Sea Level Rise Impacts on Delaware Estuary Wetlands

Delaware River Basin Commission

Fanghui Chen, PhD. , P.E.
Senior Water Resource Engineer

Team:
Water Resource Operations

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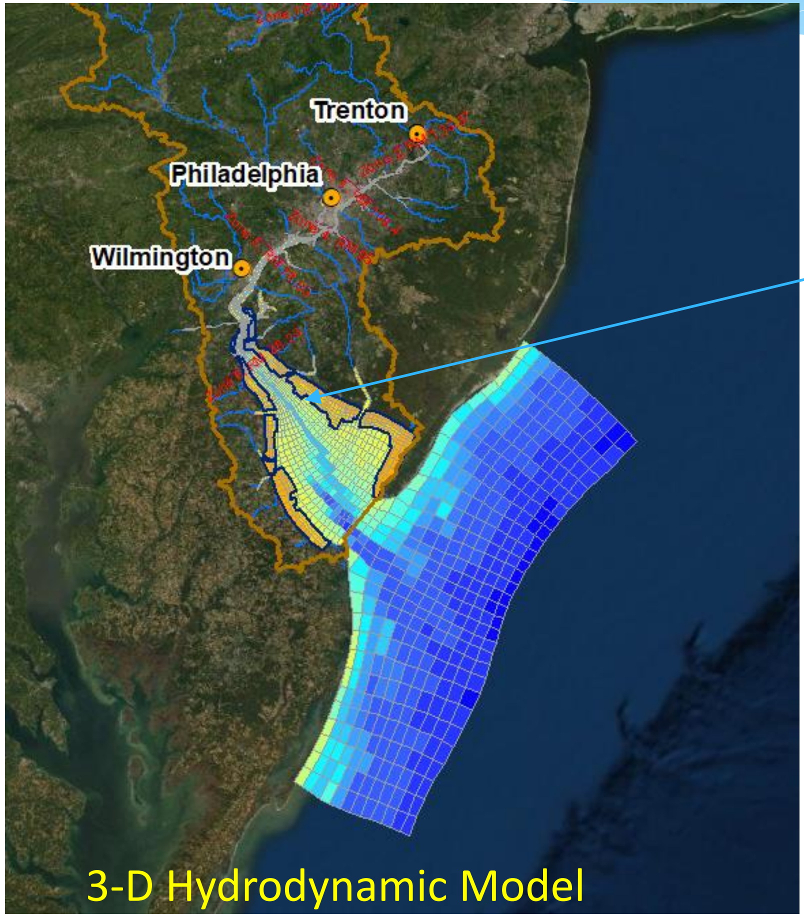

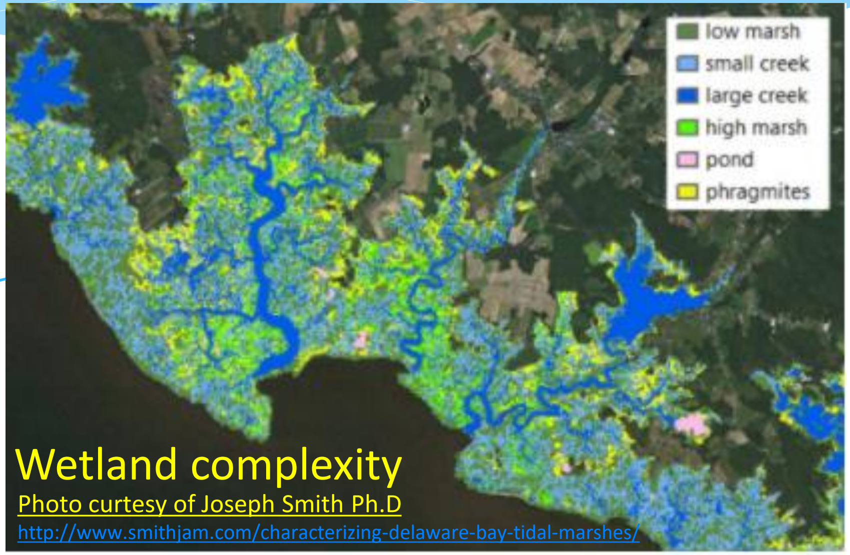

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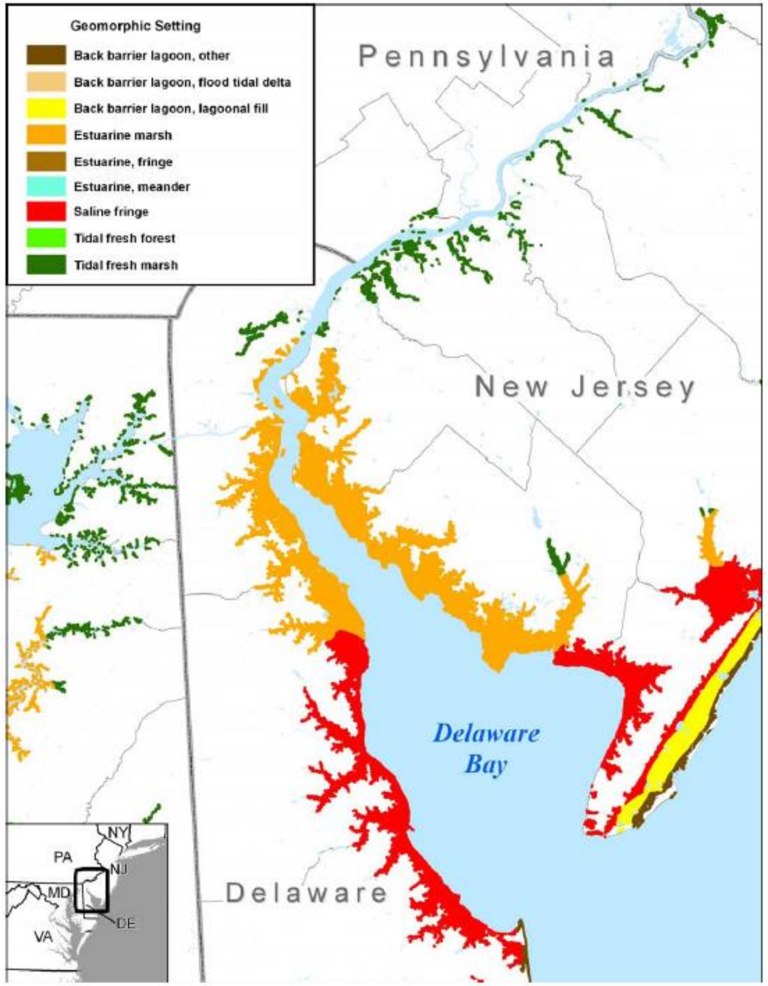
Tidal Wetlands in the Delaware Estuary



Tidal wetlands of the Delaware Estuary (Reed et al. 2008.)
http://risingsea.net/papers/federal_reports/Titus_and_Strange_EPA_section2_1_Reed_Cahoon_et_al.pdf

Wetland types

1. Freshwater tidal marshes (green)
2. Brackish estuary marshes (orange)
3. Salt marshes or salt fringe (red)

Why marshes are important

- Buffer the coastal storm
- Protect shoreline from erosion
- Essential habitat for wildlife
- Support commercial and recreational fishing
- Provide educational opportunities
- Absorb excess nutrients, improve water quality
- Impressive natural carbon sink, reduce climate change
- And more …

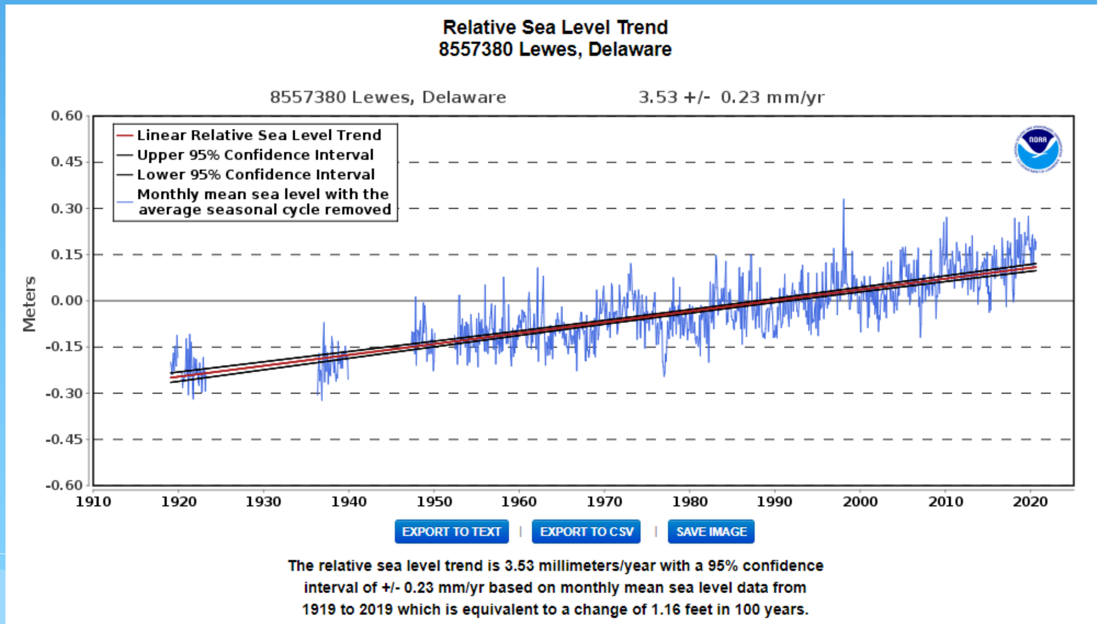
The different tidal marsh can be delineated by salinity gradient.
Among many functions, they are important natural carbon sinks to mitigate climate change

