



BOEM Bureau of
Ocean Energy Management

Atlantic CCS Assessment: An Introduction and Status Update

GOMCARB/SECARB

April 5-7, 2023

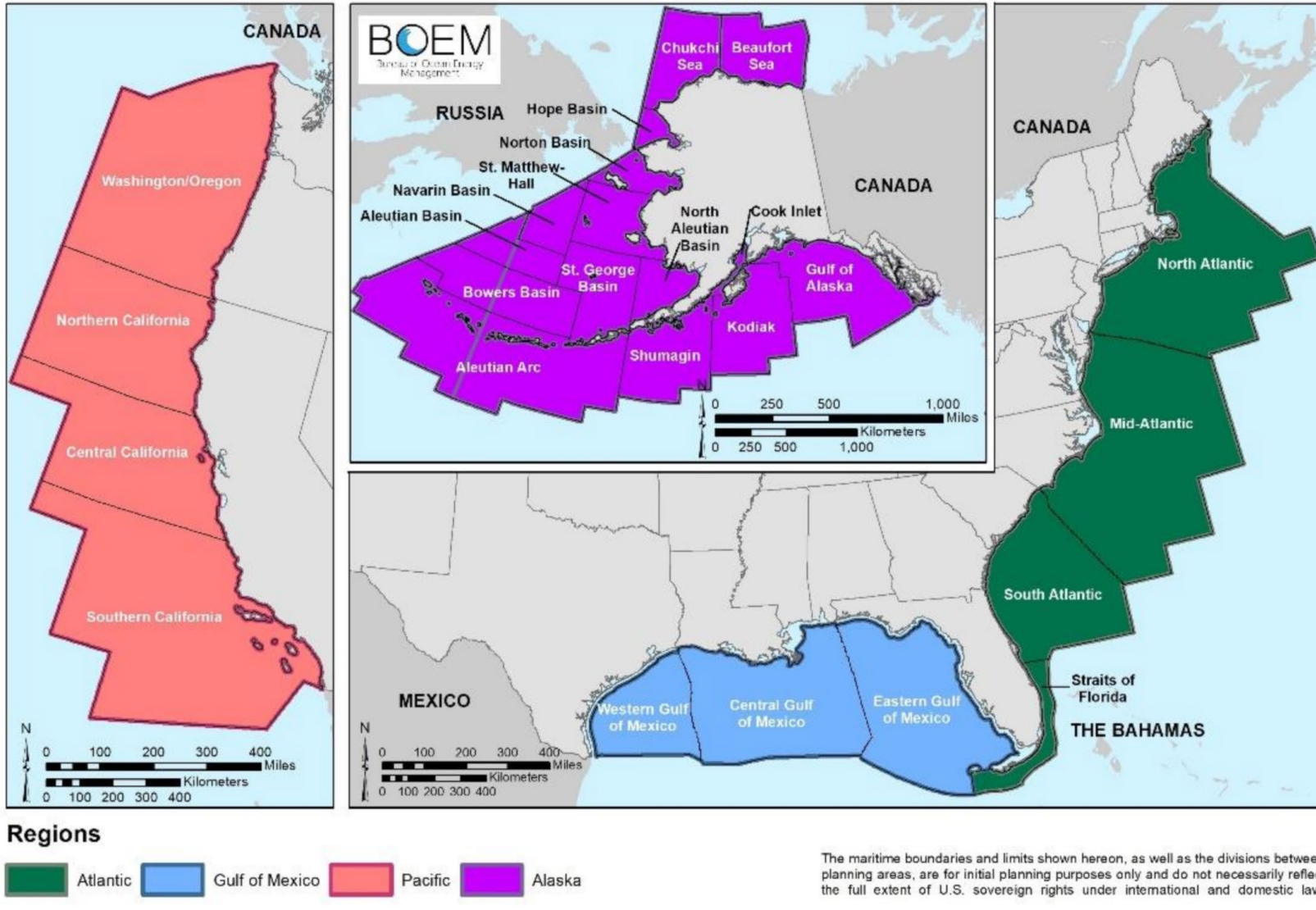
Austin, TX

Dominic Smith

Statutory Authority

On November 15, 2021, the Infrastructure Investment and Jobs Act, known as the Bipartisan Infrastructure Law (BIL), became law.

Section 40307 of the BIL amends the Outer Continental Shelf Lands Act (OCSLA) to authorize the Secretary of the Interior to grant a **lease, easement, or right-of-way** on the Outer Continental Shelf for activities that “provide for, support, or are directly related to the **injection of a carbon dioxide stream into sub-seabed geologic formations for the purpose of long-term carbon sequestration.**”



CO2 Sequestration Resource Assessment

Purpose

- **Estimate** subsurface storage **capacity** on the OCS
- **Identify & characterize** potential storage units suitable for carbon sequestration
- **Inform** leasing, environmental, regulatory, & multiple-use decisions on the OCS

CO2 Resource Assessment Development

- **Regional and national teams** composed of geologists, geophysicists, engineers, petrophysicists, and economists
- Geological, geophysical, and engineering interpretation of seismic and well-related **data** and information to define storage assessment units
- Statistical **model** development and analysis and aggregation of results



CO2 Sequestration Resource Assessment

- CCS Assessment report in 2026*.
- Frequency of published updates not yet determined.
- BOEM presentation at CCUS 2023 on April 26th. Bryan Stephens will present his team's *Saline Aquifer Areas of the Northern Gulf of Mexico Shelf, USA – A Preliminary Inventory*.

