SELVA-MANGRO:

Integrated Landscape and Stand-level Model for Predicting Mangrove Forest Growth and Distribution across the Everglades Coastal Margin under Changing Climate

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National Wetlands Research Center
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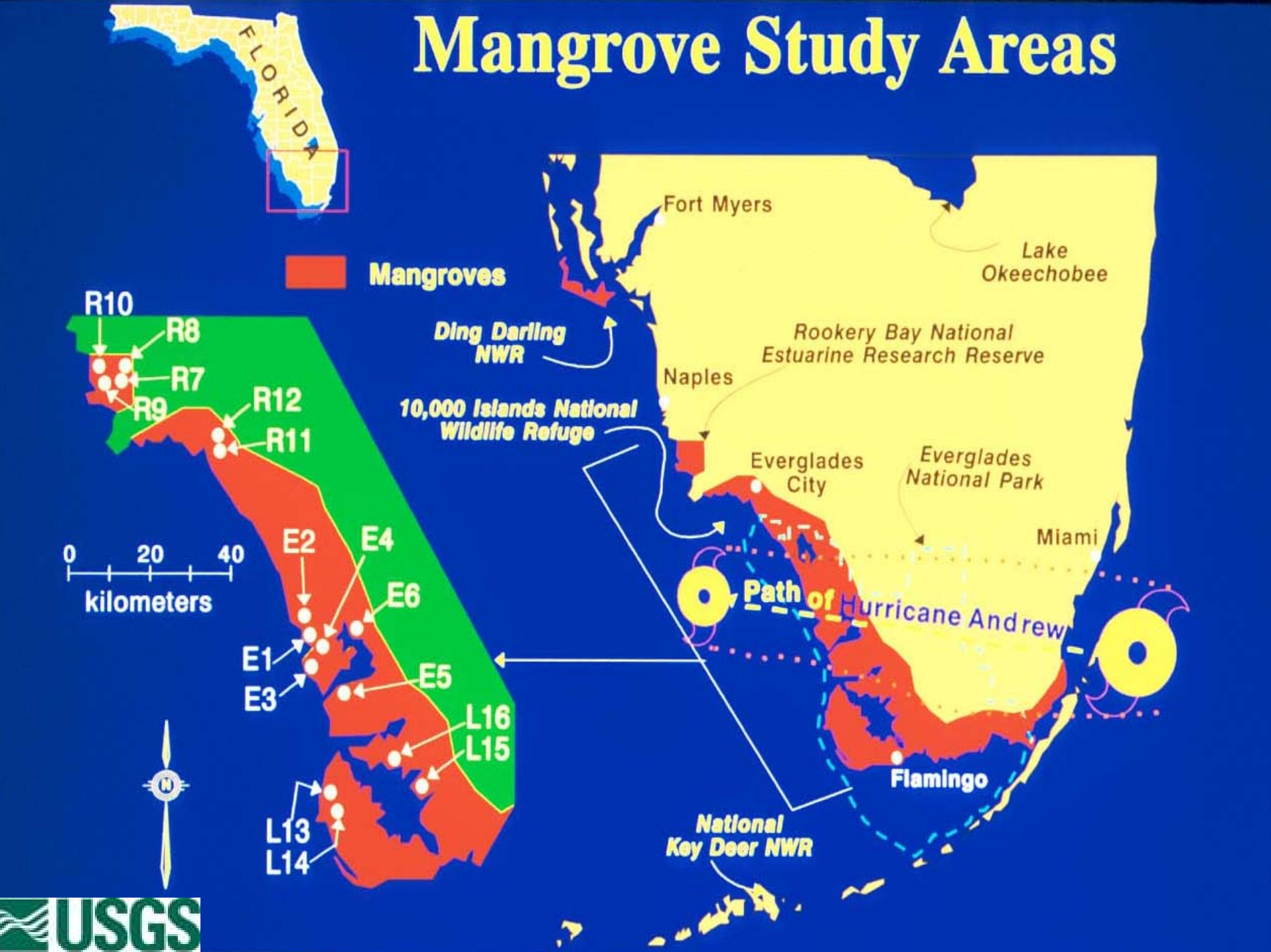
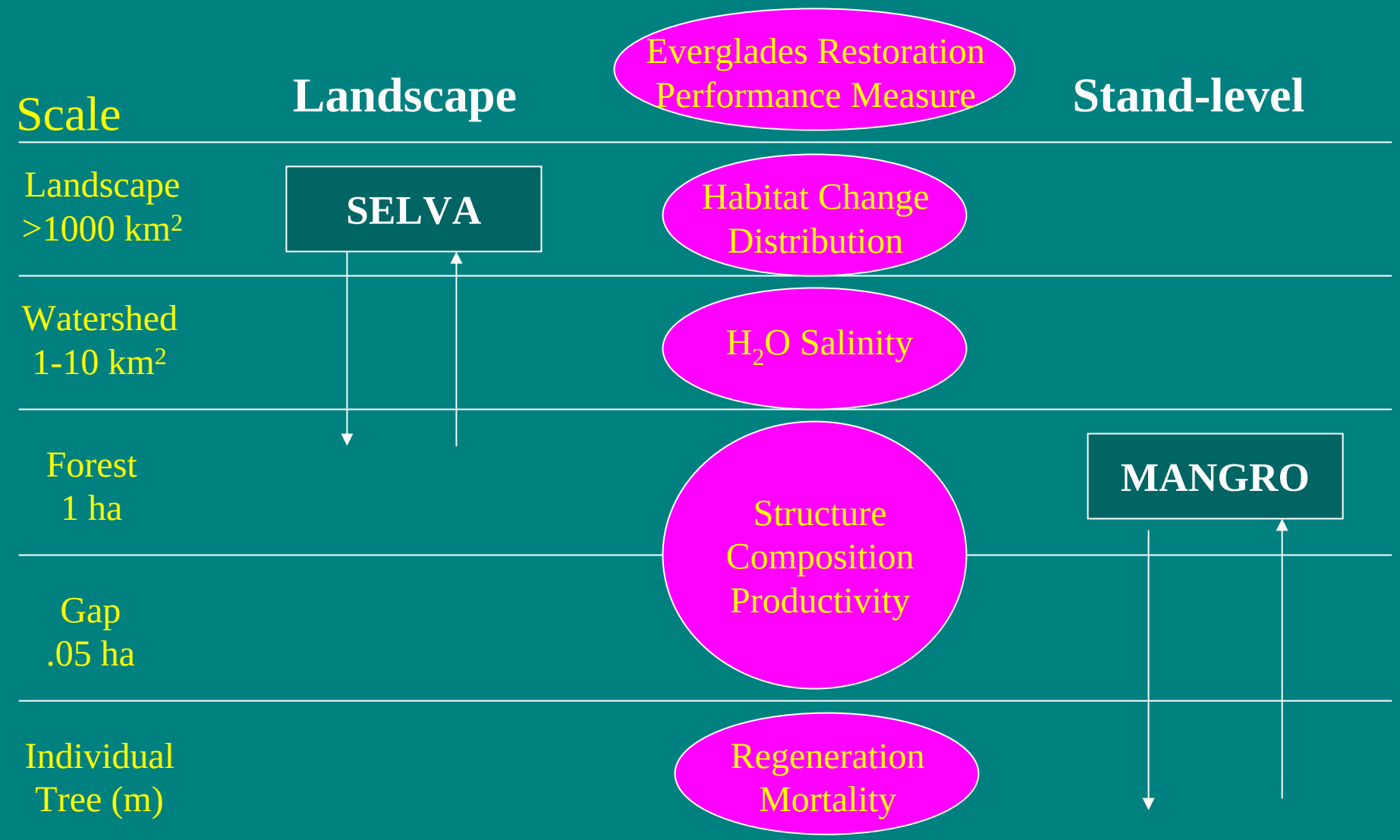
USGS


Mangrove Study Areas
FLORIDA
Mangroves
R10
R8
R7
R9
R12
R11
E2
E4
E6
E1
E3
E5
L16
L15
L13
L14
0 20 40
kilometers
Fort Myers
Lake Okeechobee
Ding Darling NWR
Rookery Bay National Estuarine Research Reserve
Naples
10,000 Islands National Wildlife Refuge
Everglades City
Everglades National Park
Miami
Path of Hurricane Andrew
Flamingo
National Key Deer NWR
USGS

SELVA-MANGRO
Model Scaling



Documentation Doyle 1997, 1998, 2001,, Doyle and Girod 1997, Doyle et al. 2003

Model Components

- **SELVA**
  - Landscape level
  - GIS-based
  - Spatially-explicit
  - Habitat-specific
  - C++, GUI interface
  - PC-Windows
- **MANGRO**
  - Stand simulator
  - Individual-based
  - Spatially-explicit
  - Species-specific
  - C++, GUI interface
  - PC-Windows

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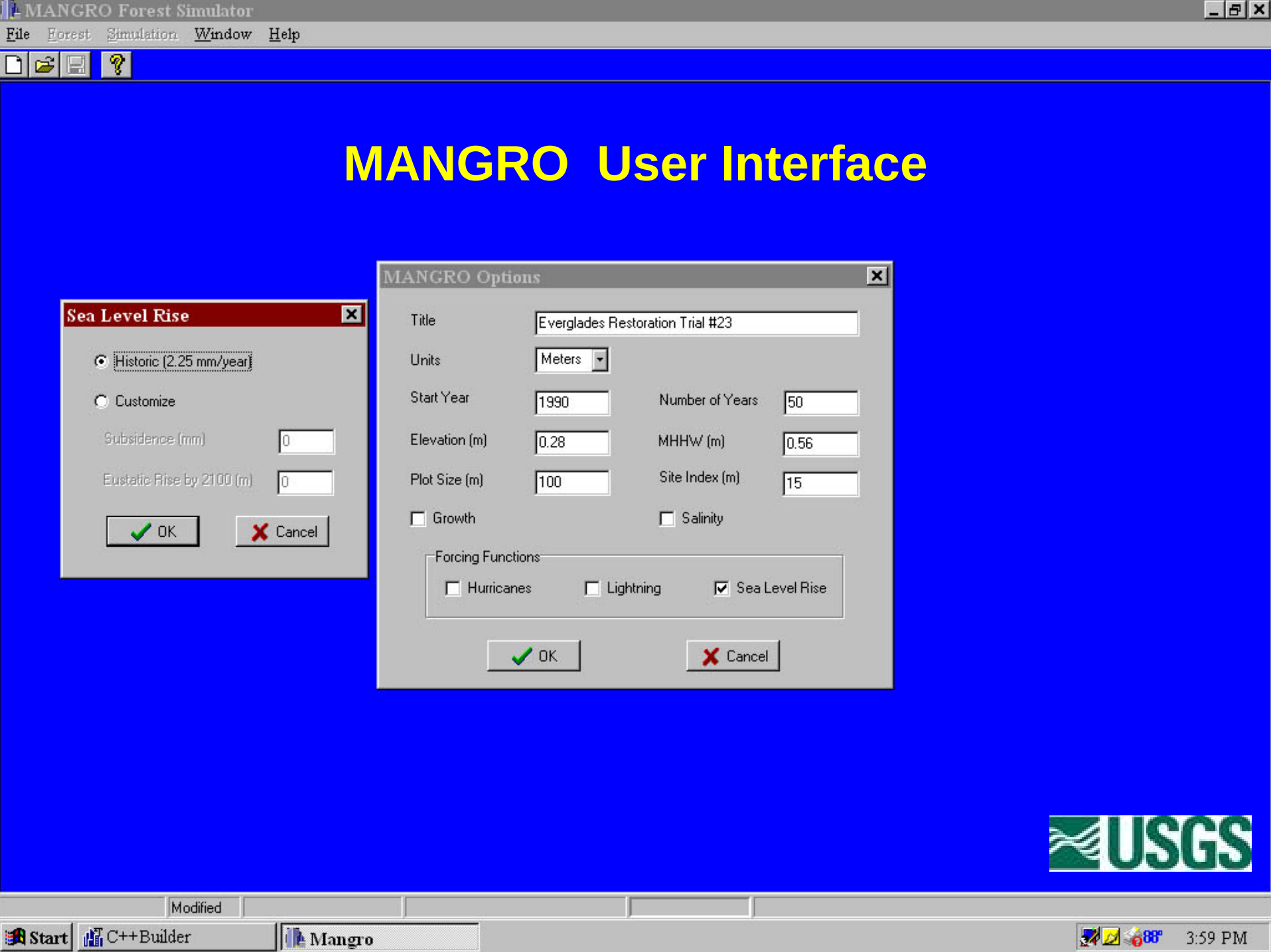
Model Mechanisms

- **SELVA**
- **Subsidence/Accretion**
- **Land/Water Elevation**
- **Sea-level Rise/Fall**
- **Hurricane Strike**
- **Lightning**
- **Freshwater Mgmt.**

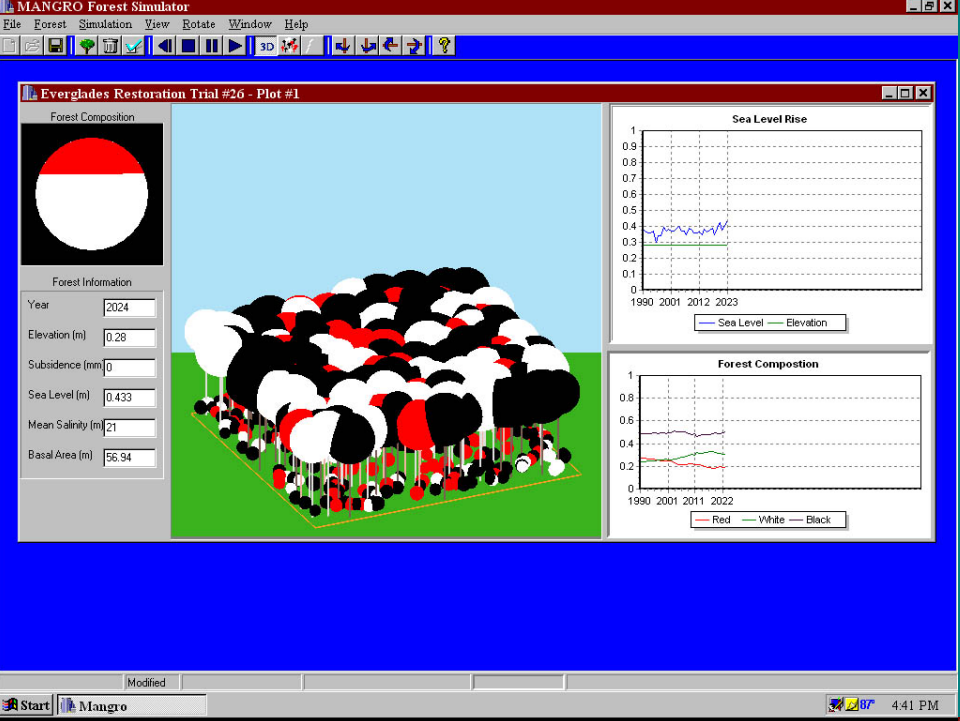
- **MANGRO**
- **Regeneration**
  - **Land/Water Relation**
- **Growth**
  - **Shading**
  - **Salinity**
  - **Competition**
- **Death**
  - **Age, Suppression**
  - **Disturbance**