SLR Projections

- Local Relative Sea Level Rise (SLR) in Delaware Bay and Estuary
- DRBC have proposed SLR scenarios (0.3, 0.5, 0.8, 1.0, 1.6) for 2060 water resource planning and salinity study
- Likelihood of those SLR scenarios was also considered

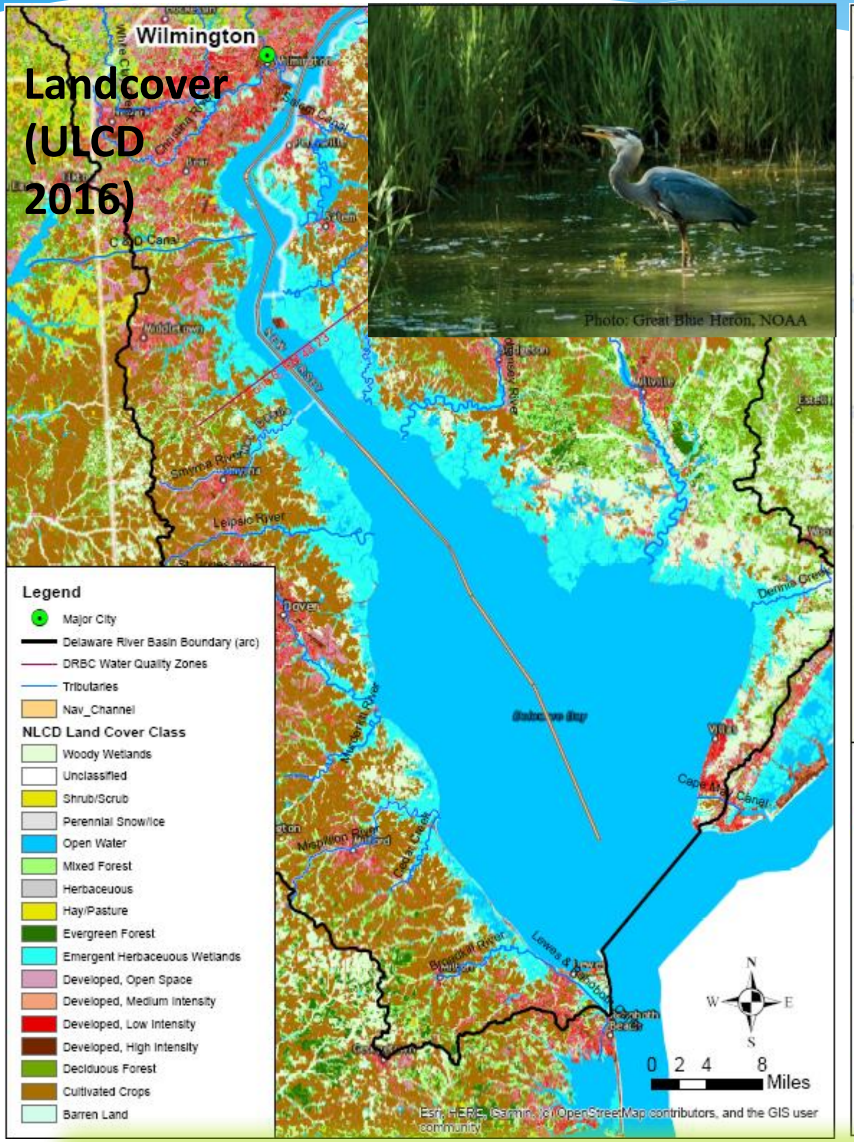
- 0.3 m SLR, and the chance for this to happen is 91 to 92% for 2060;
- 0.5 m SLR, and the chance for this to happen is 46 to 49% for 2060;
- 0.8 m SLR, and the chance for this to happen is 9 to 10% for 2060;
- 1.0 m SLR, and the chance for this to happen is 1 to 2% for 2060;
- 1.6 m SLR, and the chance for this to happen is 0 to 1% for 2060

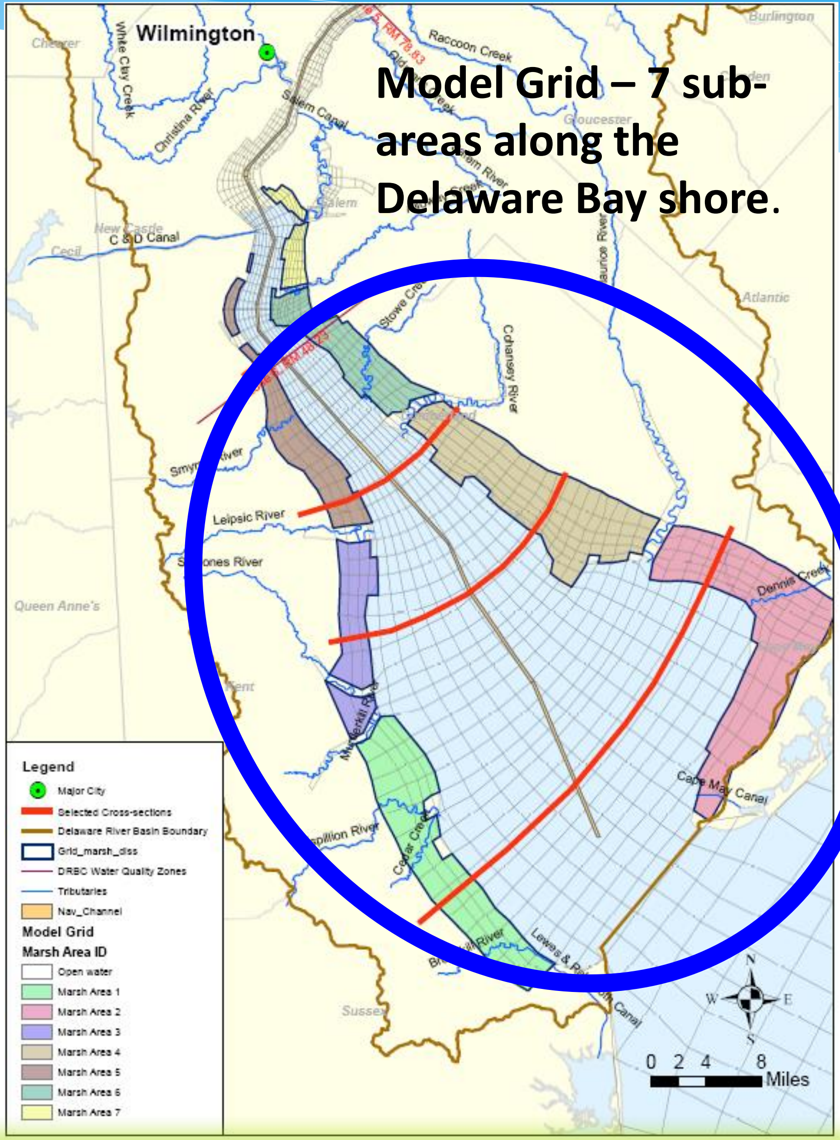
IPCC, AR5, 2014
NOAA, 2018
USACE, 2014
STAP, NJCAA, NJ. 2019
DGS, DNREC,DE. 2017



We proposed 5 SLR scenarios for 2060. Current SLR rate is 3.53 mm/year

Tidal Wetlands in the Delaware Estuary Watershed





Edward W et al. (2018) :

- Tidal wetlands lost at a rate of -1.03 sq-km/year in the Delaware Estuary.
- Land cover analysis shows 43.5 sq-km tidal wetlands lost to open water since 1975

NJ SAB (2020):

- Marsh loss rate: 1.1-1.9% per decade (horizontal extent)

