INTEGRATED CLIMATE SCIENCES DIVISION

The Intersection of Blue Carbon and Natural Infrastructure in the Chesapeake Bay

Presentation to MAWWG

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Background: What is coastal natural infrastructure (NI)?

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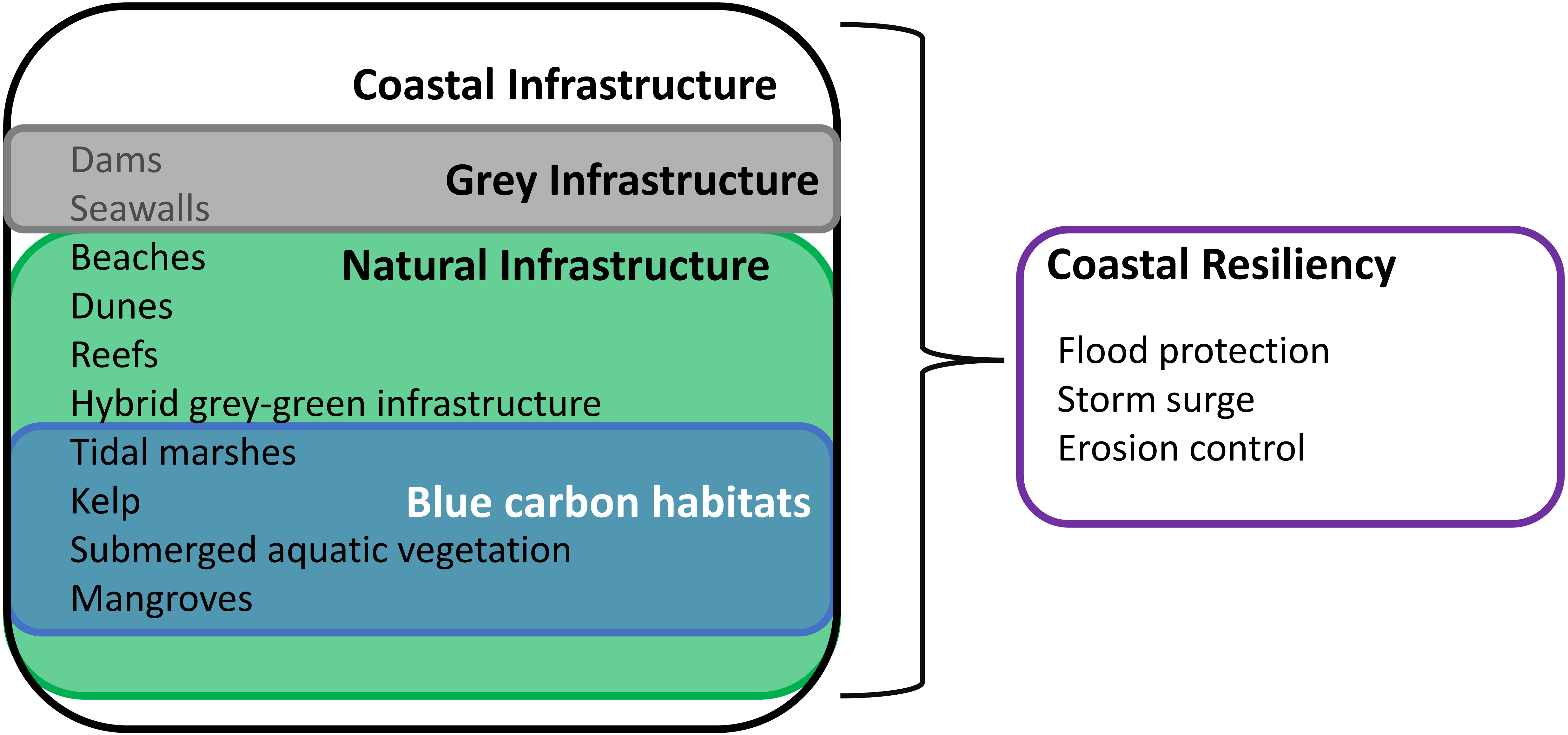
- Coastal NI enhances resilience to hazards
  - Flooding, erosion, wave energy
- Tidal marshes, submerged aquatic vegetation
  - Blue carbon ecosystems
- Living shorelines, hybrid “grey-green” infrastructure
- Climate adaptation + climate mitigation strategy

