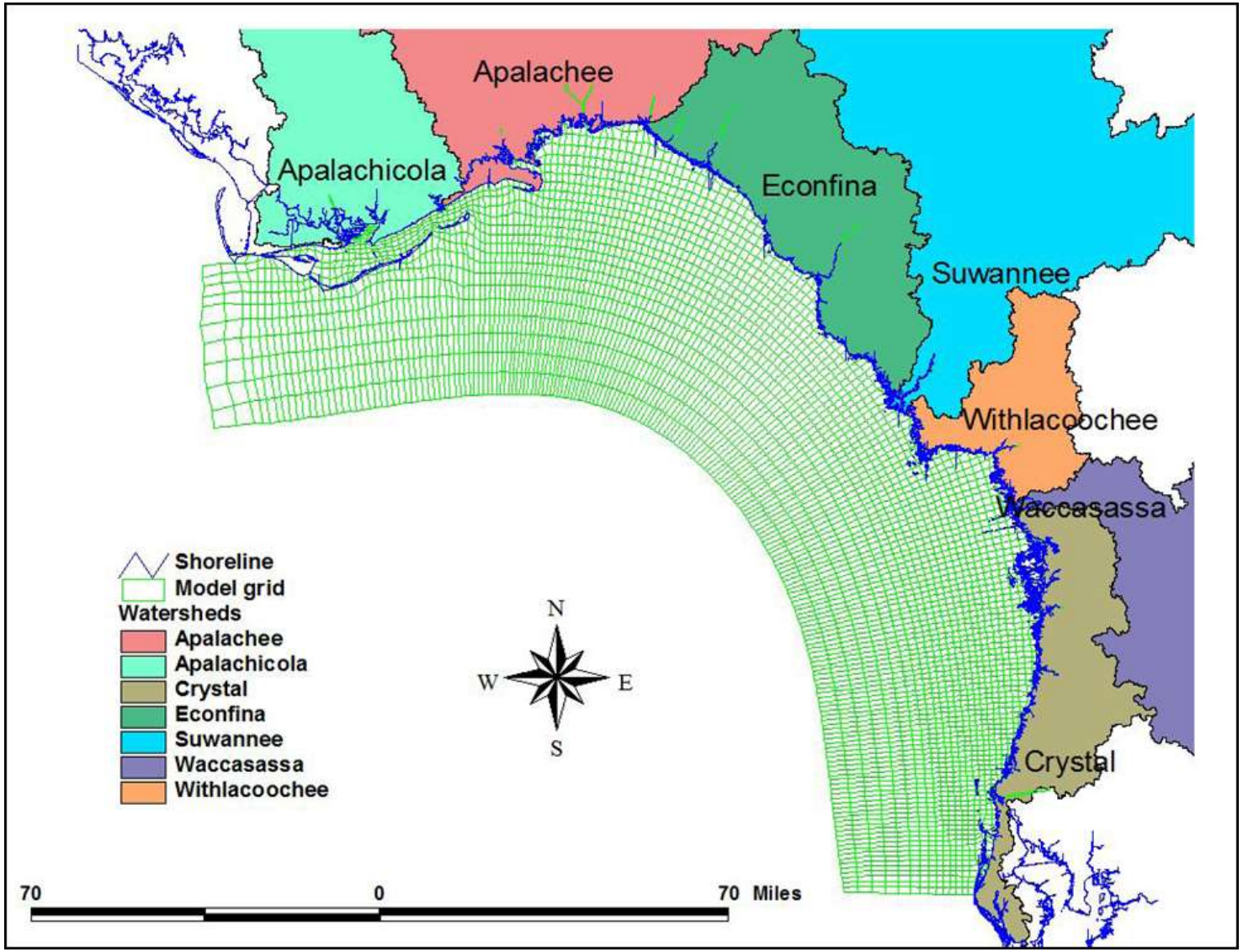
LSPC to EFDC to WASP



FLORIDA BIG BEND MODEL

- EFDC Hydrodynamic and Water Quality
- 3995 horizontal grids by 4 layers (15,980 segments)
- Apalachicola Bay to Clearwater Harbor
- Eight 8-digit HUC Watersheds
  - Apalachicola
  - Apalachee
  - Ochlocknee
  - Econfina
  - Suwannee
  - Waccasassa
  - Withlachoochee
  - Crystal
- 82 watershed flow and WQ parameter inputs from LSPC watershed models