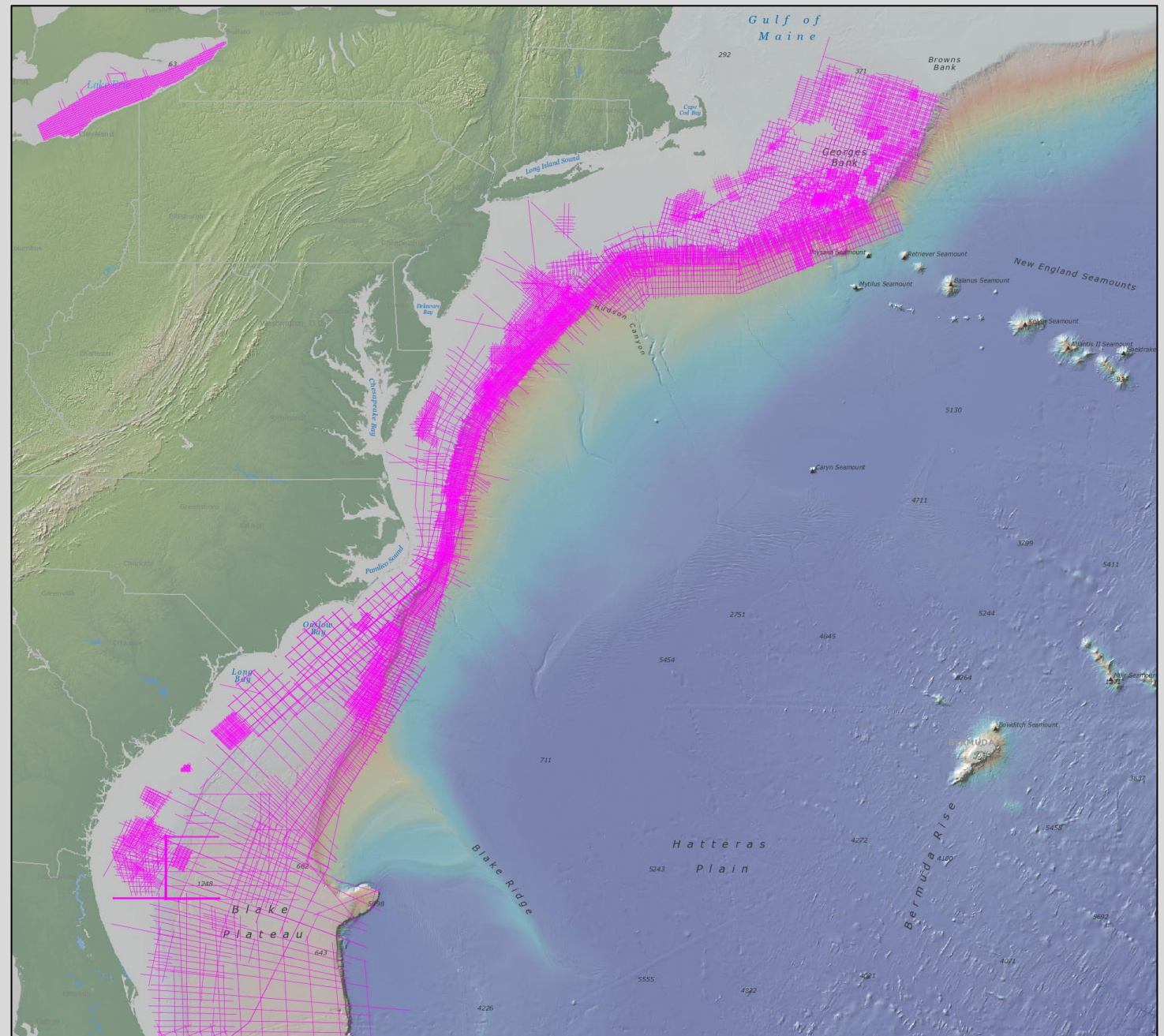
*best understanding at present, subject to change



Atlantic – Publicly Available Data

- 2D seismic (NAMSS)
- Industry wells
- Onshore wells
- DSDP, IODP, ODP wells

<https://walrus.wr.usgs.gov/namss/search/>



U.S. Atlantic O&G Leasing and Drilling History

5 Continental Offshore Stratigraphic Test (COST) wells (1976 – 1979)

- WDs 136' – 2,686' (41 – 819 m)
- TDs 13,254' – 21,873' (4,040 – 6,667 m)