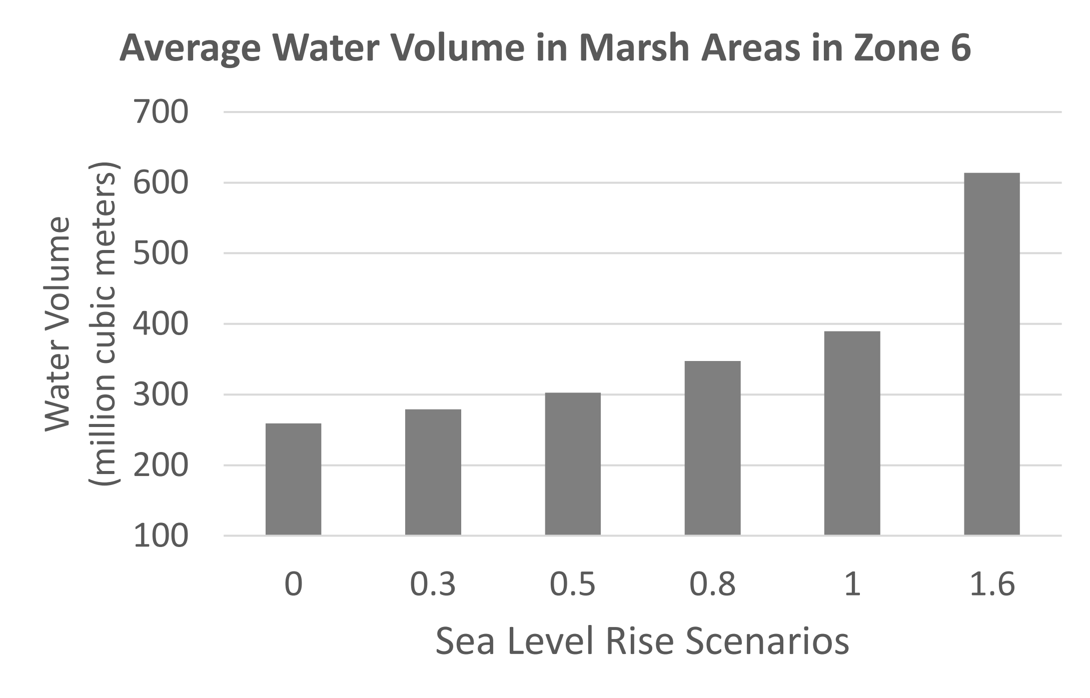
Phillips (1986):

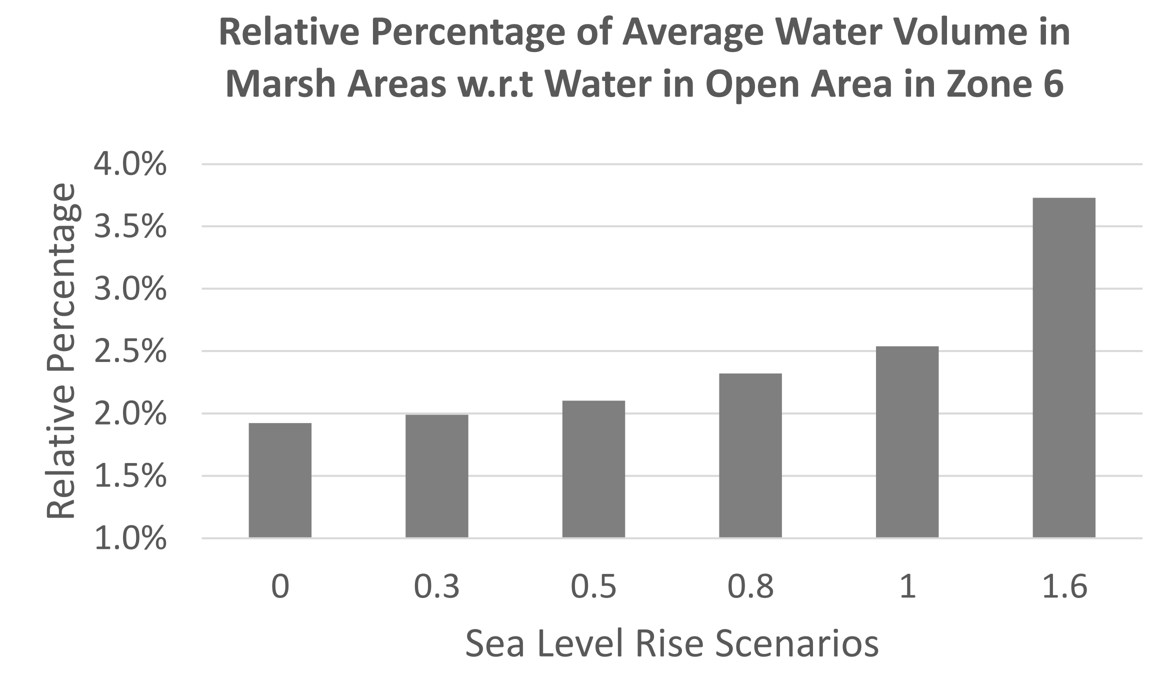
- Shoreline erosion: average rate is 3.2 m/year
  (2-5 m/year at different segments between 1940 to 1978)

Shoreline might erode, and marsh may migrate further inland due to SLR

Water Volume Change

volume is in million cubic meters, and averaged over three-month period during July 1st through September 30, 2002





Notes: volume is in million cubic meters; water in C&D canal and tributaries were excluded.

As sea level rises, more water get into the estuary.
Relative percent of water volume over marshes w.r.t. volume in the open water area of Zone 6 increased with the SLR

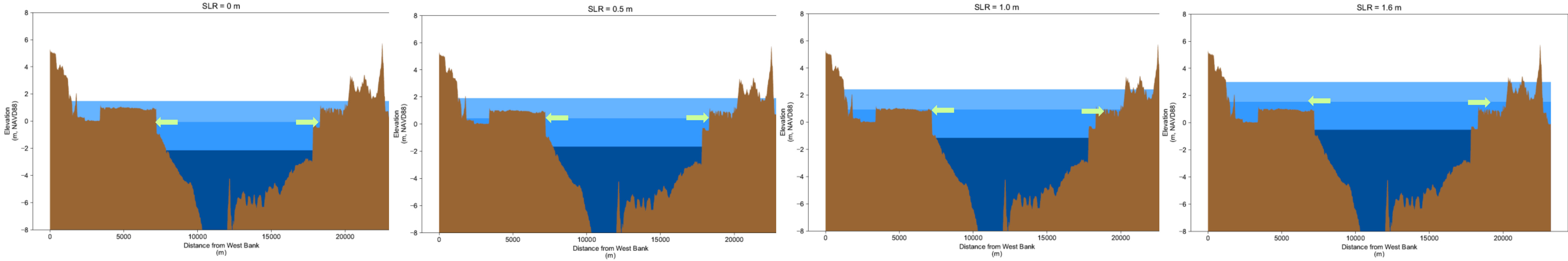
Predicted Range of Water Surface Elevation (RM 37)

SLR = 0 m

SLR = 0.5 m

SLR =1.0 m

SLR = 1.6 m



WSE (high)
WSE (mean)
WSE (low)
FEMA (2011 DEM)

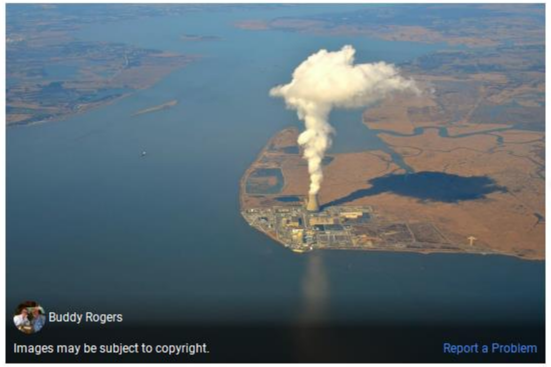
West (DE) ---------- East (NJ)
Looking towards upstream

Cross-sectional view at RM 37 across the Ship John Shoal area.

Based on predicted water surface elevation (WSE) range over one-year simulation period and with a low-flow hydrologic conditions from 2002.
Noted that X,Y are not on the same scale.