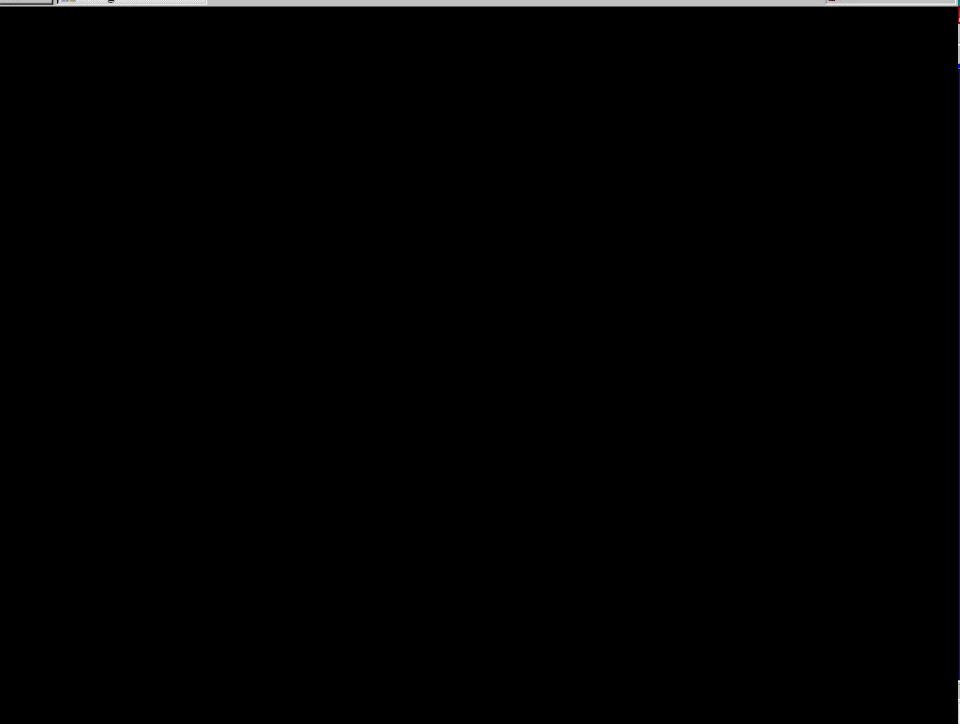

MANGRO Forest Simulator
File Forest Simulation Window Help
MANGRO User Interface
Sea Level Rise
Historic (2.25 mm/year)
Customize
Subsidence (mm)
0
Eustatic Rise by 2100 (m)
0
OK
Cancel
MANGRO Options
Title
Everglades Restoration Trial #23
Units
Meters
Start Year
1990
Number of Years
50
Elevation (m)
0.28
MHHW (m)
0.56
Plot Size (m)
100
Site Index (m)
15
Growth
Salinity
Forcing Functions
Hurricanes
Lightning
Sea Level Rise
OK
Cancel
USGS
Modified
Start
C++Builder
Mangro
3:59 PM

SELVA/MANGRO Model Output

- Tree Density (# / ha, size class)
- Stand Development (basal area)
- Species Composition (%)
- Stemwood Production (cm^2 / year)
- Canopy height (m)
- Habitat Distribution, Gain/Loss (ha)

USGS





USGS

MANGRO:

Disturbance Agents

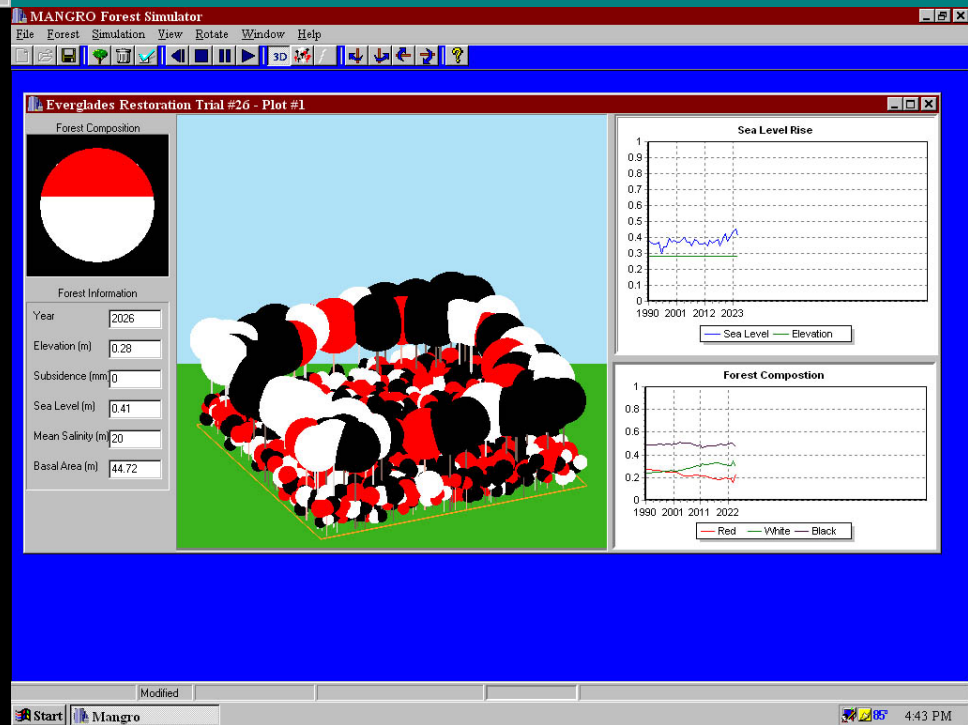
Hurricanes

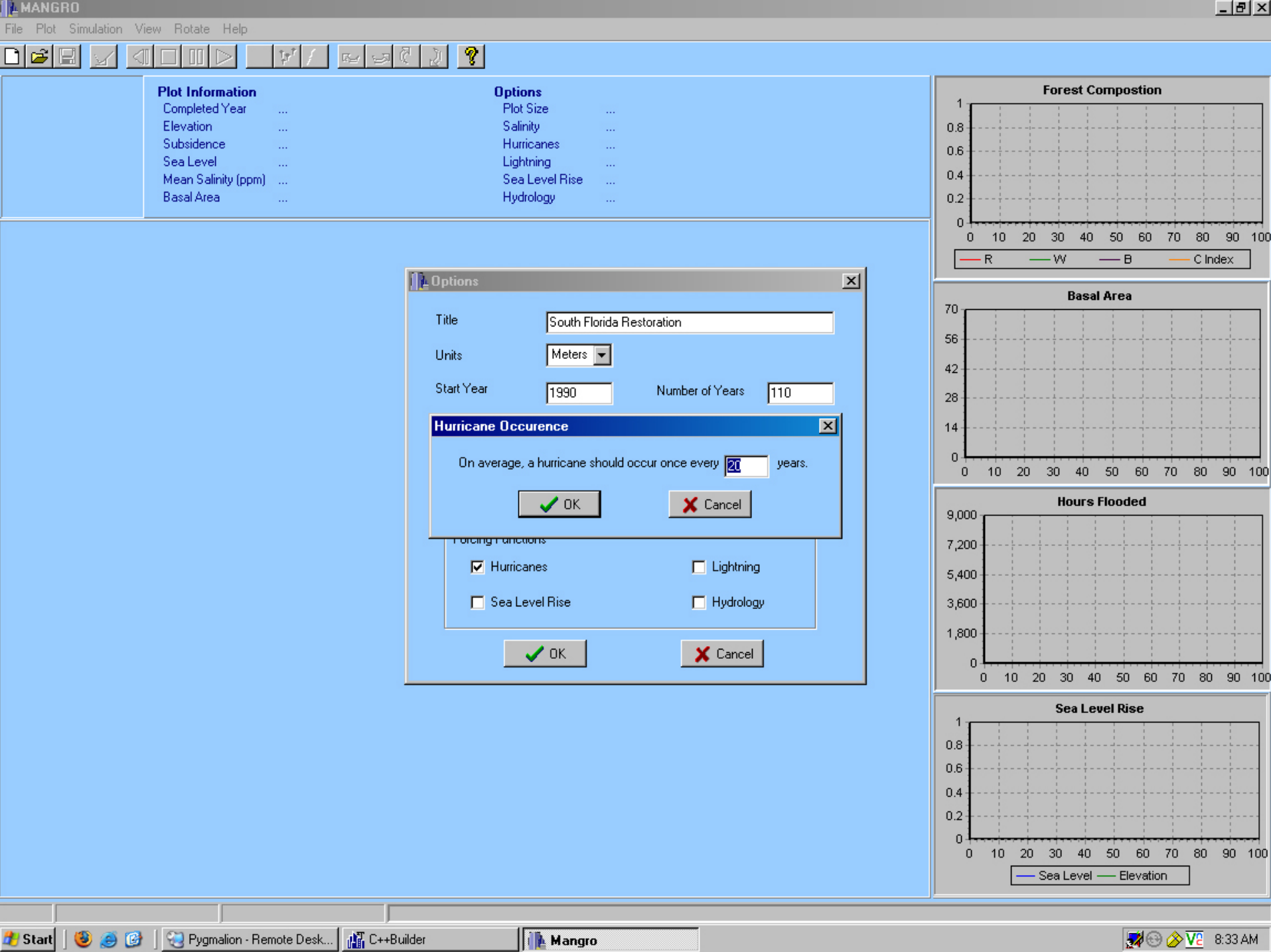
Lightning

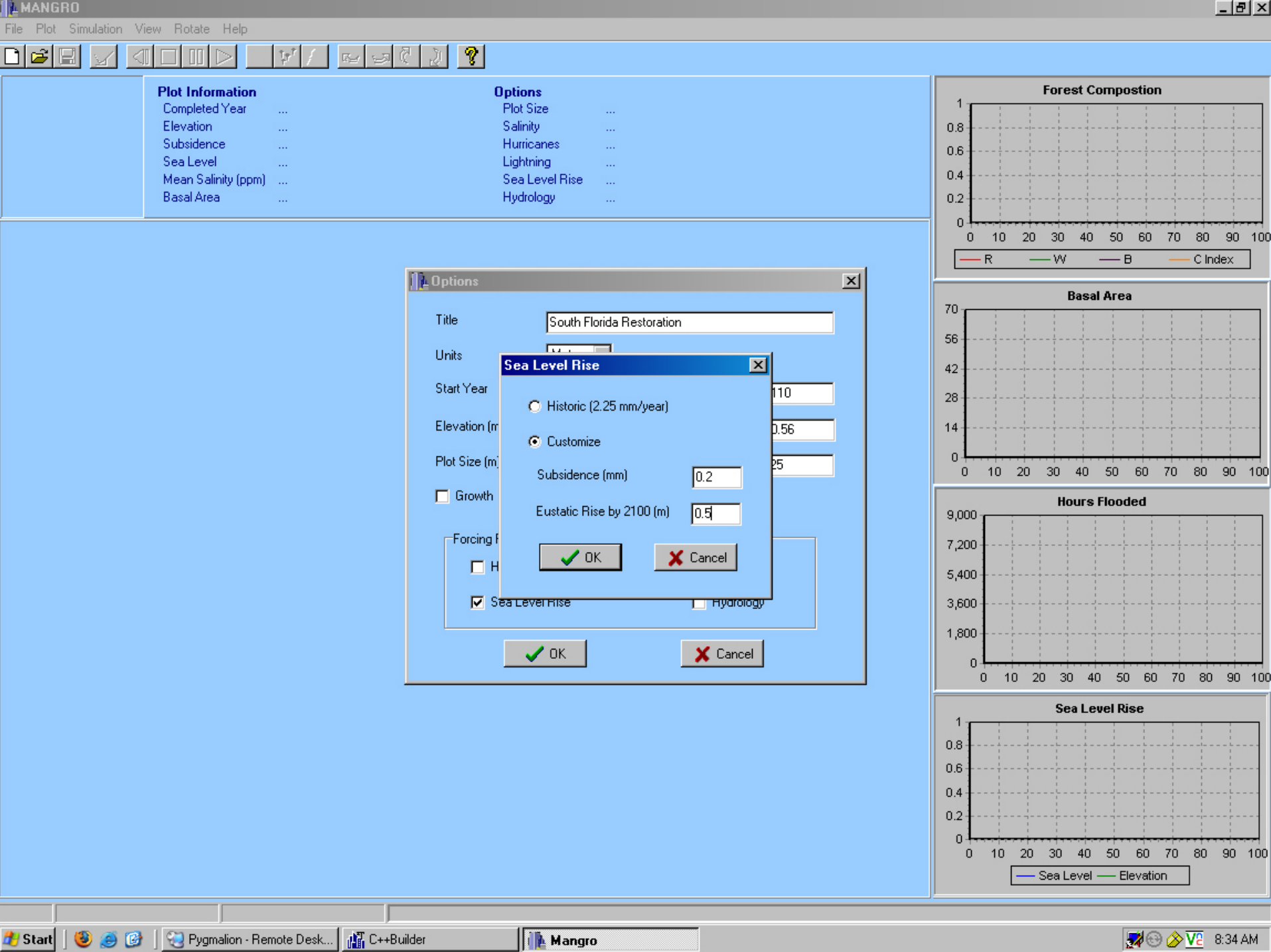
Forcing Functions

Sea-level Rise

Freshwater Flow




MANGRO
File Plot Simulation View Rotate Help
Plot Information
Completed Year ...
Elevation ...
Subsidence ...
Sea Level ...
Mean Salinity (ppm) ...
Basal Area ...
Options
Plot Size ...
Salinity ...
Hurricanes ...
Lightning ...
Sea Level Rise ...
Hydrology ...
Forest Compostion
R W B C Index
Basal Area
Hours Flooded
Sea Level Rise
Sea Level Elevation
Options
Title South Florida Restoration
Units Meters
Start Year 1990
Number of Years 110
Hurricane Occurence
On average, a hurricane should occur once every 20 years.
OK Cancel
Forcing Functions
Hurricanes
Lightning
Sea Level Rise
Hydrology
OK Cancel
Start
Pygmalion - Remote Desk...
C++Builder
Mangro
8:33 AM


MANGRO
File Plot Simulation View Rotate Help
Plot Information
Completed Year ...
Elevation ...
Subsidence ...
Sea Level ...
Mean Salinity (ppm) ...
Basal Area ...
Options
Plot Size ...
Salinity ...
Hurricanes ...
Lightning ...
Sea Level Rise ...
Hydrology ...
Forest Compostion
R W B C Index
Basal Area
Hours Flooded
Sea Level Rise
Sea Level Elevation
Options
Title
South Florida Restoration
Units
Start Year
Elevation (m
Plot Size (m)
Growth
Forcing F
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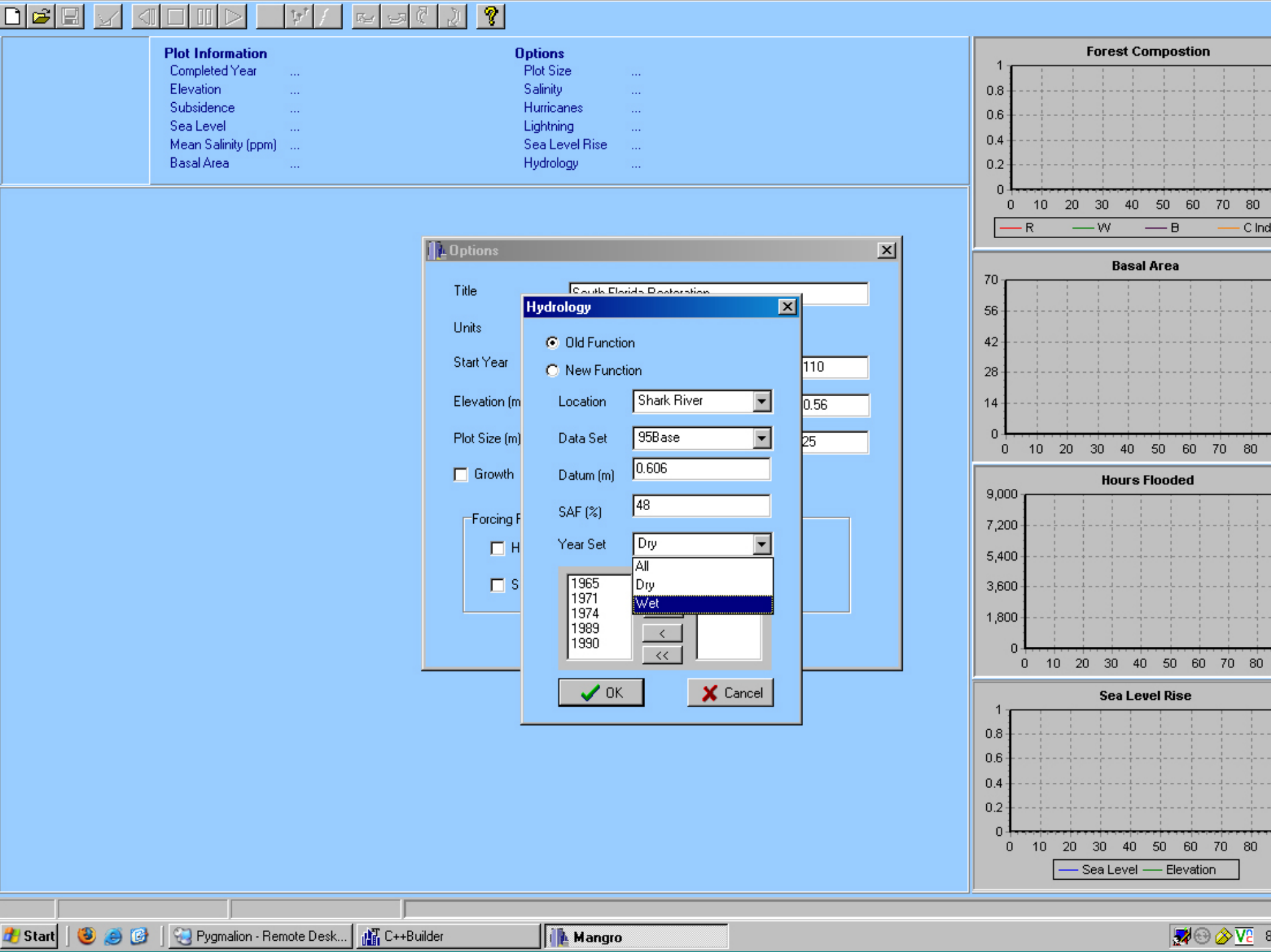
Sea Level Rise
Hydrology
OK
Cancel
Sea Level Rise
Historic (2.25 mm/year)
Customize
Subsidence (mm)
0.2
Eustatic Rise by 2100 (m)
0.5
OK
Cancel
Start
Pygmalion - Remote Desk...
C++Builder
Mangro
8:34 AM