9 lease sales from 1976 to 1983

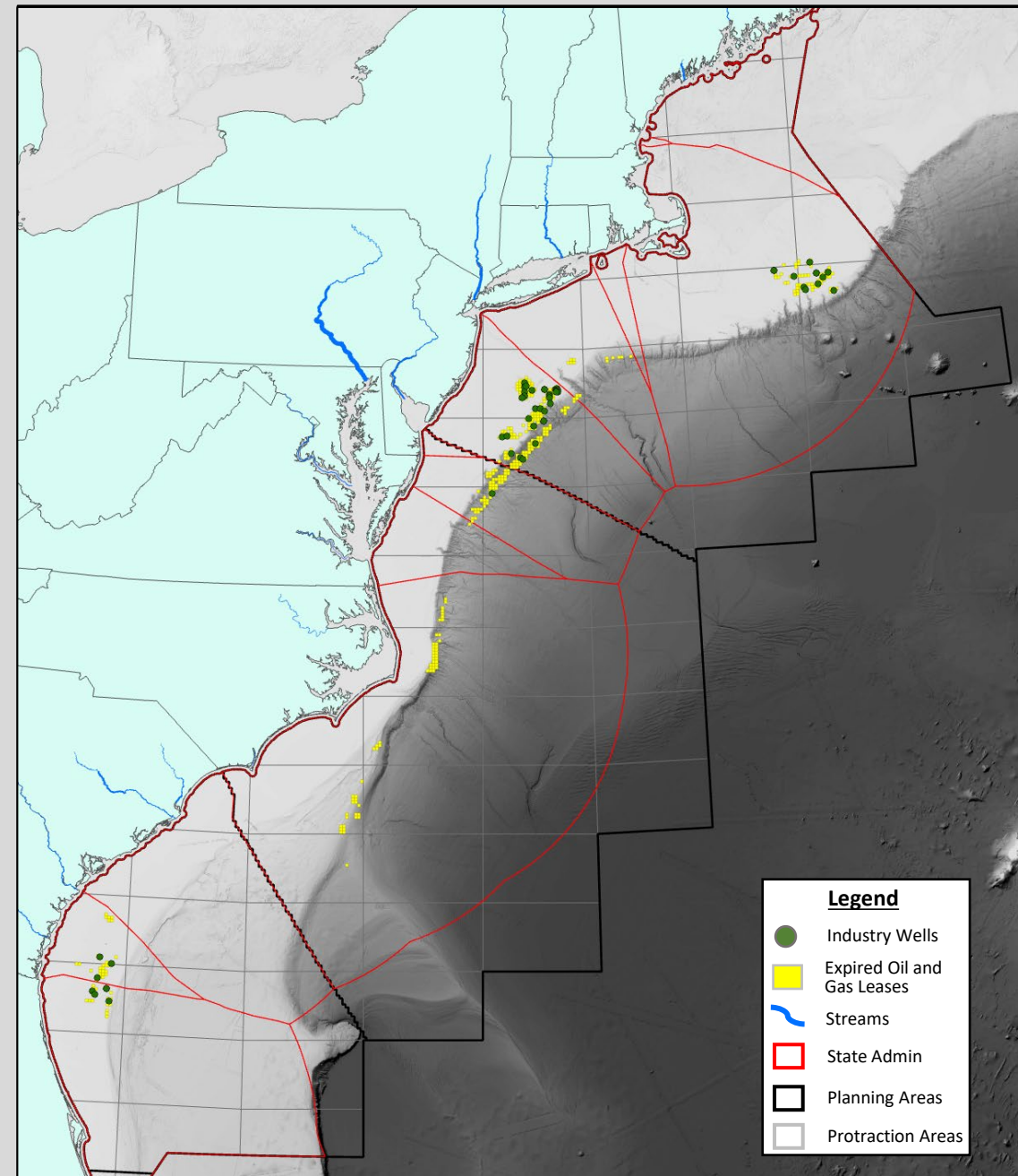
- 410 leases covering 2,334,198 acres
- \$2,840,175,477 or over \$10 Billion in today's dollars

46 Industry wells from 1978 to 1984 with 39 NFWs

- WD 98' – 6,952' (30 – 2,119 m)
- TDs 7,000' – 20,000' (2,133 – 6,096 m)
- 3 tested EK – LJ carbonate margin traps in deepwater
- 1 tested a shelf-margin structure in deepwater

No HC production so no depleted reservoirs for CCS;
buoyant traps and saline aquifers

