MODELS INSTRUMENTAL IN COASTAL LOUISIANA PLANNING EFFORTS

Integrated Compartment Model & Basin-wide Delft

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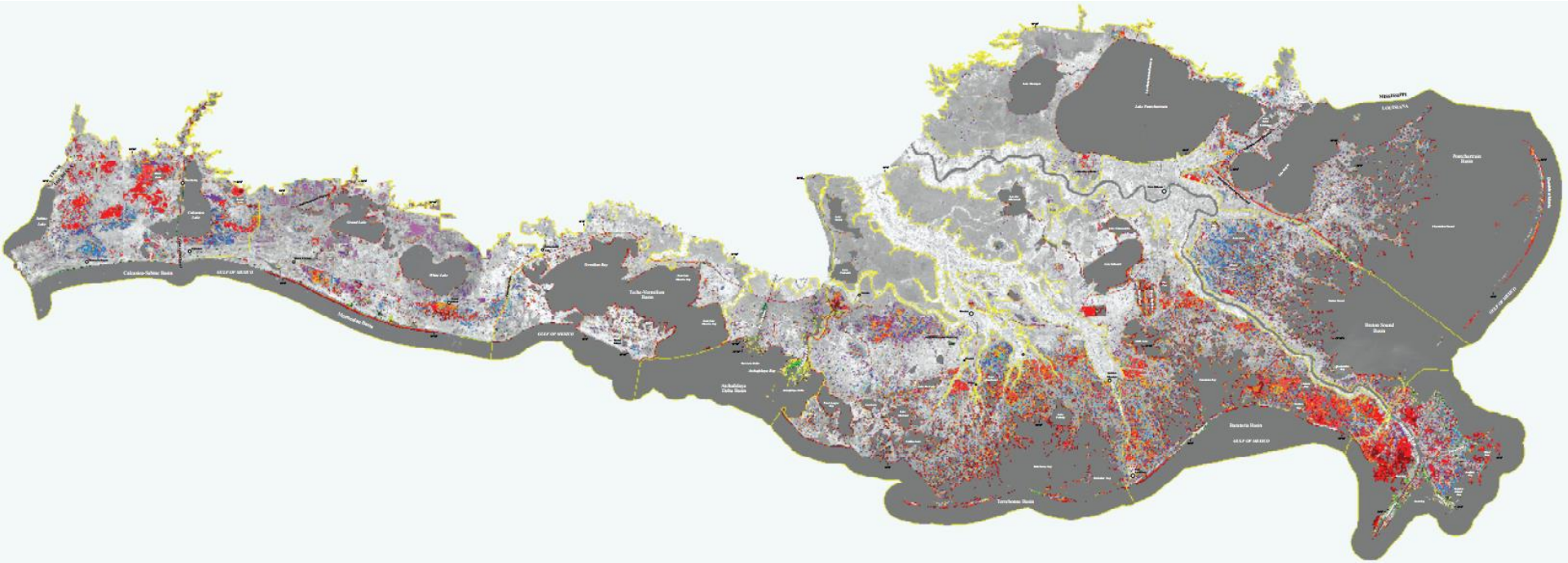
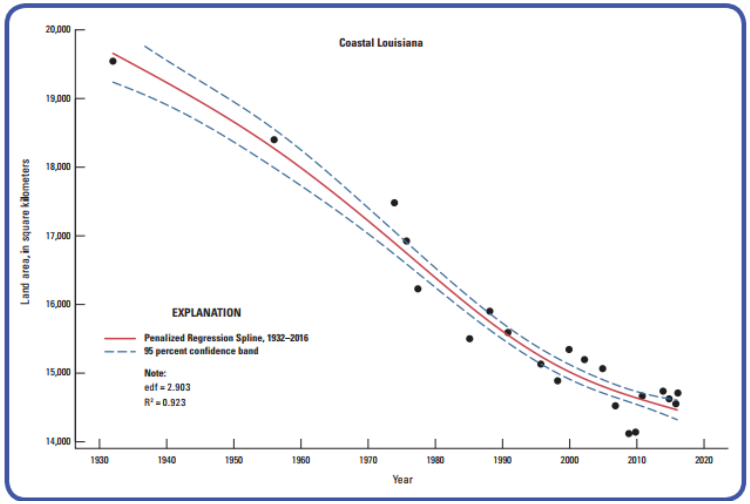
Research Engineer
October 2, 2017

THE WATER INSTITUTE
OF THE GULF®

HISTORIC WETLAND LOSS IN COASTAL LOUISIANA





Estimated land loss from 1932 – 2016:
~ 4833 km^2 (1866 mi^2)

Equivalent to 25% of 1932 wetland area

Couvillion et al. (2017). USGS. Land area change in coastal Louisiana (1932 to 2016). https://doi.org/10.3133/sim3381

2017 COASTAL MASTER PLAN

MASTER PLAN MODELING TEAM

CPRA Lead
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David Lindquist

PM-TAC Team
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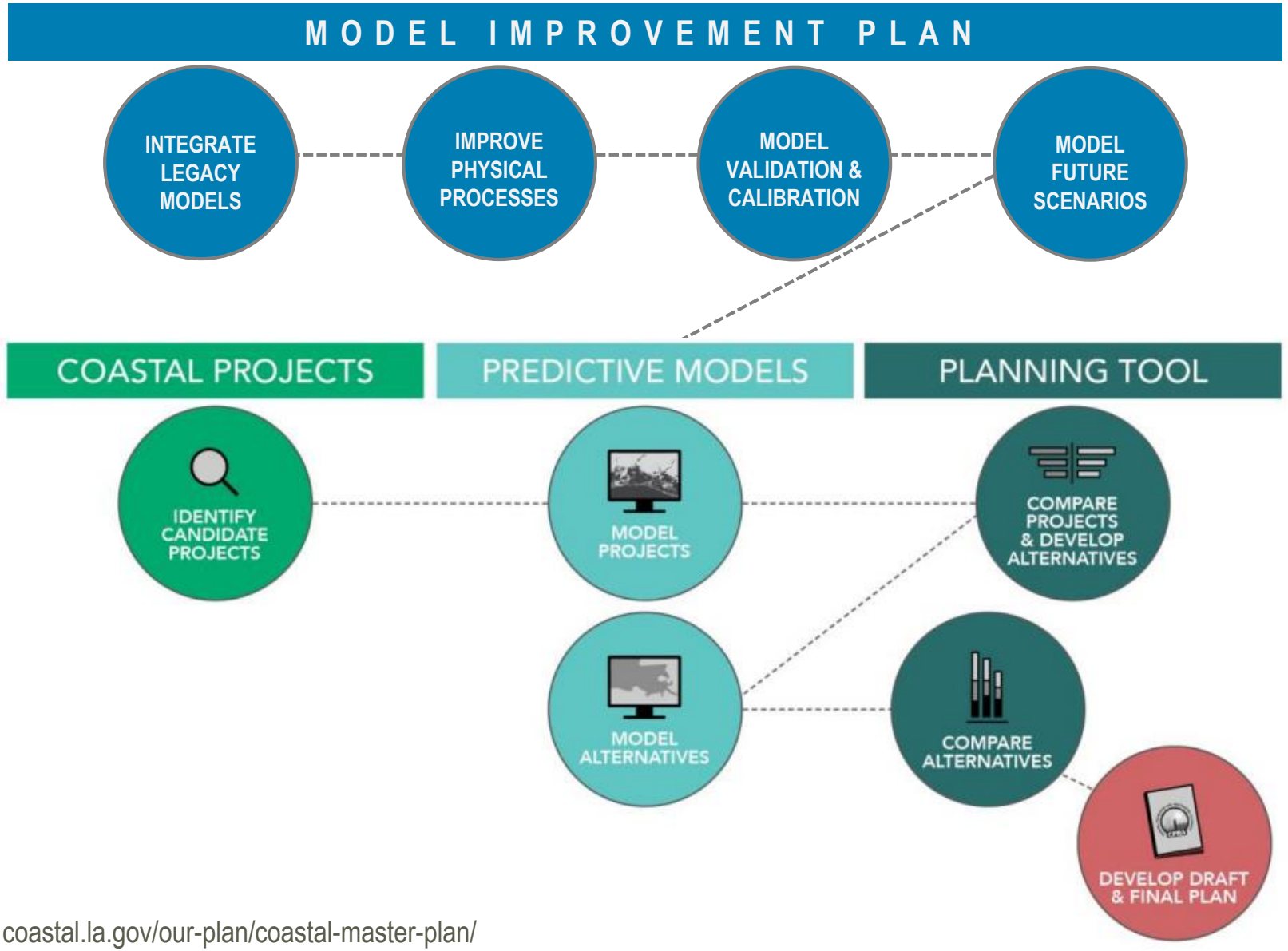
Kristy Lewis (GMU)

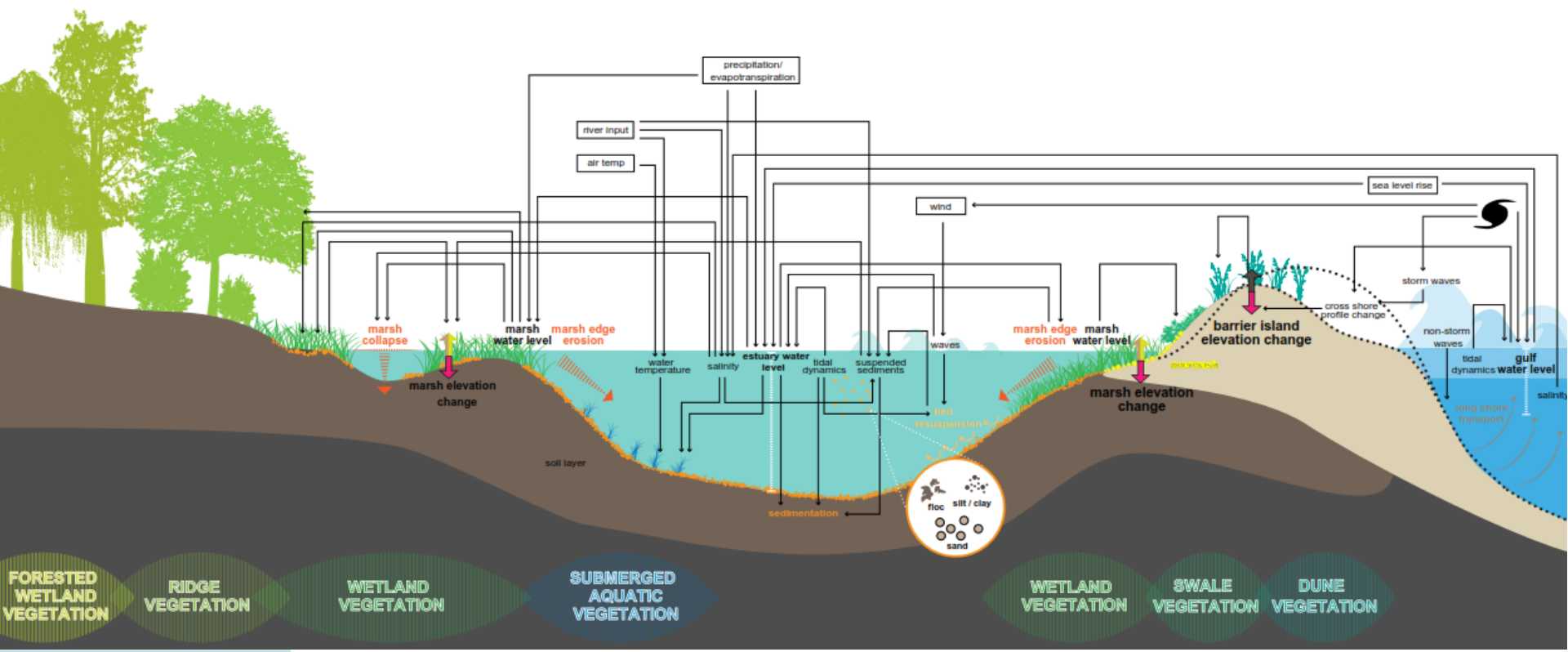
coastal.la.gov/our-plan/coastal-master-plan/