Plot Information
Completed Year ...
Elevation ...
Subsidence ...
Sea Level ...
Mean Salinity (ppm) ...
Basal Area ...
Options
Plot Size ...
Salinity ...
Hurricanes ...
Lightning ...
Sea Level Rise ...
Hydrology ...
Forest Compostion
R W B C Ind
Basal Area
Hours Flooded
Sea Level Rise
Sea Level Elevation
Options
Title
Units
Start Year
Elevation (m
Plot Size (m)
Growth
Forcing F
H
S
110
0.56
25
Hydrology
Old Function
New Function
Location
Shark River
Data Set
95Base
Datum (m)
0.606
SAF (%)
48
Year Set
Dry
All
Dry
Wet
1965
1971
1974
1989
1990
<
<<
OK
Cancel
Start
Pygmalion - Remote Desk...
C++Builder
Mangro

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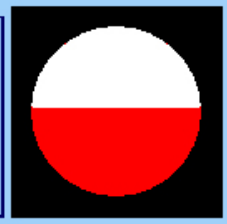
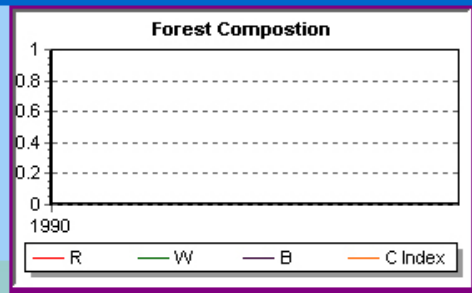
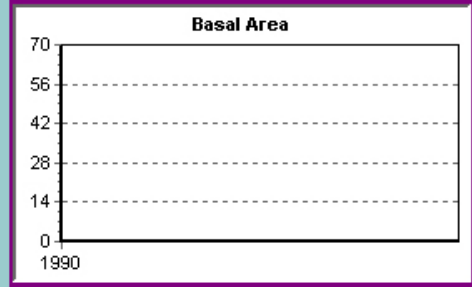
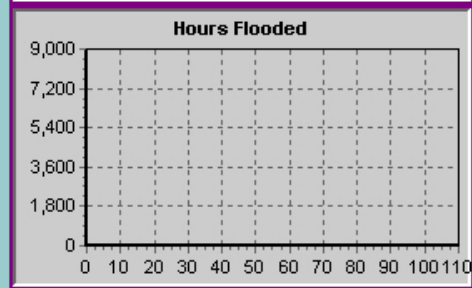
EcoModel - NWRC

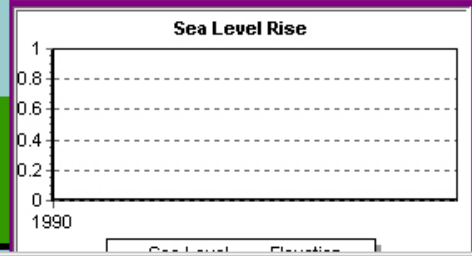
Plot Information		Options	
Completed Year	1990	Plot Size	50 m
Elevation (m)	0.28	Salinity	Off
Subsidence (mm)	0	Hurricanes	Off
Sea Level (m)	0.31	Lightning	Off
Mean Salinity (ppt)	35	Sea Level Rise	On
Basal Area (sq m/ha)	0.64	Hydrology	Off

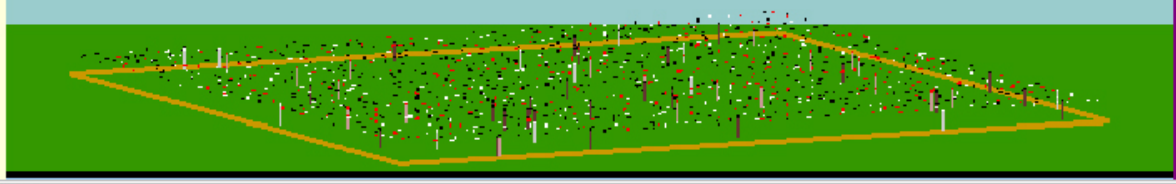












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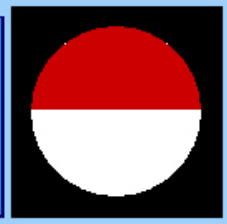
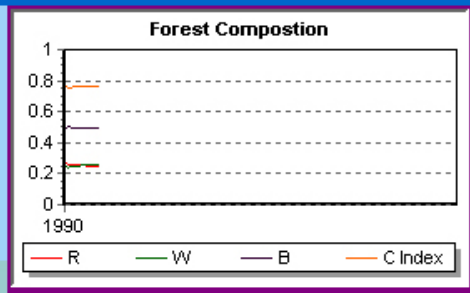
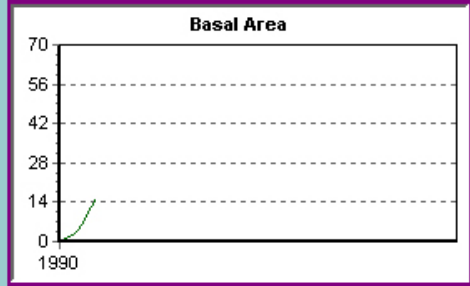
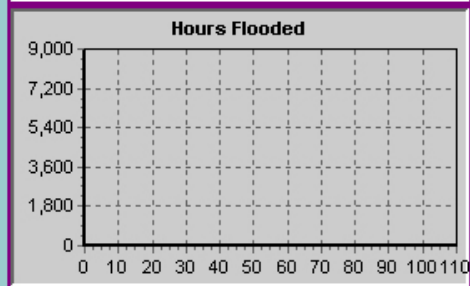
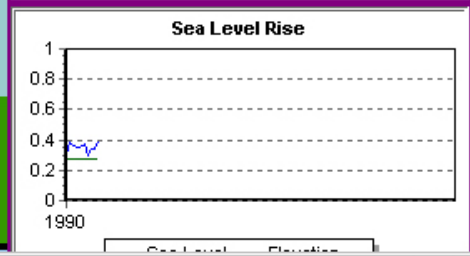
Plot Information		Options	
Completed Year	2000	Plot Size	50 m
Elevation (m)	0.28	Salinity	Off
Subsidence (mm)	0	Hurricanes	Off
Sea Level (m)	0.37	Lightning	Off
Mean Salinity (ppt)	35	Sea Level Rise	On
Basal Area (sq m/ha)	15.72	Hydrology	Off











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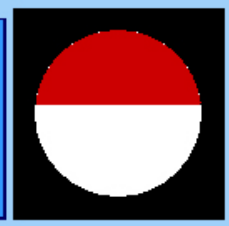
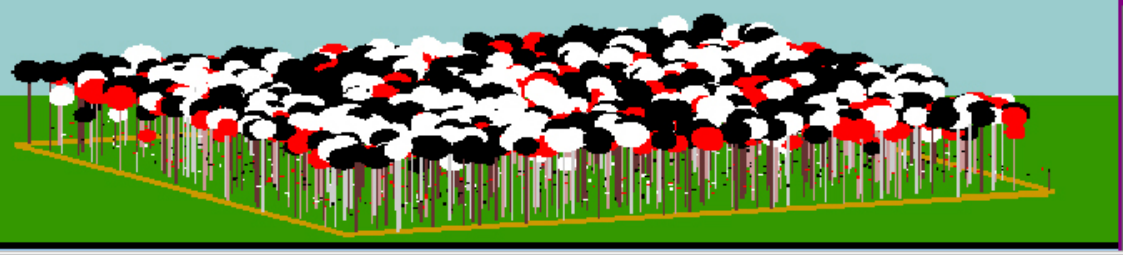
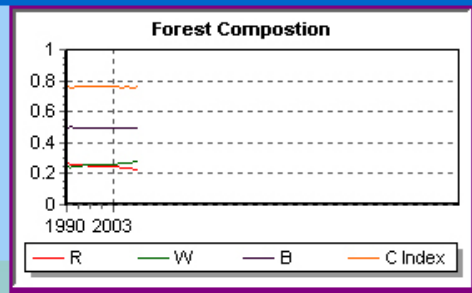
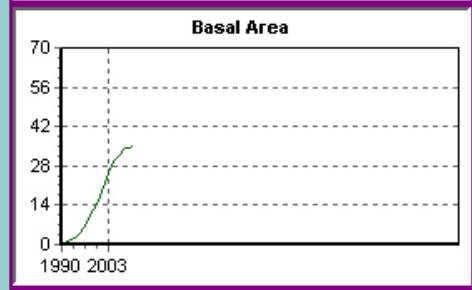
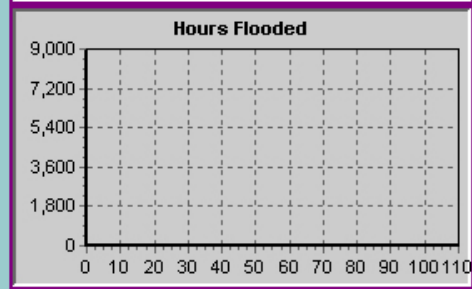
Plot Information		Options	
Completed Year	2010	Plot Size	50 m
Elevation (m)	0.28	Salinity	Off
Subsidence (mm)	0	Hurricanes	Off
Sea Level (m)	0.38	Lightning	Off
Mean Salinity (ppt)	35	Sea Level Rise	On
Basal Area (sq m/ha)	35.38	Hydrology	Off

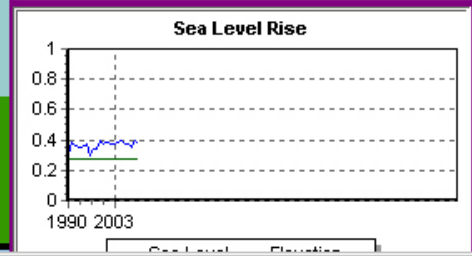












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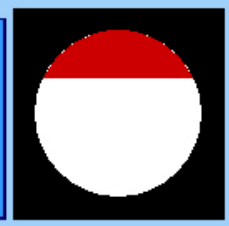
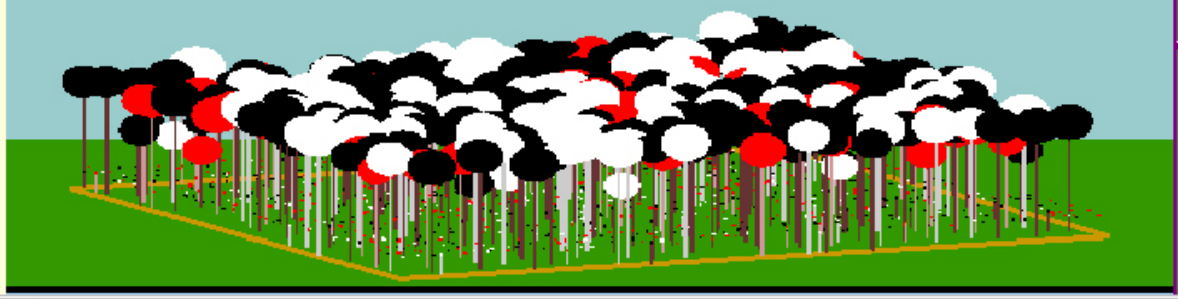
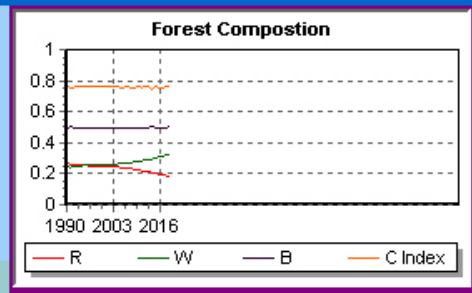
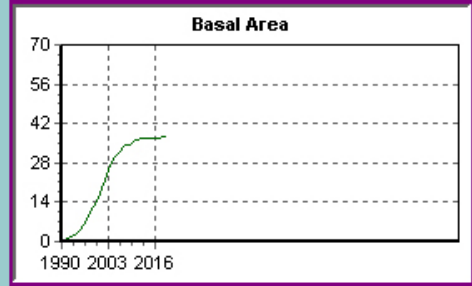
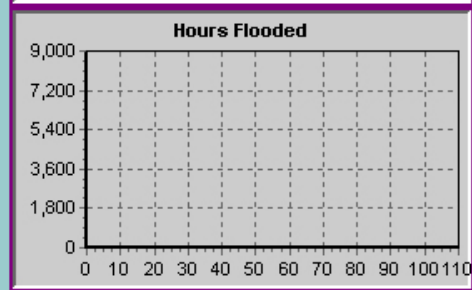
Plot Information		Options	
Completed Year	2020	Plot Size	50 m
Elevation (m)	0.28	Salinity	Off
Subsidence (mm)	0	Hurricanes	Off
Sea Level (m)	0.39	Lightning	Off
Mean Salinity (ppt)	35	Sea Level Rise	On
Basal Area (sq m/ha)	37.68	Hydrology	Off