<https://www.data.bsee.gov/>



Atlantic CCS Assessments to Date

USGS UK (NC): **~1/2 Gt**

USGS LK (NC&GA): **14 Gt**

BEG South Georgia Basin: **15 Gt**

BEG Upper K: **16 Gt**

BEG Lower K: **178 Gt**

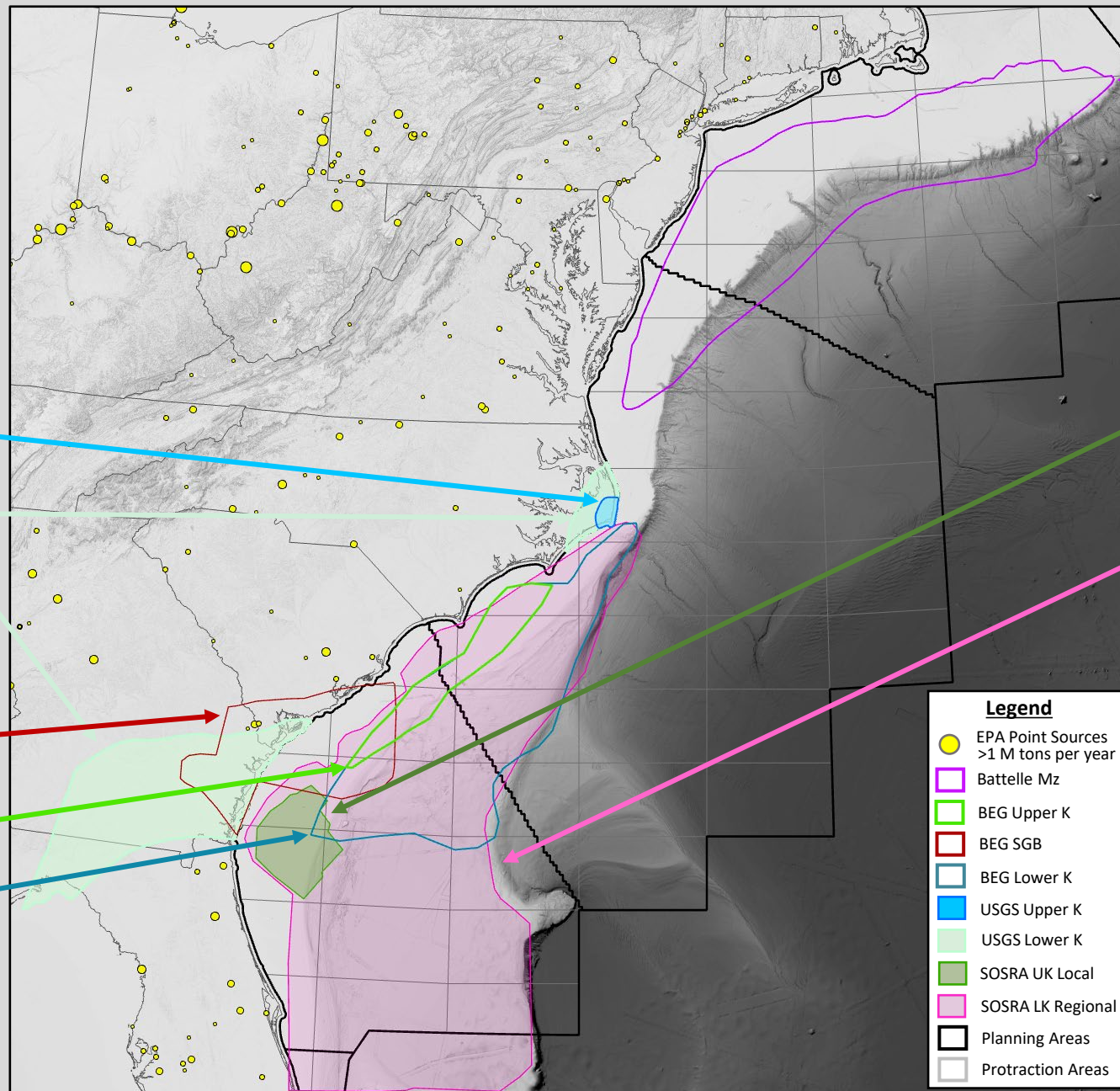
Battelle Mz Intervals (DOE funded): **150-1,136 Gt**

SOSRA Upper K Local: **9 Gt.**

SOSRA Upper K Regional: **32 Gt**

SOSRA Lower Cretaceous estimate soon to be published

~375 – 1,350 Gt Estimate Offshore



Refinement of CO₂ storage estimates

More detailed site characterization may lead to decreases in CO₂ storage capacity estimates.