Selected Locations for Diagnostic Analysis of Water Surface Elevation

Google Earth



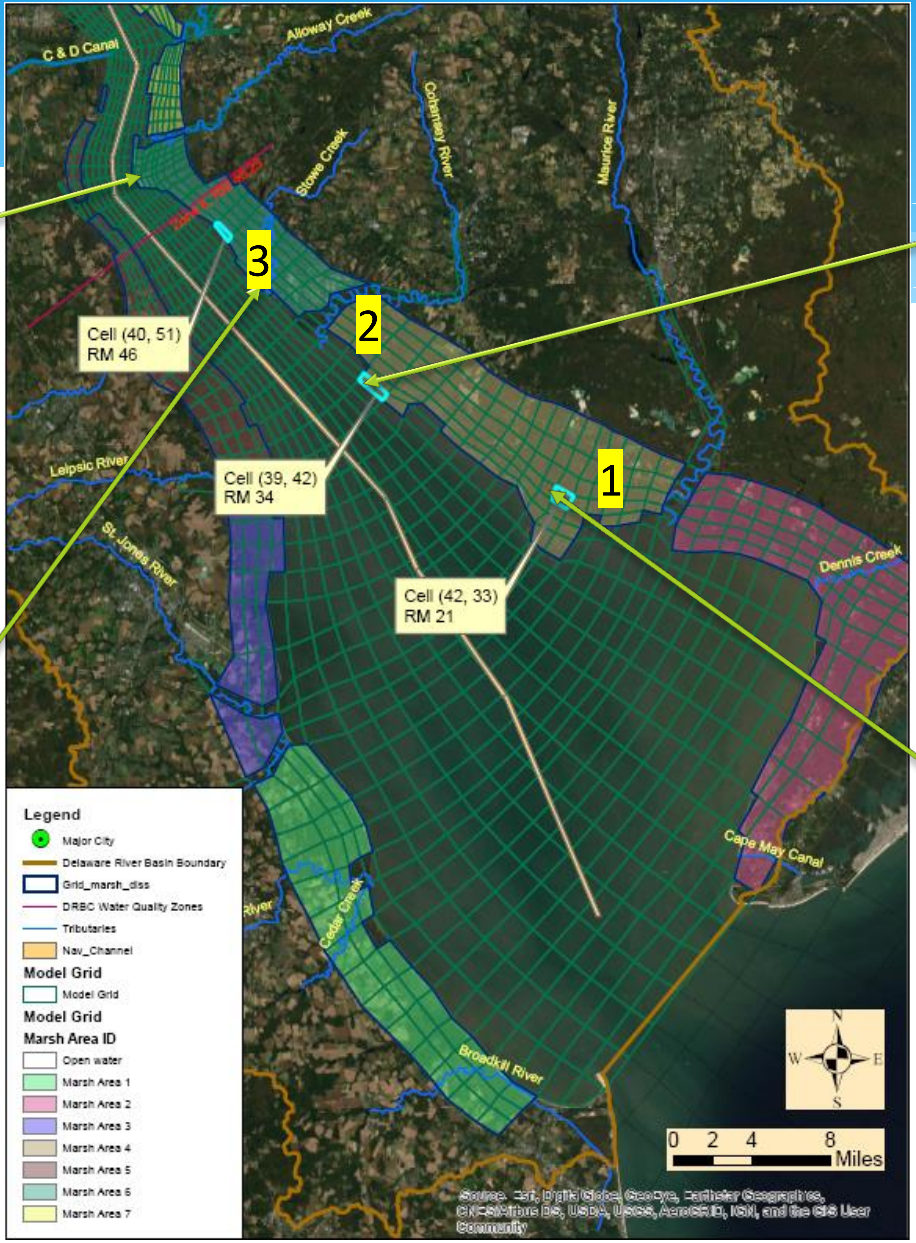
Hope Creek Nuclear Power Plant, Lower Alloways Creek, NJ

Hope Creek Nuclear Power Plant, NJ

Google Earth

Bay Point, NJ at sunset

Bay Point, NJ

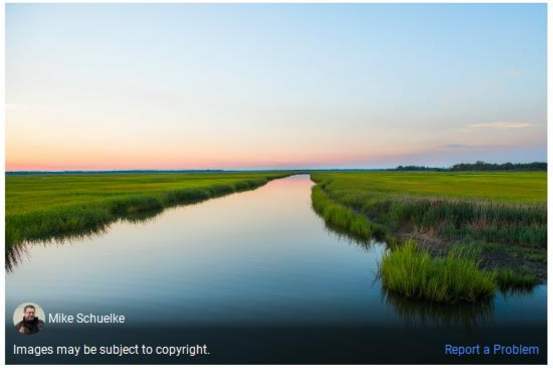


Google Earth

Nantuxent Cove - 1988 (P10F)

Nantuxent Cove, NJ

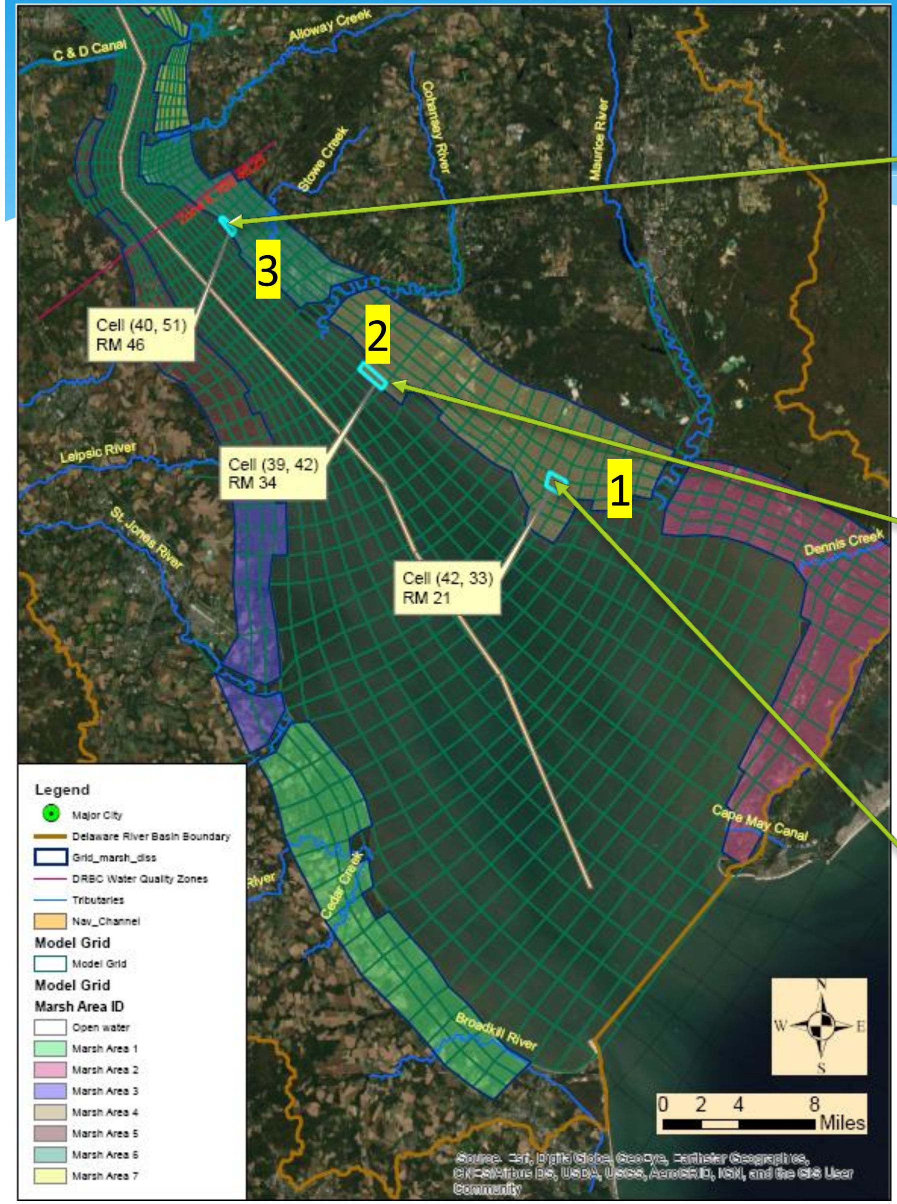
Google Earth

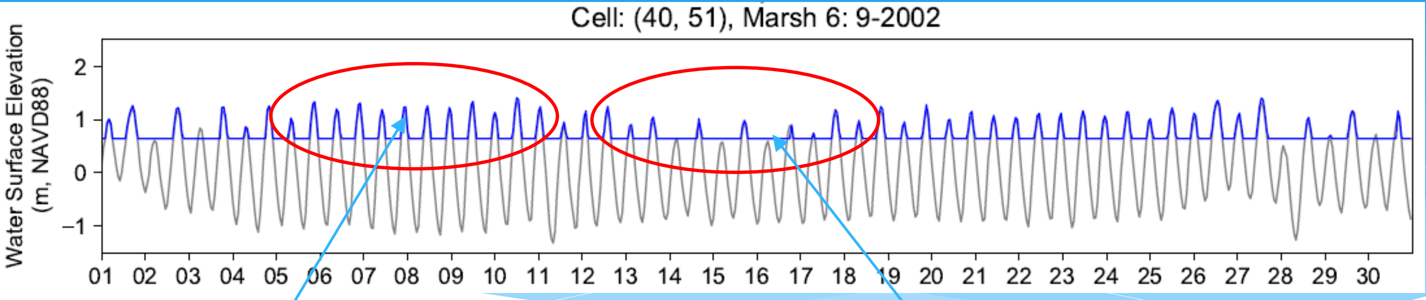


Johnson's Ditch from the Bridge

Johnson’s Ditch
north of the Egg Island Fish and Wildlife Management Area

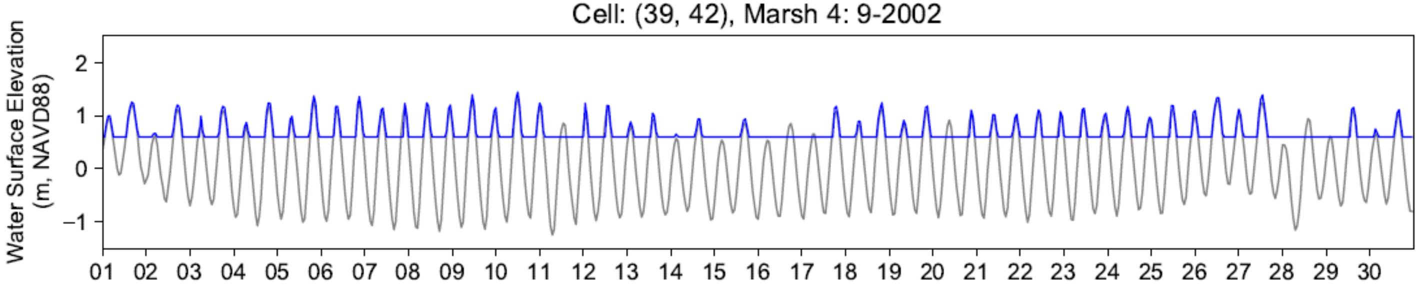
Simulated WSE Showing Flooding at Selected Locations (Baseline, 0m SLR)