BIG BEND MODEL DOMAIN



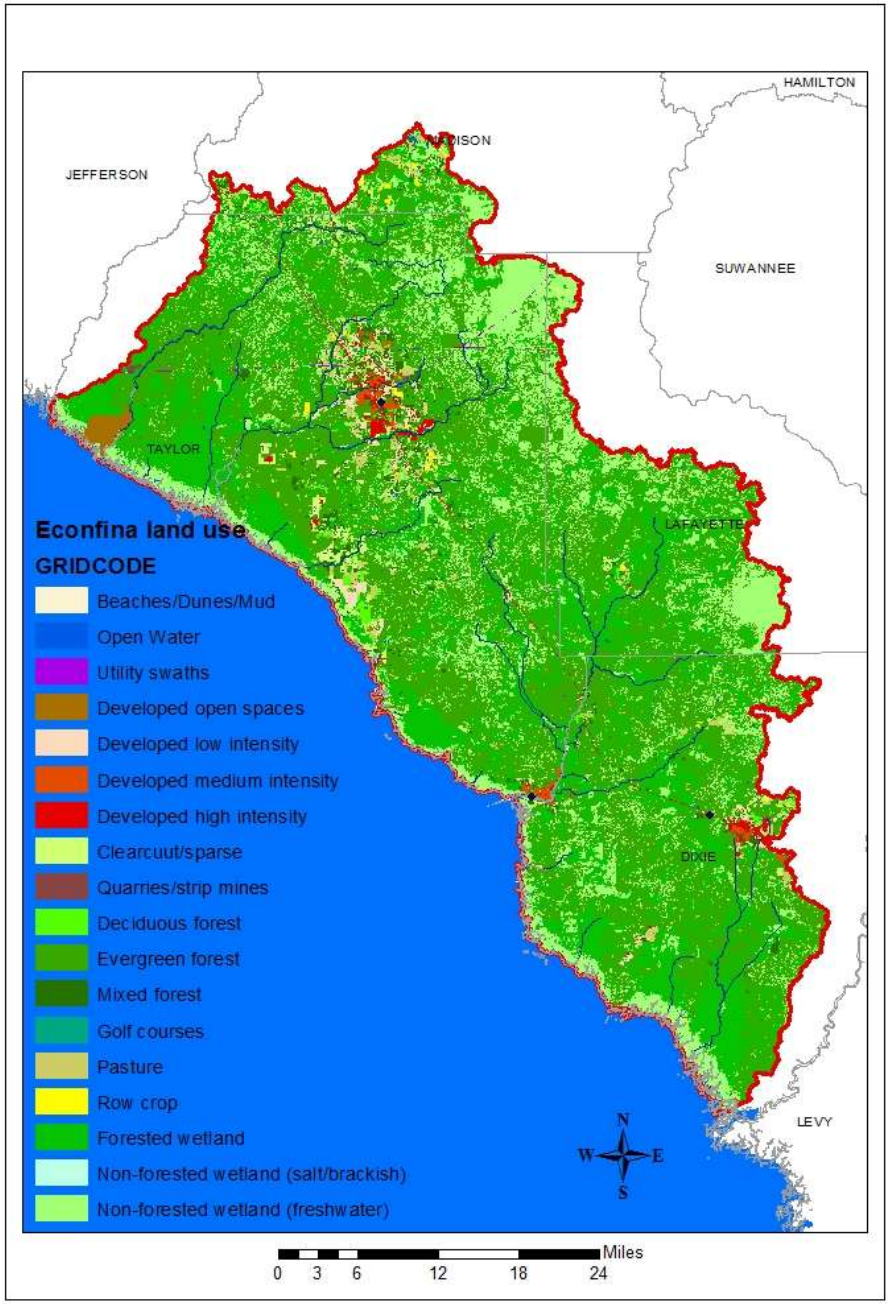
CONTRIBUTING WATERSHEDS

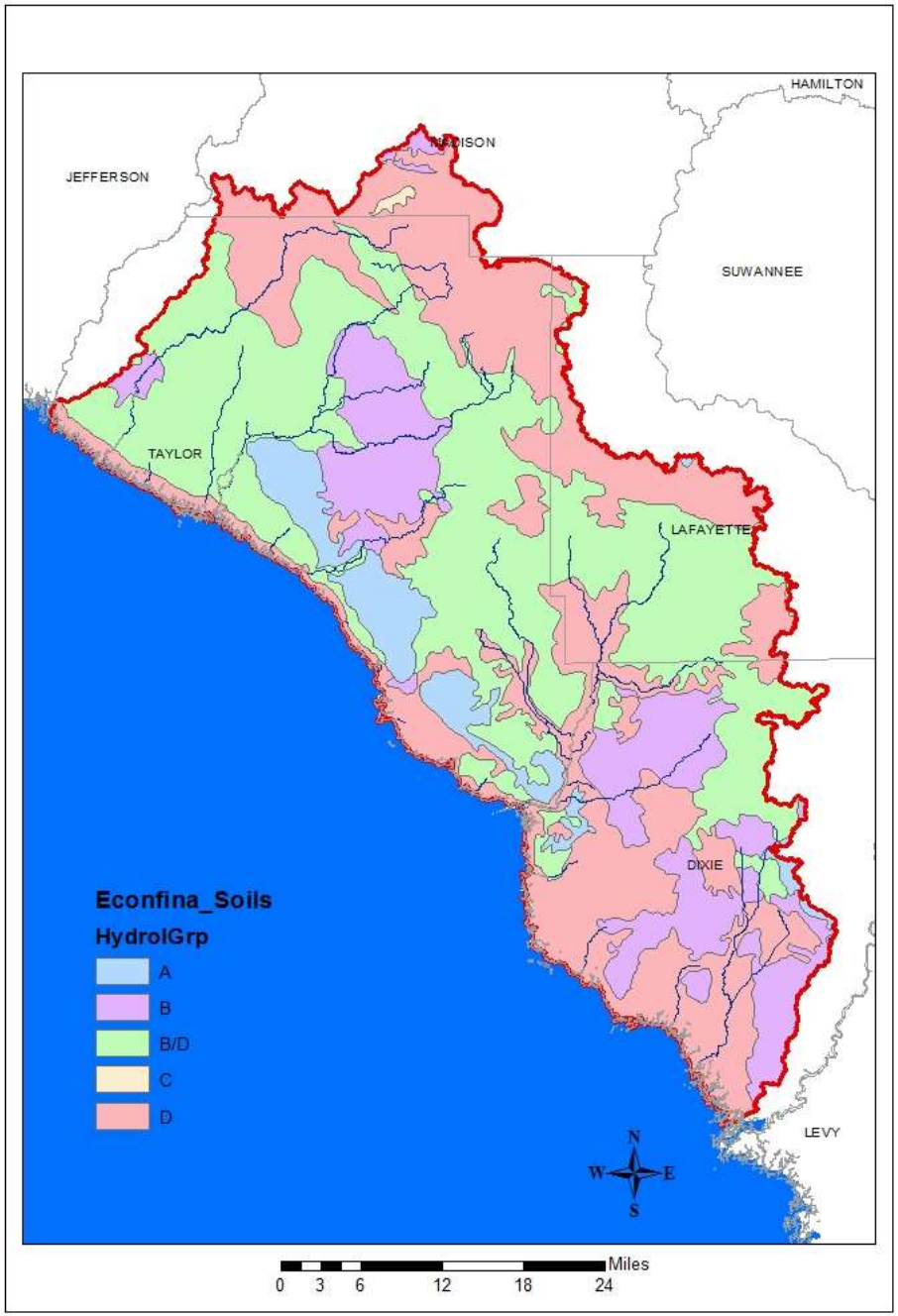
Watershed Model Components

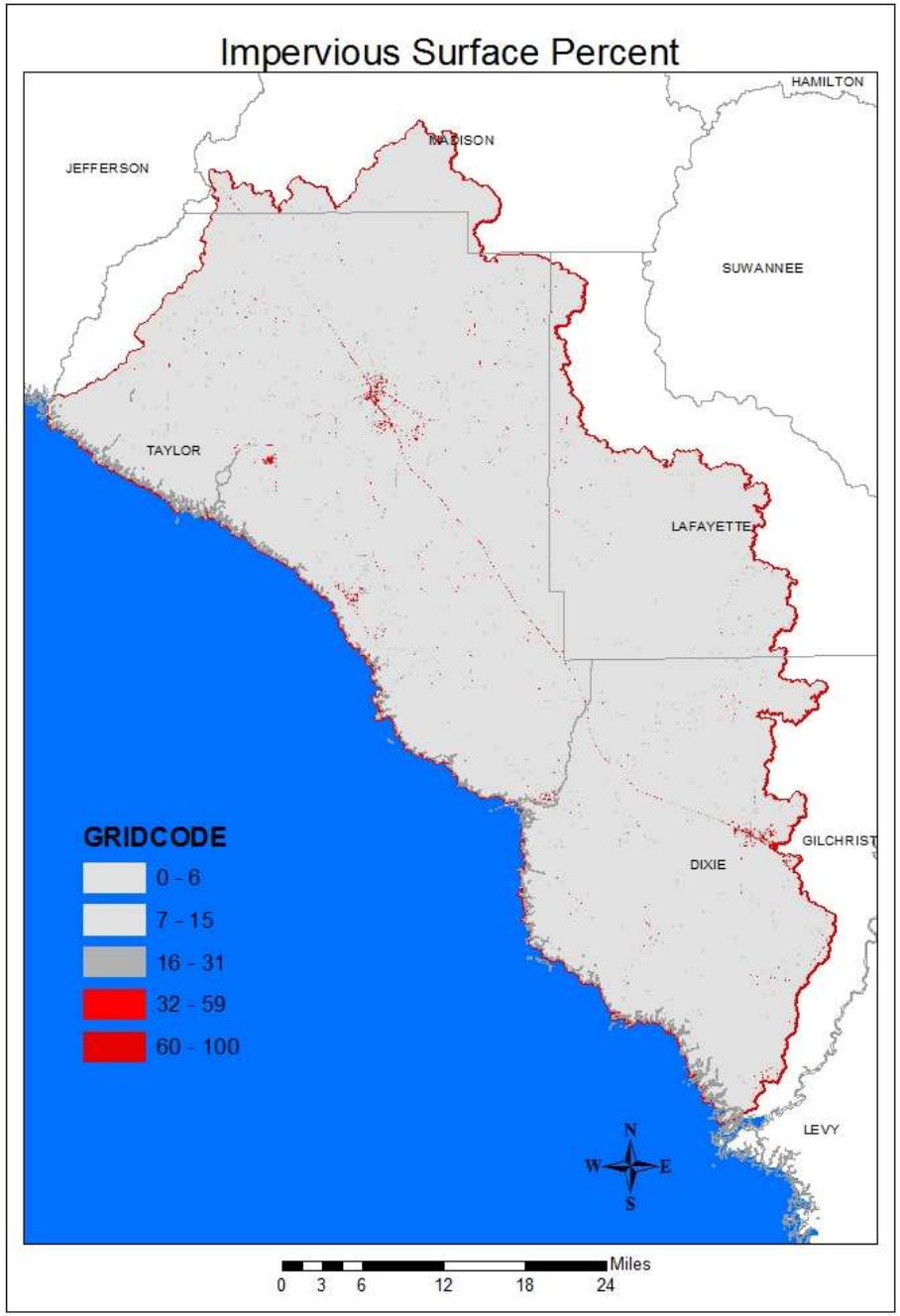
- Hydrology and Drainage Characteristics
  - Subwatersheds
  - Reaches
- Land Use
- Soil Characteristics
- Weather Stations
- Point Sources
- Flow Gages
- Water Quality Stations