[+]primary model code developer of Master Plan model subroutines

2017 COASTAL MASTER PLAN



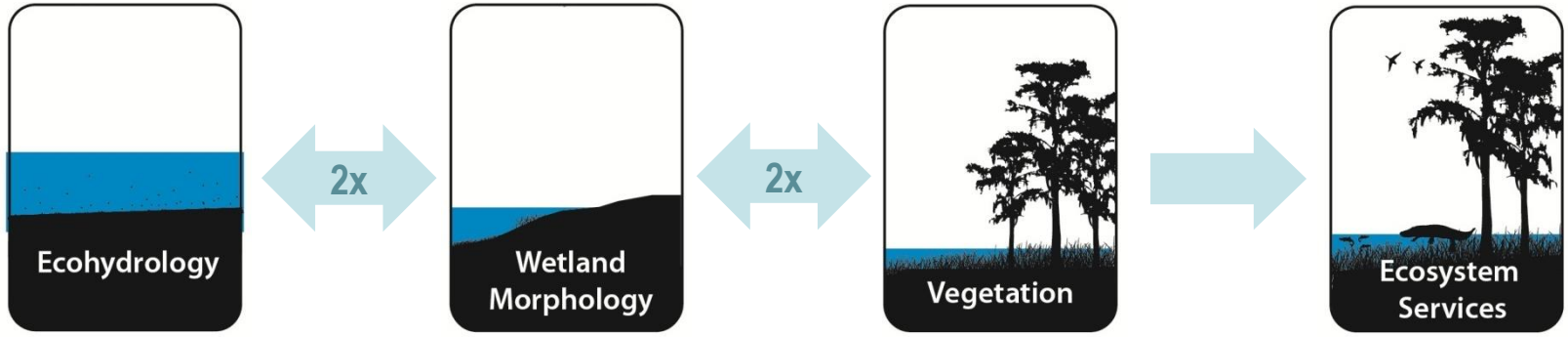
coastal.la.gov/our-plan/coastal-master-plan/



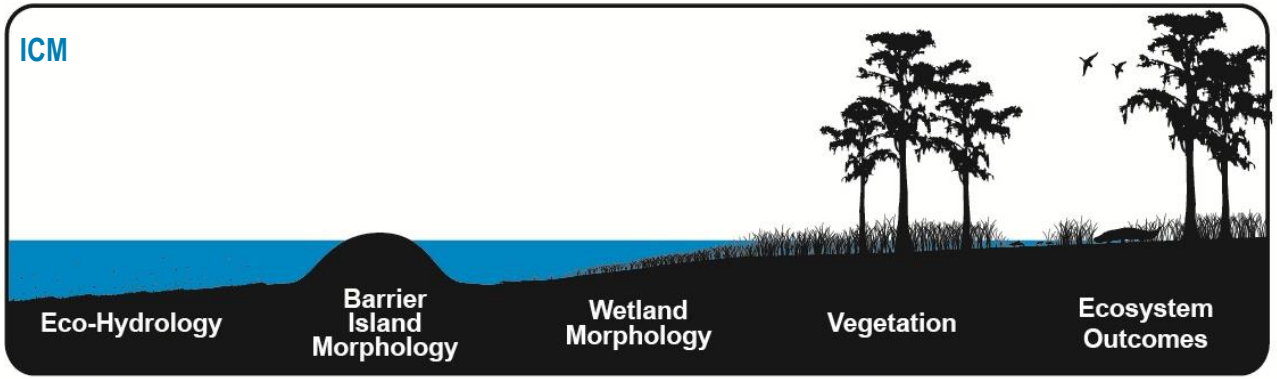
ICM: INTEGRATED COMPARTMENT MODEL

ICM: MODEL INTEGRATION

2012 MASTER PLAN LANDSCAPE MODELS



2017 MASTER PLAN LANDSCAPE MODEL



2012 & 2017 RISK ASSESSMENT

ICM: BARRIER ISLAND PROCESSES

- Island elevation change
- Breaching
- Overwash / cross shore profile change
- Longshore transport
- Wave transformation
- Storm effects (SBEACH)
- Back-barrier marsh, dune and swale vegetation

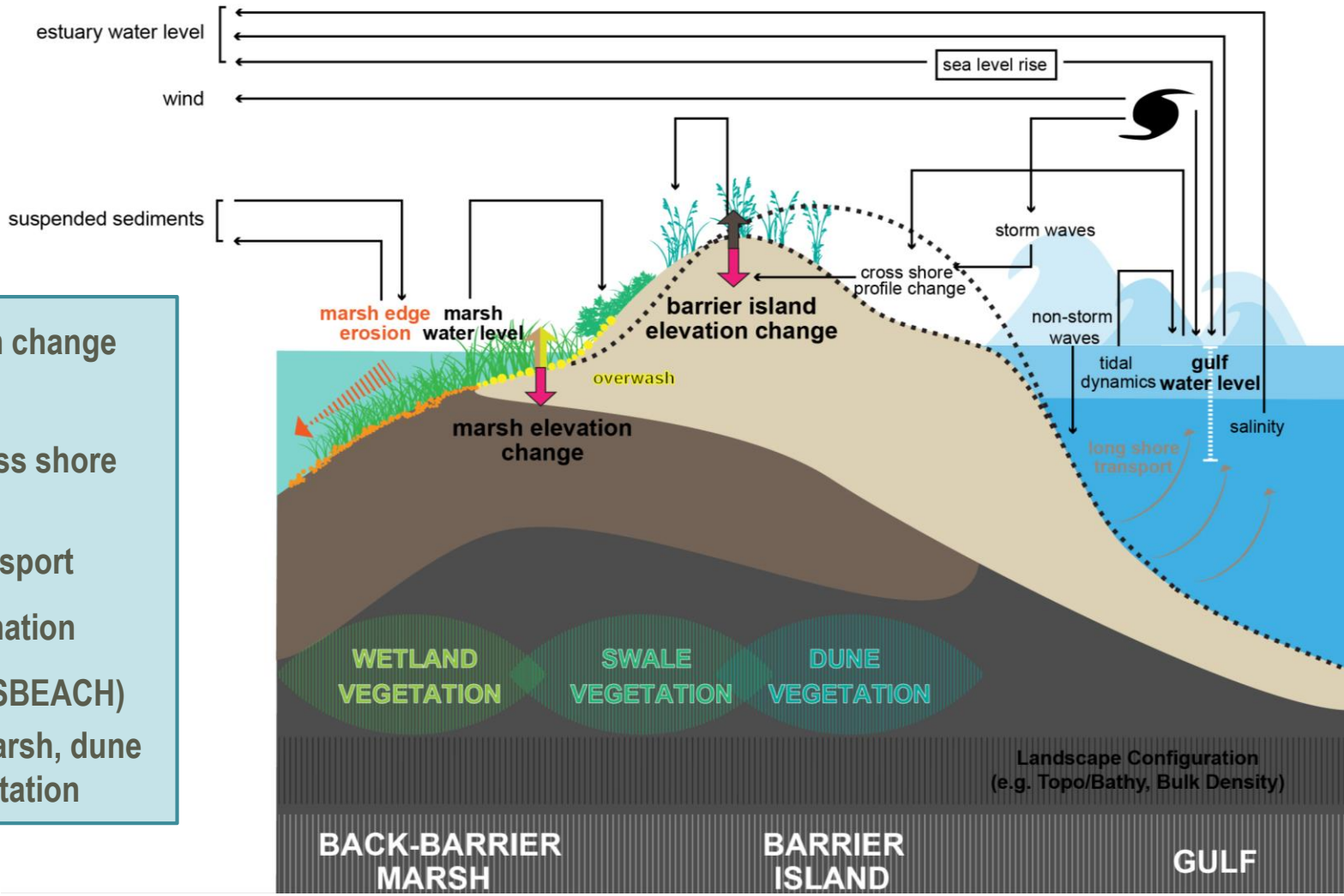
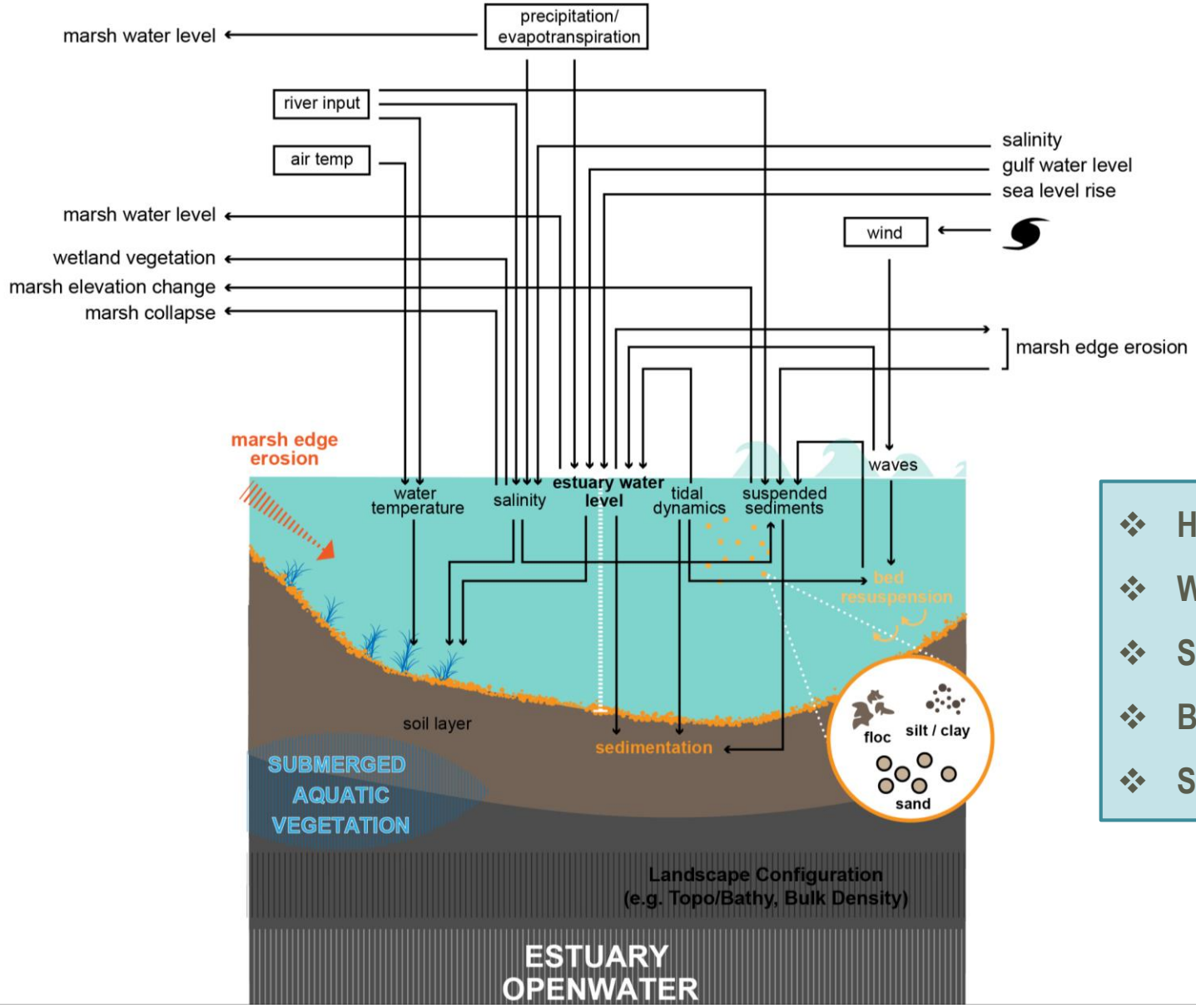
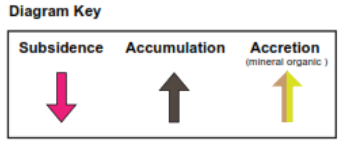