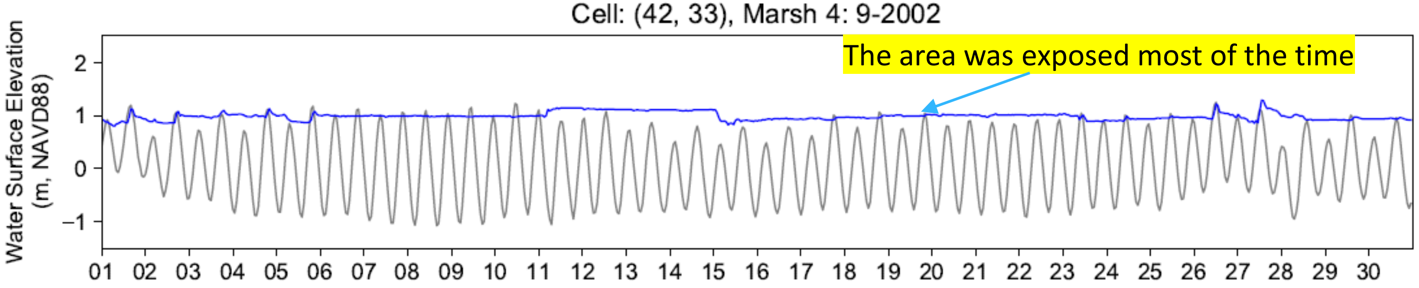




Flooded during spring tide and high tide

Exposed during neap tide and low tide

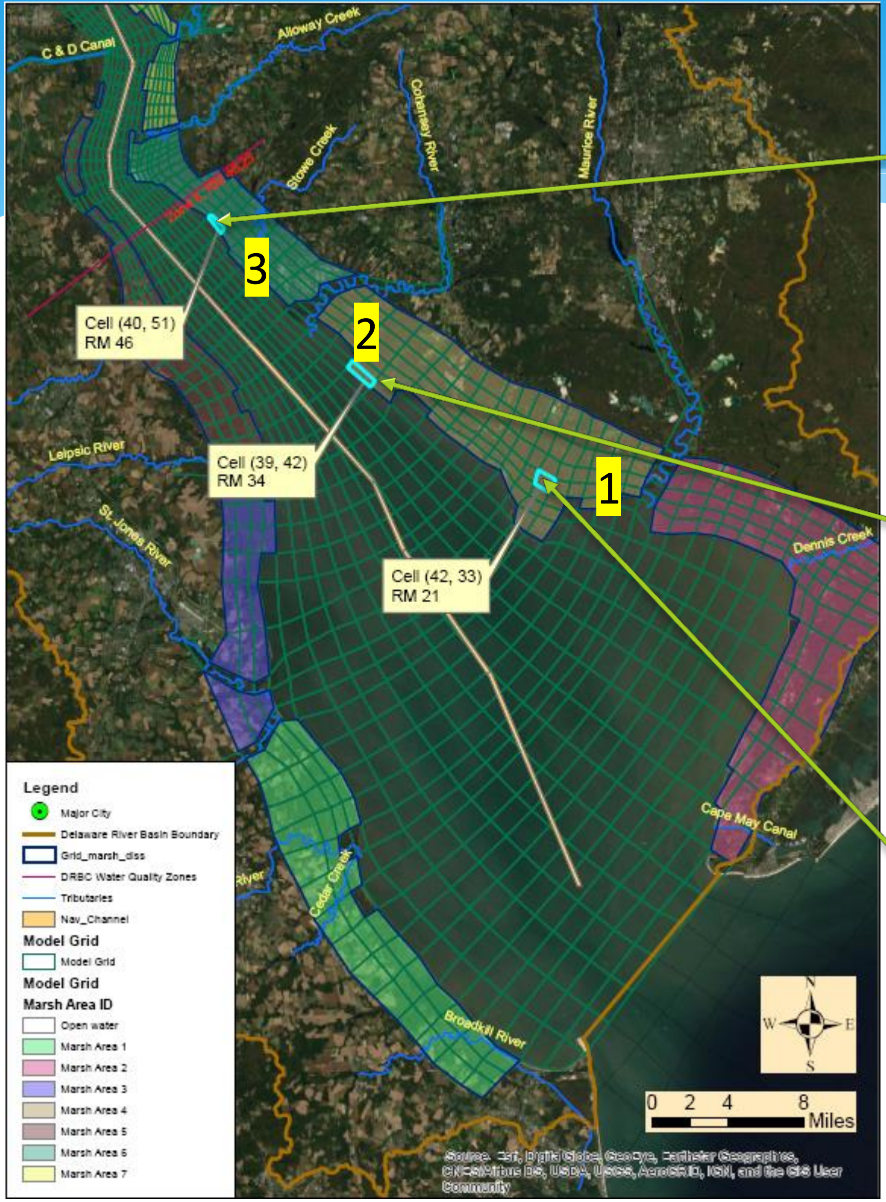


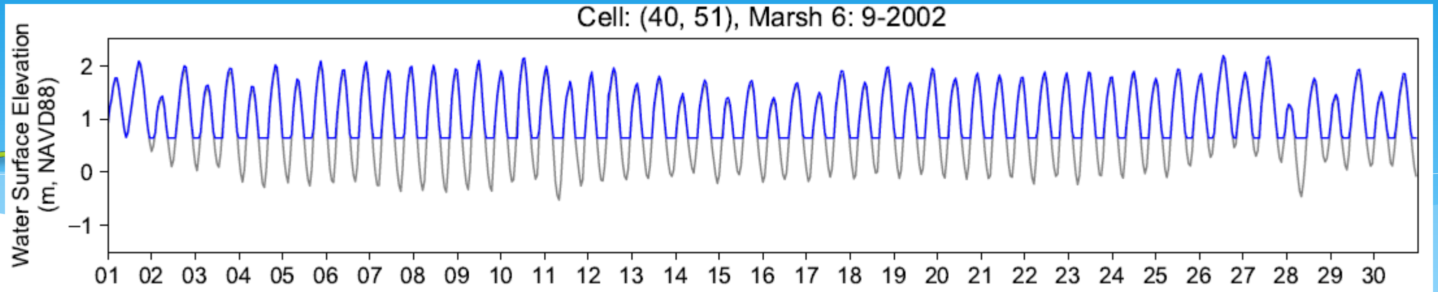


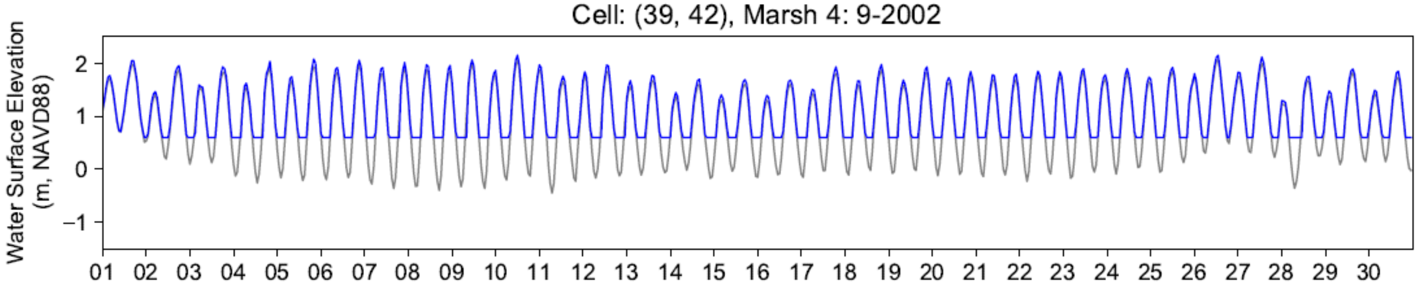
The area was exposed most of the time

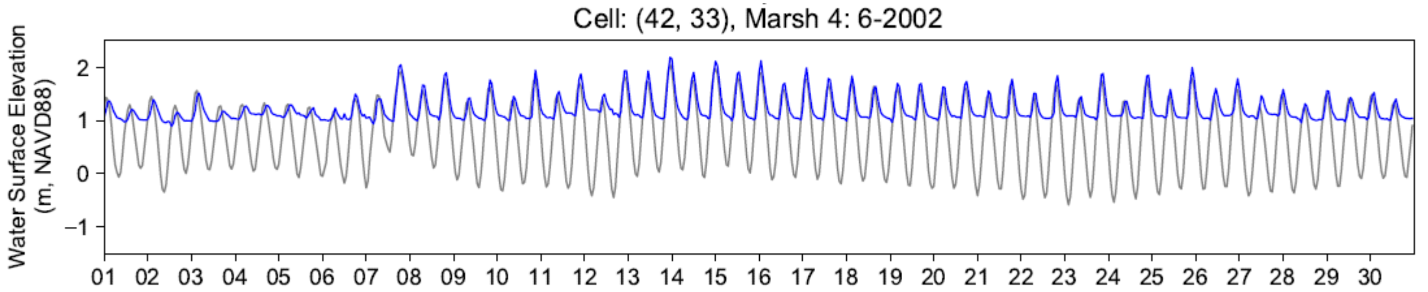
This example is for SLR = 0 m (baseline), only flooded during short period of time often during spring tide with shallow water depth