Intersection of Blue Carbon and Natural Infrastructure



Background: ROAR Project

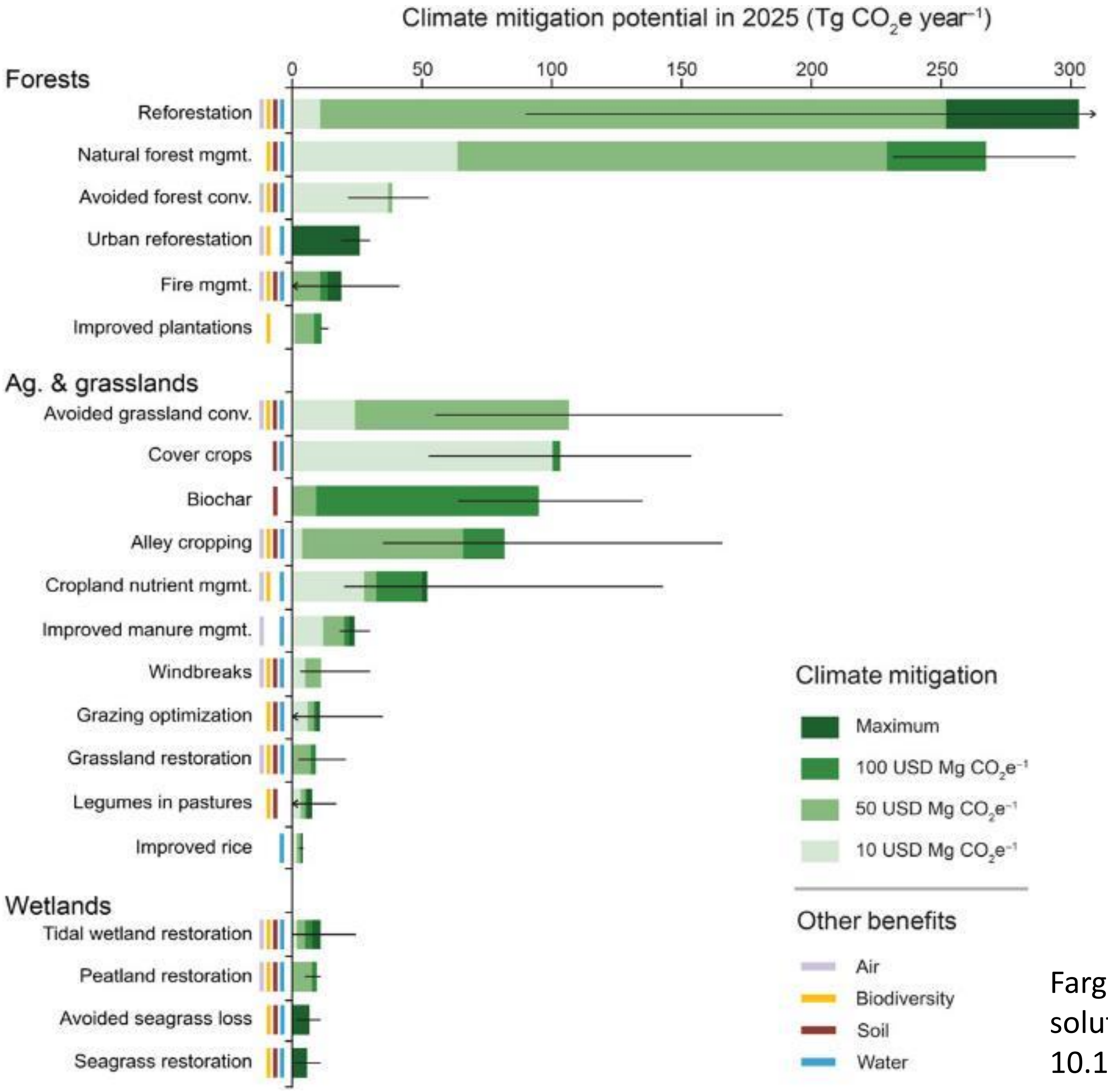
- Synthesize existing research to better understand the carbon sequestration potential of natural infrastructure
- Audience: those interested in NI for coastal resiliency
- Help decision-makers weigh NI options and consider blue carbon