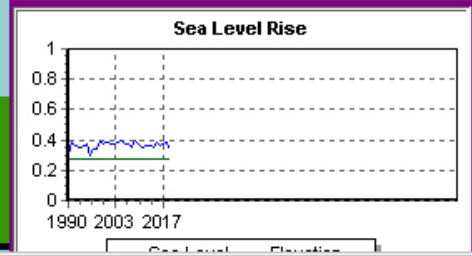












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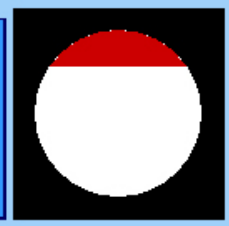
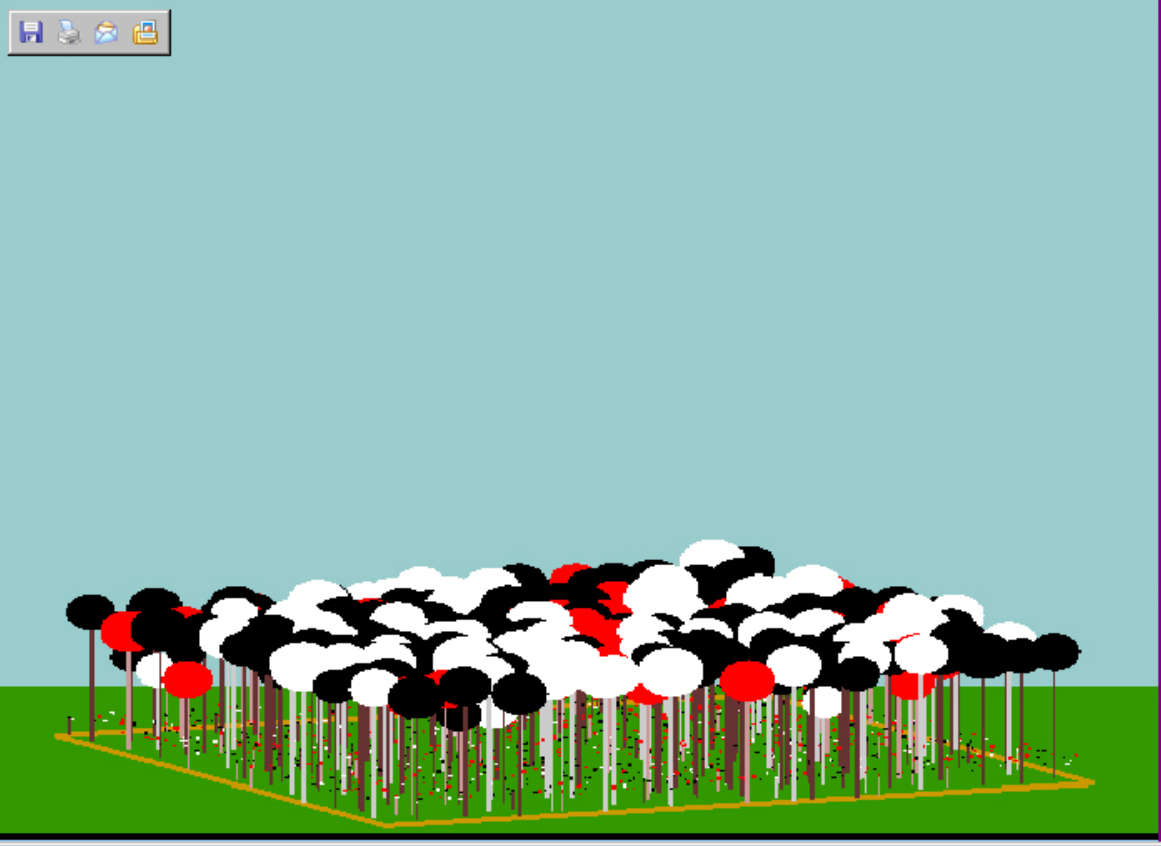
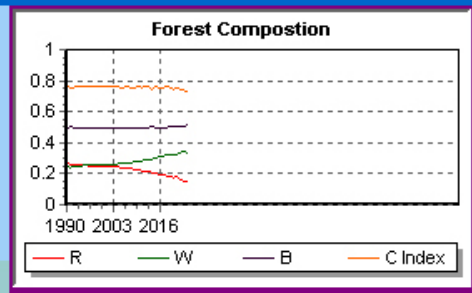
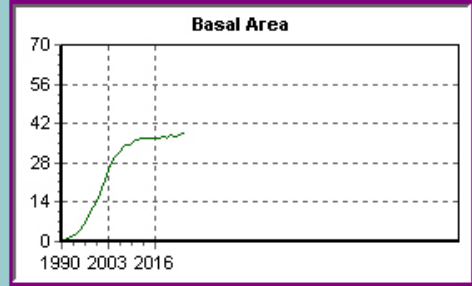
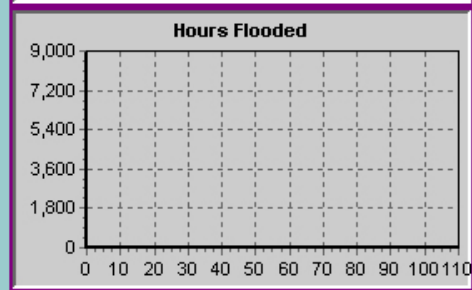
Plot Information		Options	
Completed Year	2025	Plot Size	50 m
Elevation (m)	0.28	Salinity	Off
Subsidence (mm)	0	Hurricanes	Off
Sea Level (m)	0.45	Lightning	Off
Mean Salinity (ppt)	35	Sea Level Rise	On
Basal Area (sq m/ha)	38.65	Hydrology	Off

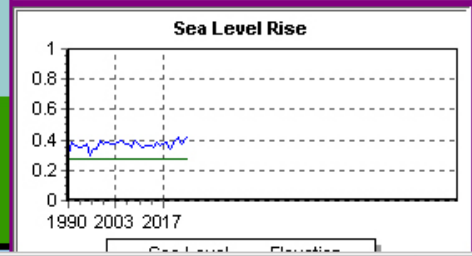












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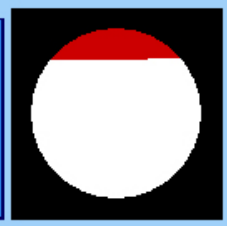
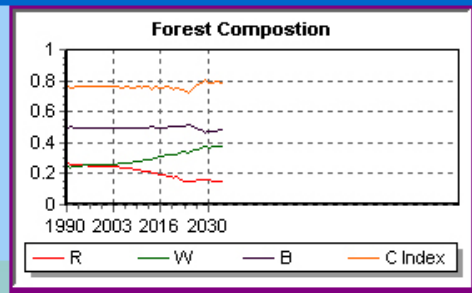
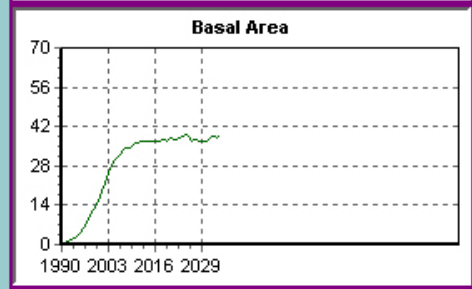
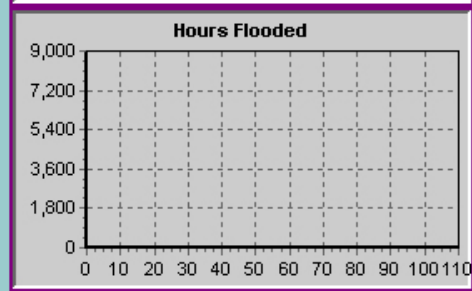
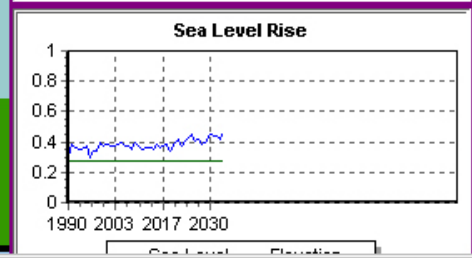
Plot Information		Options	
Completed Year	2035	Plot Size	50 m
Elevation (m)	0.28	Salinity	Off
Subsidence (mm)	0	Hurricanes	Off
Sea Level (m)	0.49	Lightning	Off
Mean Salinity (ppt)	35	Sea Level Rise	On
Basal Area (sq m/ha)	38.55	Hydrology	Off











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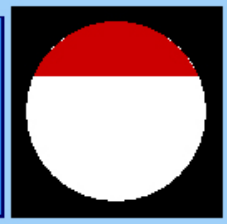
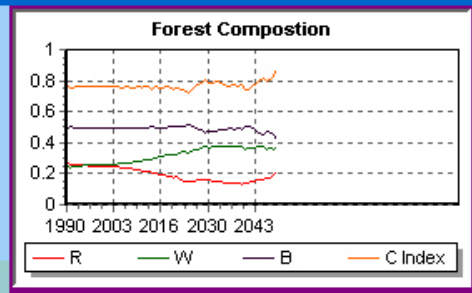
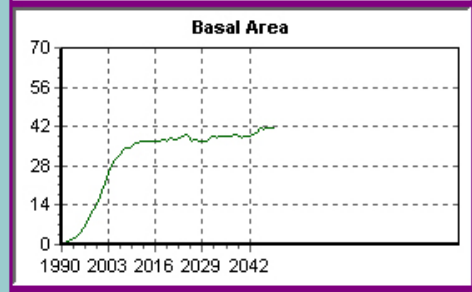
USGS science for a changing world

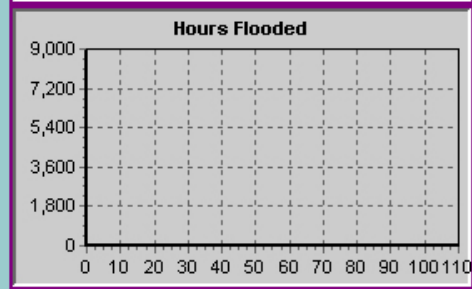
EcoModel - NWRC

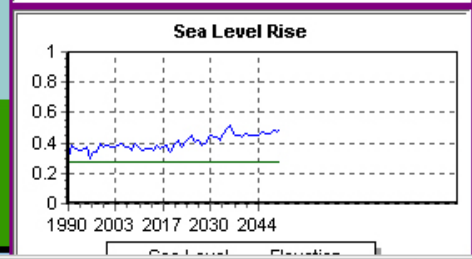
Plot Information		Options	
Completed Year	2050	Plot Size	50 m
Elevation (m)	0.28	Salinity	Off
Subsidence (mm)	0	Hurricanes	Off
Sea Level (m)	0.48	Lightning	Off
Mean Salinity (ppt)	35	Sea Level Rise	On
Basal Area (sq m/ha)	43.04	Hydrology	Off











Done

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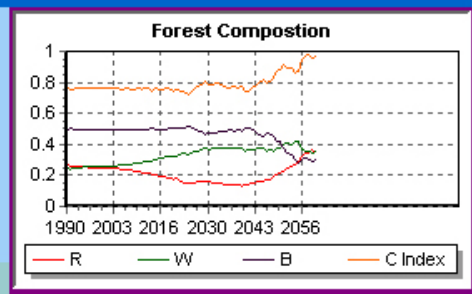
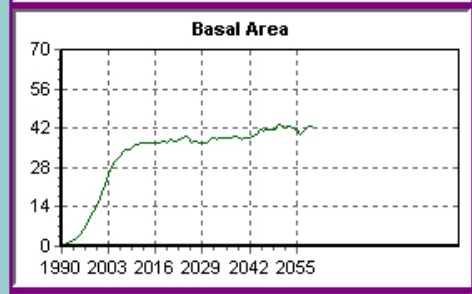
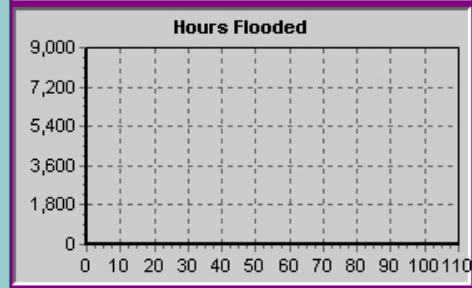
USGS science for a changing world

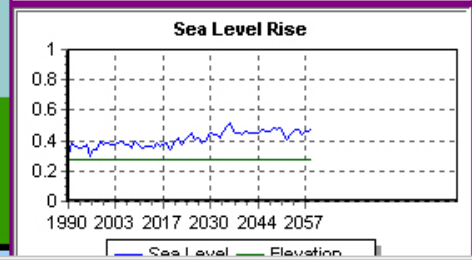
EcoModel - NWRC

Plot Information		Options	
Completed Year	2060	Plot Size	50 m
Elevation (m)	0.28	Salinity	Off
Subsidence (mm)	0	Hurricanes	Off
Sea Level (m)	0.51	Lightning	Off
Mean Salinity (ppt)	35	Sea Level Rise	On
Basal Area (sq m/ha)	42.55	Hydrology	Off









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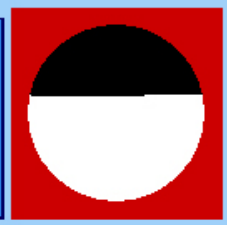
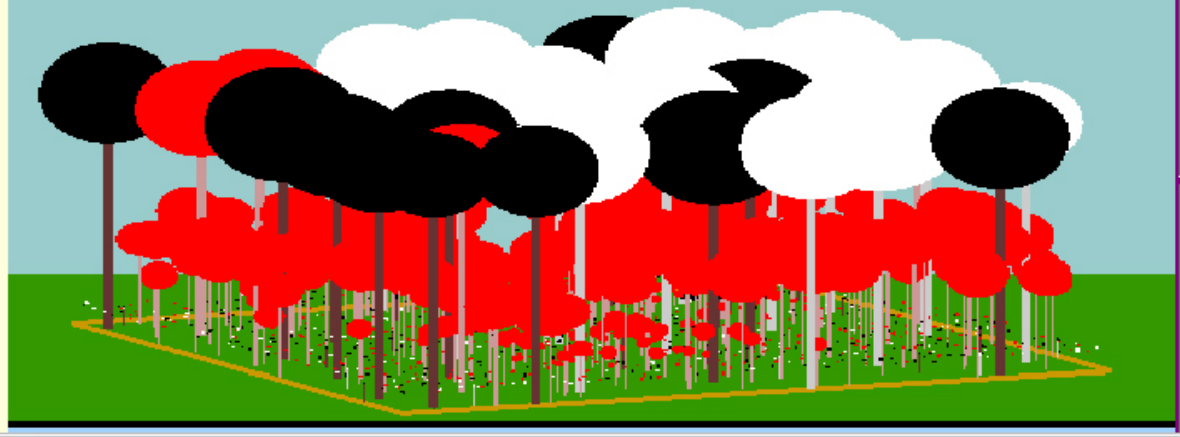
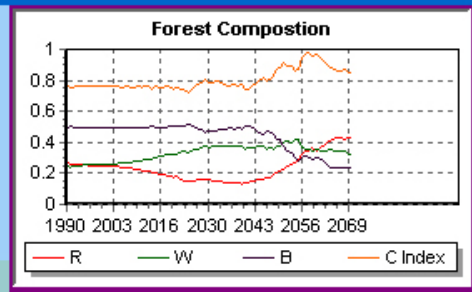
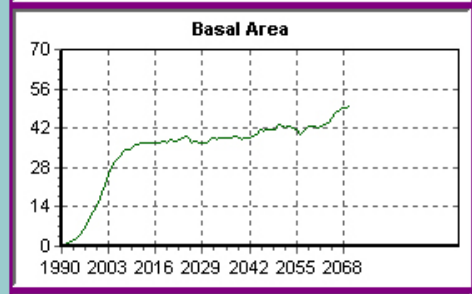
EcoModel - NWRC

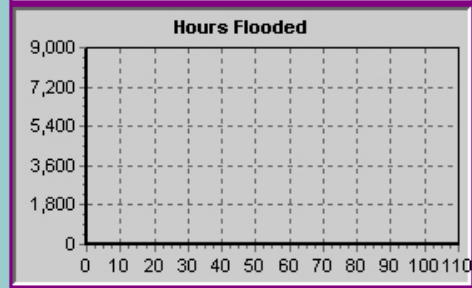
Plot Information		Options	
Completed Year	2070	Plot Size	50 m
Elevation (m)	0.28	Salinity	Off
Subsidence (mm)	0	Hurricanes	Off
Sea Level (m)	0.52	Lightning	Off
Mean Salinity (ppt)	35	Sea Level Rise	On
Basal Area (sq m/ha)	50.44	Hydrology	Off