Econfina Watershed
HAMILTON
MADISON
JEFFERSON
Aucilla River
Econfina River
Suwannee River
SUWANNEE
Fenholloway River
TAYLOR
LAFAYETTE
Steinhatchee River
DIXIE
Pocoson Swamp
California Swamp
Suwannee River
LEVY
Black Point Swamp
N
W
E
S
Miles
0 3 6 12 18 24

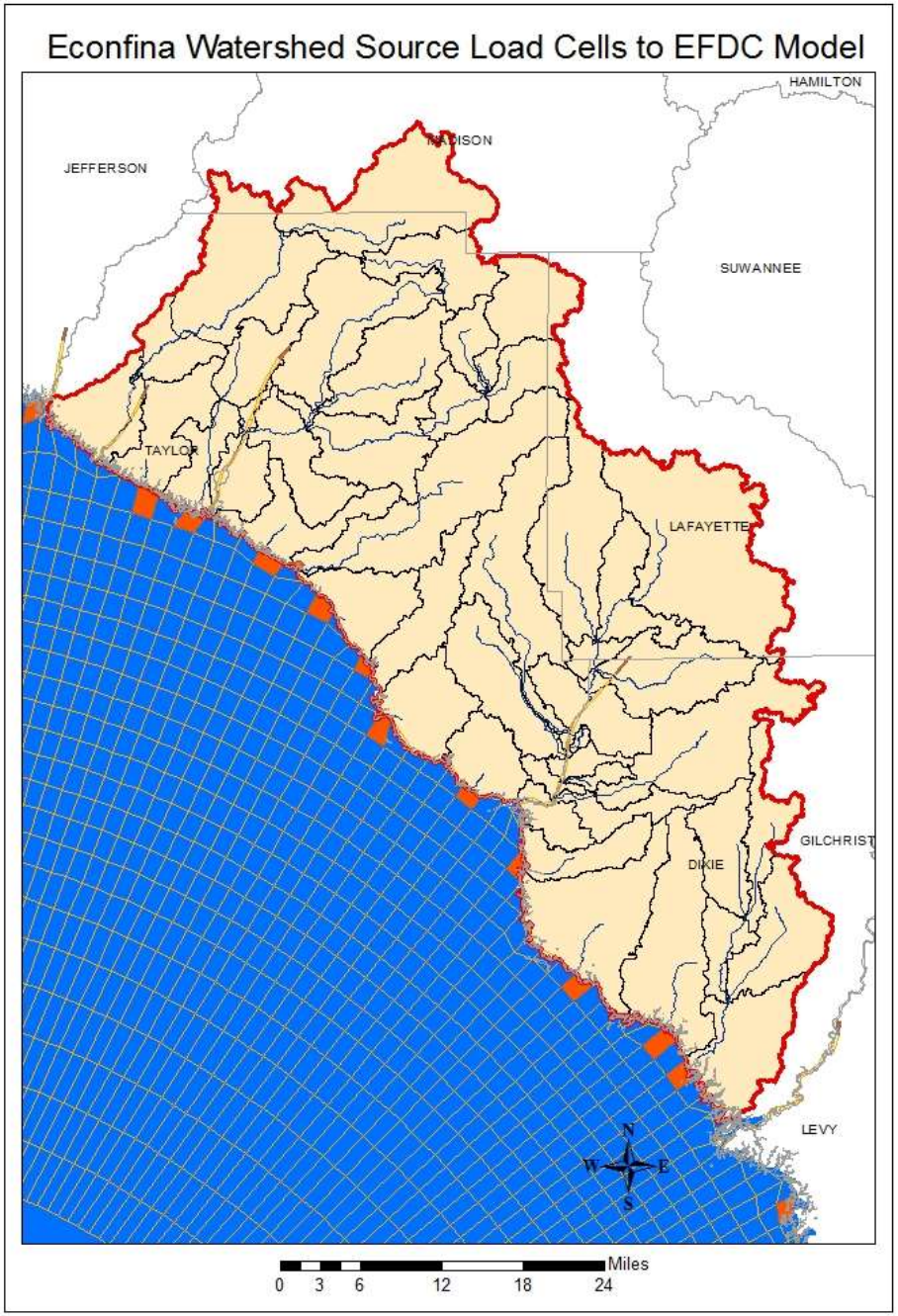
Econfina Subwatersheds


HAMILTON
JEFFERSON
SUWANNEE
TAYLOR
LAFAYETTE
DIXIE
LEVY
Econfina land use
GRIDCODE
Beaches/Dunes/Mud
Open Water
Utility swaths
Developed open spaces
Developed low intensity
Developed medium intensity
Developed high intensity
Clearcuut/sparse
Quarries/strip mines
Deciduous forest
Evergreen forest
Mixed forest
Golf courses
Pasture
Row crop
Forested wetland
Non-forested wetland (salt/brackish)
Non-forested wetland (freshwater)
N
W
E
S
Miles
0 3 6 12 18 24


HAMILTON
MADISON
JEFFERSON
SUWANNEE
TAYLOR
LAFAYETTE
DIXIE
LEVY
Econfina_Soils
HydrolGrp
A
B
B/D
C
D
N
W
E
S
Miles
0 3 6 12 18 24


Impervious Surface Percent
HAMILTON
MADISON
JEFFERSON
SUWANNEE
TAYLOR
LAFAYETTE
GILCHRIST
DIXIE
LEVY
GRIDCODE
0 - 6
7 - 15
16 - 31
32 - 59
60 - 100
N
W
E
S
Miles
0 3 6 12 18 24


HAMILTON
MADISON
JEFFERSON
Aucilla River
Econfina River
Suwannee River
SUWANNEE
87025
Fenholloway River
TAYLOR
LAFAYETTE
Steinhatchee River
88076
82008
GILCHRIST
DIXIE
Econfina Weather Stations
Econfina USGS Gages
Pocoson Swamp
California Swamp
Suwannee River
LEVY
Black Point Swamp
N
W
E
S
Miles
0 3 6 12 18 24


Econfina Watershed Source Load Cells to EFDC Model
HAMILTON
JEFFERSON
MADISON
SUWANNEE
TAYLOR
LAFAYETTE
GILCHRIST
DIXIE
LEVY
N
W
E
S
Miles
0 3 6 12 18 24

Watershed Simulation

- Simulation period 1997 – 2009
- Hydrology Calibration and Validation
  - Available long-term USGS flow gages
  - Evaluated using a set of flow statistics
- Water Quality Calibration and Validation
  - Long-term water quality stations associated with flow stations (IWR database)
  - Evaluated water temperature, TN and TP concentrations, TN and TP modeled loads versus simulated loads