Diagram Key

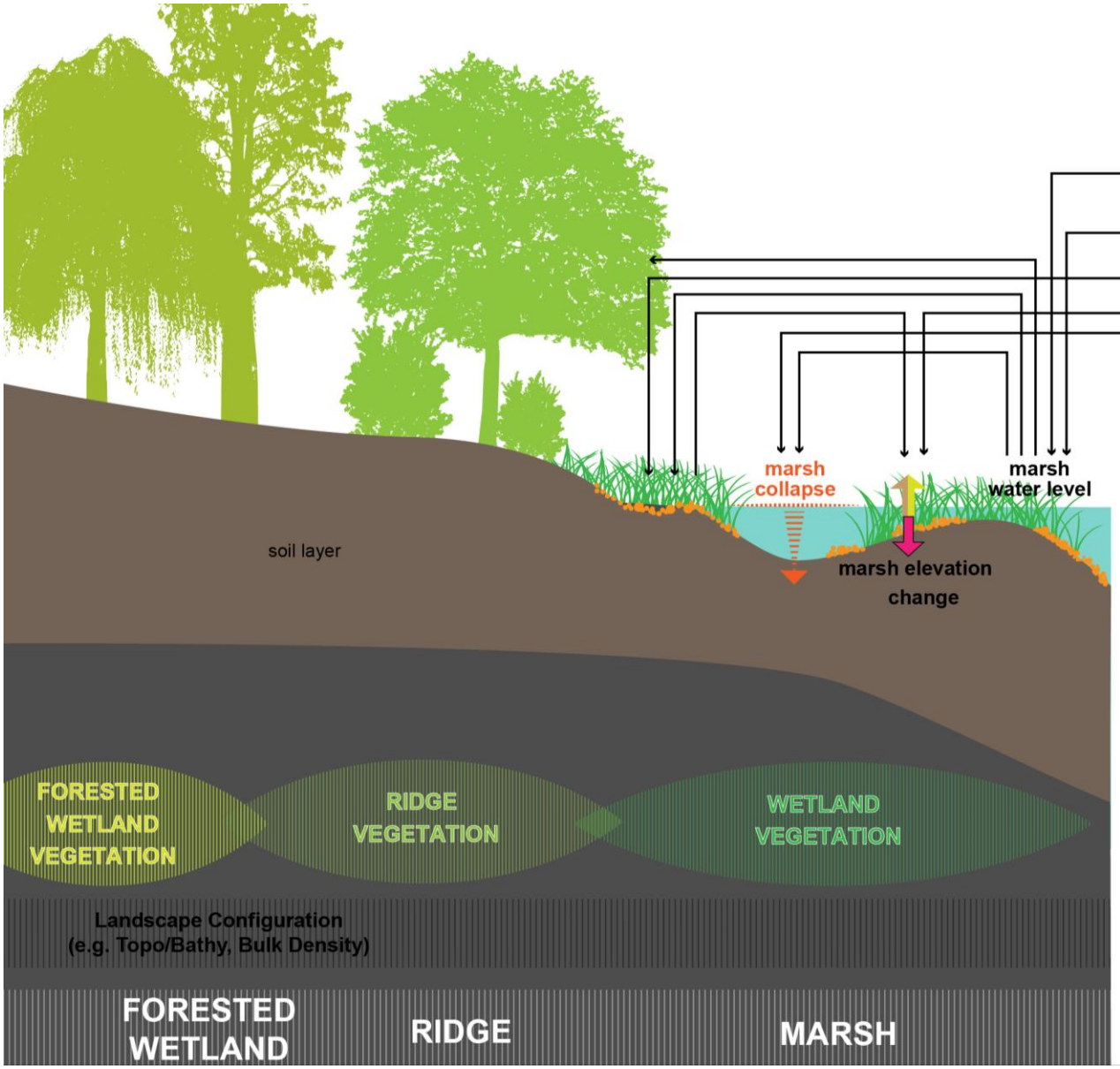
ICM: ESTUARY & OPEN WATER PROCESSES



- Hydrodynamics
- Water quality
- Sedimentation
- Bed resuspension
- Sediment distribution



ICM: WETLAND PROCESSES & VEGETATION

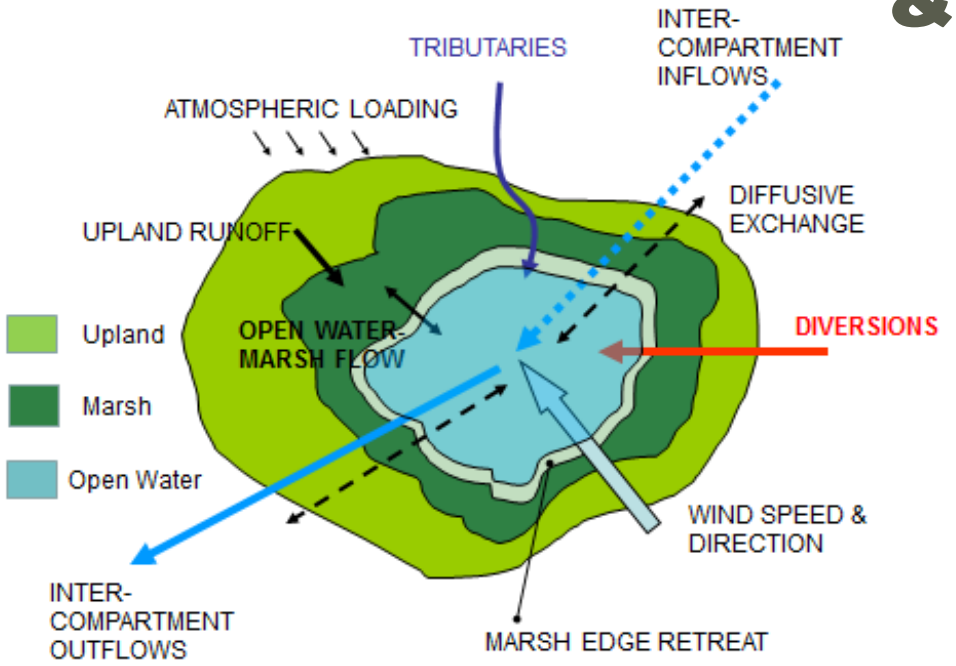


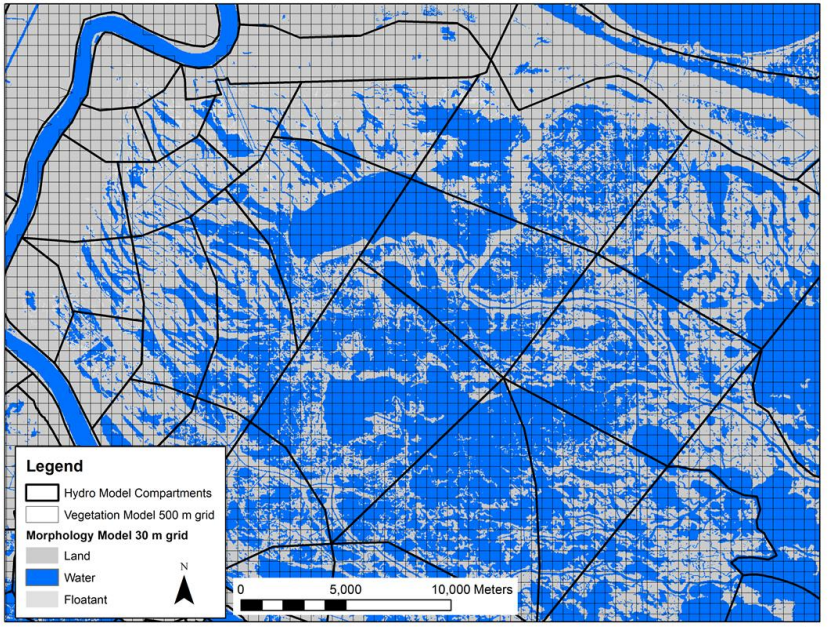
- Wetland elevation change
- Wetland area change
- Marsh collapse
- Marsh edge erosion
- Storm effects
- Coastal vegetation

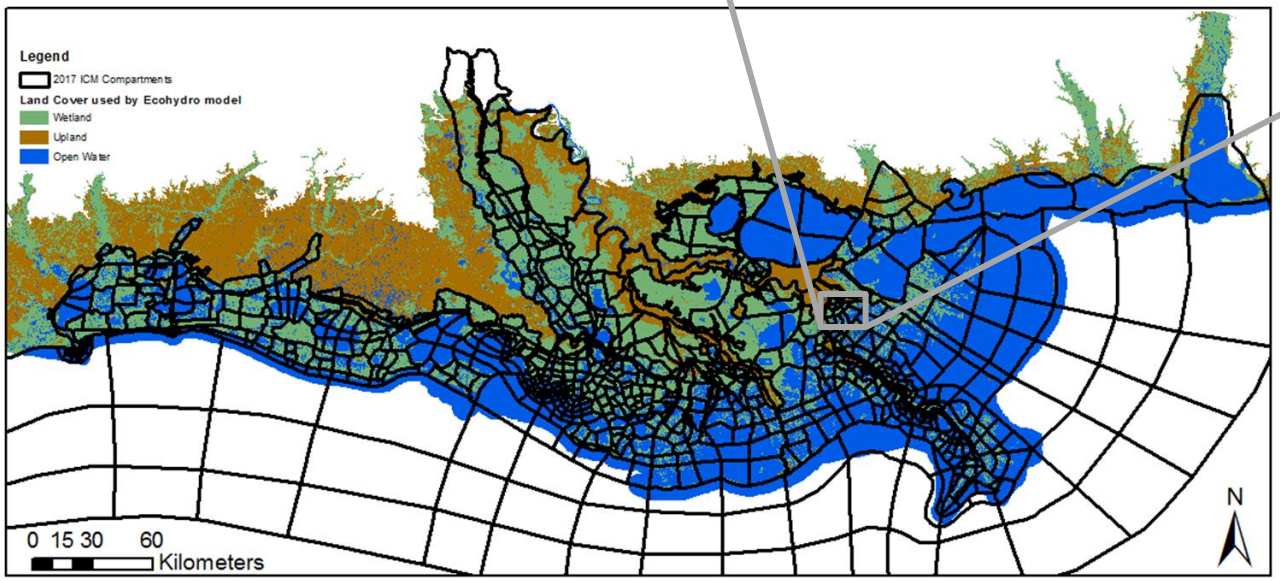
Diagram Key

Subsidence	Accumulation	Accretion (mineral organic)

