Chesapeake Bay Program
Science. Restoration. Partnership.

Adapting to Changing Environmental Conditions Outcome

Julia Fucci (CRC) and Julie Reichert-Nguyen (NOAA)

Climate Resiliency Workgroup

Science support group for outcomes under the climate resiliency goal in the 2014 Chesapeake Bay Watershed Agreement

Adapting to Changing Environmental Conditions Outcome (accepted language)

Increase the capacity for pursuing nature-based solutions to improve planning and response to changing conditions while balancing long-term resiliency of watershed communities, economies, and ecosystems.

Outcome Targets

By 2040, workgroup activities will inform and lead to an increase in the implementation of adaptation strategies that integrate nature-based solutions in [seven identified] subwatershed areas.

By 2040, at least seven subwatershed areas have benefited from knowledge-sharing and technical assistance to identify adaptation options with nature-based solutions. These solutions include restoration and protection projects that will help address risks to people, infrastructure, and habitats from changes in temperature, precipitation, and landscapes.

Outcome Science Needs

- **Improve knowledge of nature-based solutions**
  - Better understanding of the resilience effectiveness of natural infrastructure (e.g., living shorelines, marshes, forest buffers, oyster reefs) strategies to maintain/enhance ecosystem services to climate change impacts
- **Need for methods and products that quantify resilience benefits of nature based solutions**
  - Such a product would inform selection of adaptation strategies for new outcome
- **Climate resiliency workgroup supporting STAC synthesis project on nature-based solutions by ODU and Tetra Tech**

June 17, 2025

Nature-based solutions and natural capital accounting in Chesapeake Bay

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&
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INSTITUTE FOR COASTAL ADAPTATION & RESILIENCE

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TETRA TECH
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Roadmap

- Background on nature and nature-based solutions
- Outline of projects and fundamental ideas
- What has been done to date

Background

Evaluating the Performance of Nature-Based Coastal Protection Solutions for Natural Capital Accounting

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Degradation of coastal ecosystems

- Coastal ecosystems are degrading at an accelerated pace due to various stressors
- Loss of essential services such as shoreline protection, fisheries support, and tourism jobs
- Profound impacts on people and economies

NNBS (Nature and Nature-Based Solutions)

…”Strategies that utilize natural coastal ecosystems like dunes, wetlands, and oyster reefs to protect coastlines from erosion, flooding, and other hazards, while also providing ecological and social benefits”