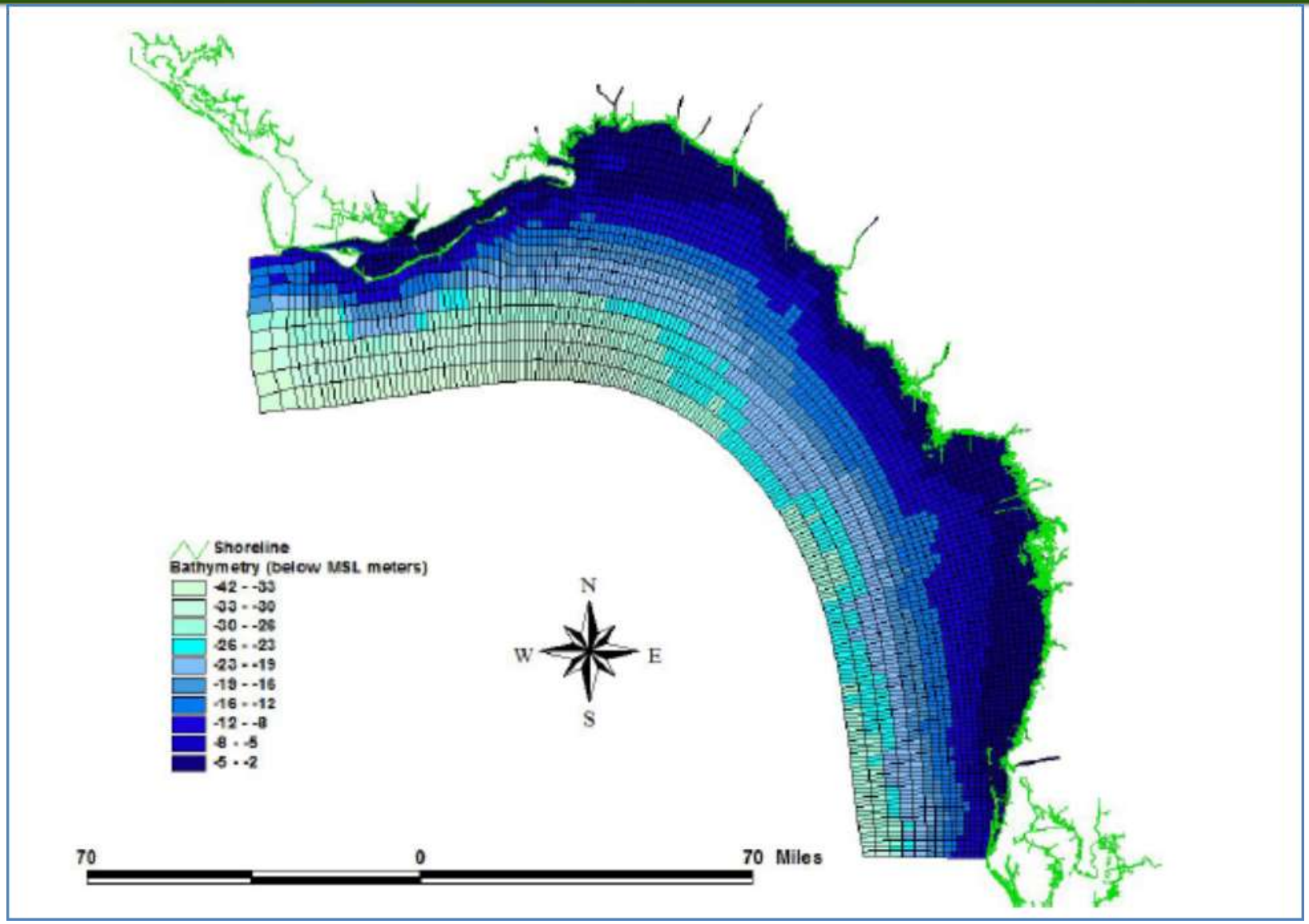
Estuary Model Setup

- Model Grid (typically 4-5 vertical layers)
- Linkage from LSPC Model
  - LSPC terminal reaches
    - LSPC flow and temperature to EFDC
    - LSPC concentrations to WASP
- Driving Forces (Boundary Conditions)