ICM: COMPARTMENT CONCEPTUALIZATION & SPATIAL RESOLUTION







ICM: ECOSYSTEM OUTCOMES & DECISION METRICS

PLANNING TOOL

DECISION DRIVERS

REDUCING FLOOD RISK

BUILDING/ MAINTAINING LAND

CONSTRAINTS

SEDIMENT

FUNDING

METRICS

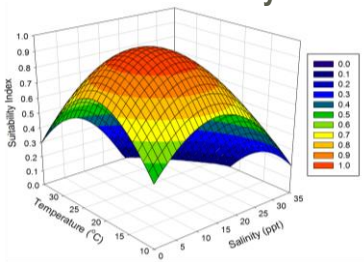
COMMUNITY METRICS

- AGRICULTURAL COMMUNITIES
- FLOOD PROTECTION OF STRATEGIC ASSETS
- OIL & GAS COMMUNITIES
- SOCIAL VULNERABILITY
- FLOOD PROTECTION OF HISTORIC PROPERTIES
- NAVIGATION
- TRADITIONAL FISHING COMMUNITIES

ENVIRONMENTAL METRICS

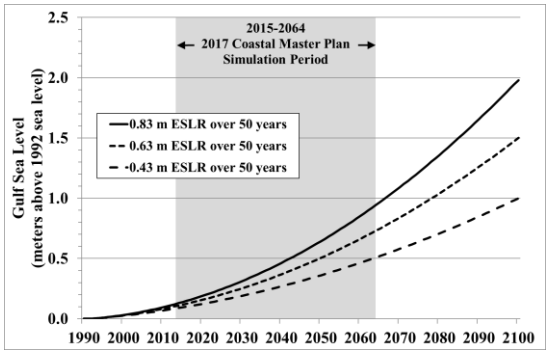
- ALLIGATOR
- CRAWFISH
- SALTWATER FISH
- USE OF NATURAL PROCESSES
- BLUE CRAB
- FRESHWATER FISH
- SHRIMP
- WATERFOWL
- BROWN PELICAN
- OYSTERS
- SUSTAINABILITY OF LAND

HSIs: Habitat Suitability Indices

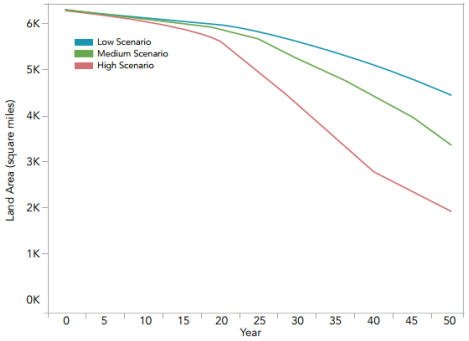


EwE: Ecopath with Ecosim and Ecospace food web model

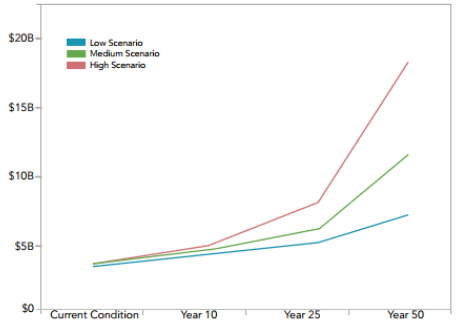
PROJECTED FUTURE CONDITIONS



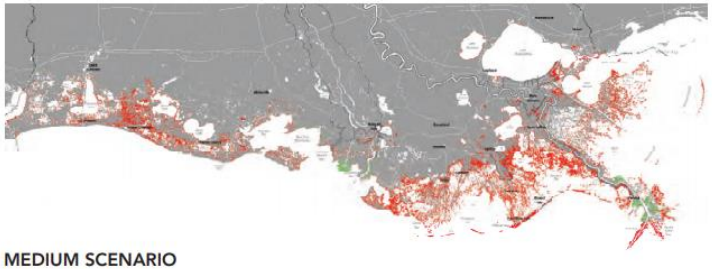
POTENTIAL LAND LOSS OVER THE NEXT 50 YEARS



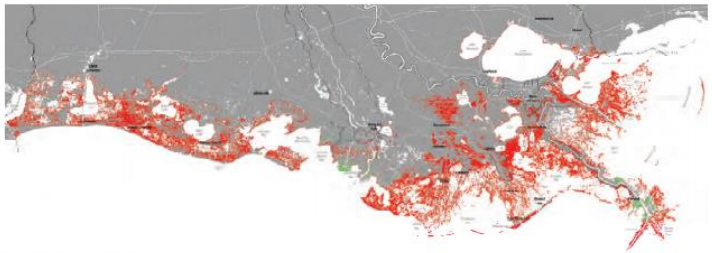
EXPECTED ANNUAL DAMAGE FROM FLOODING OVER THE NEXT 50 YEARS



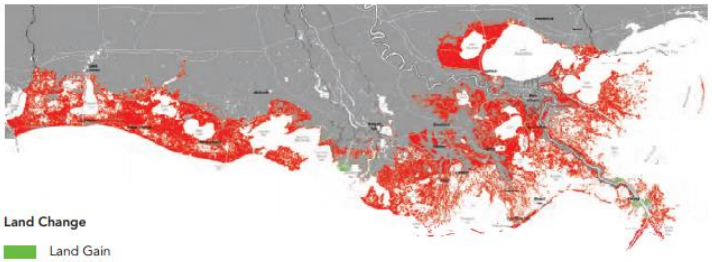
LOW SCENARIO



MEDIUM SCENARIO



HIGH SCENARIO



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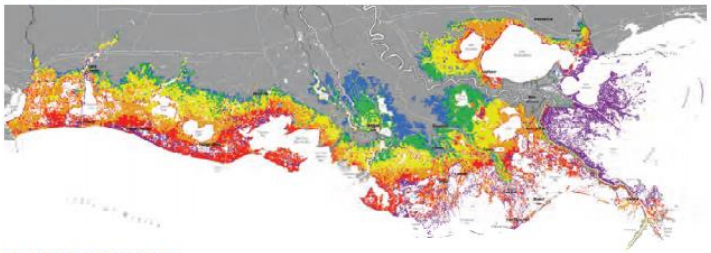

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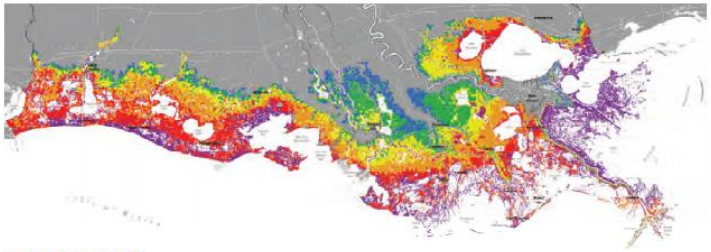

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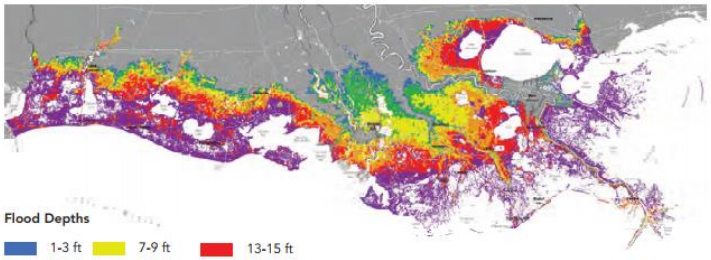