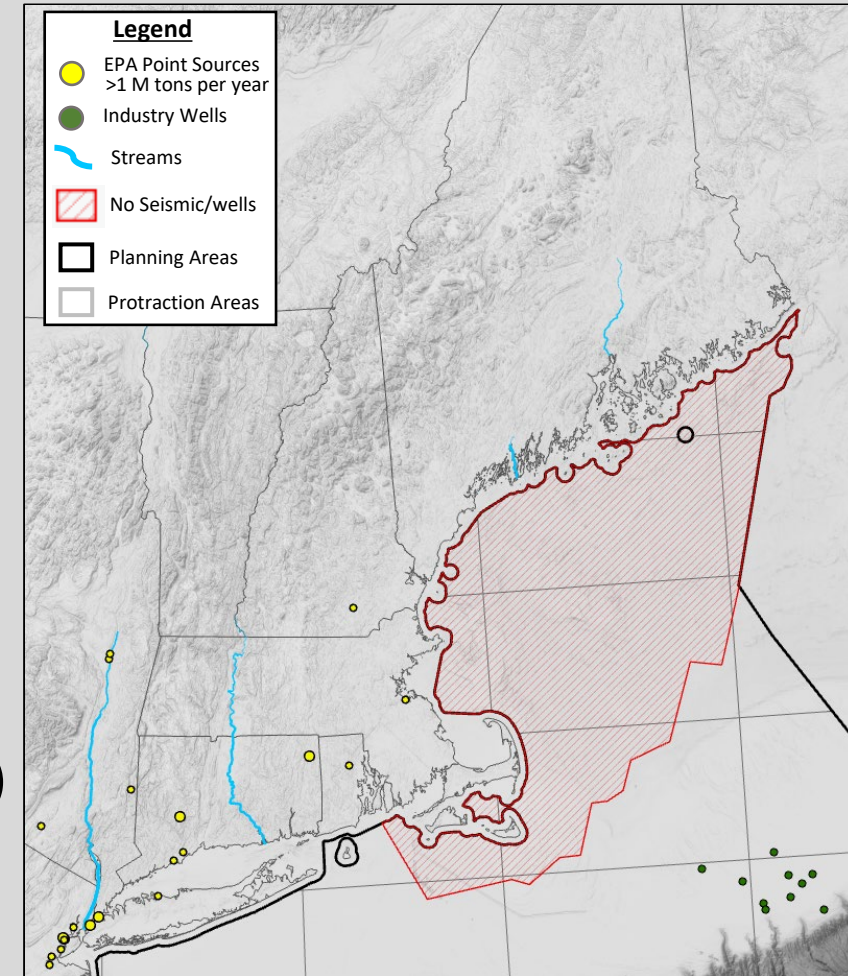
- Geology - reservoir heterogeneity and compartmentalization
- Utilization:
 - Economics – distance from point sources
 - Exclusion areas, limited access areas, multi-use

Texas coast example had ~90% reduction of potential CO₂ storage with refined estimate:

- Atlantic 10% = **38-135** Gt
- 25-90 years of Atlantic states' emissions (~1.5 Gt per year)

Potential CO₂ Storage Increases: Unassessed

- Insufficient data – e.g. Data gap Maine to Massachusetts (~23k SqMi)
- Deeper water (continental slope)
- “Unconventionals”



Atlantic “Unconventional” Storage Types

- Basalt Mineralization:

- David S. Goldberg, Dennis V. Kent, and Paul E. Olsen, Potential on-shore and off-shore reservoirs for CO₂ sequestration in Central Atlantic magmatic province basalts. *Proceedings of the National Academy of Sciences*, vol. 107, no. 4, 2010, pp. 1327–1332. https://www.researchgate.net/publication/41040372_Potential_on-shore_and_off-shore_reservoirs_for_CO2_sequestration_in_Central_Atlantic_magmatic_province_basalts
- Pogge von Strandmann, P.A.E., Burton, K.W., Snæbjörnsdóttir, S.O. et al. Rapid CO₂ mineralisation into calcite at the CarbFix storage site quantified using calcium isotopes. *Nat Commun* 10, 1983 (2019). <https://doi.org/10.1038/s41467-019-10003-8>

- Deep water shallow sediments

- House, Kurt Zenz, Daniel P. Schrag, Charles F. Harvey, and Klaus S. Lackner, Permanent Carbon Dioxide Storage in Deep-Sea Sediments, *Proceedings of the National Academy of Sciences of the United States of America*, vol. 103, no. 33, 2006, pp. 12291–95. *JSTOR*, <http://www.jstor.org/stable/30050557>

- Methane hydrate replacement:

- No Atlantic O&G Exploration and Development however



BOEM Assessment Methodology

- Define Storage Assessment Units (SAUs)
- Reservoir Input parameters from available data
- Stochastic modeling to arrive at a min, mean, and max.
- More info at BOEM's CCUS 2023 poster in Houston (April 27th). Joe Maloney will present, *National U.S. Outer Continental Shelf Inventory of Carbon Storage Resources – Overview of Methodologies and Process.*
- Methodology report coming out in 2024*.

*best understanding at present, subject to change



BOEM Atlantic Work Done to Date

- Literature review
- Model comparisons
- Licensed reprocessed seismic data and gridded interpretations, and modern well analysis from commercially available sources
- BOEM Petrophysicist evaluated the 7 SEGE wells for CO₂ storage.
- BOEM Petrophysicist evaluating the petrophysics data shared from the Battelle-led, DOE funded study
- Previous interpretations for Oil and Gas