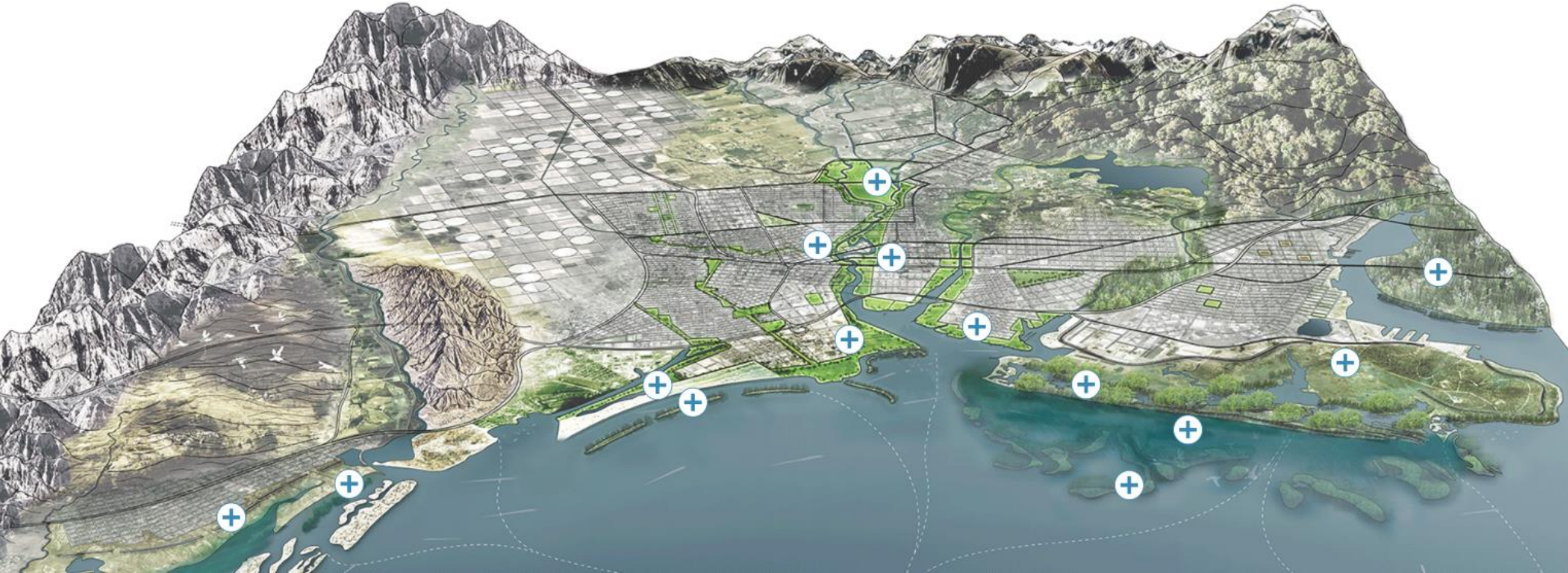
Oyster reefs

Living shoreline

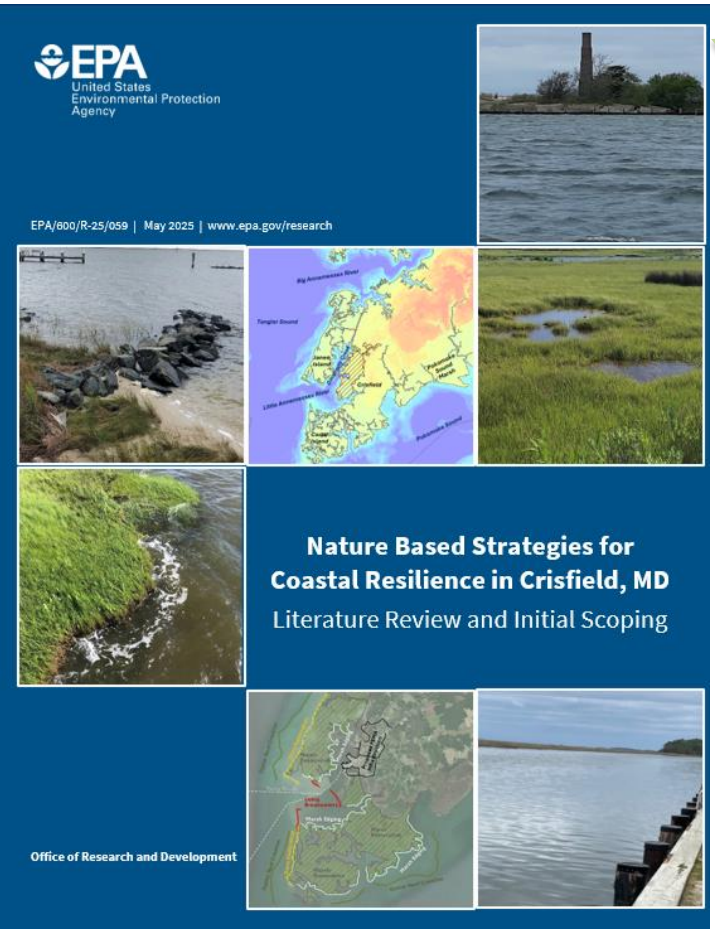
Marsh restoration

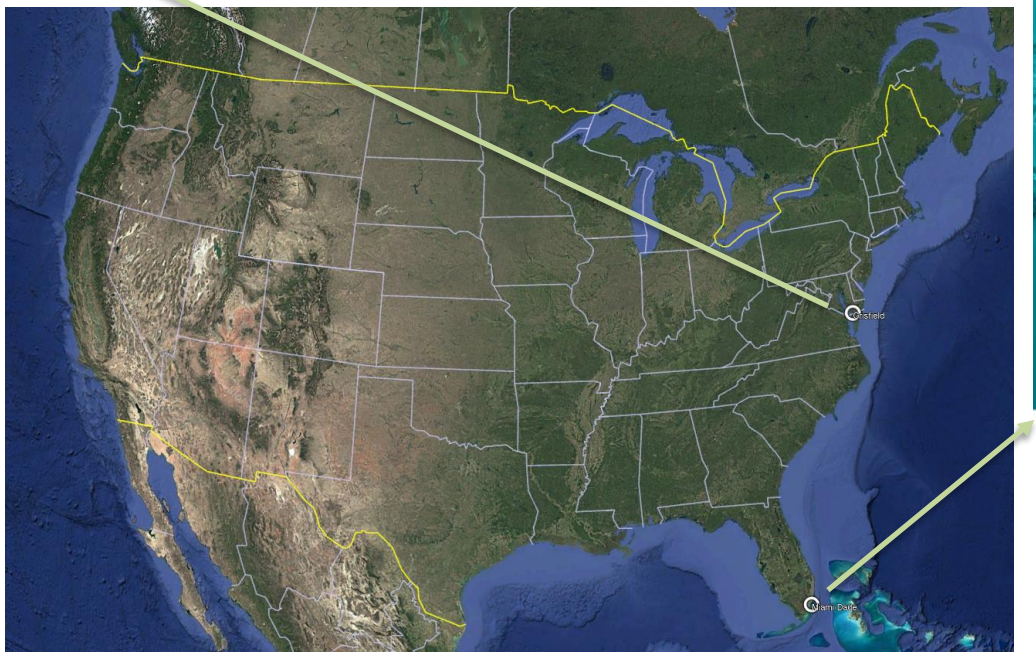
NNBSs Can Be Anywhere