  - Weather from weather station (WBAN Apalachicola and Clearwater Harbor)
  - Tides from available NOAA sites
  - Open boundary temperature from NOAA or other available data
  - Open boundary salinity typically a constant value

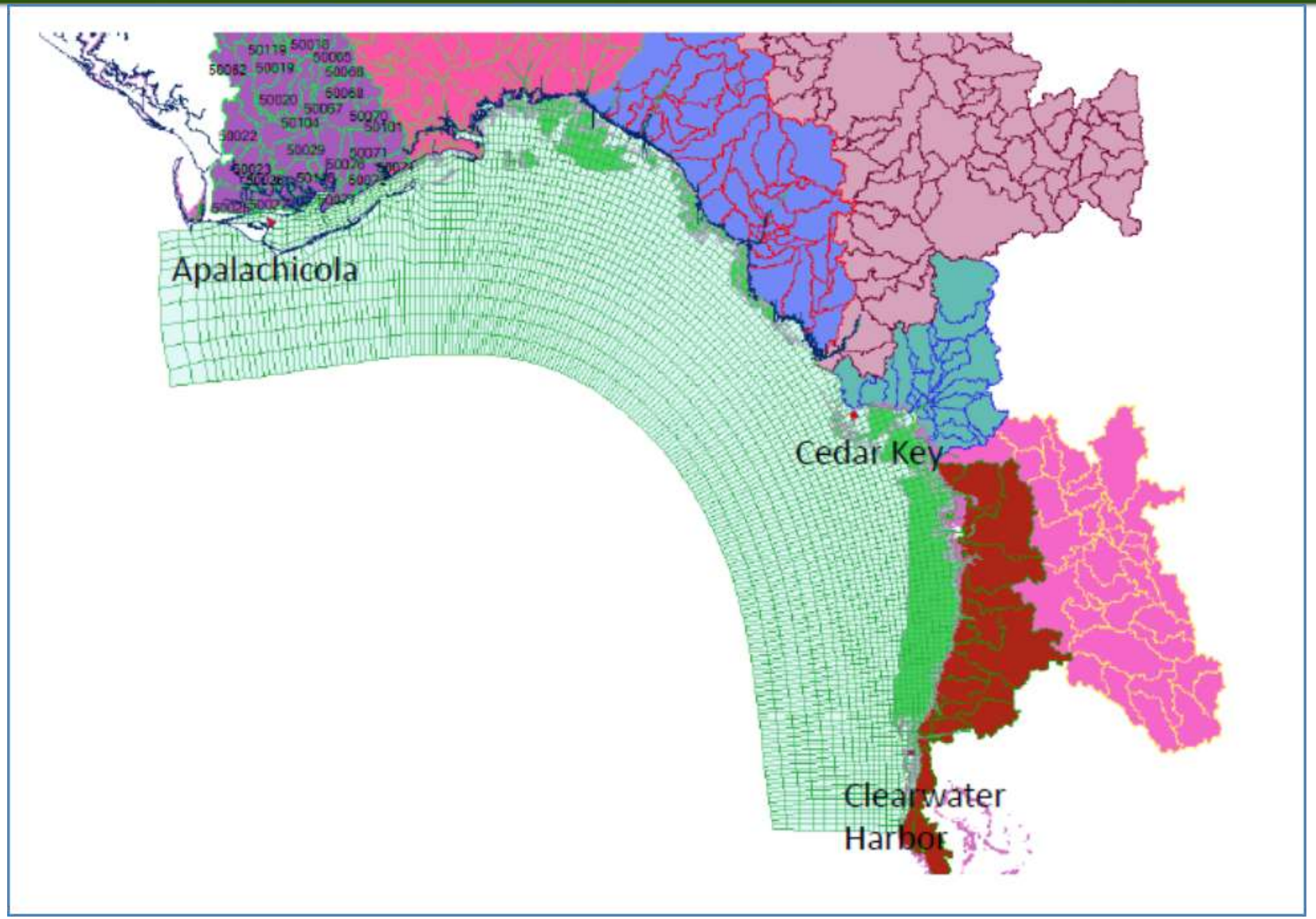
Estuary Model Setup (cont.)