BASIN-WIDE DELFT3D MODELING

PROJECT TEAM

The Water Institute of the Gulf

Natural Systems Modeling and Monitoring

- Model setup, calibration, validation and production runs

Physical Processes and Sediment Systems

- Data collection for model calibration and validation
- QA/QC model output

Coastal Ecology

- Data collection for model calibration and validation
- QA/QC model output

People, Resources & Technology

- Calculation and preparation of land change maps

Collaborators

University of Louisiana-Lafayette

- Development and integration of vegetation model

Louisiana State University

- Geotechnical data collection and laboratory analysis

Deltares

- Support of model setup, calibration and validation activities

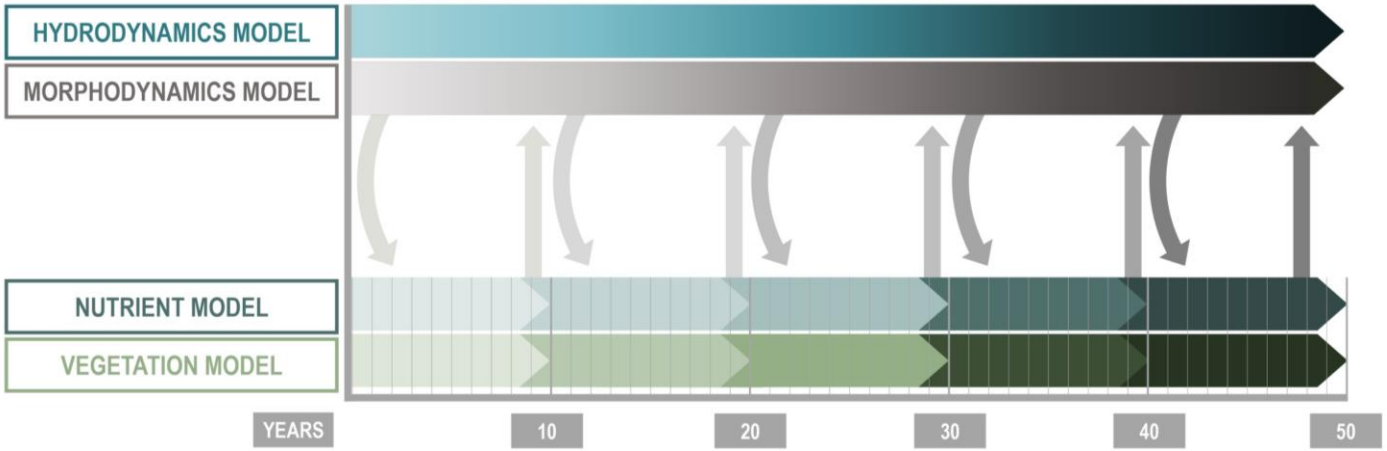
PROPOSED SEDIMENT DIVERSIONS

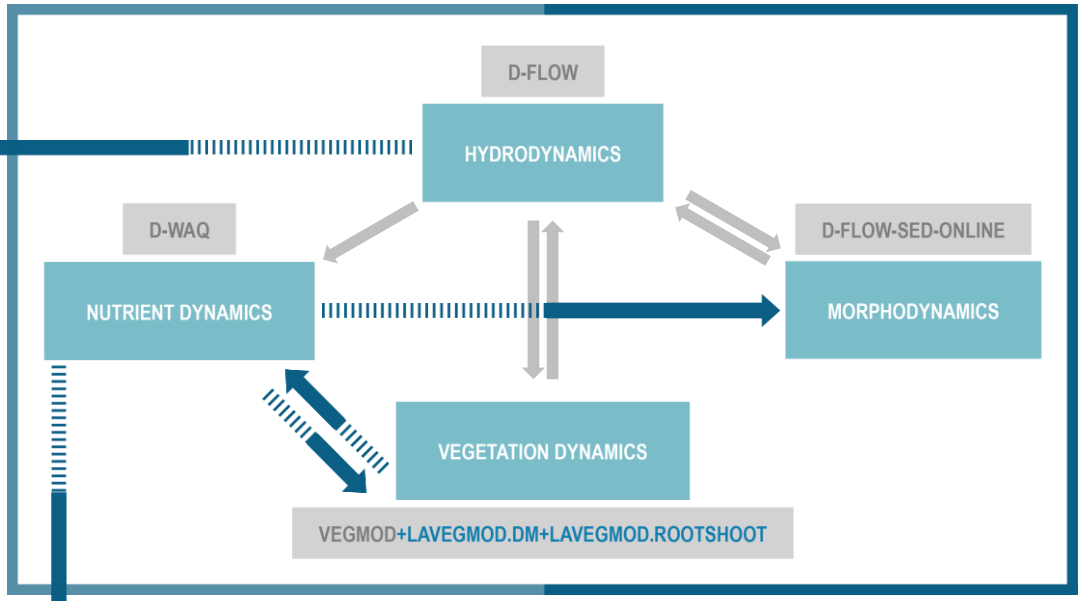
PROJECT GOAL

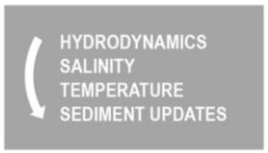
Produce a calibrated and validated model capable of simulating:

- Land change processes that occur during the creation of a new delta and wetland areas
- Nutrient effects to the wetland vegetation, soil, and the phytoplankton of Breton Sound and Barataria Basin

BASIN-WIDE DELFT3D MODEL FRAMEWORK



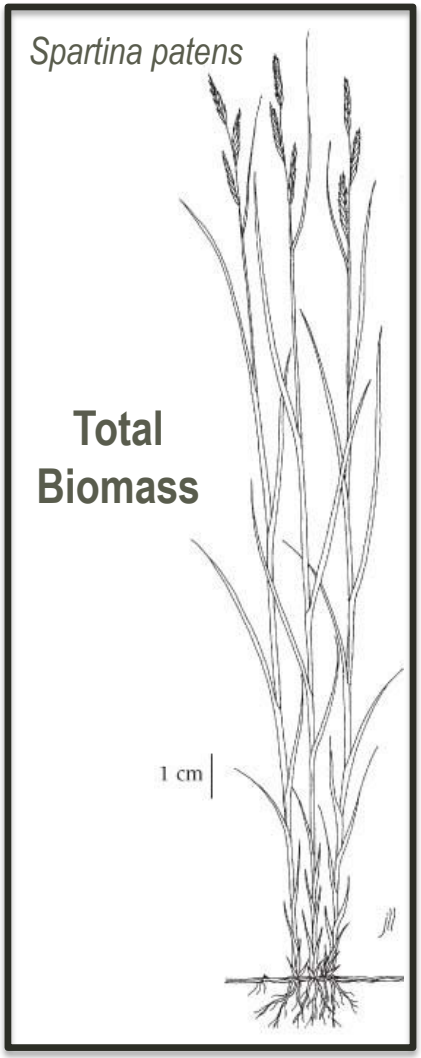




FOOD WEBS

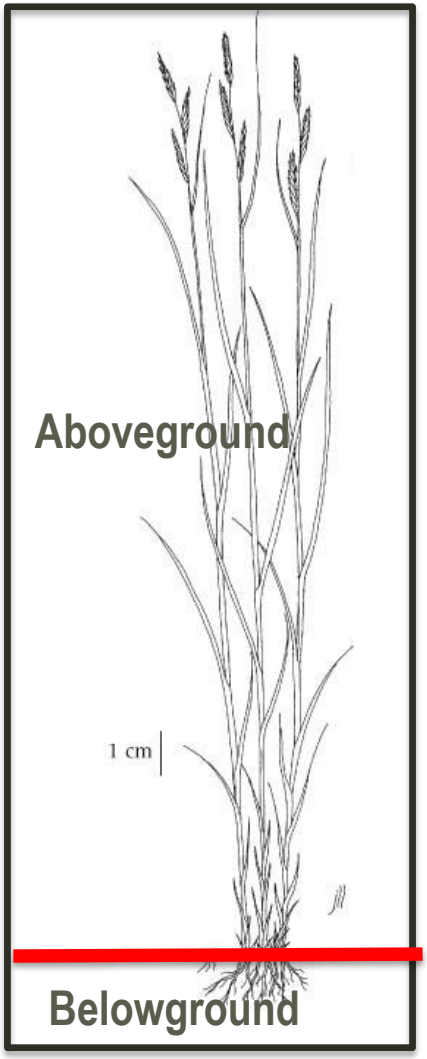
EWE & CASM

VEGETATION DYNAMICS: ORGANIC MATTER ACCUMULATION



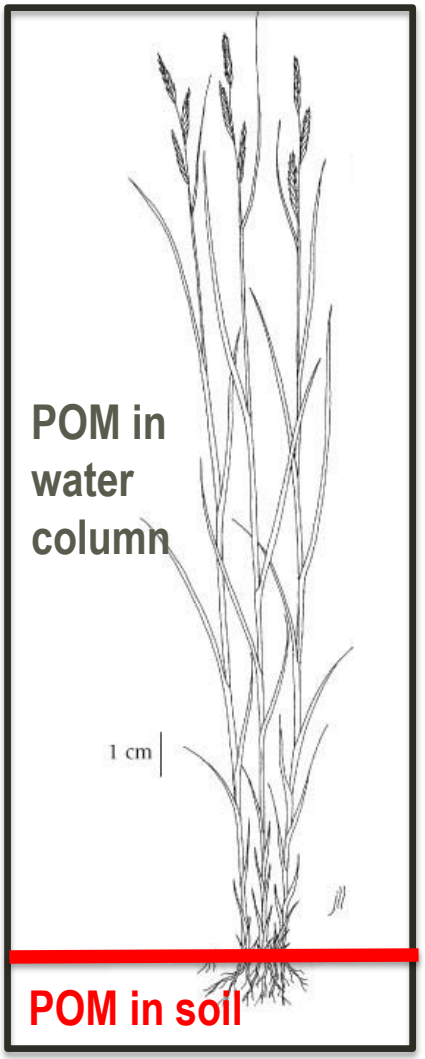
(VEGMOD)

Biomass Allocation



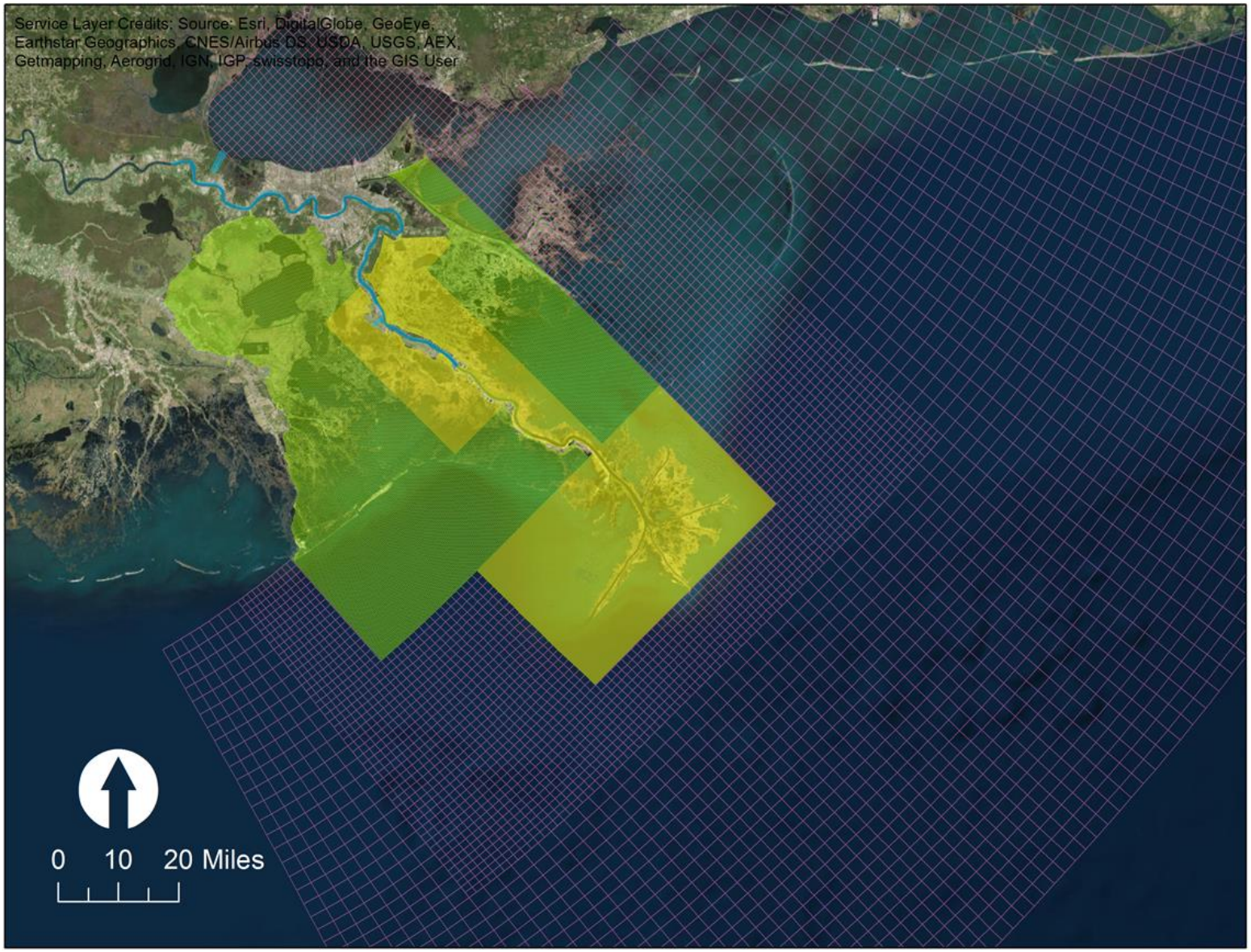
(LaVegMod.RootShoot)