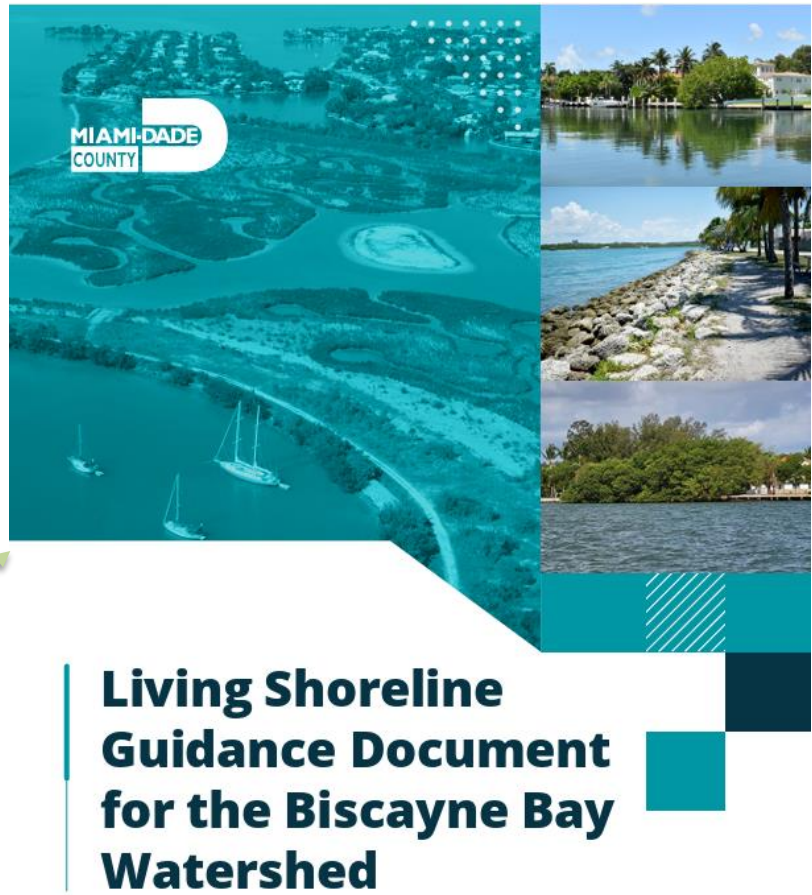
Naturally Resilient Communities
https://nrcsolutions.org/



More Local







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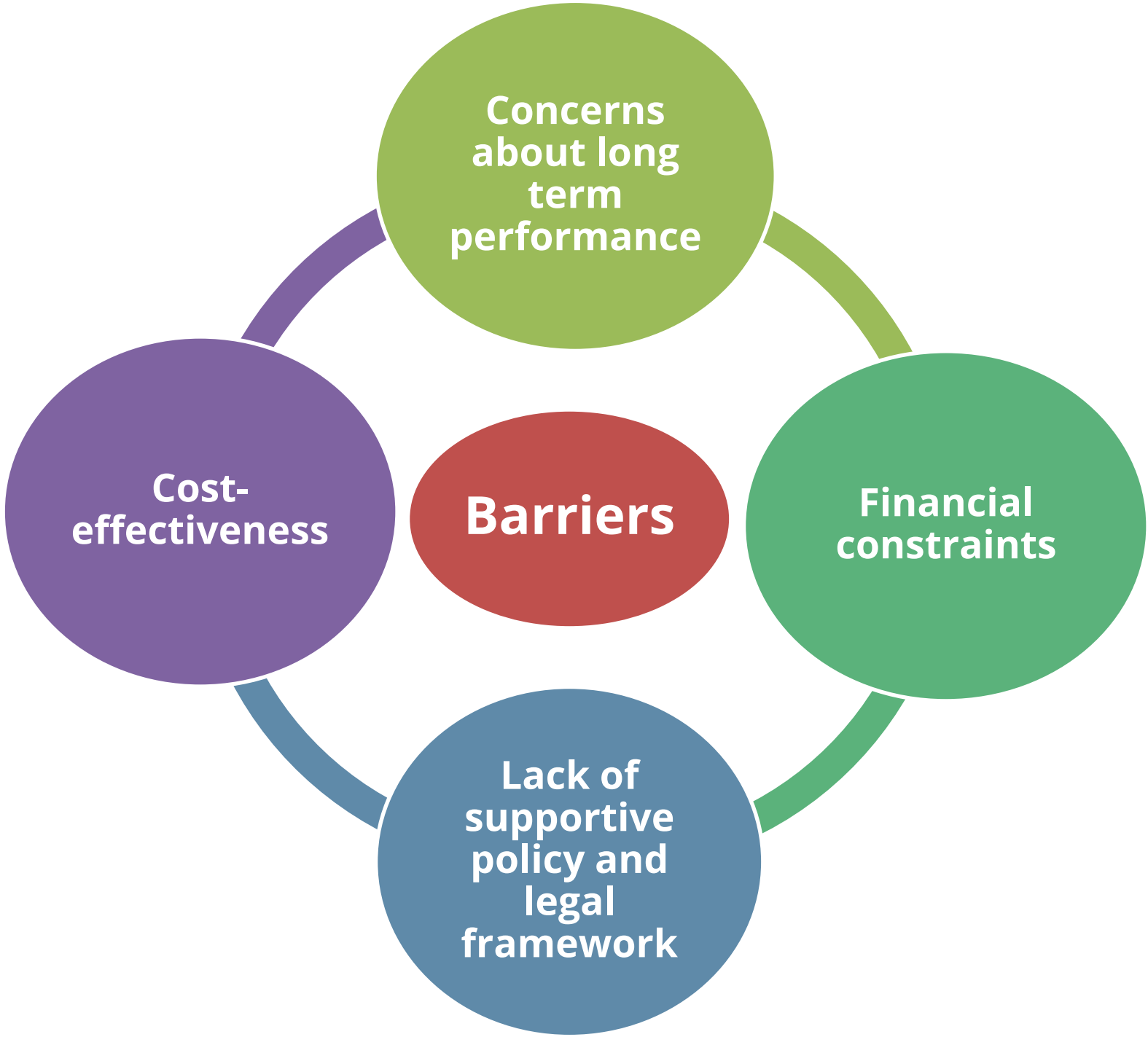
Barriers to NNBSs