Simulated WSE Showing Flooding at Selected Locations, SLR = 0.8 m



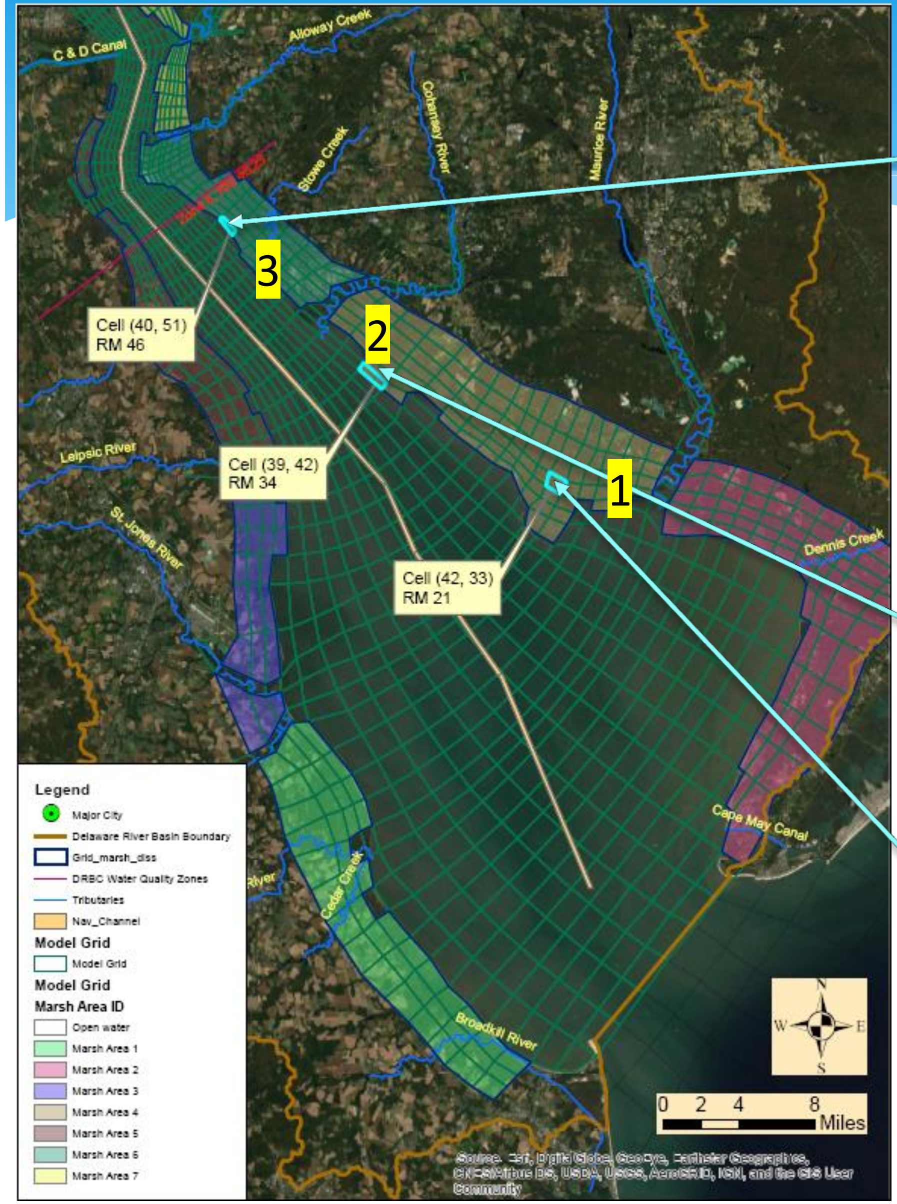


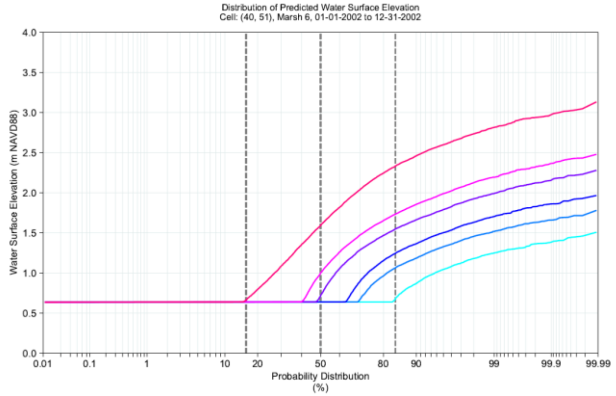


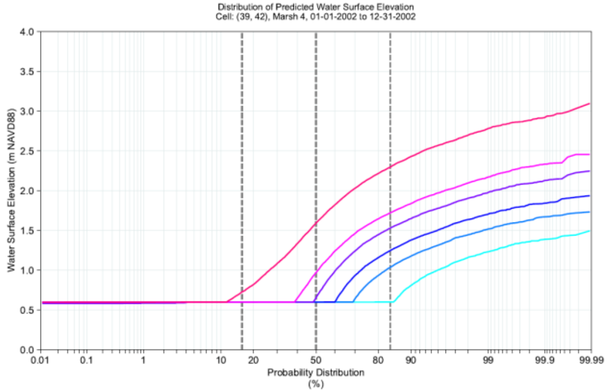


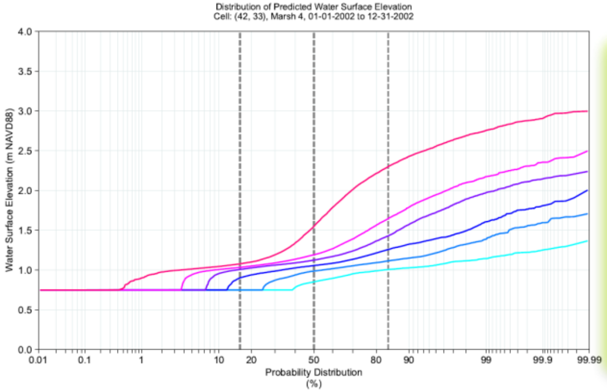
This example is for SLR = 0.8 m (2.6 ft)
Inundation duration became longer, water depth increased more with SLR