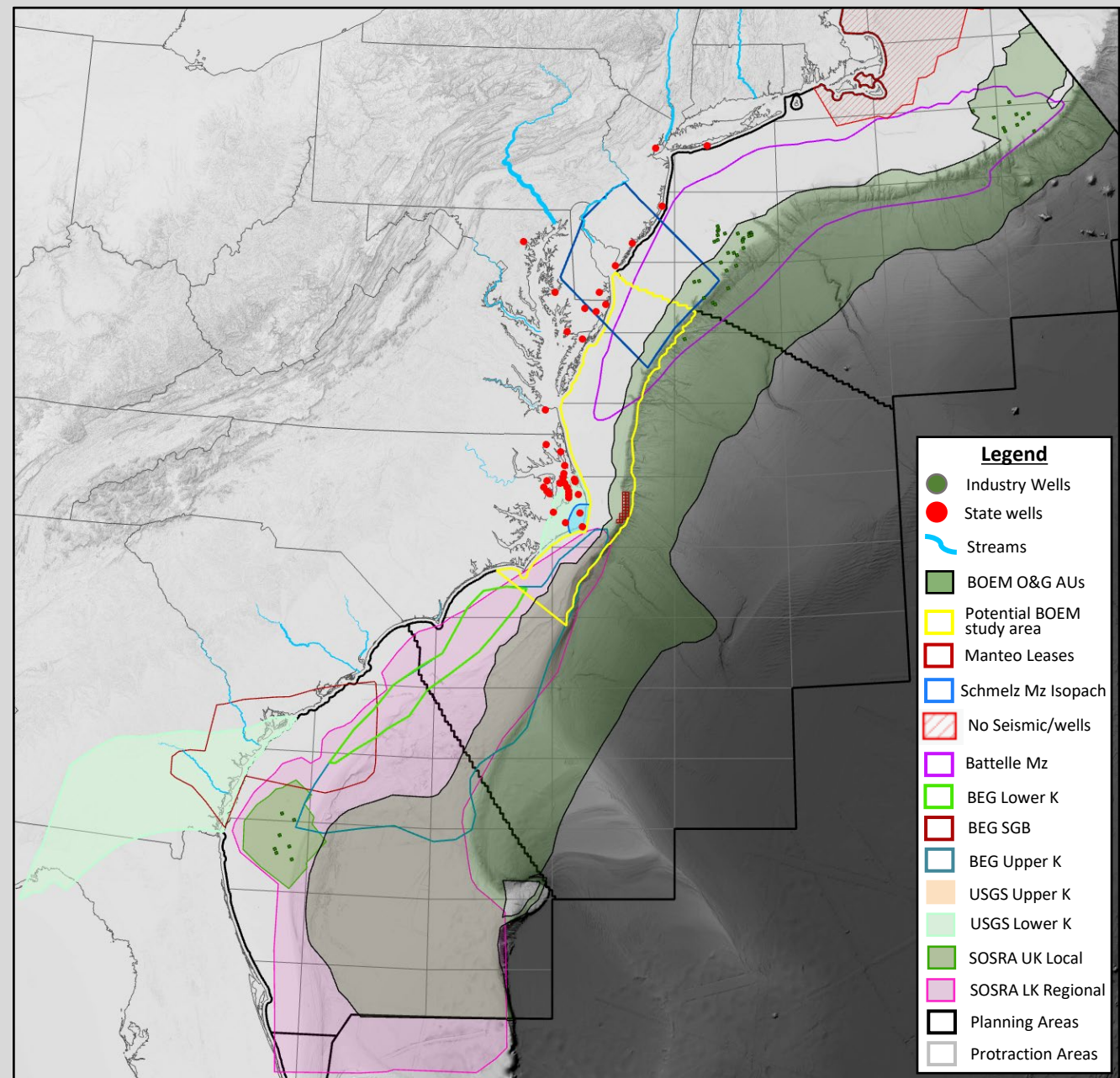
BOEM Future Work

- Incorporate licensed data and Sequence Stratigraphy Framework with work from publications.
- Obtain additional datasets from NETL's EDX, NCGS, etc.
- Evaluate the state water and Southern BCT wells.
- Run BOEM's stochastic models with published inputs to compare to published results.
- Publish an Atlantic CCS Fact Sheet to BOEM's website.