Mortality



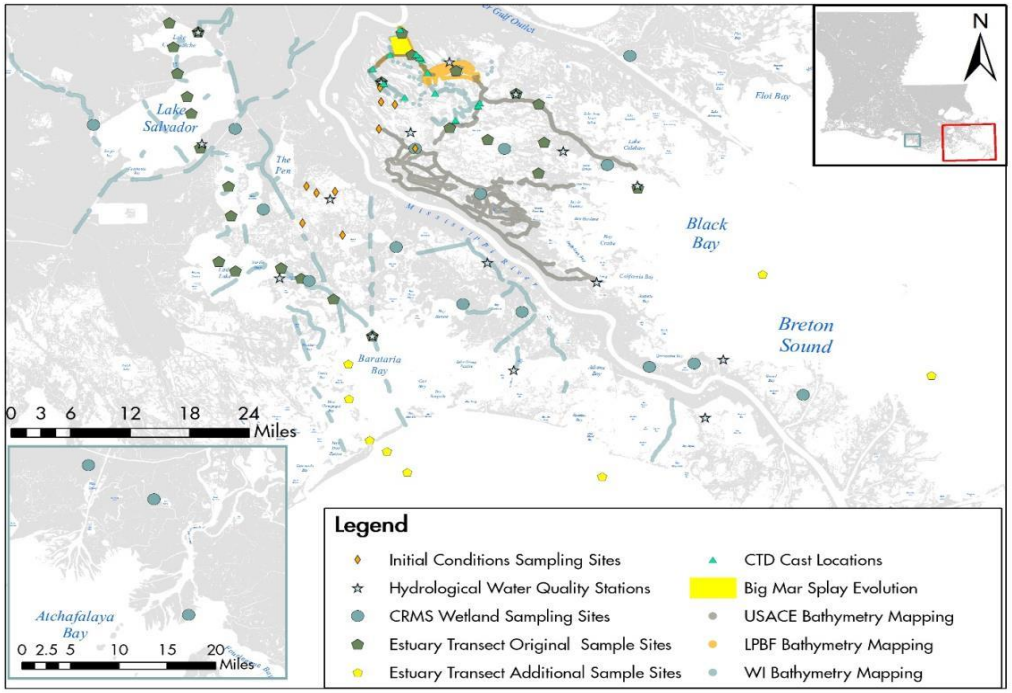
(VEGMOD)

BASIN-WIDE DELFT3D MODEL DOMAIN

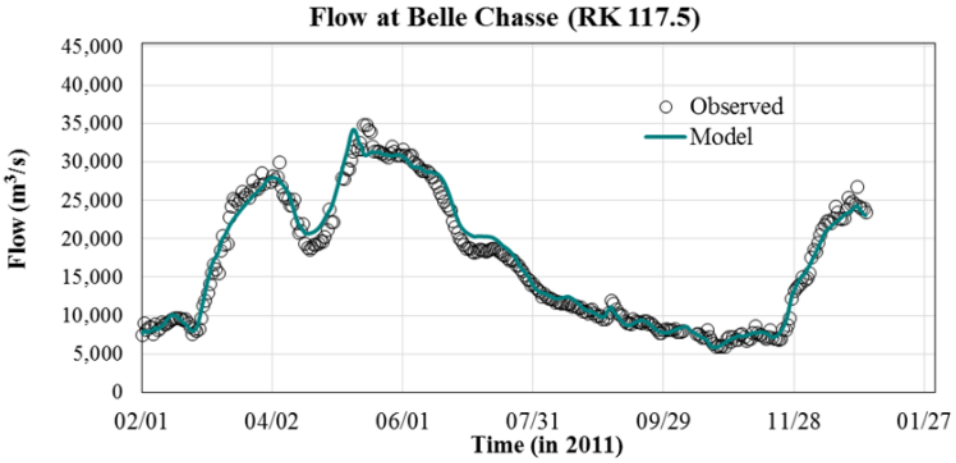


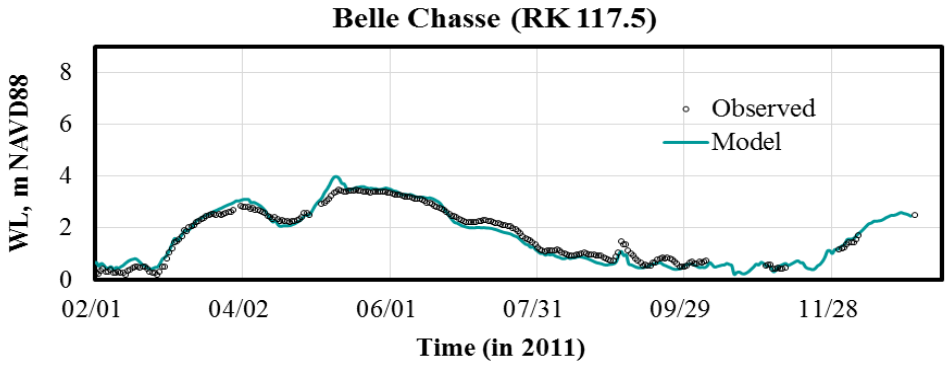
SUPPLEMENT EXISTING DATA WITH TARGETED COLLECTION

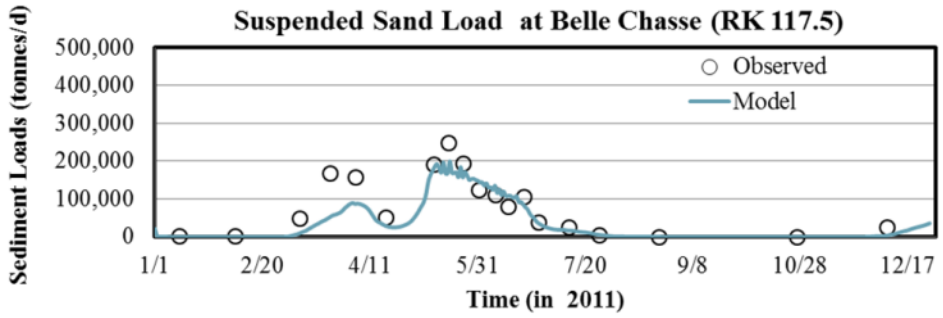
- **Model Setup**
  - Update bathymetry to build grids
  - Utilize locally observed values within model
    (e.g., soil properties, water quality, meteorology, ocean forcing, etc.)
- **Calibration and Validation**
  - Key parameters to tune model performance
- **Improved Understanding of Processes**
  - Compare model outputs to observed basin behavior, ensuring dynamics are captured by the model design