Simulated Inundation Frequency at Selected Locations



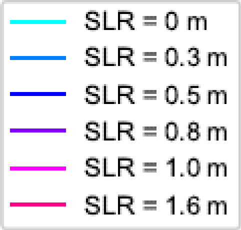






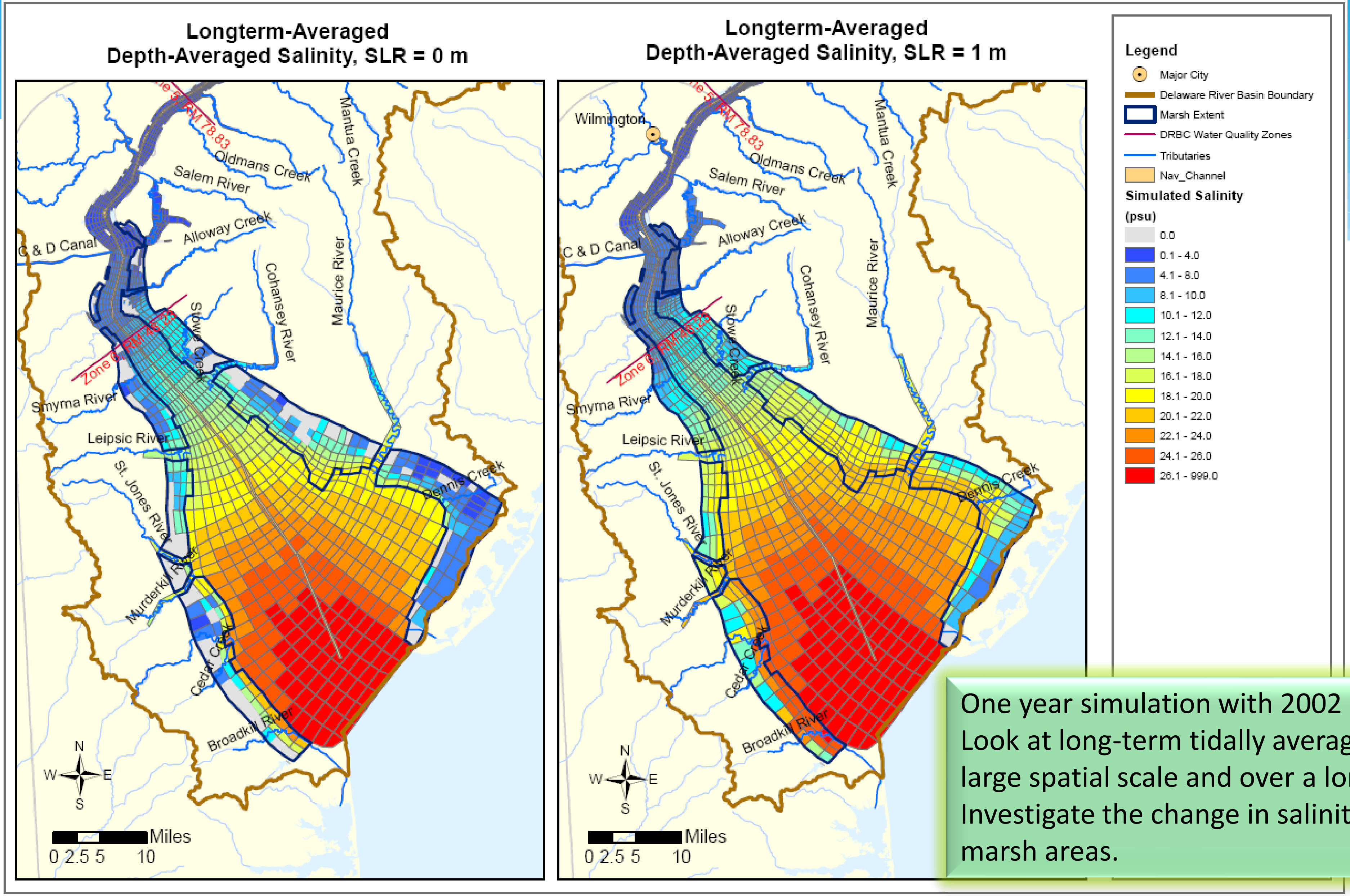
Predicted Inundation Frequency

	Location 1	Location2	Location 3
SLR	RM 21	Rm 34	RM 46
0	61.50%	14.61%	16.95%
0.3	75.79%	31.11%	30.70%
0.5	88.16%	39.91%	37.02%
0.8	92.84%	50.90%	52.42%
1	96.42%	61.63%	60.11%
1.6	99.58%	88.44%	85.27%



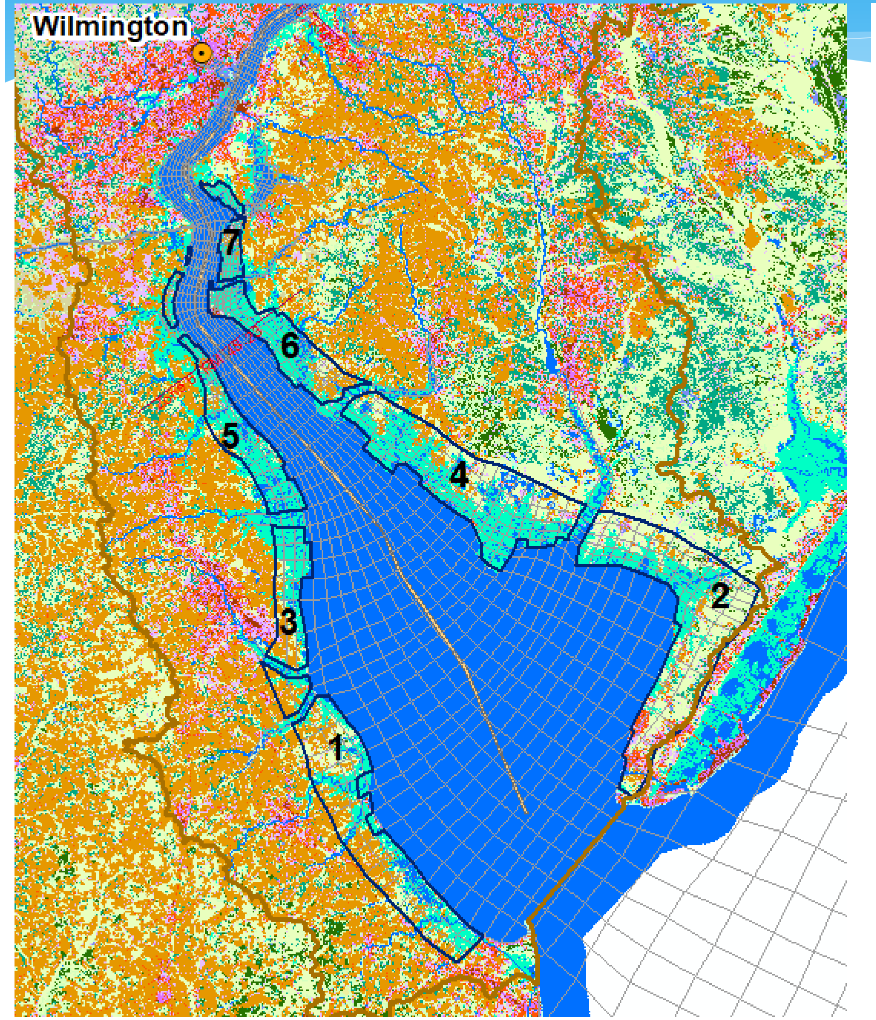
As Sea level rises, inundation frequency increases. For example, at the 2 locations further north, it increased from ~15% (or 3.6 hours a day) to more than 50% (or 12 hours a day) with 0.8 m SLR .

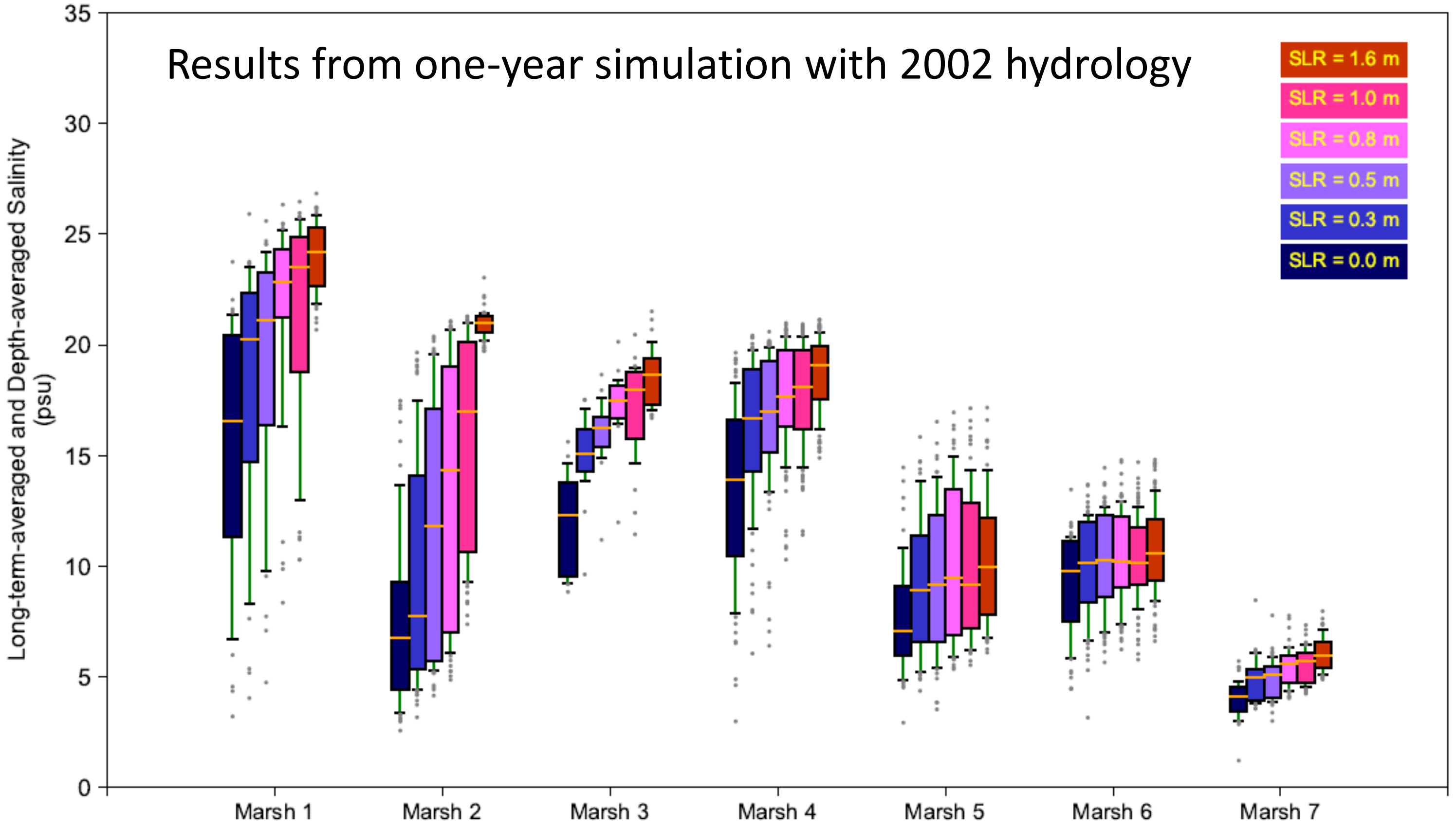
Predicted Salinity, 0 m vs. 1 m SLR
long-time averaged results, 2002 hydrologic conditions



One year simulation with 2002 hydrology.
Look at long-term tidally averaged salinity on a large spatial scale and over a long time period.
Investigate the change in salinity regime over marsh areas.