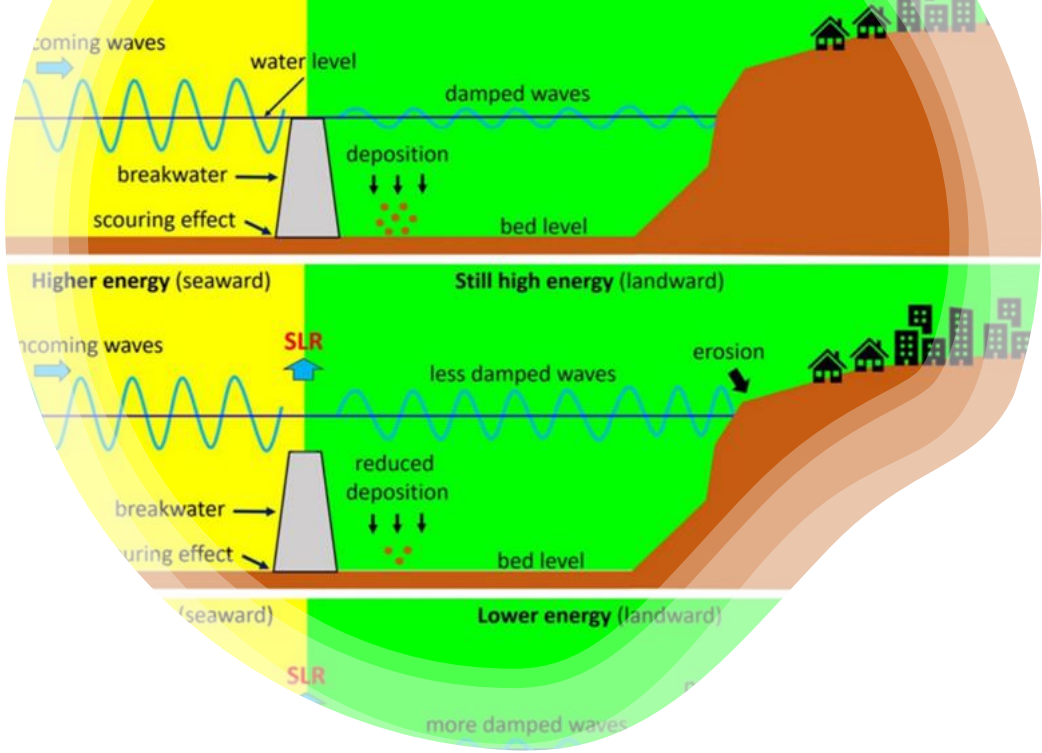
"Living shoreline still aren't used very widely because few landowners and marine contractor know about them, […], and regulators are more comfortable writing permits for bulkheads." – Malijenovsky 2014 (CoastalReview)

"There's a lot of things you have to look at; and so the challenge is creating a one-size-fits-all general permit that will allow something to go in numerous small properties across the state and not result in any unanticipated result" – Davis, NC DCM



Why this project?

CBP Climate Science Need: Better understanding of the resilience effectiveness of natural infrastructure (e.g., living shorelines, marshes, forest buffers, oyster reefs) strategies to maintain/enhance ecosystem services to climate change impacts.



- What works?
- Why does it work?
- What are the data gaps?
- How can solution benefits be valued?