Methods

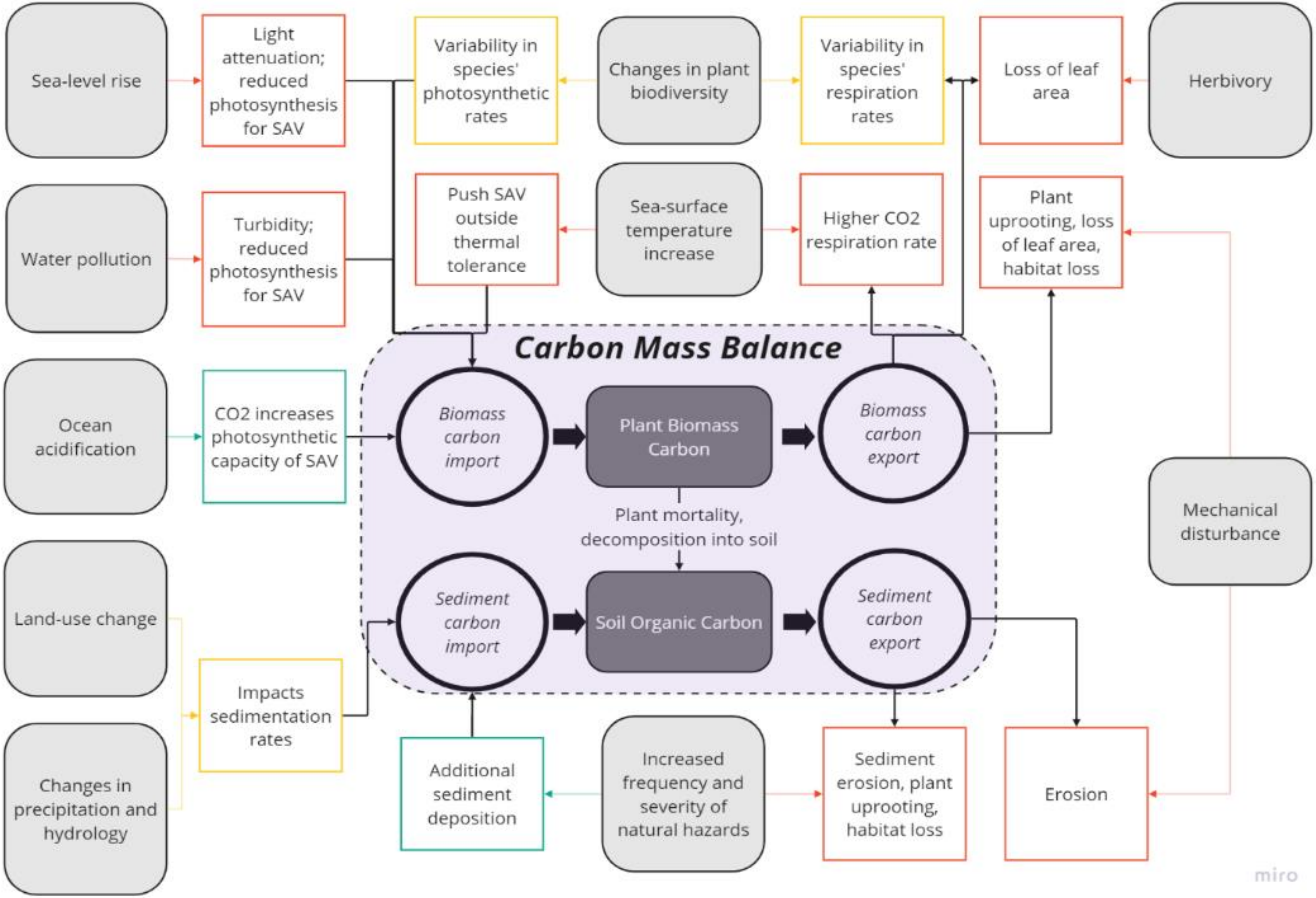
1. Literature review and synthesis
2. Advisory committee outreach and feedback
3. Database development

1. Literature review and synthesis

- Reviewed 200+ documents focusing on blue carbon (BC) and natural infrastructure (NI)
  - Scientific articles, government reports, presentations, workshop results, etc.
- Synthesis report summarizes the state of the science of BC and NI
  - Blue Carbon in context
  - Impact of climate and anthropogenic effects
  - Additional ecosystem services
  - Natural Infrastructure uses
  - Scientific needs, research gaps, uncertainties



Fargione et al. (2018) Natural climate solutions for the United States. *Sci. Adv*. 4, 10.1126/sciadv.aat1869