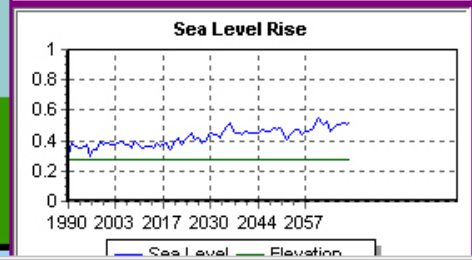












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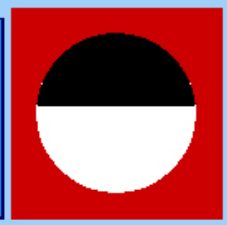
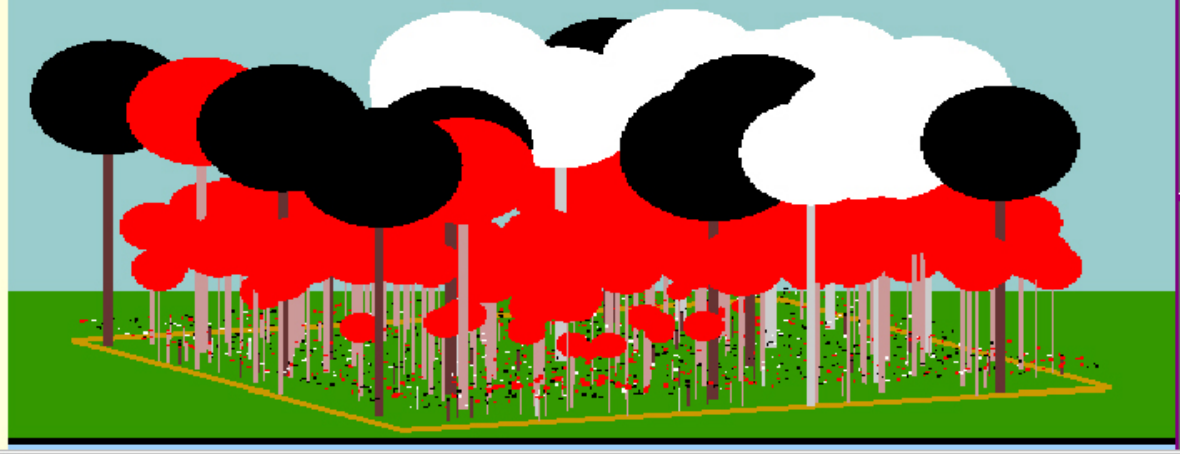
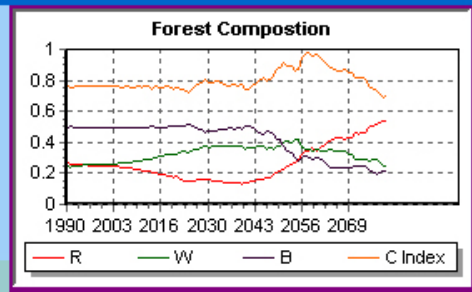
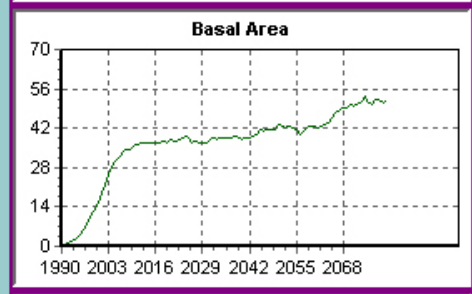
EcoModel - NWRC

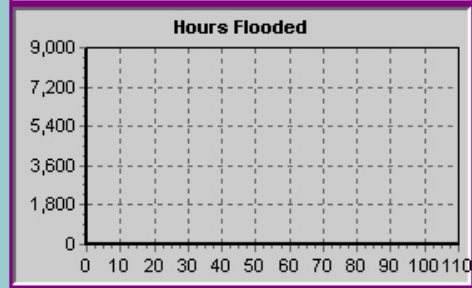
Plot Information		Options	
Completed Year	2080	Plot Size	50 m
Elevation (m)	0.28	Salinity	Off
Subsidence (mm)	0	Hurricanes	Off
Sea Level (m)	0.56	Lightning	Off
Mean Salinity (ppt)	35	Sea Level Rise	On
Basal Area (sq m/ha)	51.96	Hydrology	Off

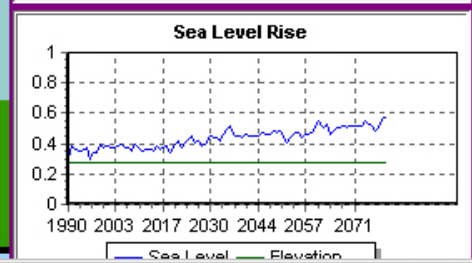












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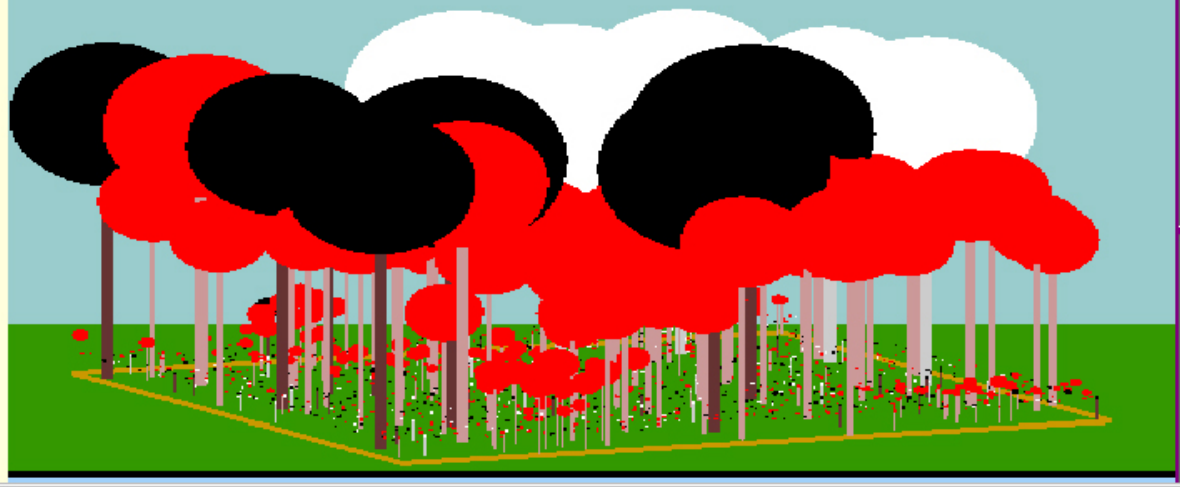
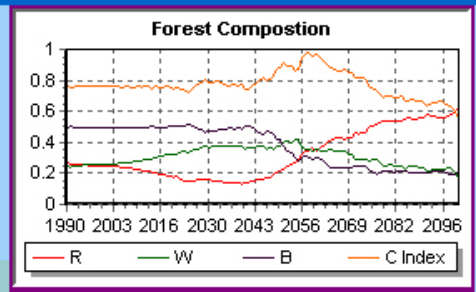
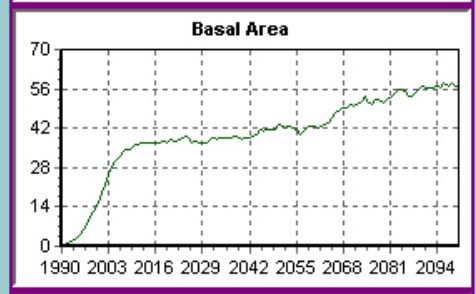
USGS science for a changing world

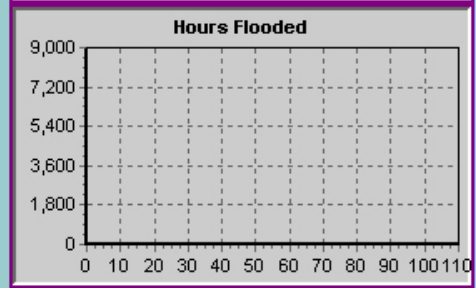
EcoModel - NWRC

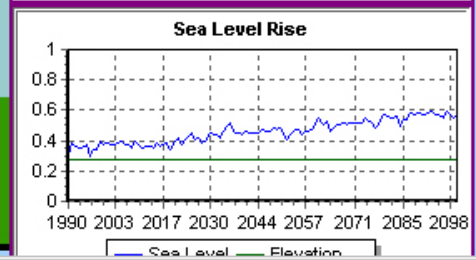
Plot Information		Options	
Completed Year	2100	Plot Size	50 m
Elevation (m)	0.28	Salinity	Off
Subsidence (mm)	0	Hurricanes	Off
Sea Level (m)	0.56	Lightning	Off
Mean Salinity (ppt)	35	Sea Level Rise	On
Basal Area (sq m/ha)	56.26	Hydrology	Off











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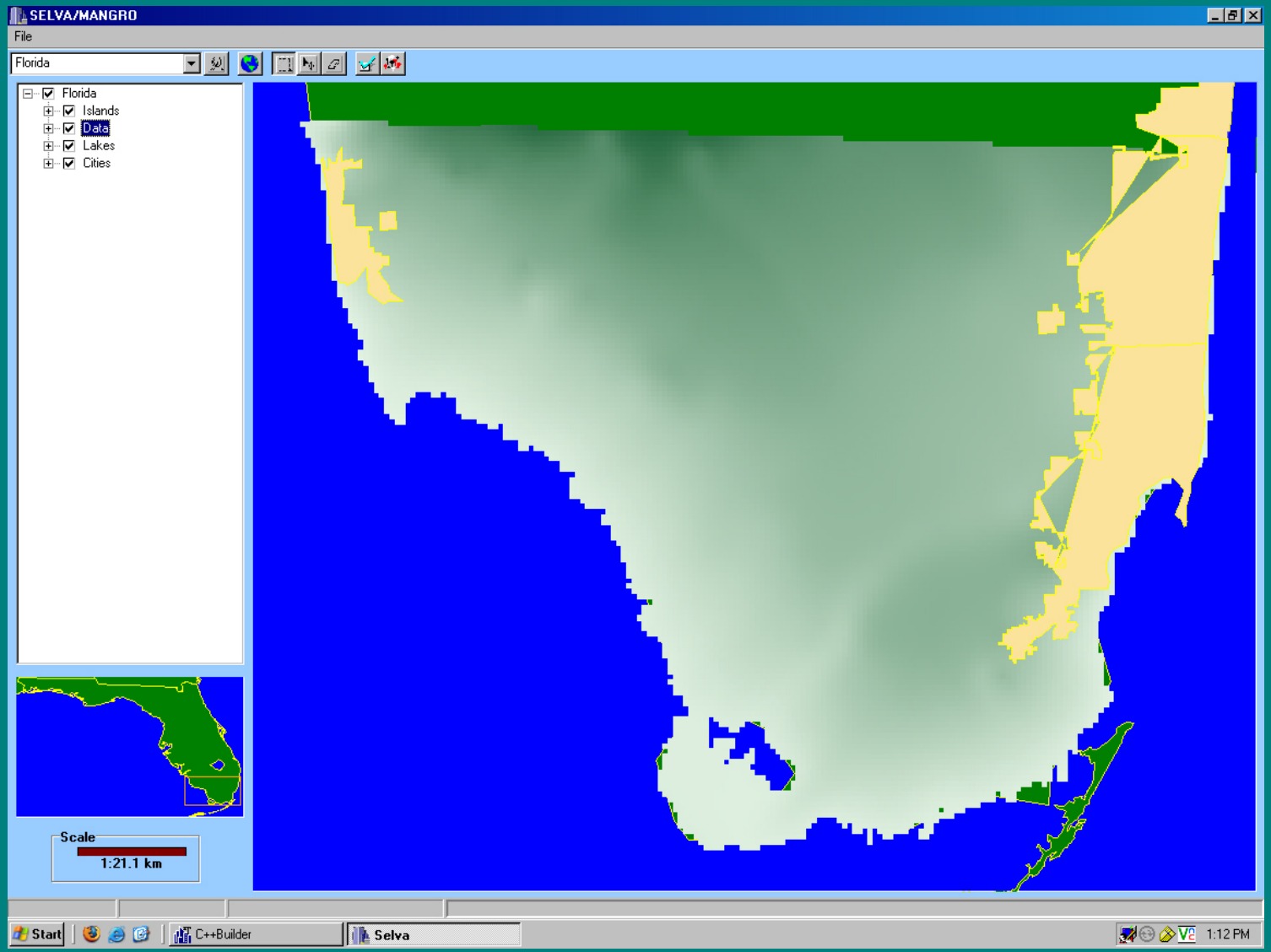
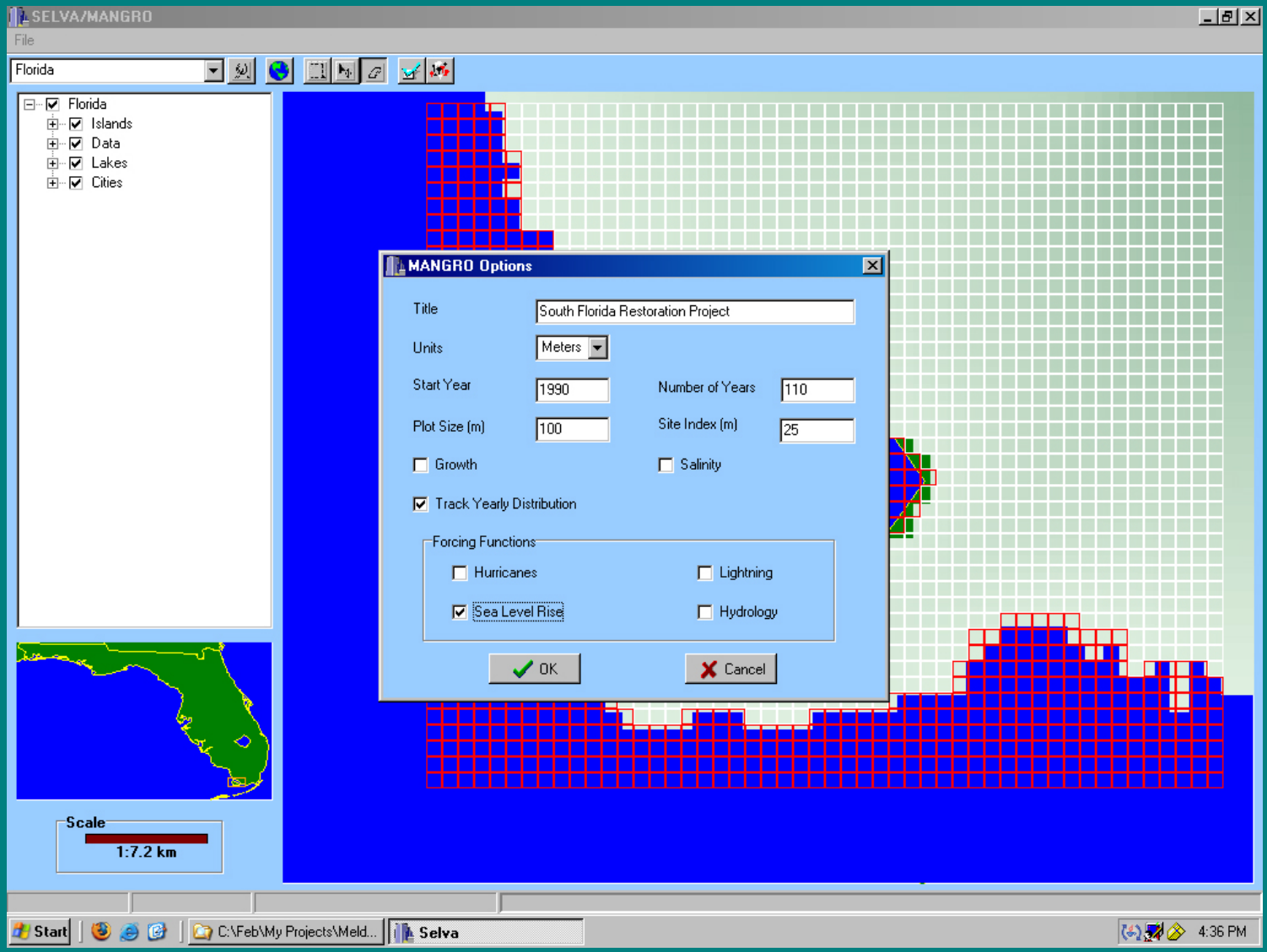
Digital Elevation Model of South Florida