Definitions

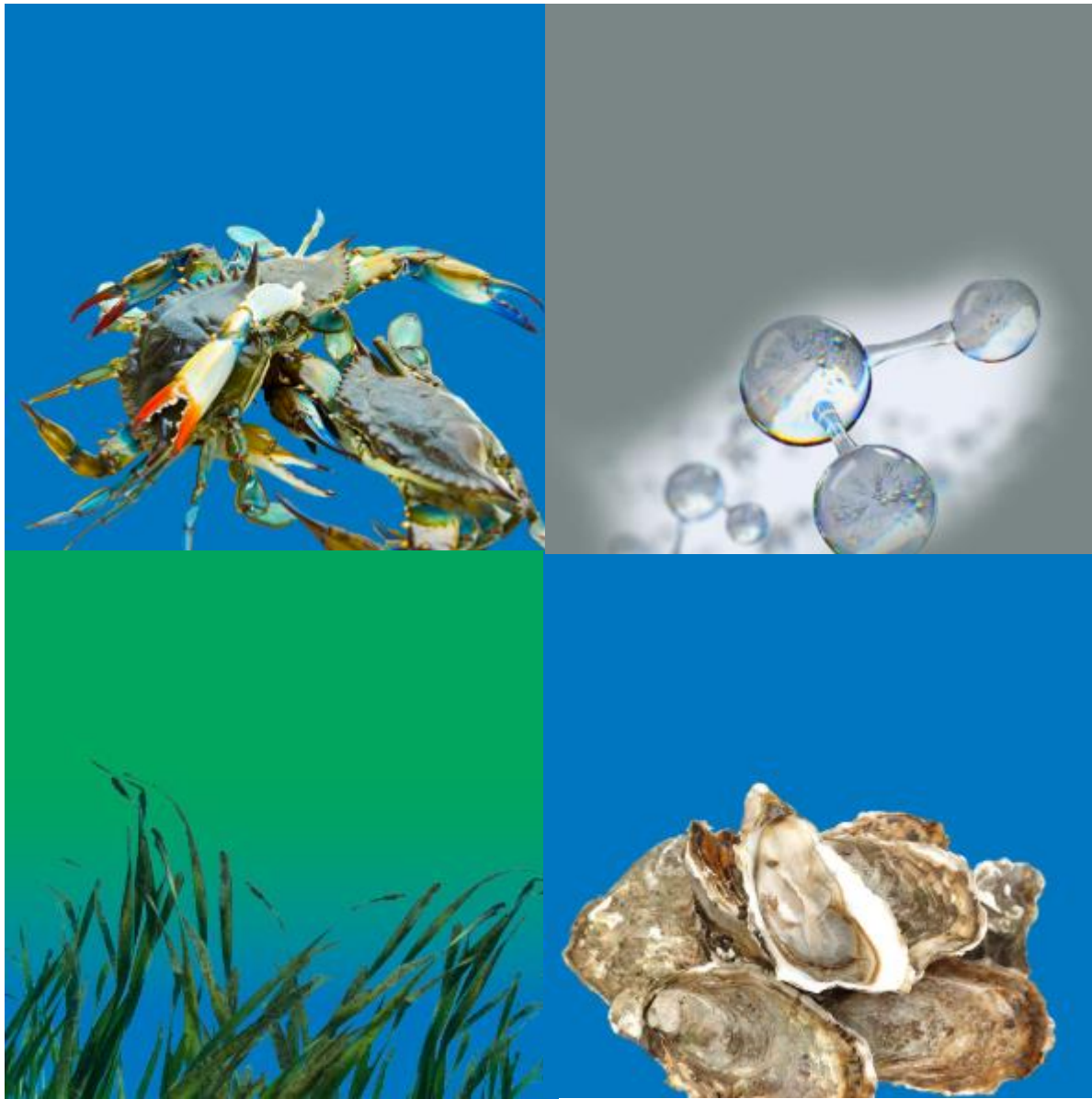
Indicators are direct quantities that can be measured - such as the abundance of a specific species that encodes information about the health of the ecosystem.

Performance metrics are linked to engineering outcomes, such as wave energy reduction, erosion control, water quality improvement, and similar outcomes.

Metrics can be any broadly defined quantity - a composite variable, a dimensionless term, a single variable, or even a sentiment that is defined in relation to one or more specific questions. Metrics can encompass indicators and performance indicators.