Sea-level rise
Light attenuation; reduced photosynthesis for SAV
Variability in species' photosynthetic rates
Changes in plant biodiversity
Variability in species' respiration rates
Loss of leaf area
Herbivory
Water pollution
Turbidity; reduced photosynthesis for SAV
Push SAV outside thermal tolerance
Sea-surface temperature increase
Higher CO2 respiration rate
Plant uprooting, loss of leaf area, habitat loss
Carbon Mass Balance
Ocean acidification
CO2 increases photosynthetic capacity of SAV
Biomass carbon import
Plant Biomass Carbon
Biomass carbon export
Plant mortality, decomposition into soil
Mechanical disturbance
Land-use change
Sediment carbon import
Soil Organic Carbon
Sediment carbon export
Impacts sedimentation rates
Changes in precipitation and hydrology
Additional sediment deposition
Increased frequency and severity of natural hazards
Sediment erosion, plant uprooting, habitat loss
Erosion
miro

Research needs identified

- Better mapping capabilities
  - Remote sensing; increased frequency and higher resolution
- Carbon fluxes (import + export)
- Difficulty measuring GHG fluxes (CH_4, N_2O)
- Land-use change with sea-level rise

1. Literature review and synthesis

- Applied section:
  - Discussion of considerations needed to incorporate BC into NI
  - Descriptions of data, models, mapping tools

2) NOAA Sea-level rise Global and Regional Scenarios
   a) NOAA compiled national and regional datasets of sea level rise scenarios through 2150 that are useful for habitat projections in coastal ecosystems, including salt marshes and seagrass habitats.
3) Virginia Institute of Marine Science SAV Surveys
   a) Distribution of submerged aquatic vegetation (SAV) in Chesapeake Bay, mapped using aerial multispectral digital imagery and satellite imagery. Relatively high resolution for SAV.
4) Wetland Habitats and SLR Maps by Katie Warnell and Lydia Olander
   a) Katie Warnell and Lydia Olander from Duke University have developed Dataset/project that maps blue carbon habitat in Maryland and Virginia and predicts how SLR will alter those habitats.
5) USGS Unvegetated to Vegetated Ratio Maps for Salt Marshes
   a) USGS developed datasets of the Unvegetated to Vegetated Ratio (UVVR) of the U.S. coastal wetlands computed from Landsat data (2014 - 2018). These datasets provide annual averages at 30-meter resolution over the contiguous U.S. Research has shown that the UVVR can act as proxy indicators of microtidal marsh vulnerability.
6) National Estuarine Research Reserve System Datasets
   a) The National Estuarine Research Reserve System is a network of 30 sites protected for long-term research, ecosystem monitoring, education, and coastal stewardship. 2 of the 30 sites are in the Chesapeake Bay region (MD and VA Chesapeake Bay Reserves). The dataset contains standardized, quantitative measures of abiotic indicators of water quality and weather, biological monitoring, and watershed, habitat, and land use mapping.

2. Advisory committee outreach

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CENTER FOR PUBLIC HEALTH & ENVIRONMENTAL ASSESSMENT

- Developed list of 12 advisory committee members to review document
- Comprised of governmental, nongovernmental, and academic institutions

Advisory Committee Organizations

Maryland Department of Natural Resources	Maryland Department of the Environment	US Environmental Protection Agency	Virginia Institute of Marine Science
Old Dominion University	University of Maryland Center for Environmental Science	NOAA	The Conservation Fund

Advisory Committee Expertise

- Blue Carbon accounting
- Natural Climate Solutions
- Remote sensing
- Tidal marsh ecology and mapping
- Seagrass and SAV ecology
- Living shorelines and natural infrastructure
- Chesapeake Bay community conservation
- Climate adaptation and resiliency

3. Database Development

- Collating data to produce database:
  - Carbon stock, flux, GIS layers
  - Standardizing across different methods
  - Chesapeake Bay focused, but latitudinal approach
- End goal: link applied section of synthesis report to relevant data in database
  - Direct users to relevant data needed for their specific project