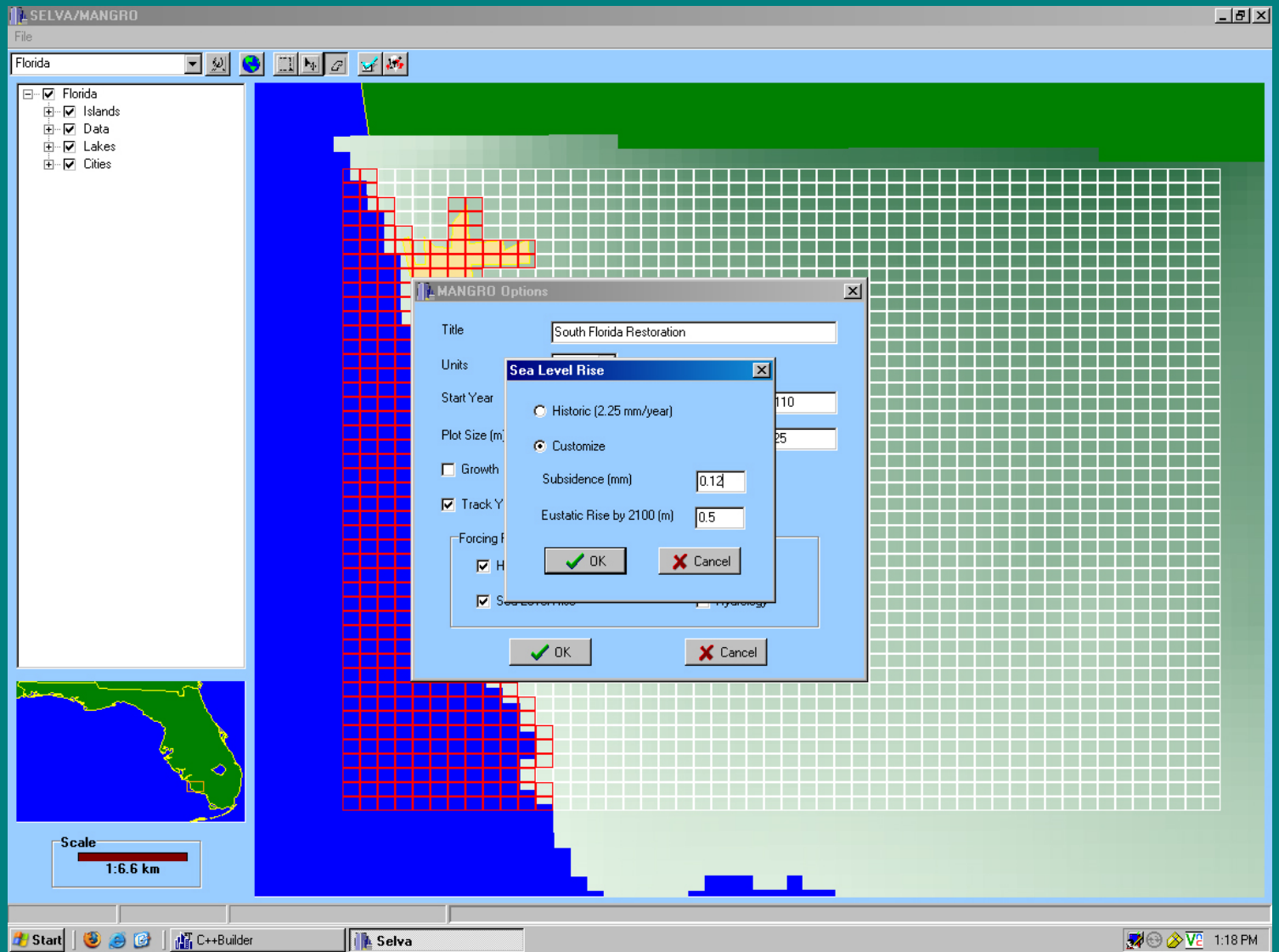
SELVA Grid Zone

Sea Level Rise options



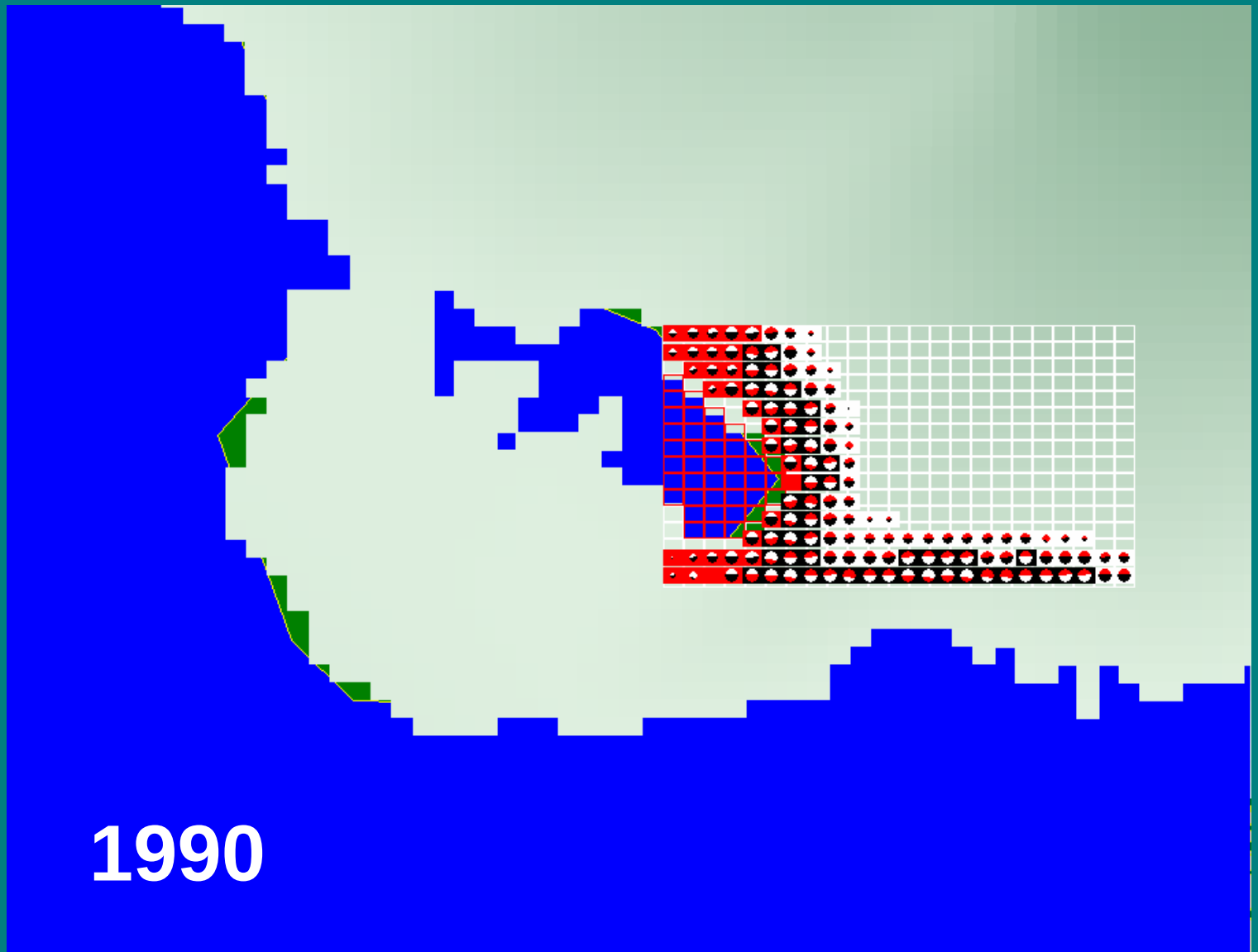
SELVA Grid Zone

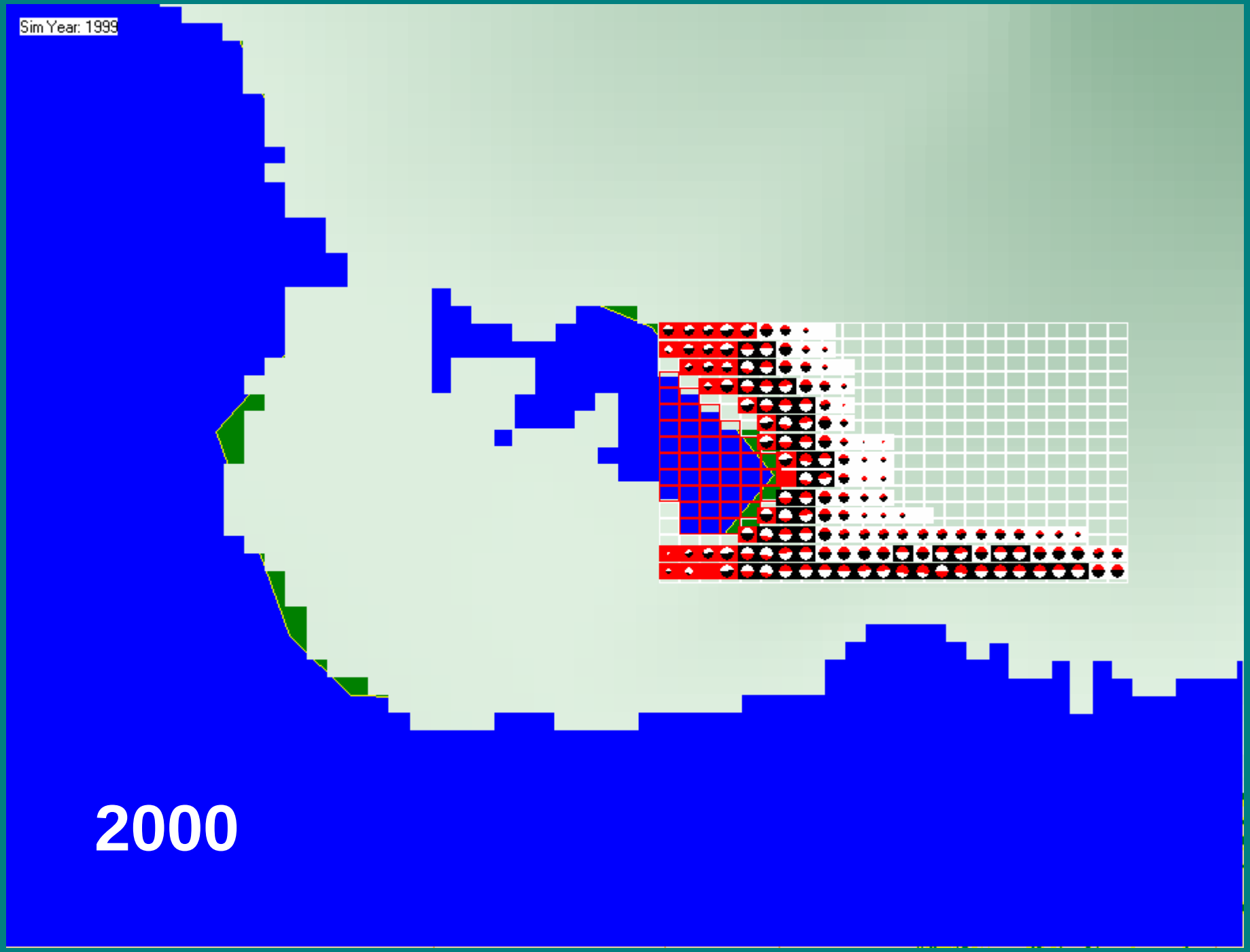
Sea Level Rise options

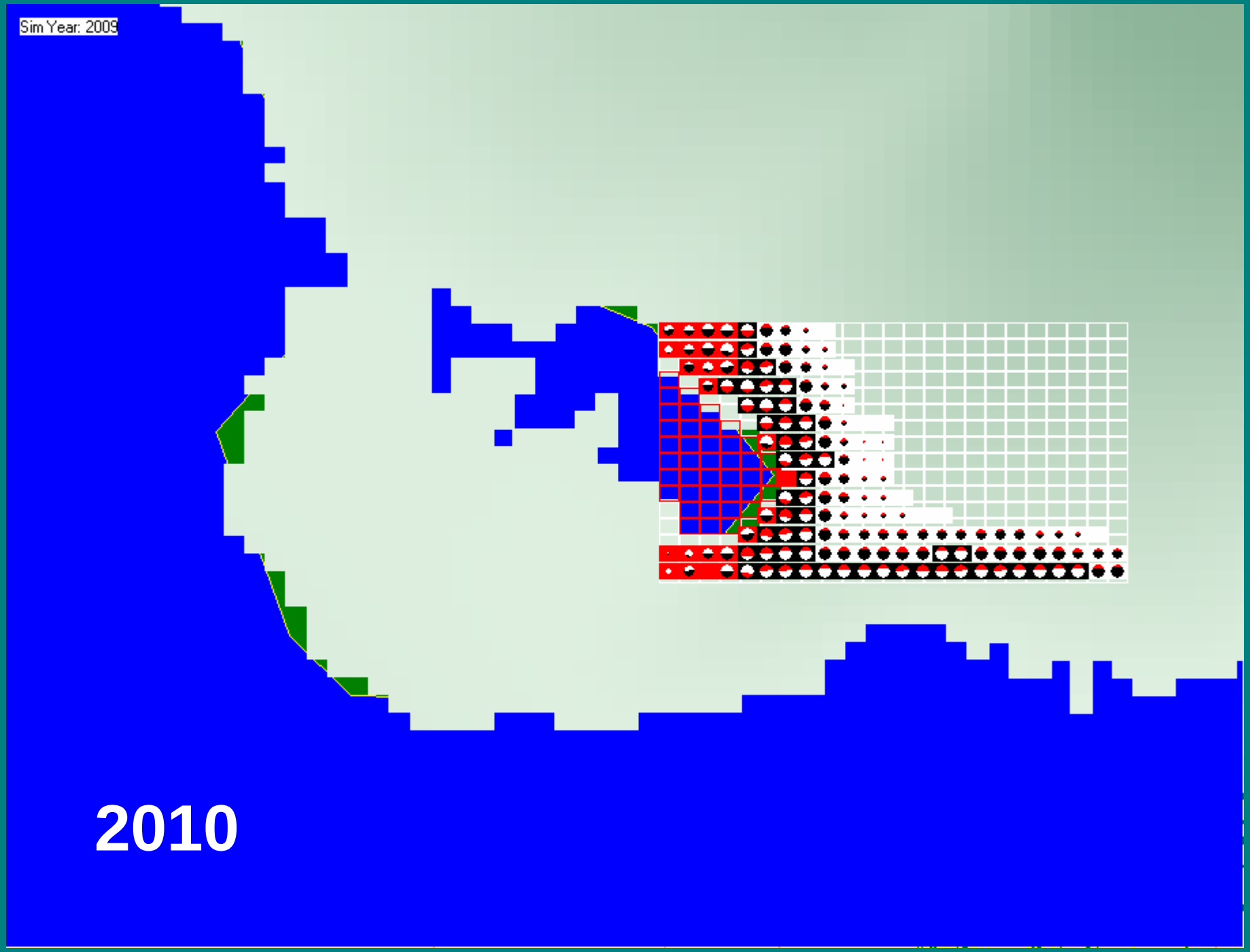


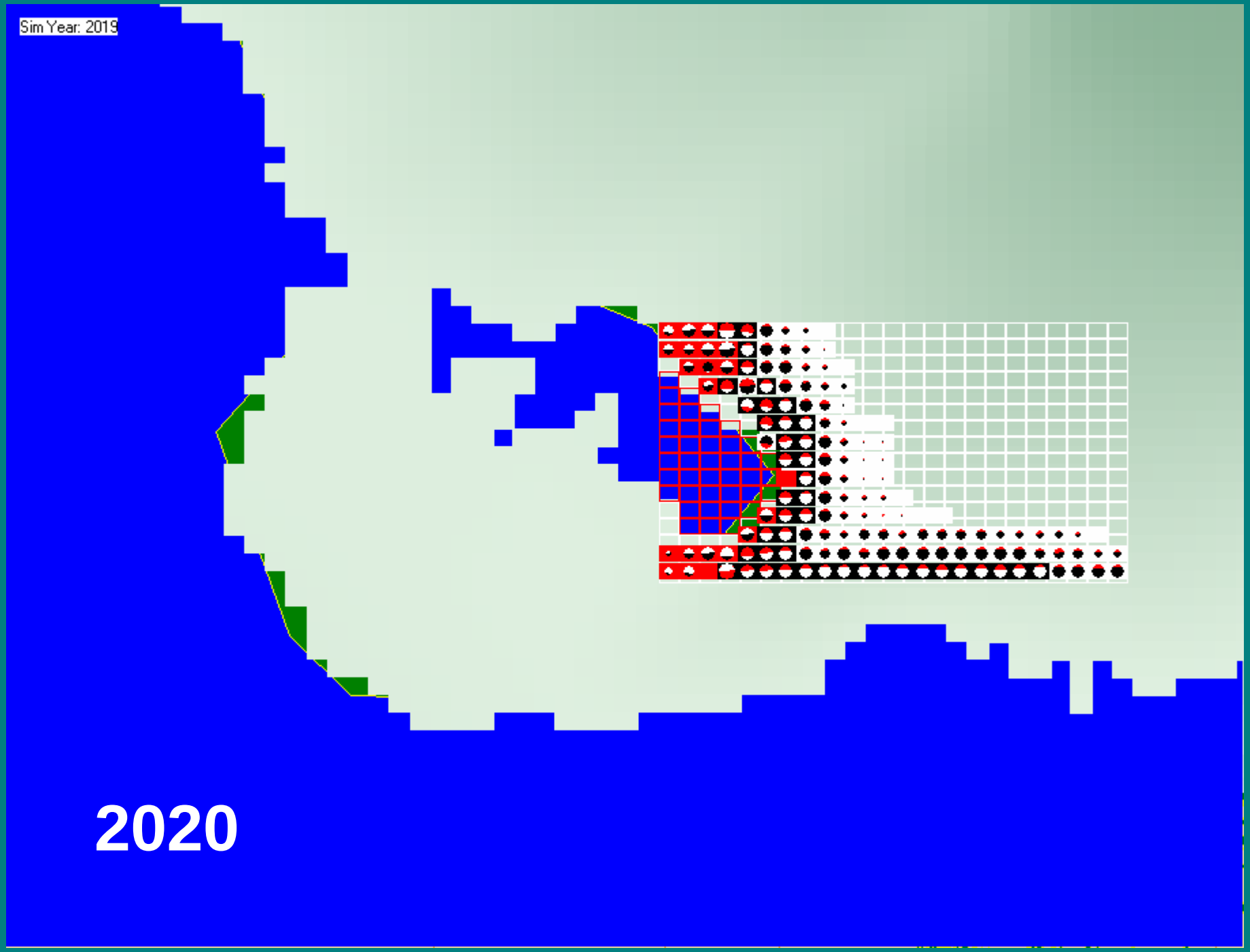
SELVA Grid Simulation

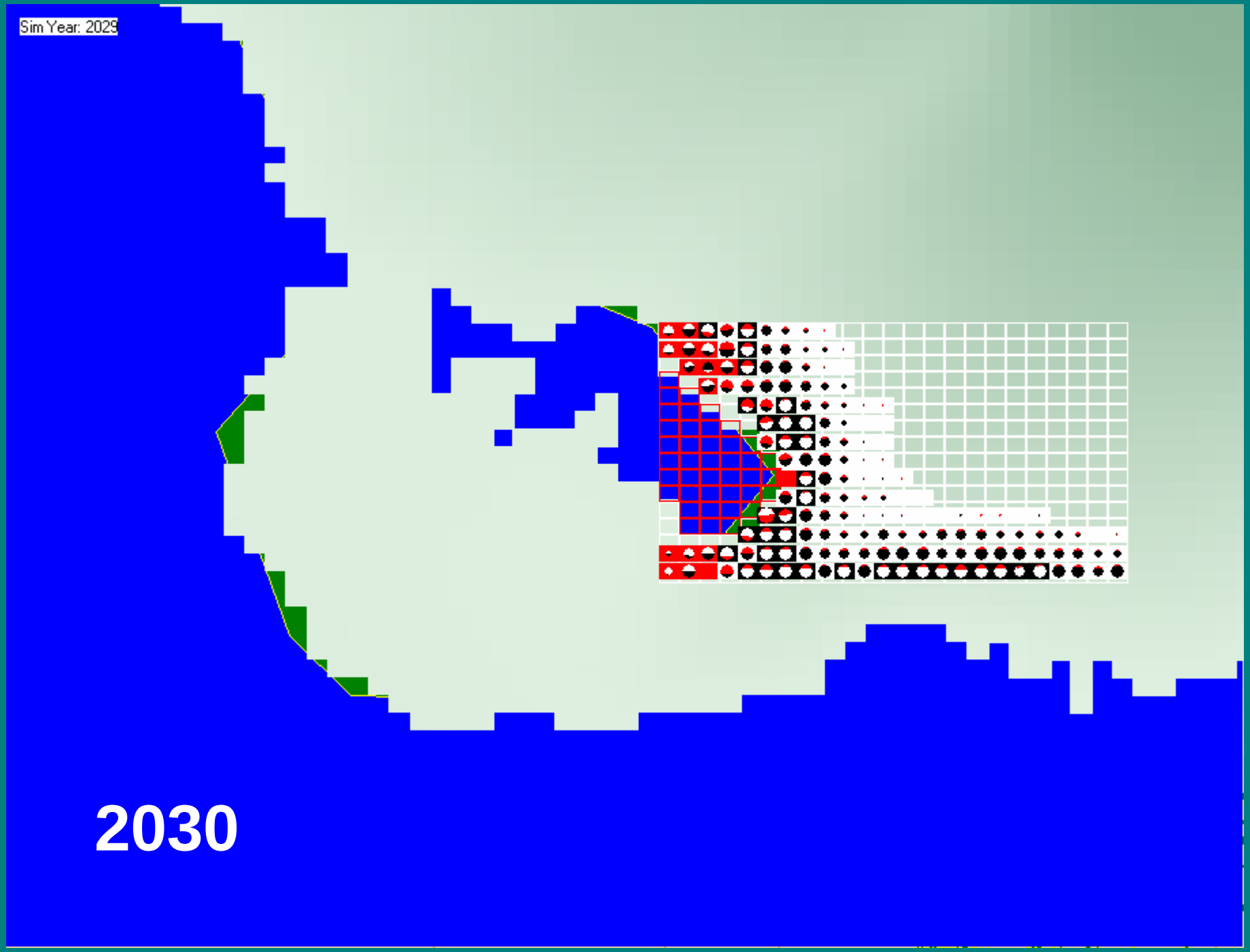
East of Whitewater Bay, ENP

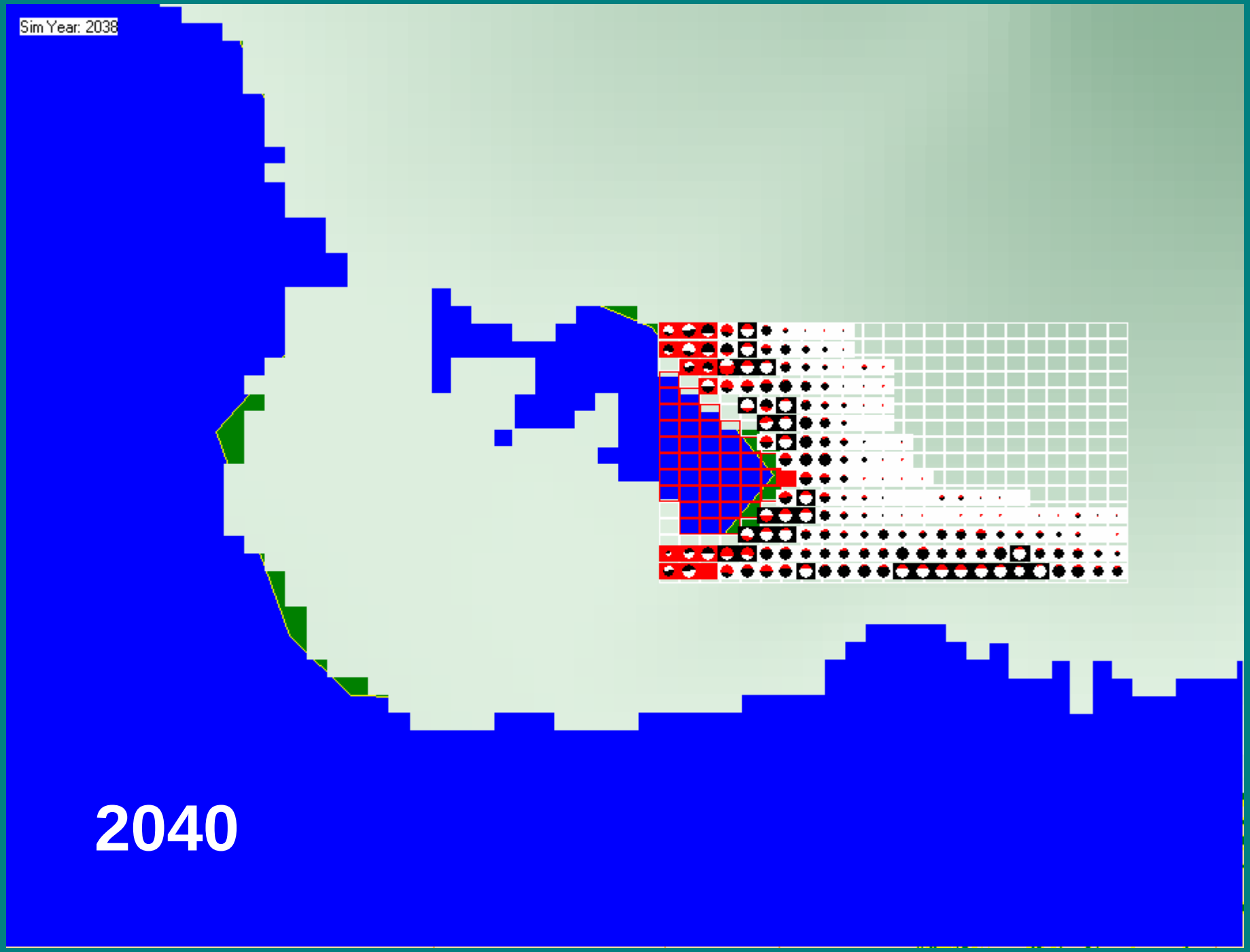



Sim Year: 1999
2000


Sim Year: 2009
2010

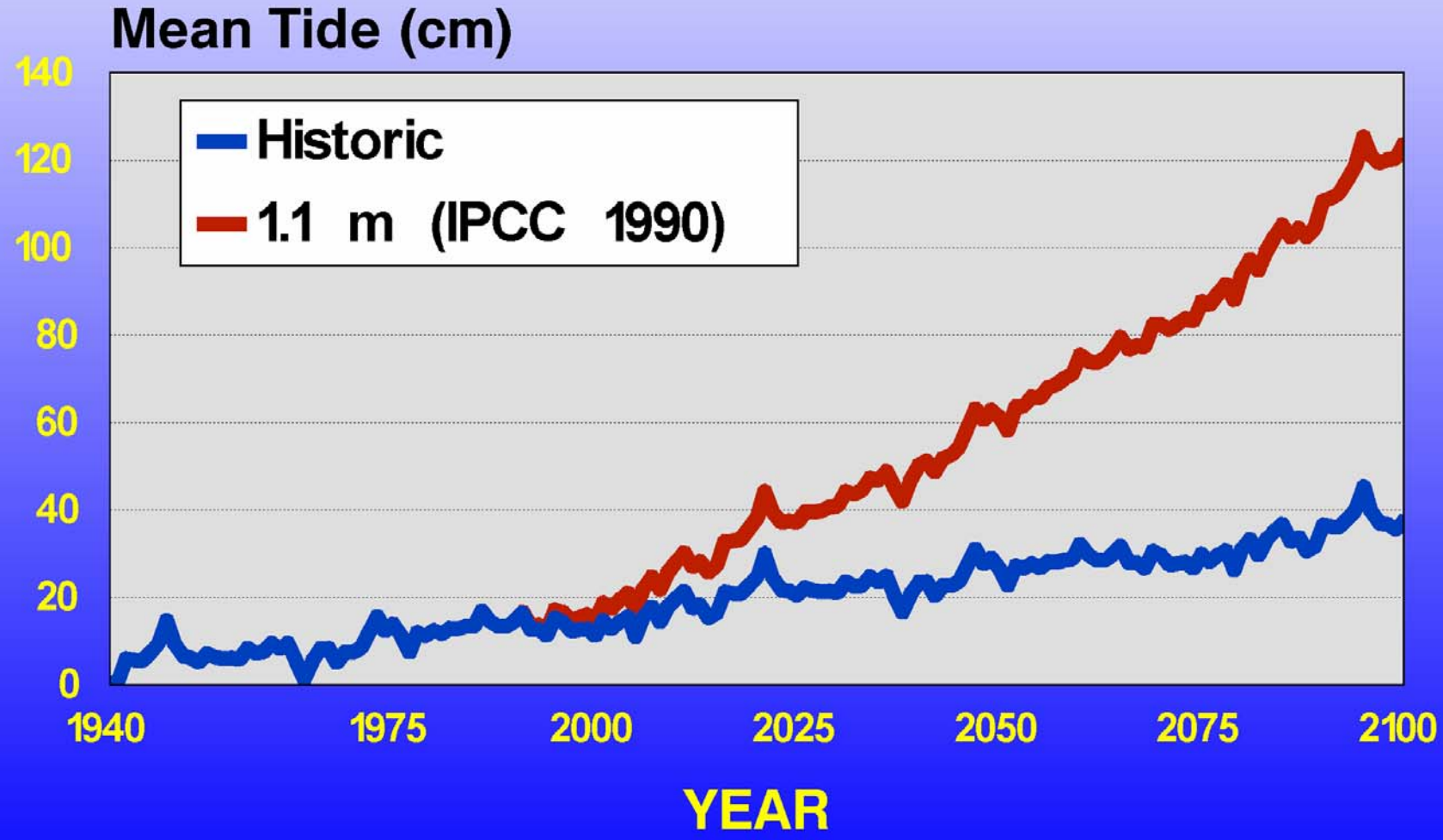