Key Performance Indicators (KPIs) Management-related metrics

Key Result Areas (KRAs) associated with specific project goals



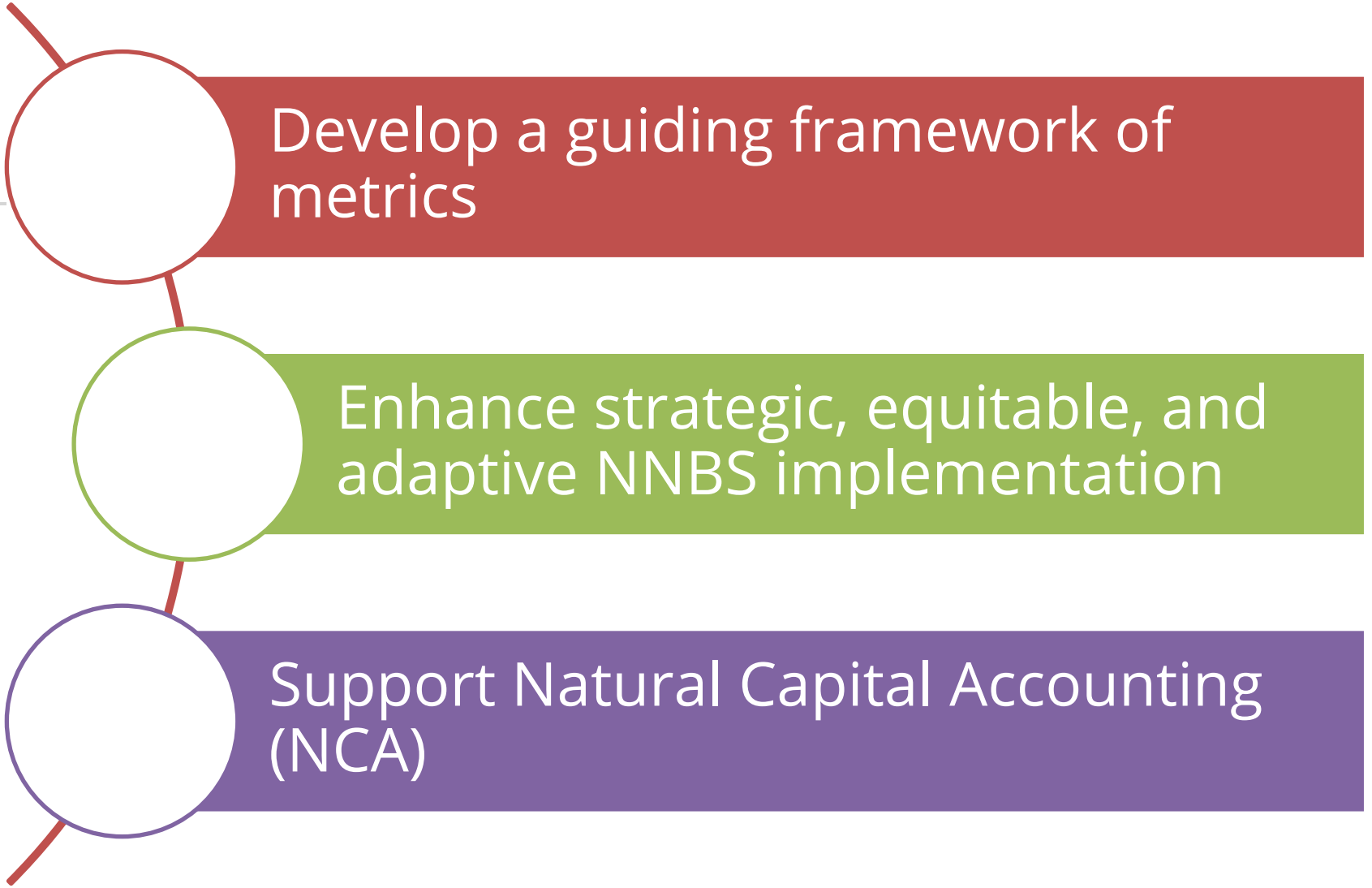
STAC Recommendations on Types of Matrics

Metrics to address:

- Monitoring, evaluation, and management
- How is the project performing against its goals and objectives
- Is the project incorporating natural elements and addressing local needs
- Value-added co-benefits
- Are there specific biological indicators that evaluate restoration success
- Is there a good understanding on how and why a project works
- How much awareness is being created through community engagement and outreach
- Design performance evaluation

Evaluating the Performance of Nature-Based Coastal Protection Solutions for Natural Capital Accounting