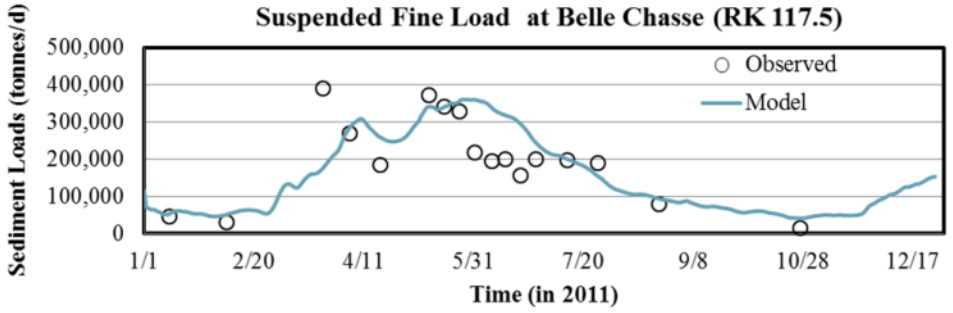


RIVER HYDRODYNAMICS: CALIBRATION & VALIDATION

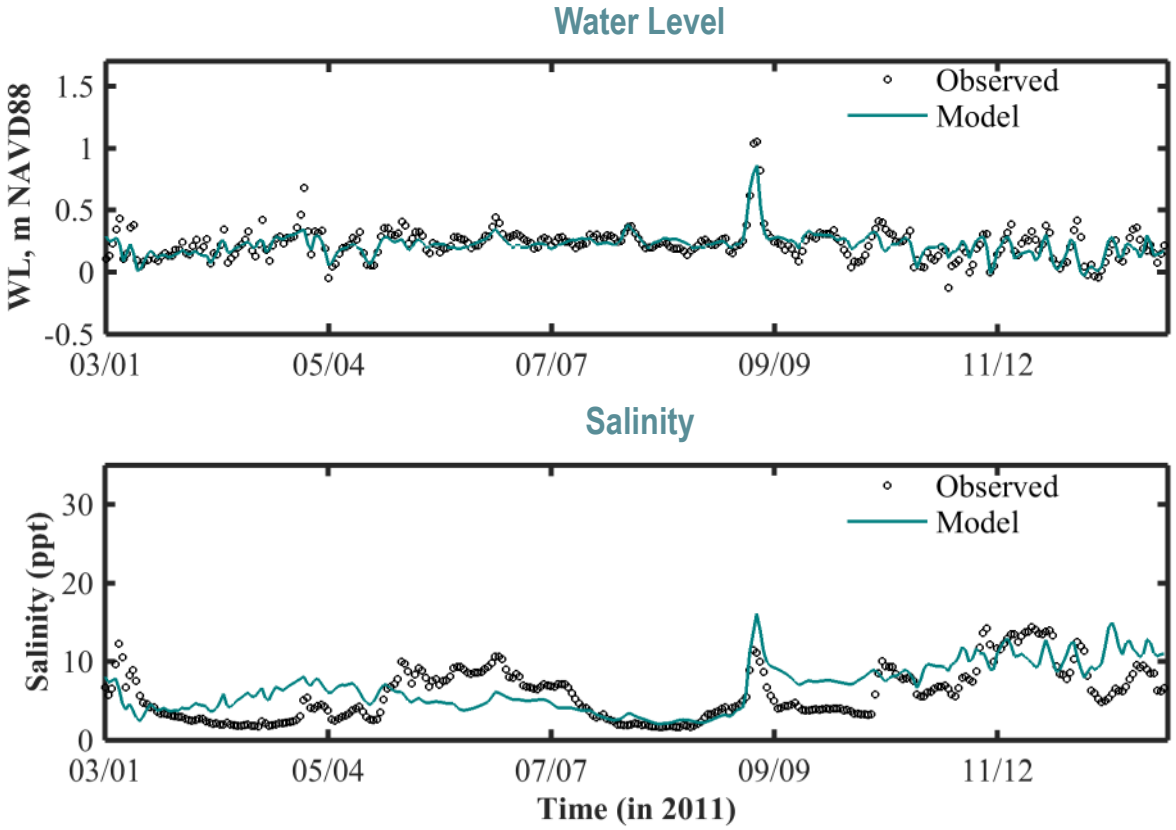


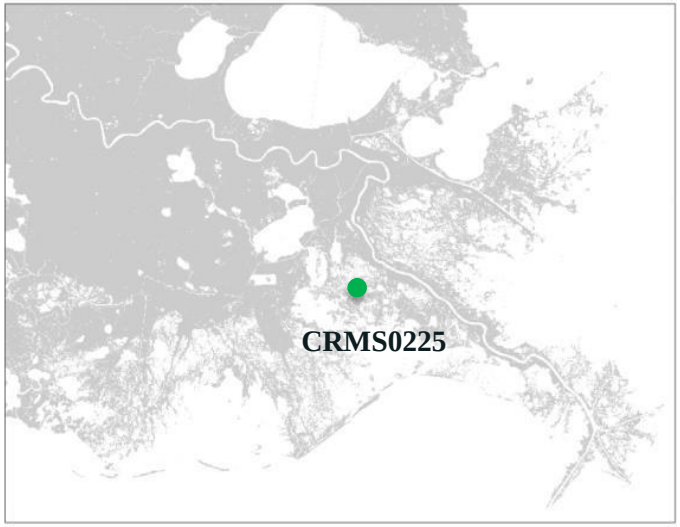




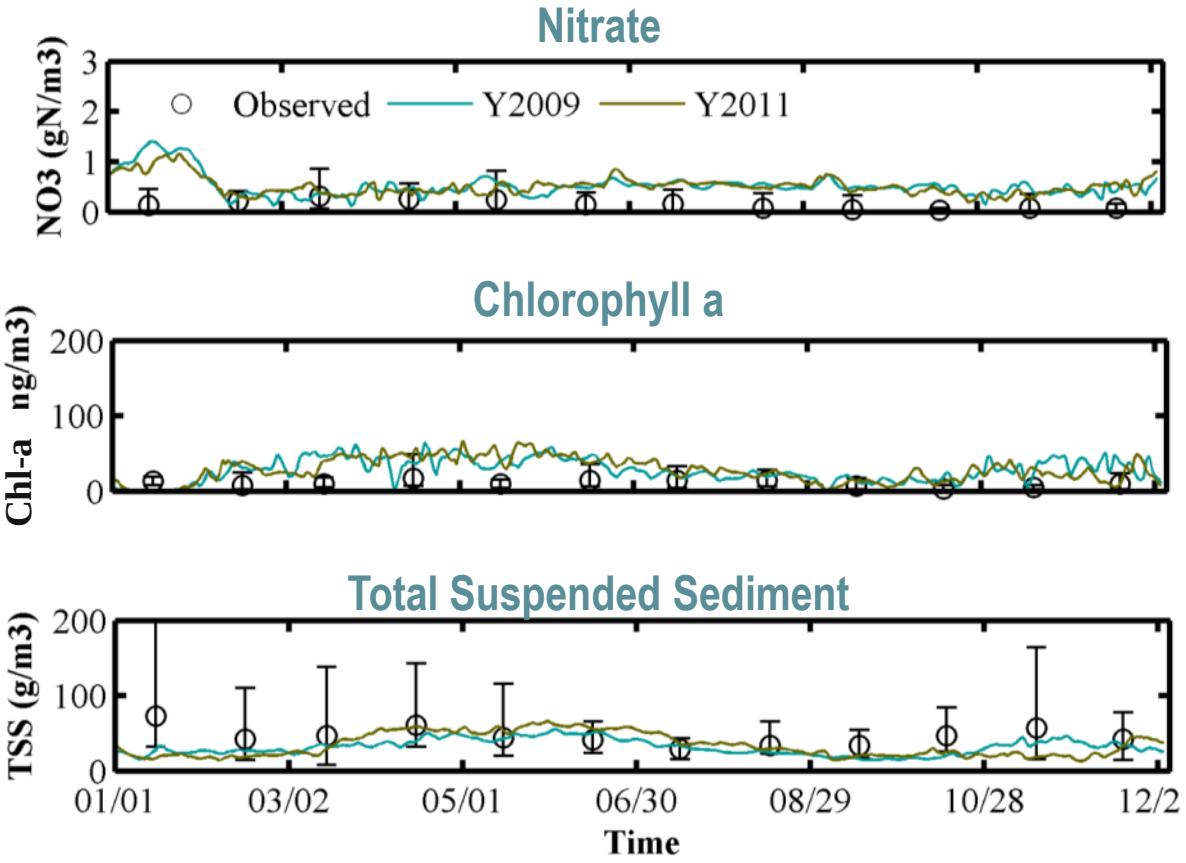


BASIN HYDRODYNAMICS: CALIBRATION & VALIDATION

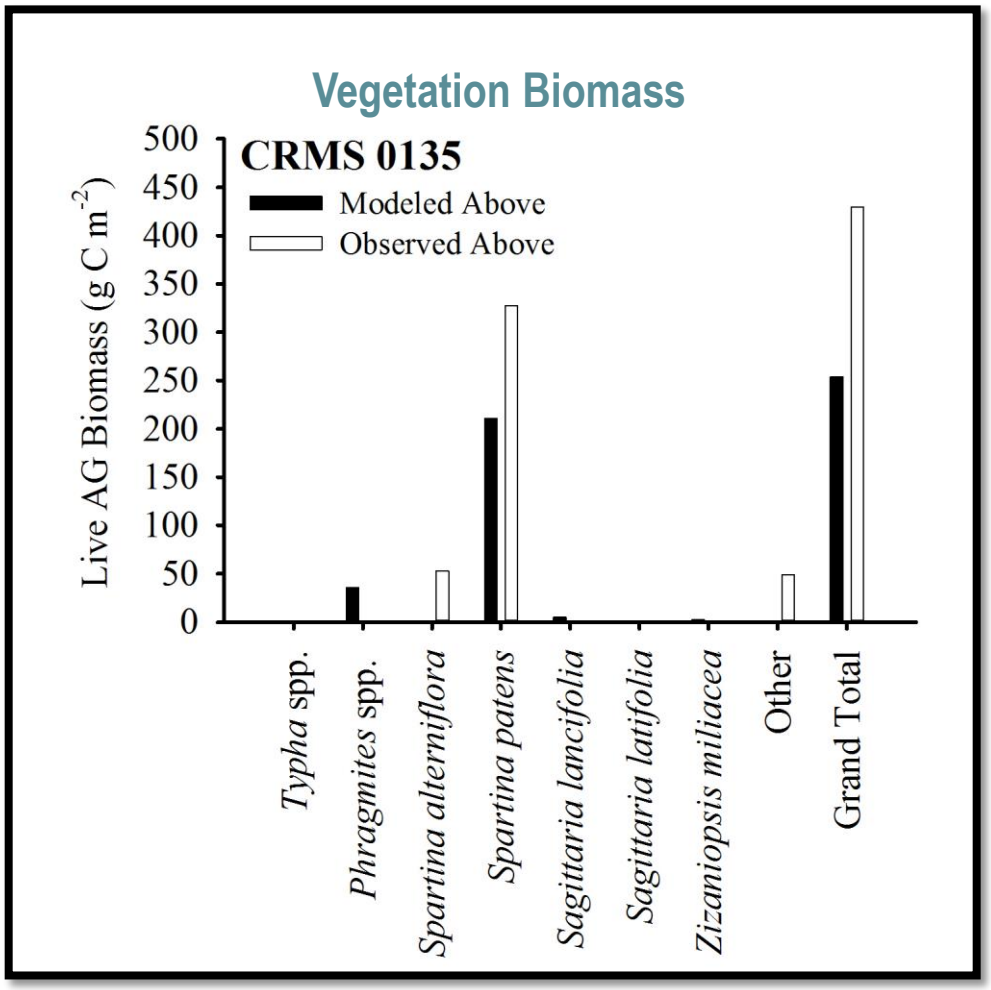


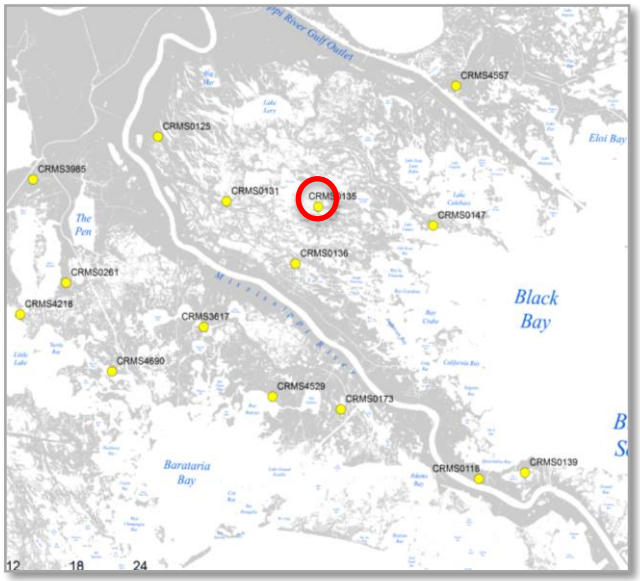


NUTRIENT DYNAMICS: CALIBRATION & VALIDATION



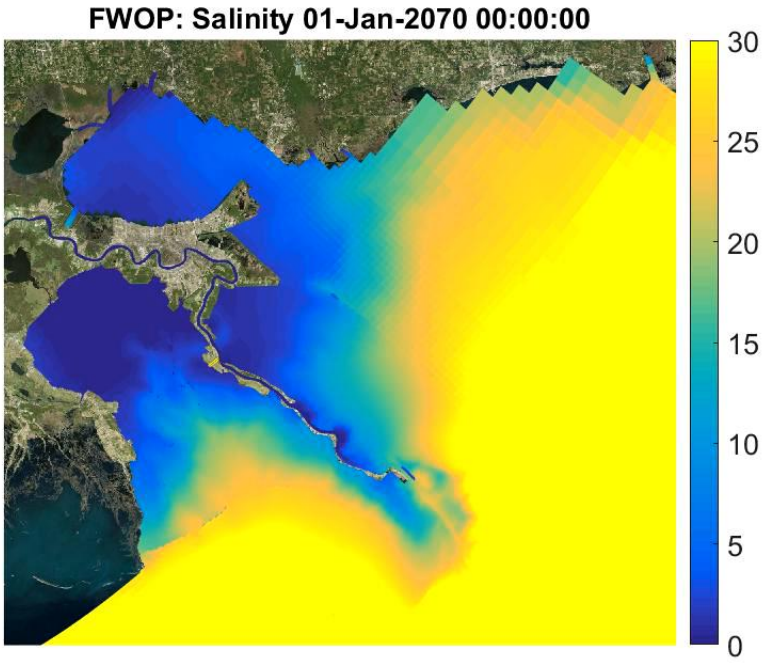
VEGETATION DYNAMICS: CALIBRATION & VALIDATION