Sim Year: 2019
2020

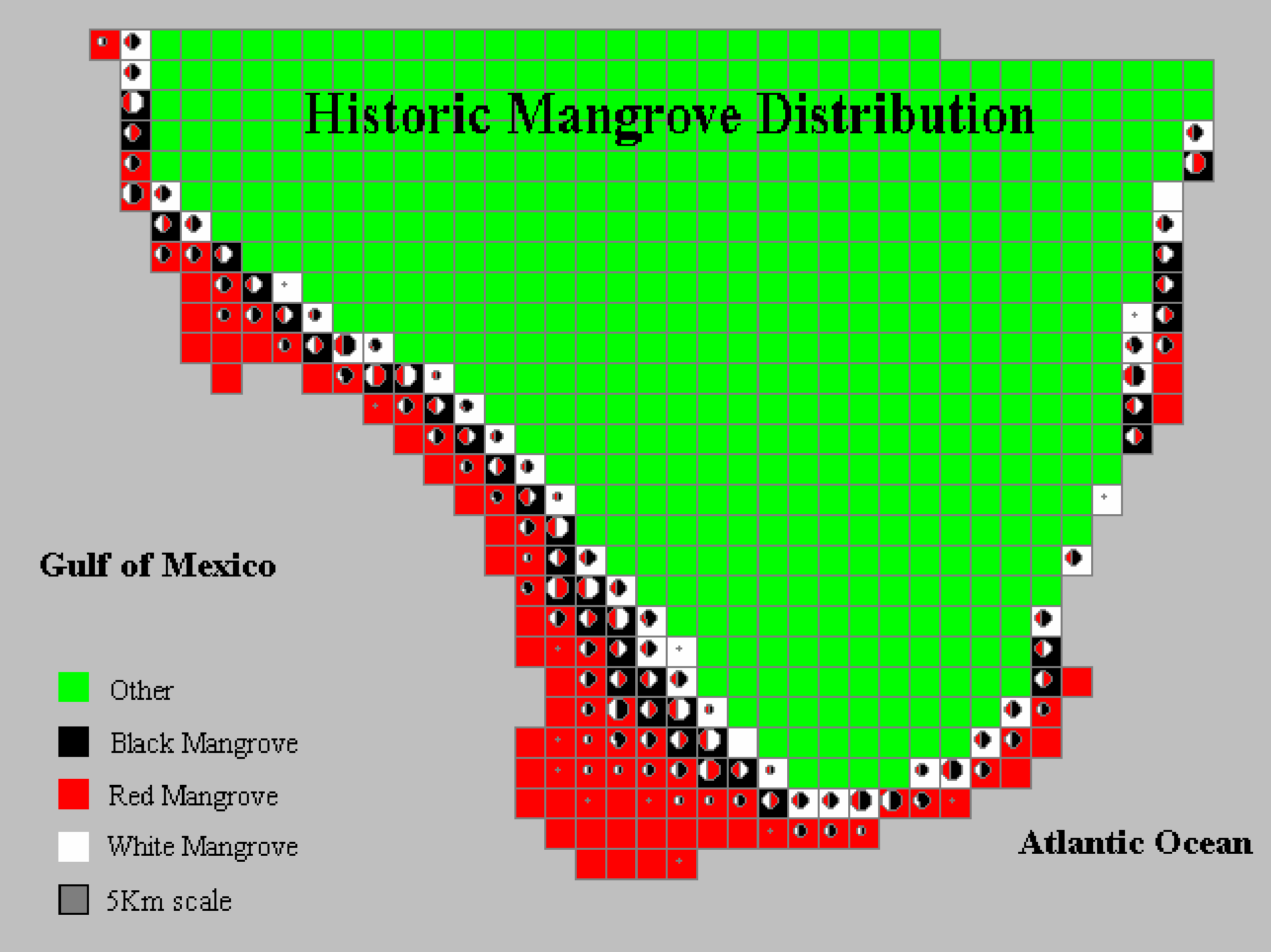

Sim Year: 2029
2030

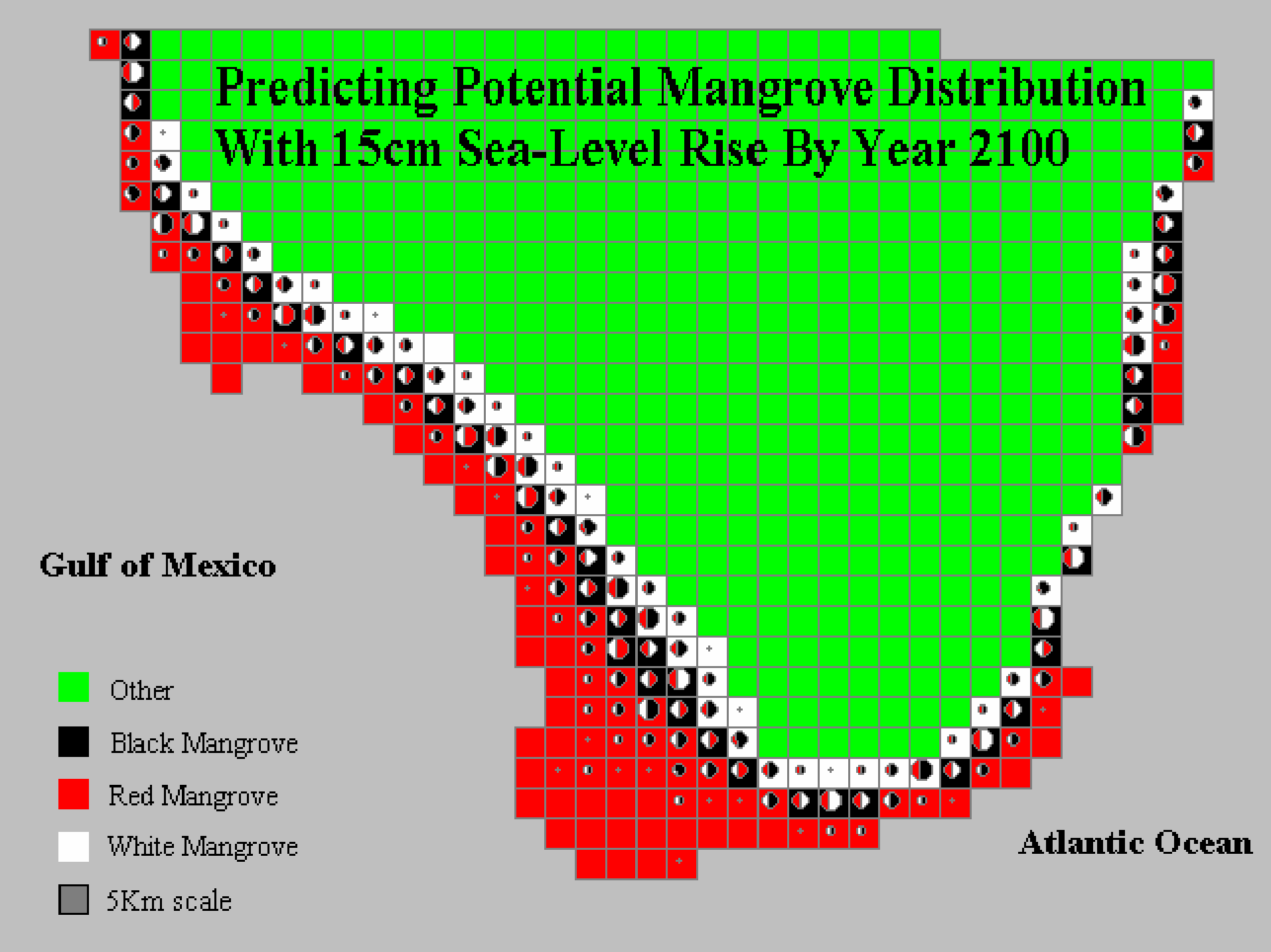

Sim Year: 2038
2040

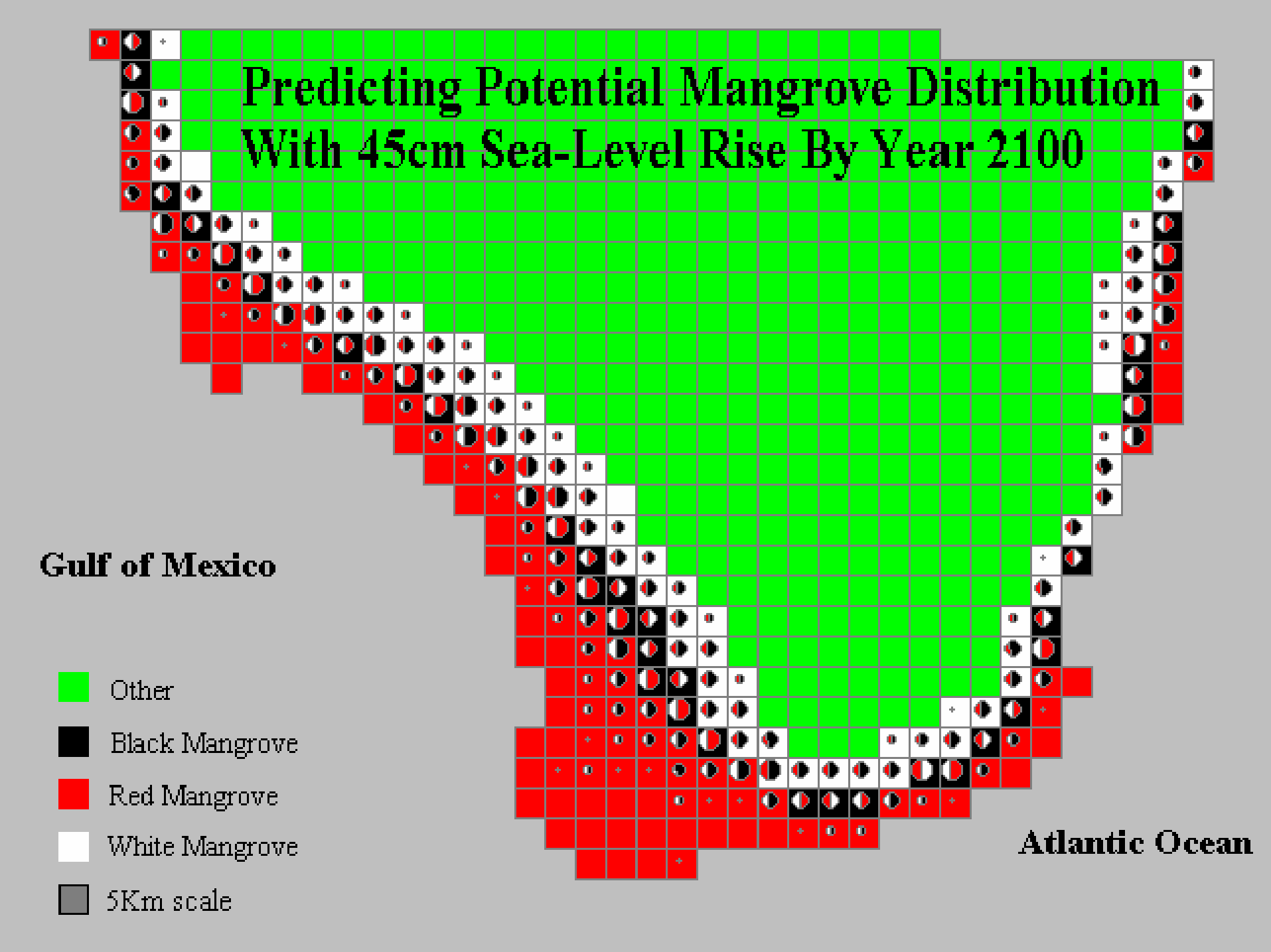
Sea-Level Rise Projections

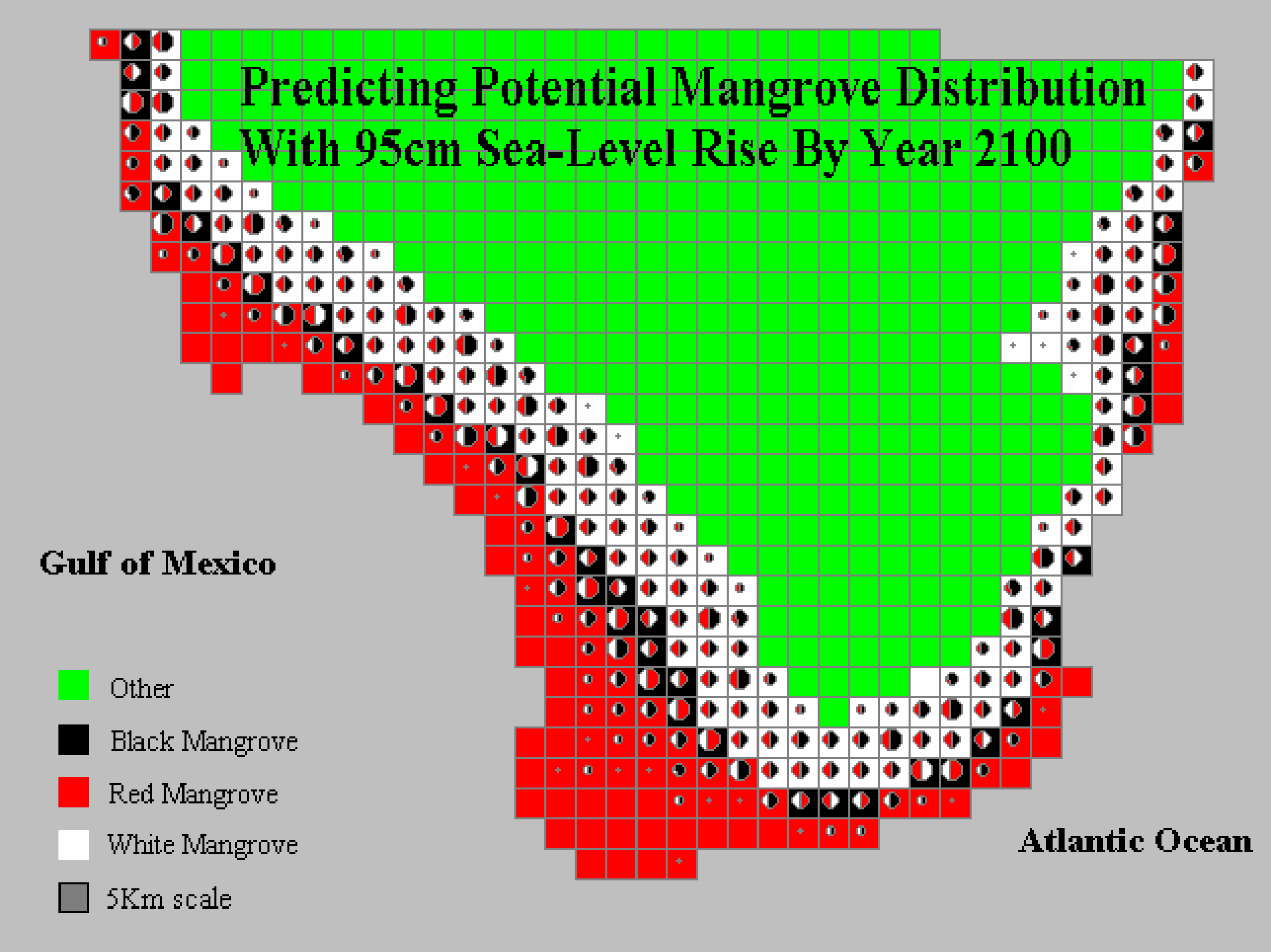
Tide Record, Key West, Florida




Historic Mangrove Distribution
Gulf of Mexico
Atlantic Ocean
Other
Black Mangrove
Red Mangrove
White Mangrove
5Km scale


Predicting Potential Mangrove Distribution
With 15cm Sea-Level Rise By Year 2100
Gulf of Mexico
Other
Black Mangrove
Red Mangrove
White Mangrove
5Km scale
Atlantic Ocean


Predicting Potential Mangrove Distribution
With 45cm Sea-Level Rise By Year 2100
Gulf of Mexico
Atlantic Ocean
Other
Black Mangrove
Red Mangrove
White Mangrove
5Km scale


Predicting Potential Mangrove Distribution
With 95cm Sea-Level Rise By Year 2100
Gulf of Mexico
Atlantic Ocean
Other
Black Mangrove
Red Mangrove
White Mangrove
5Km scale

Predicted Mangrove Habitat Gain

Sea-Level Rise Projections by 2100