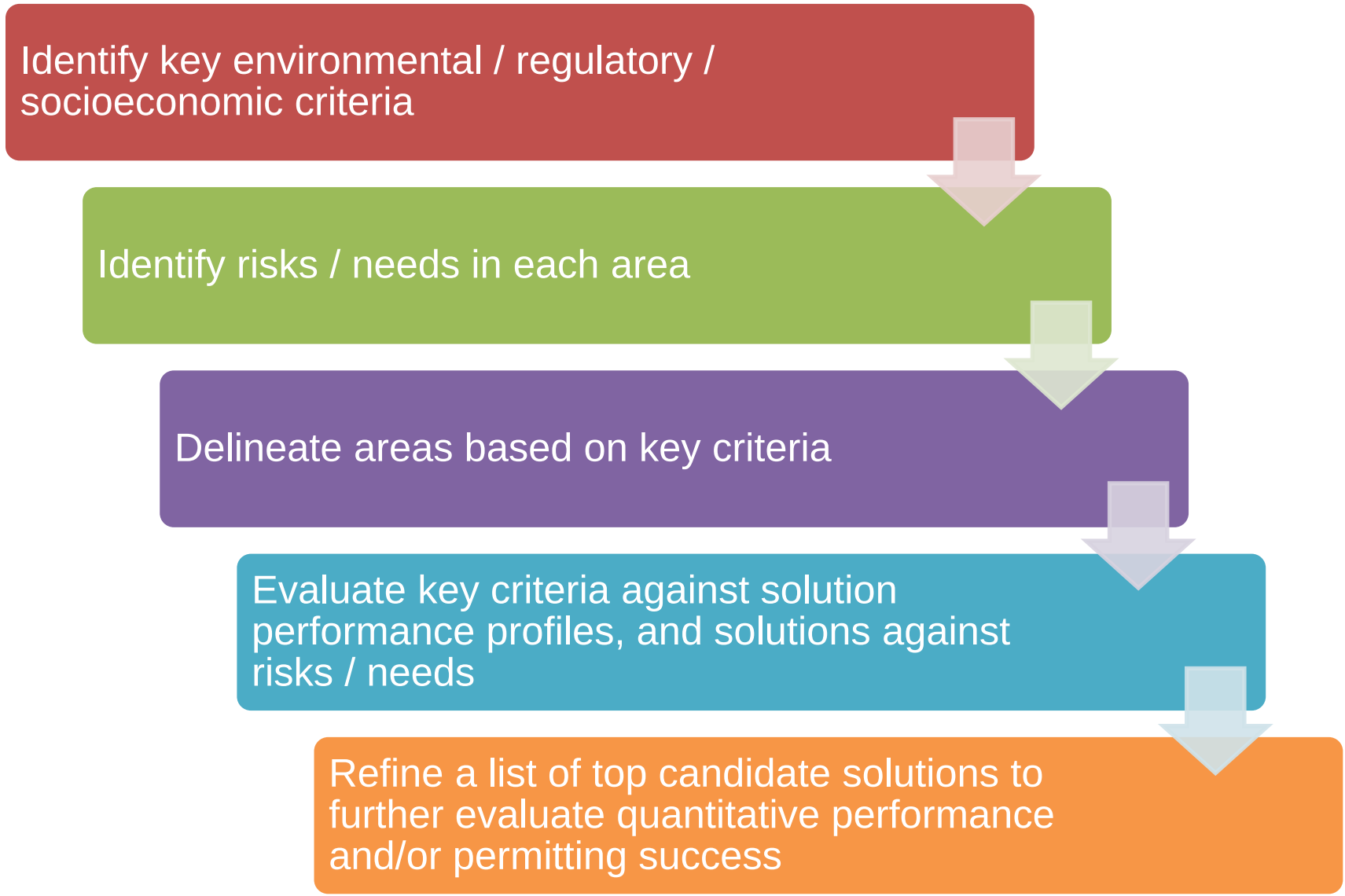
Project Goals



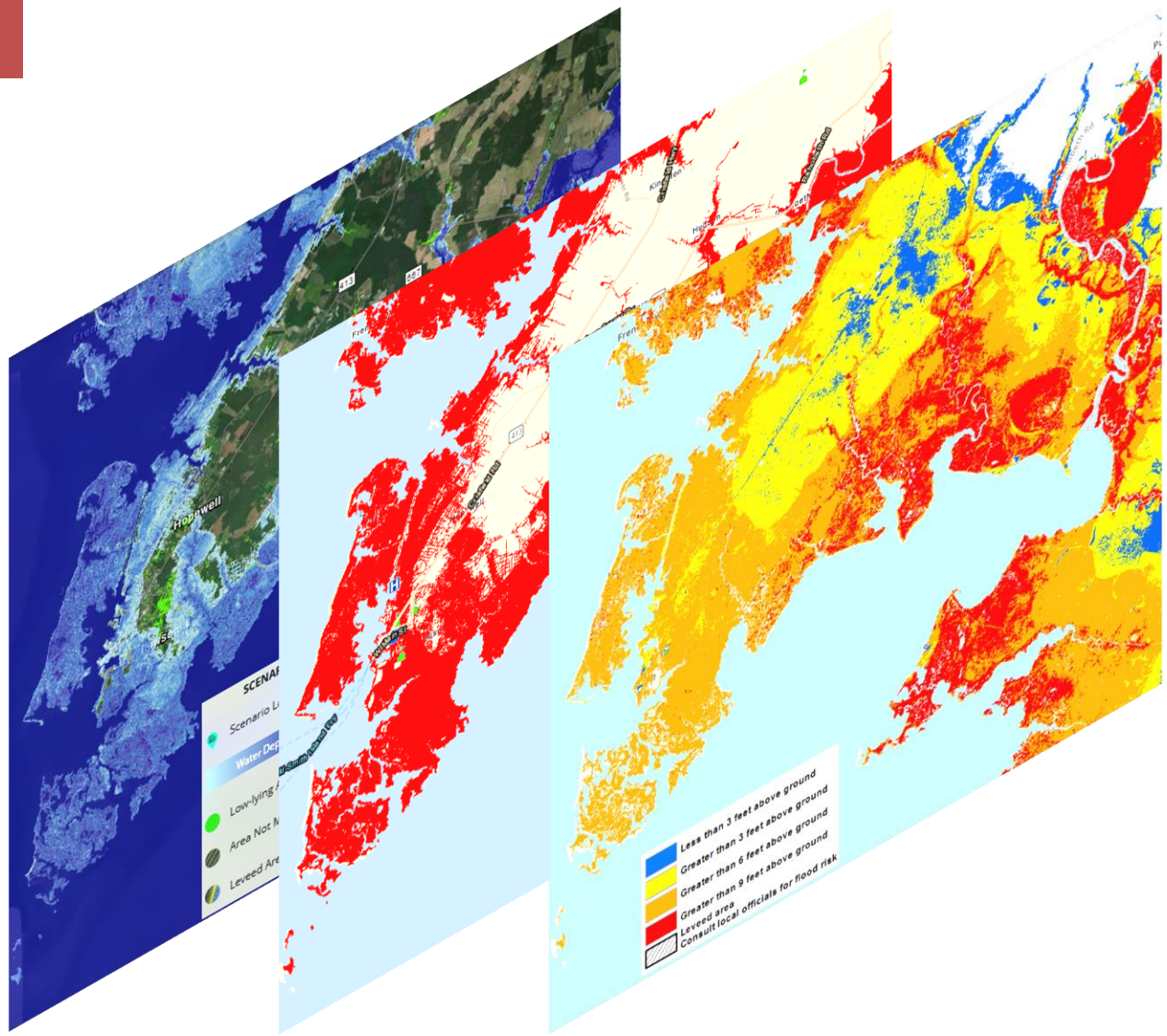
Need for a unified, standardized evaluation framework