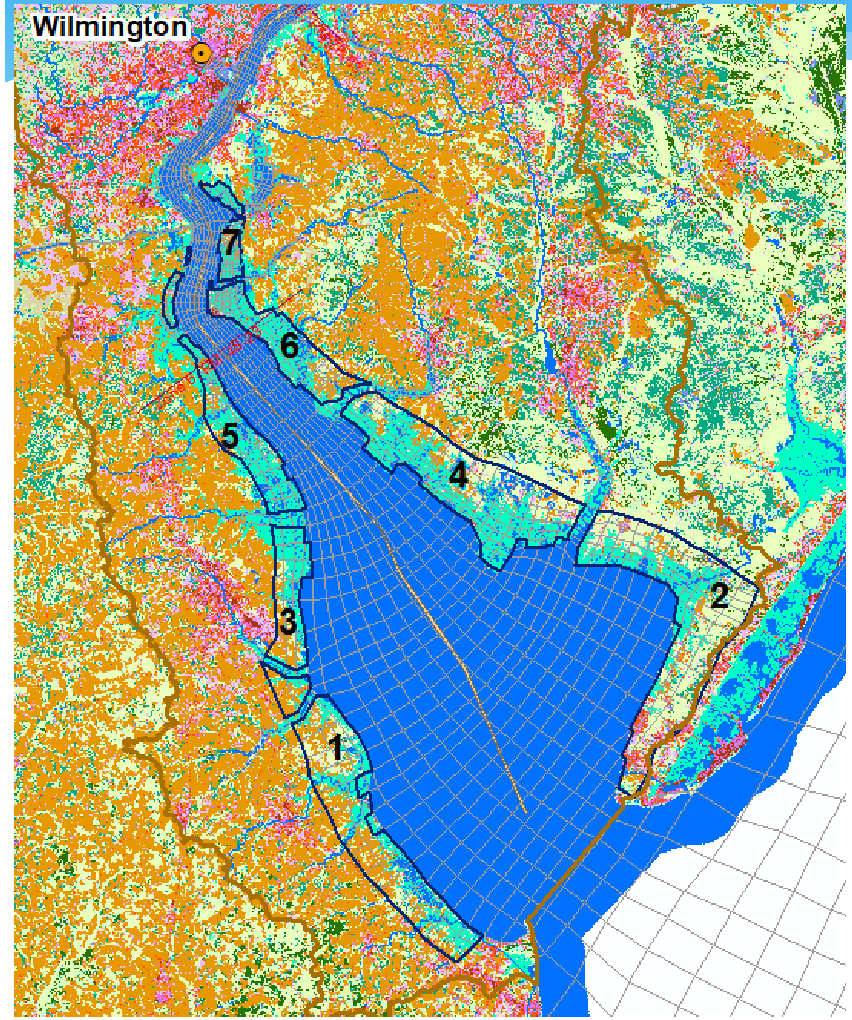
Predicted Long-term-averaged and Depth-averaged Salinity In Marsh Areas

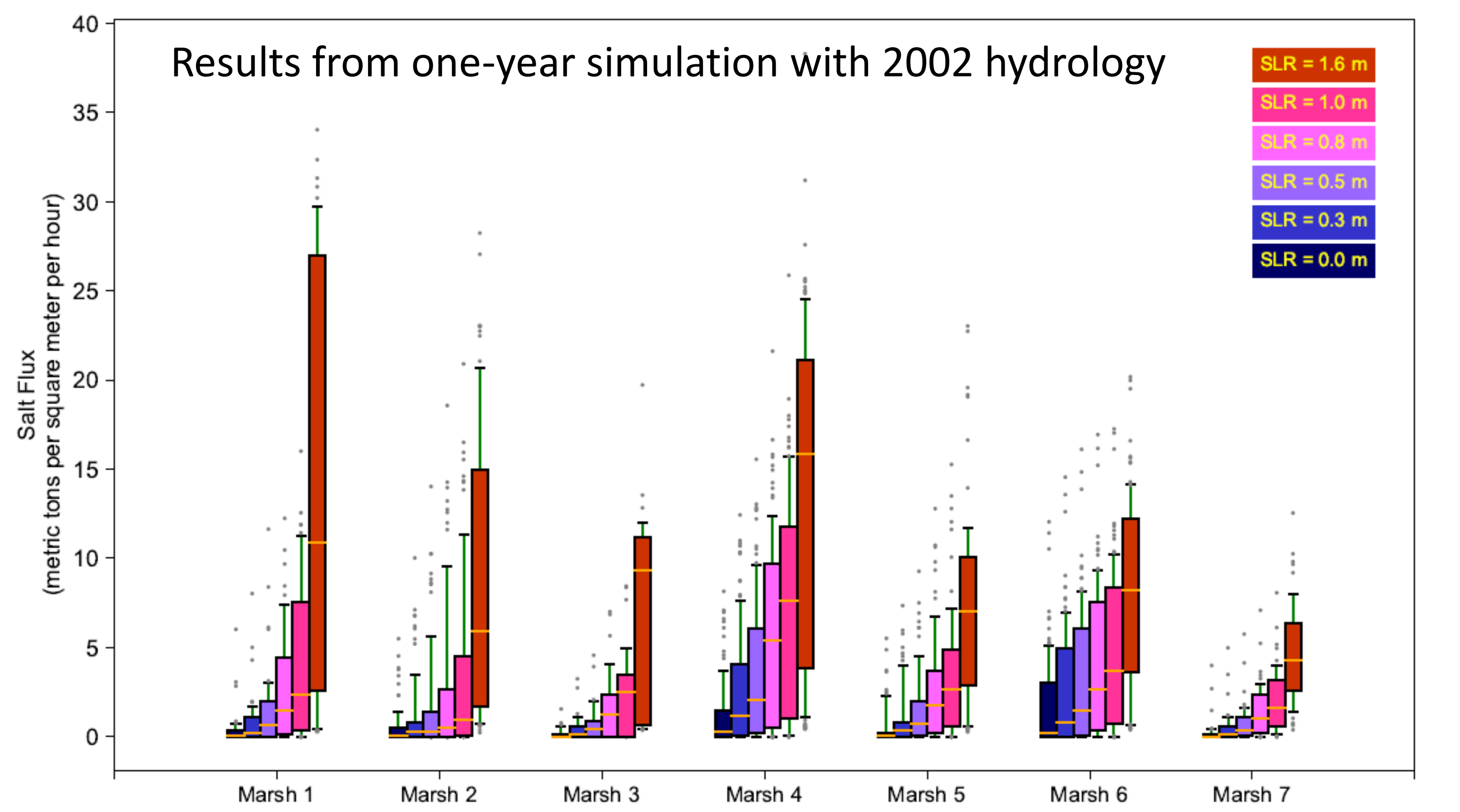




A clear gradient in salinity exists from the bay mouth towards upstream. For given marsh, tidally-averaged salinity increases as sea level rises.

Predicted Long-term-averaged Salt Mass In Marsh Areas (metric tons per square meter per hour)





The amount of salt contained in the water column was evenly distributed over 12-month and over unit area for comparison.

As sea level rises, the amount of salt in the water column in marsh increases in terms of mass per unit area per given time period.

Conclusions

* As sea level rises, total amount of saltwater moving in and out of marsh areas, the inundation frequency, and water depths all increase. Sea level rise may change the salinity regime in marsh wetlands that may have profound influence on the health of marsh habitat
* Ecologist and biologist may take this physics predicted by the model and make their assessment of the ecological effects associated with SLR on these marsh habitats
* Numerical model simulations indicate that SLR may significantly alter the key environmental parameters in the Delaware Estuary wetlands. We should look at the difference predicted by the model rather than the absolute values in these parameters.

Questions ?

My contact information

Fanghui Chen, Ph.D., P.E.

Senior Water Resource Engineer - Operations

Delaware River Basin Commission | PO Box 7360 | 25 Cosey Road | West Trenton, NJ 08628-0360

Direct: 609-477-7225 | Main: 609-883-9500 ext 225

Email: Fanghui.Chen@drbc.nj.gov

https://www.state.nj.us/drbc/