QUANTITATIVE DATA	Area (sq.Km)	Area of the region associated with the blue carbon stock or flux
	Minimum area (sq.Km)	
	Maximum area (sq.Km)	
	Accretion rate (mm/yr)	Rate of sediment accretion (positve) or erosion (negative)
	Minimum accretion (mm/yr)	
	Maximum accretion (mm/yr)	
	Carbon density (MgC/ha)	Areal density of carbon stored per unit area of ecosystem
	Minimum carbon density (MgC/ha)	
	Maximum carbon density (MgC/ha)	
	SOC (%)	Soil organic carbon fraction
	Minimum SOC (%)	
	Maximum SOC (%)	
	Total carbon stock (PgC)	Total amount of carbon estimated within the ecosystem
	Minimum total carbon stock (PgC)	
	Maximum total carbon stock (PgC)	
	Aboveground carbon stock (PgC)	Total carbon stored above ground
	Minimum aboveground carbon stock (PgC)	
	Maximum aboveground carbon stock (PgC)	
	Belowground (<1m) carbon stock (PgC)	Total carbon stored in the near-surface under ground
	Minimum belowground (<1m) carbon stock (PgC)	
	Maximum belowground (<1m) carbon stock (PgC)	
	Belowground (1-2m) carbon stock (PgC)	Total carbon stored in the deep under ground
	Minimum belowground (1-2m) carbon stock (PgC)	
	Maximum belowground (1-2m) carbon stock (PgC)	
	Carbon burial flux (g/m2/yr)	Rate of carbon sequestration into the ground
	Minimum carbon burial flux (g/m2/yr)	
	Maximum carbon burial flux (g/m2/yr)	
	Carbon total emission flux (g/m2/yr)	Rate of carbon emission into the atmosphere
	Minimum carbon total emission flux (g/m2/yr)	
	Maximum carbon total emission flux (g/m2/yr)	
	Carbon belowground emission flux (g/m2/yr)	Rate of carbon emission into the atmosphere from below ground stores
	Minimum carbon belowground emission flux (g/m2/yr)	

ID	Resource Type	Title	Author(s)/Relevant People Involved	Date/Year	Journal/Organization	DOI	Link to Online page/Supplementary Information/Data	Reviewer name	Methods Summary	Methodology Keywords	Approach	Research Summary/Main Finding Relevance
5a	Research Article	Dynamics of carbon sequestration in a coastal wetland using radiocarbon measurements	Yonghoon Choi, Yang Wang	2004	Global Biogeochemical Cycles	10.1029/2004GB002261	https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2004GB002261	VKS	Estimated the long-term and short-term rates of C accumulation, using C and C isotopic measurements of peat cores collected along a soil chronosequence, in a coastal wetland in north Florida. Sampled soil cores and assessed radioactive decay	soil carbon; peat; soil cores	Sampling	Recent, shorter term rates of C a in the peatlands is higher than th rates, likely due to increased pri production from sea level rise ar change over the last century. Spe this area in Florida, salt marshes a strong carbon sink both now an potential for carbon sequestratic climate warms.
5b	Research Article	Dynamics of carbon sequestration in a coastal wetland using radiocarbon measurements	Yonghoon Choi, Yang Wang	2004	Global Biogeochemical Cycles	10.1029/2004GB002261	https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2004GB002261	VKS	Estimated the long-term and short-term rates of C accumulation, using C and C isotopic measurements of peat cores collected along a soil chronosequence, in a coastal wetland in north Florida. Sampled soil cores and assessed radioactive decay	soil carbon; peat; soil cores	Sampling	Recent, shorter term rates of C a in the peatlands is higher than th rates, likely due to increased pri production from sea level rise ar change over the last century. Spe this area in Florida, salt marshes a strong carbon sink both now an potential for carbon sequestratic climate warms.
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6a	Research Article	Vegetation and hydrology stratification as proxies to estimate methane emission from tidal marshes	R. Kyle Derby, Brian A. Needelman, Ana A. Roden, J. Patrick Megonigal	2021	Biogeochemistry	10.1007/s10533-021-00870-z	https://link.springer.com/article/10.1007/s10533-021-00870-z	VKS	Sampled 4 different strata of varying plant composition and elevation; measured CH_4 fluxes and collected field data on water level, soil	methane; wetlands; soil cores	Sampling	Aimed to assess the potential of species composition and hydrolo proxies for CH_4 emissions in brac marshes. Found that CH_4 emissio plant community type and hydro

Database basic overview

- Data pulled from 4 different databases (CCRCN, NGGI, SAVCB, DUBC)
- Data pulled from 130 published/unpublished datasets
- Total carbon stock measurements: 272
- Number of studies in Chesapeake boundary: 26 inside, 104 outside
- Aboveground biomass measurements: 232
- Belowground biomass measurements: 131

Future Directions for this Project

- Modeling the blue carbon consequences of several natural infrastructure solutions, both direct and indirect
- Supplement additional modeling efforts (seagrass suitability)

Acknowledgements/Relevant contacts

- R3-ORD ROAR Team:
  - Roxolana Kashuba (Kashuba.Roxolana@epa.gov)
  - Steve Pacella (Pacella.Stephen@epa.gov)
  - Bill Jenkins (Jenkins.Bill@epa.gov)
- Advisory committee members
- Questions?
- Dhond.Alexander@epa.gov