BOEM Future Work

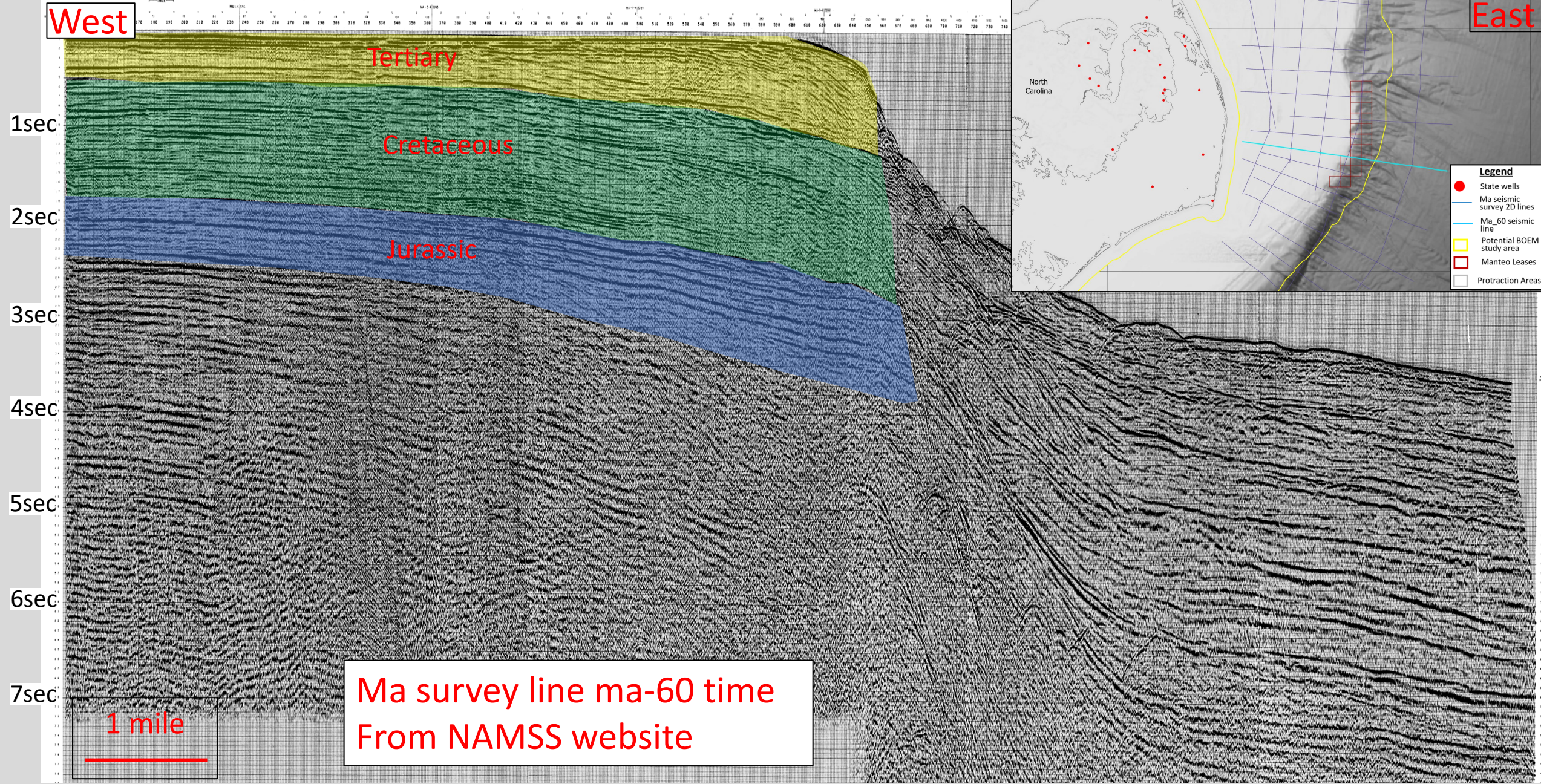
Study area example:

- CO₂ research gap on the shelf offshore NC and VA
- Try to incorporate NCGS wells with offshore seismic and Baltimore Canyon Trough wells
- USGS SAUs nearby to tie to