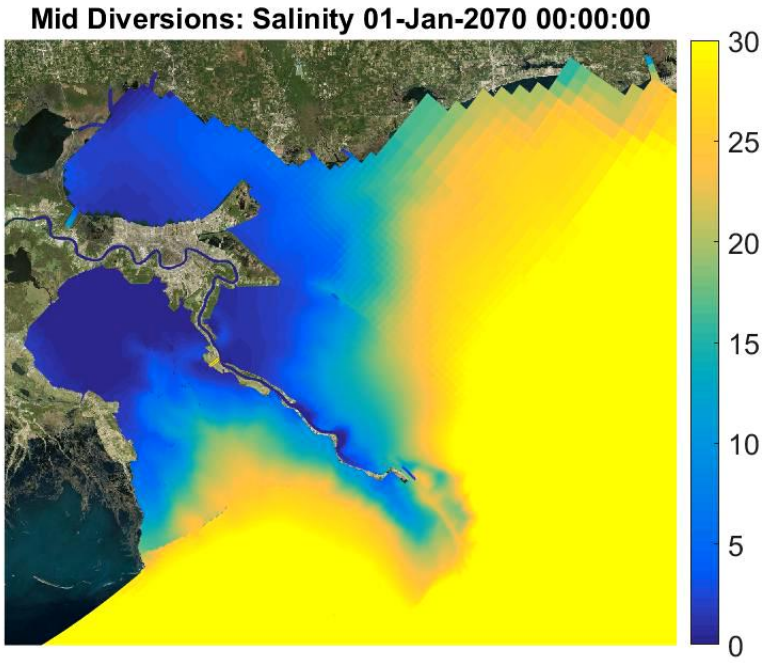


BASIN-WIDE DELFT3D : YEAR 50 (2070) SALINITY

No Diversions Active

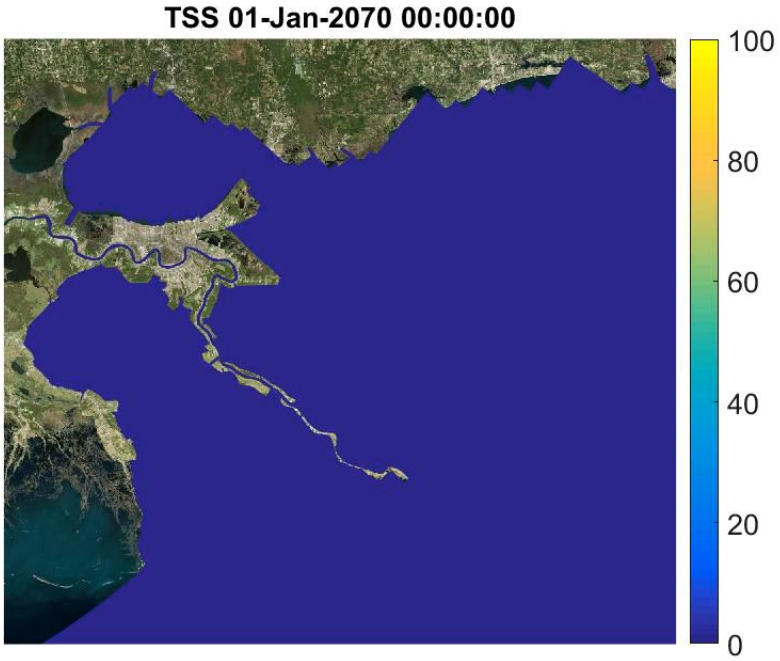


Mid Diversions Active

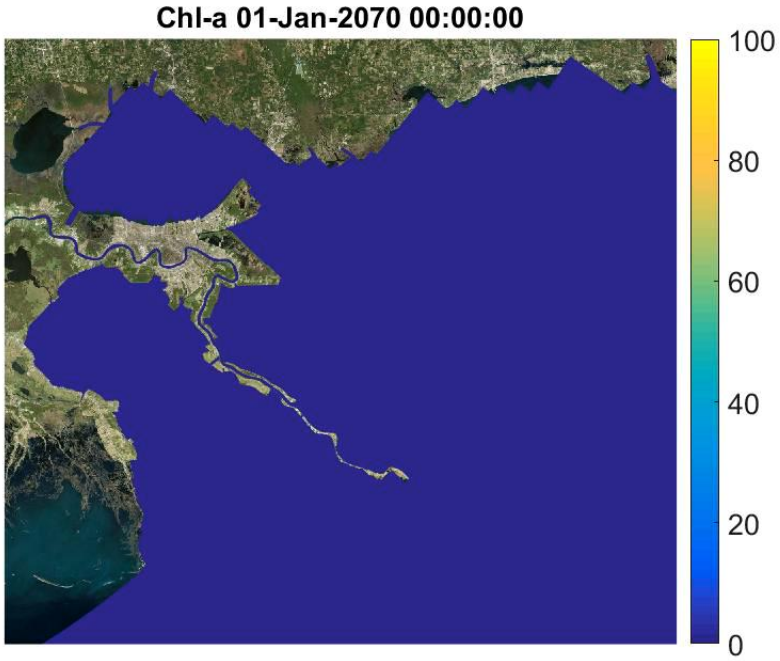


BASIN-WIDE DELFT3D : YEAR 50 (2070) WATER QUALITY

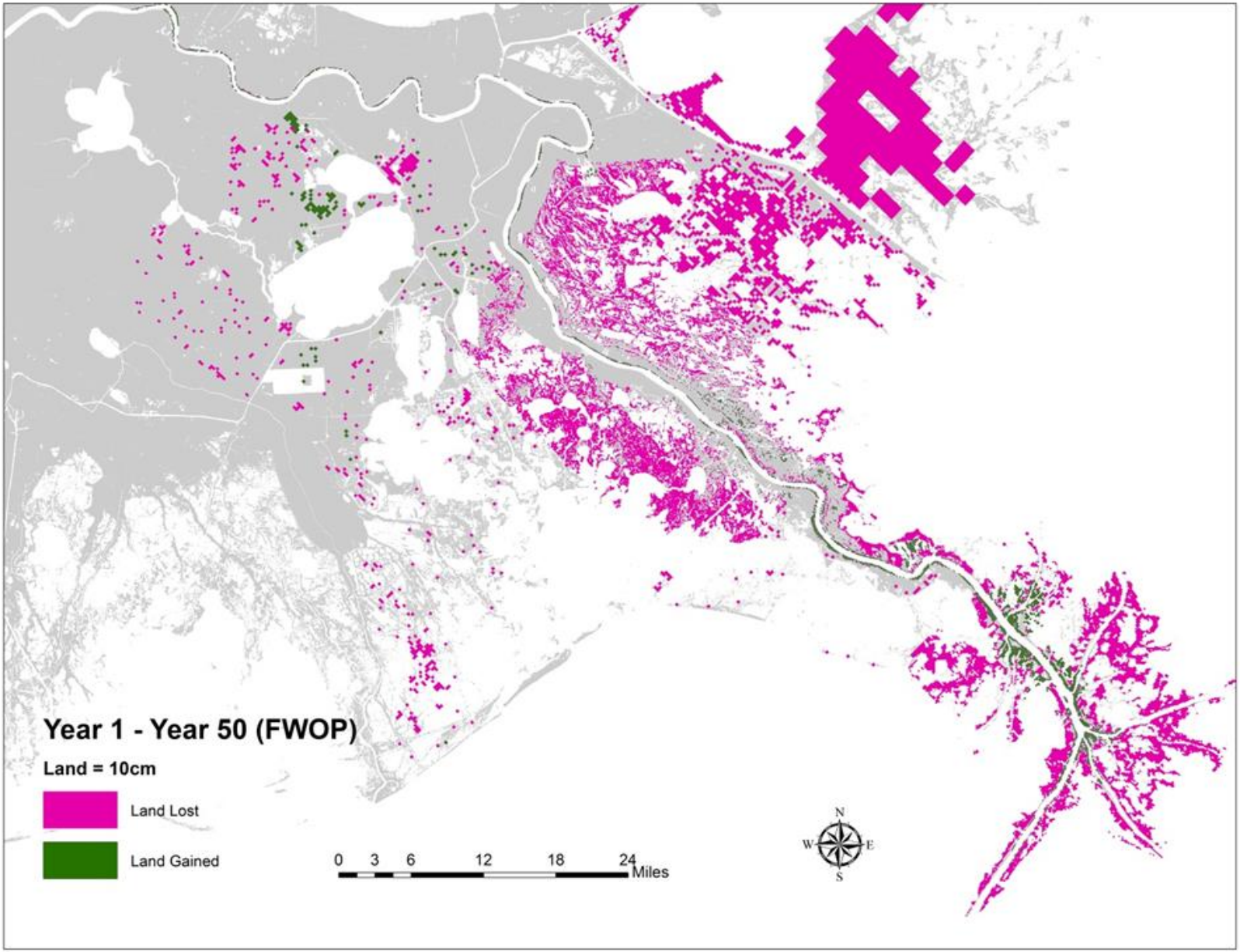
Mid Diversions Active



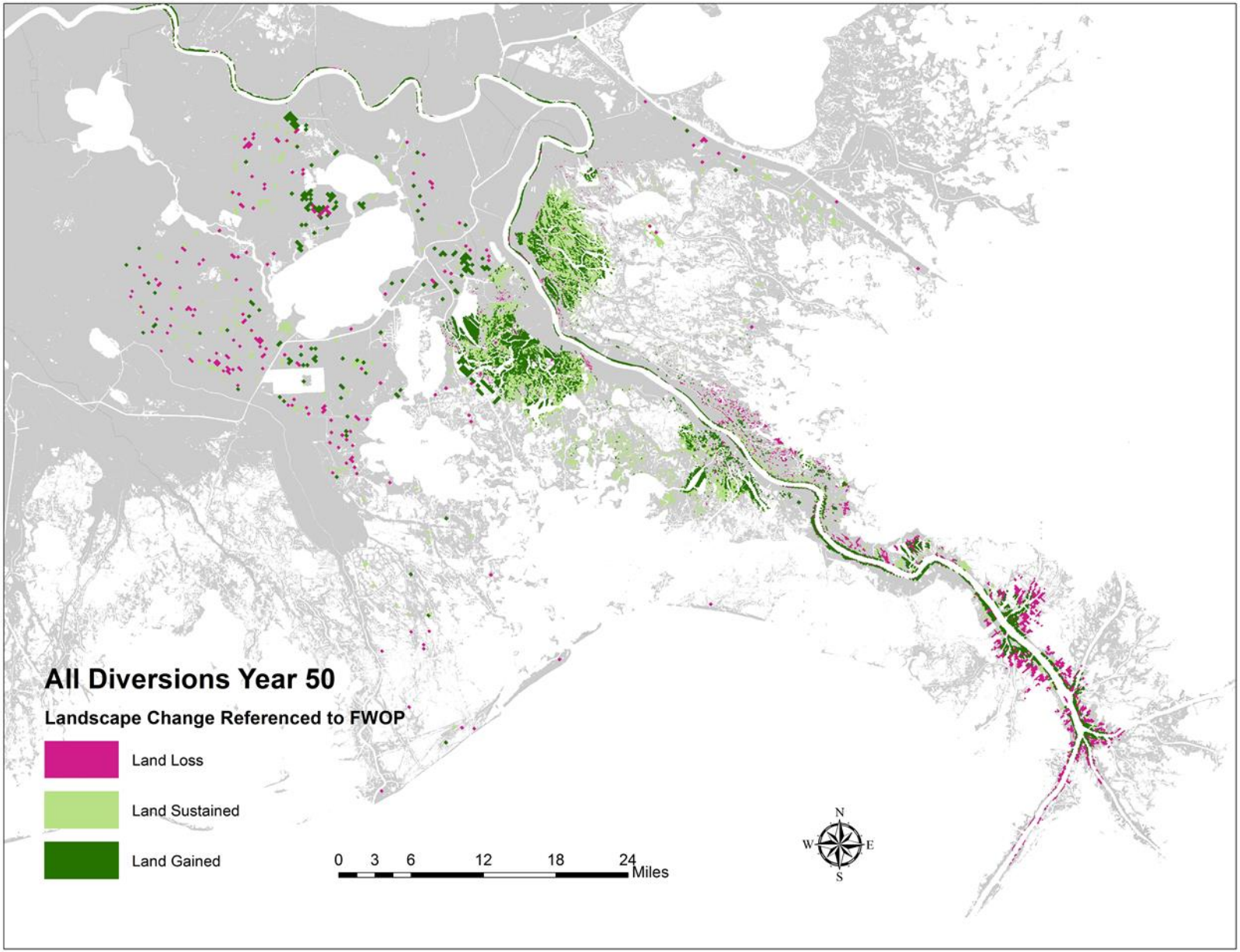
Mid Diversions Active



BASIN-WIDE DELFT3D : 50-YEAR FUTURE WITH NO PROJECT



BASIN-WIDE DELFT3D : 50-YEAR FUTURE WITH ALL DIVERSIONS



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THANK YOU

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