- Direct Point Source Discharges
  - Data from FDEP Wastewater Facility Regulation Database (WAFR)
- Hydrology Calibration and Validation
  - NOAA stations (water surface elevation)
- Water Quality Calibration and Validation
  - Data from IWR database and other available data sets

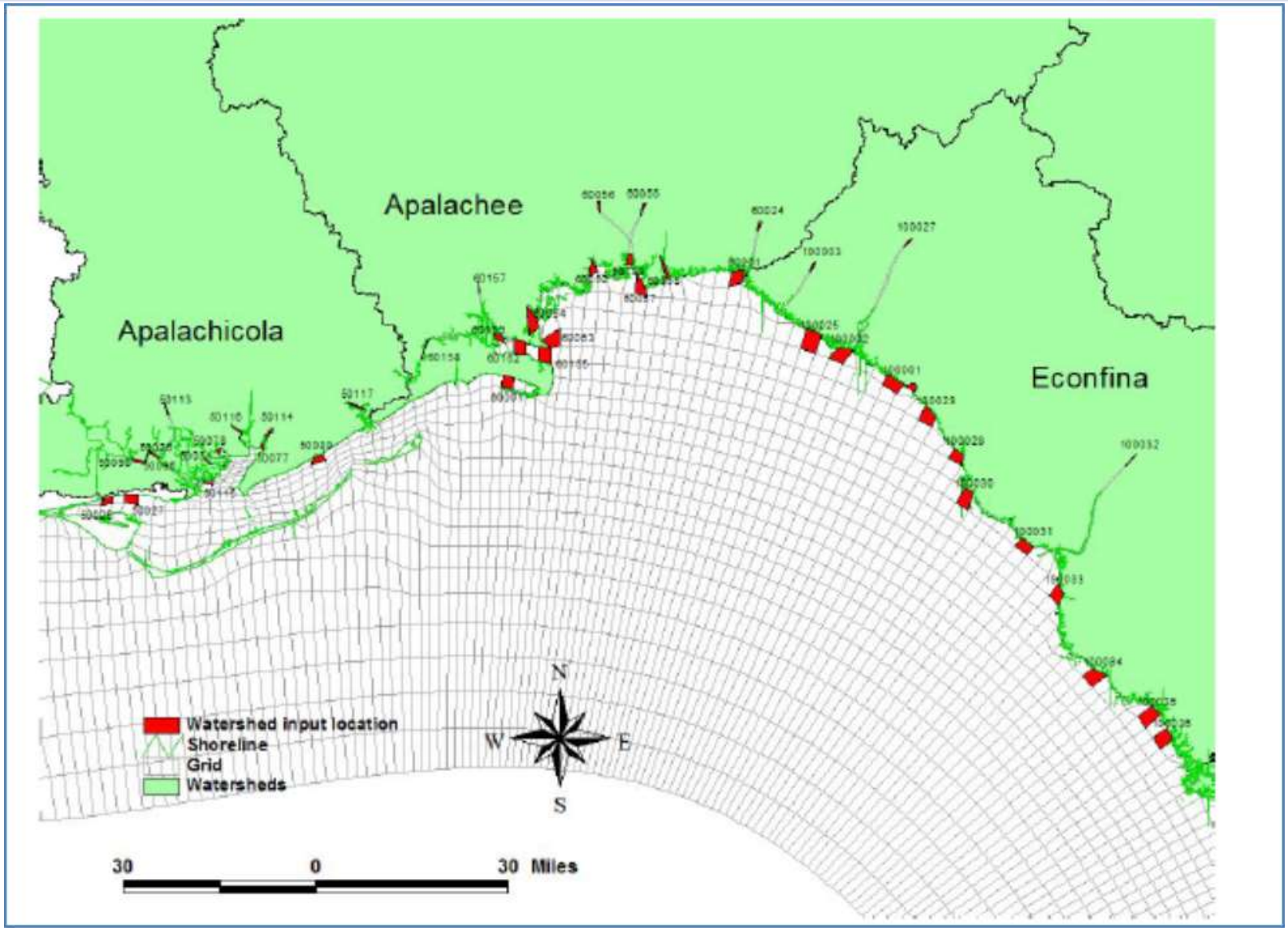
BIG BEND MODEL BATHYMETRY



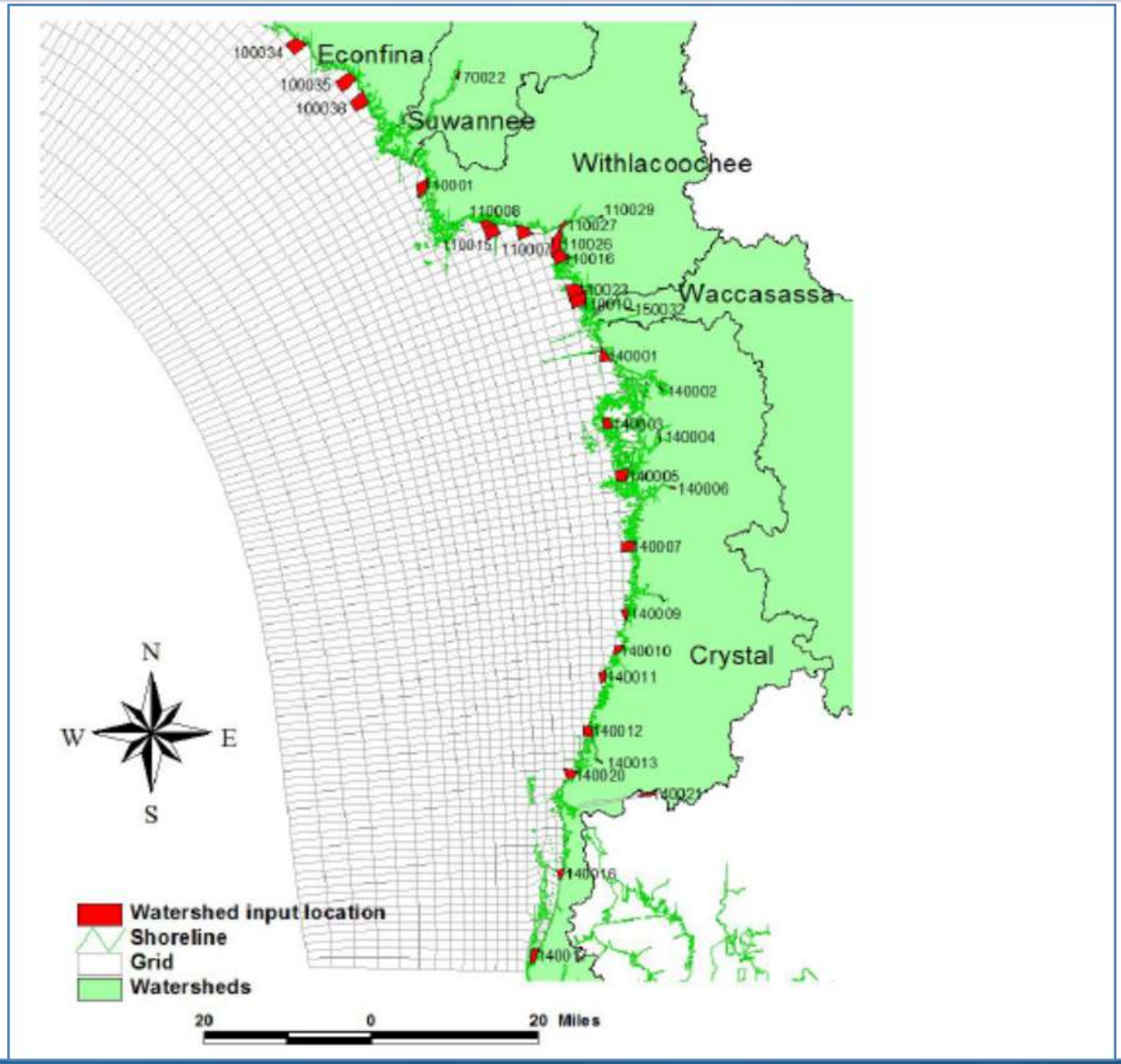
NOAA TIDAL STATIONS



Watershed Inputs from the Apalachicola River to Econfina River Watersheds.



Watershed Inputs from the Econfina River to Crystal River Watersheds



EFDC WATER QUALITY-EUTROPHICATION

- Directly Coupled to Hydrodynamics
- Based on CE-QUAL-ICM (Chesapeake Bay WQ Model) Kinetics
- 21 Water Column State Variables Including Multiple Classes of Algae and Organic Carbon, Nitrogen and Phosphorous
- Optional 27 State Variable Sediment Diagenesis Sub-model
- Reduced Number of State Variable Version Equivalent to WASP

EFDC WQ STATE VARIABLES

1) cyanobacteria
2) diatom algae
3) green algae
4) refractory particulate organic carbon
5) labile particulate organic carbon
6) dissolved carbon
7) refractory part. organic phosphorus
8) labile particulate organic phosphorus
9) dissolved organic phosphorus
10) total phosphate
11) refractory part. organic nitrogen
12) labile part. organic nitrogen
13) dissolved organic nitrogen
14) ammonia nitrogen
15) nitrate nitrogen
16) particulate biogenic silica
17) dissolved available silica
18) chemical oxygen demand
19) dissolved oxygen
20) total active metal
21) fecal coliform bacteria
22) macroalgae

QUESTIONS?