West

East

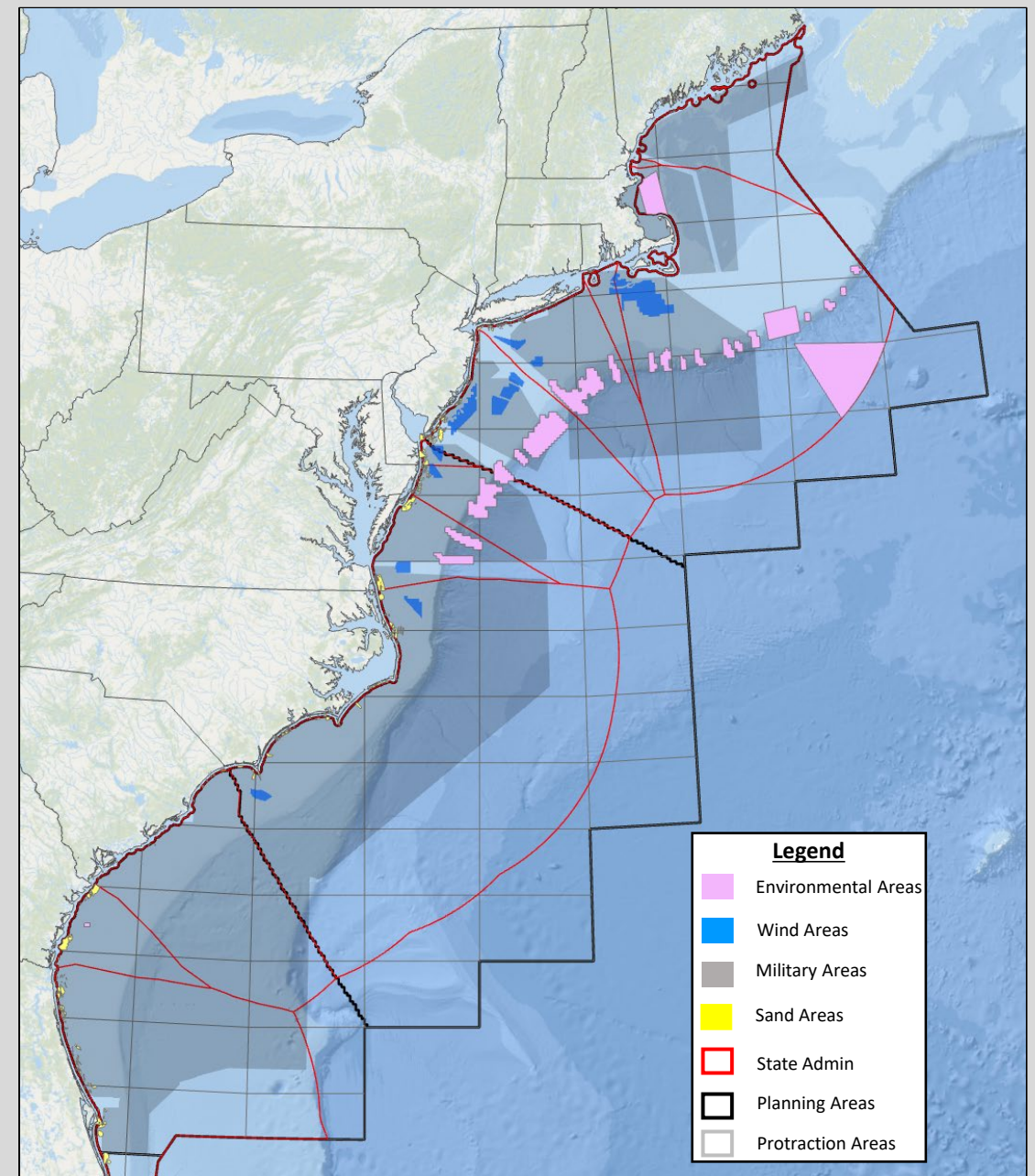


Deconfliction

Select Atlantic Activities and closures

(<https://marinecadastre.gov/data/>)

- Wind
- DoD
- Marine minerals
- Environmental areas (MMPA and ESA)
- Political boundaries.
 - planning areas
 - states administrative boundaries. (CZMA)
- Shipping lanes (AIS)
- Fishing
 - <https://www.fisheries.noaa.gov/>
 - <https://data.gov/>



Public Engagement: Critical to Atlantic CCS success.

Federal, State, and other stakeholders

Example: Atlantic Oil and Gas History (~3 decades of inactivity)

- Untested Manteo Prospect – blocks leased in 1981 and 1983
 - https://www.boem.gov/sites/default/files/uploadedFiles/BOEM/Oil_and_Gas_Energy_Program/Resource_Evaluation/Geological_and_Geophysical_Data_Acquisition/ManteoProspect-MMS_Report.pdf
- Virginia Sale 220 – proposed for 2012 but cancelled May 2010
 - <https://www.boem.gov/oil-gas-energy/leasing/virginia-lease-sale-220-information>
 - <https://www.doi.gov/news/pressreleases/Salazar-Calls-for-New-Safety-Measures-for-Offshore-Oil-and-Gas-Operations-Orders-Six-Month-Moratorium-on-Deepwater-Drilling>
- New data acquisition – multiple 2D seismic, a 3D survey, Aeromag, cores
 - https://www.boem.gov/sites/default/files/documents/Atlantic-Pending-Permit-Map_6.pdf



Atlantic CO₂ Storage: Pros

- Significant storage potential: ~**375 – 1,350 Gt** (current published estimates).
- Individual storage volumes potentially large.
- Minimal leak likelihood (few legacy wells and passive margin geology)
 - Less faulting, little diapiric salt, few overpressured zones
- Numerous, large CO₂ Point sources nearby
- Minimal USDWs: little to no storage reduction for freshwater intervals or concerns of plume pressure front pushing saline water into freshwater sources.
- Minimal induced seismicity concerns
- Limited storage potential onshore in Eastern U.S.



Atlantic CO₂ Storage: Cons

- Poor data
- Little infrastructure
- Industry not established in the area
- Public perception

All of which can be Improved!



Selected References

U.S. Geological Survey Geologic Carbon Dioxide Storage Resources Assessment Team, 2013, National assessment of geologic carbon dioxide storage resources—Results (ver. 1.1, September 2013): U.S. Geological Survey Circular 1386, 41 p., <http://pubs.usgs.gov/circ/1386/>. (Supersedes ver. 1.0 released June 26, 2013.)

Gupta, Neeraj. Mid-Atlantic U.S. Offshore Carbon Storage Resource Assessment Project (Final Technical Report). United States: N. p., 2019. Web. doi:10.2172/1566748.

Smyth, R. C., Hovorka, S. D., Meckel, T. A., Breton, C. L., Paine, J. G., and Hill, G. R., 2007, Potential sinks for geologic storage of CO₂ generated in the Carolinas: The University of Texas at Austin, Bureau of Economic Geology, final report prepared for Southern States Energy Board and Electric Power Research Institute (http://www.beg.utexas.edu/environq/ty/co2seq/pubs_presentations/CarolinasSummary_16April07.pdf), 14 p. GCCC Digital Publication Series #07-01.

Khaled F. Almutairi, Camelia C. Knapp, James H. Knapp, and Darrell A. Terry, 2017, Assessment of Upper Cretaceous Strata for Offshore CO₂ Storage, Southeastern United States. Modern Environmental Science and Engineering (ISSN 2333-2581). August 2017, Volume 3, No. 8, pp. 532-552. <http://www.academicstar.us/UploadFile/Picture/2018-1/20181301259753.pdf>

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