- Metrics are difficult to develop and standardize without good post-implementation data
- Multitude of methods leads to a “paradox of choice”
- Need to better understand what qualitative and quantitative metrics of NNBS can be used in decision making
- Need for intercomparison data of NNBSs in different settings

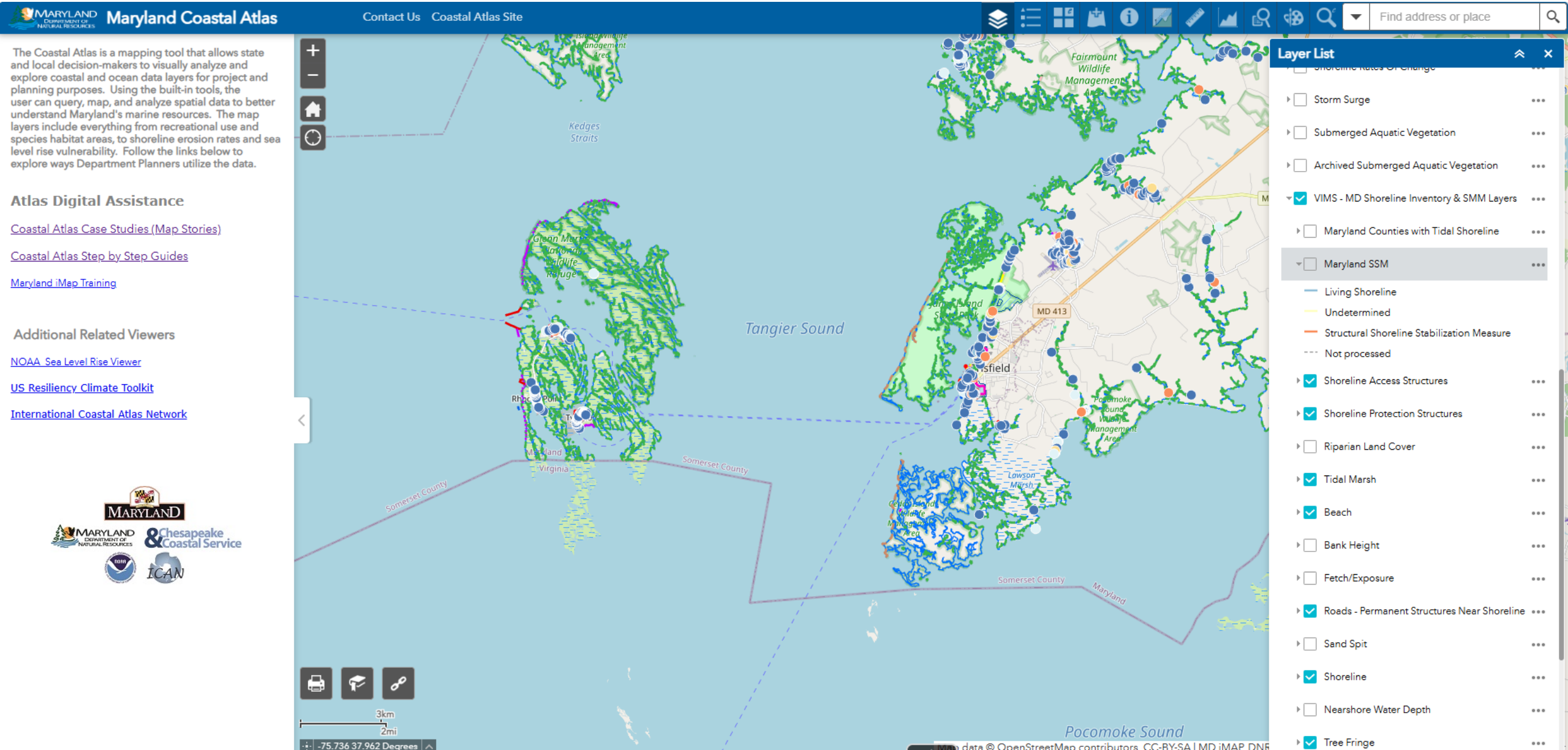
Why Do We Need a Framework of Performance Indicators?



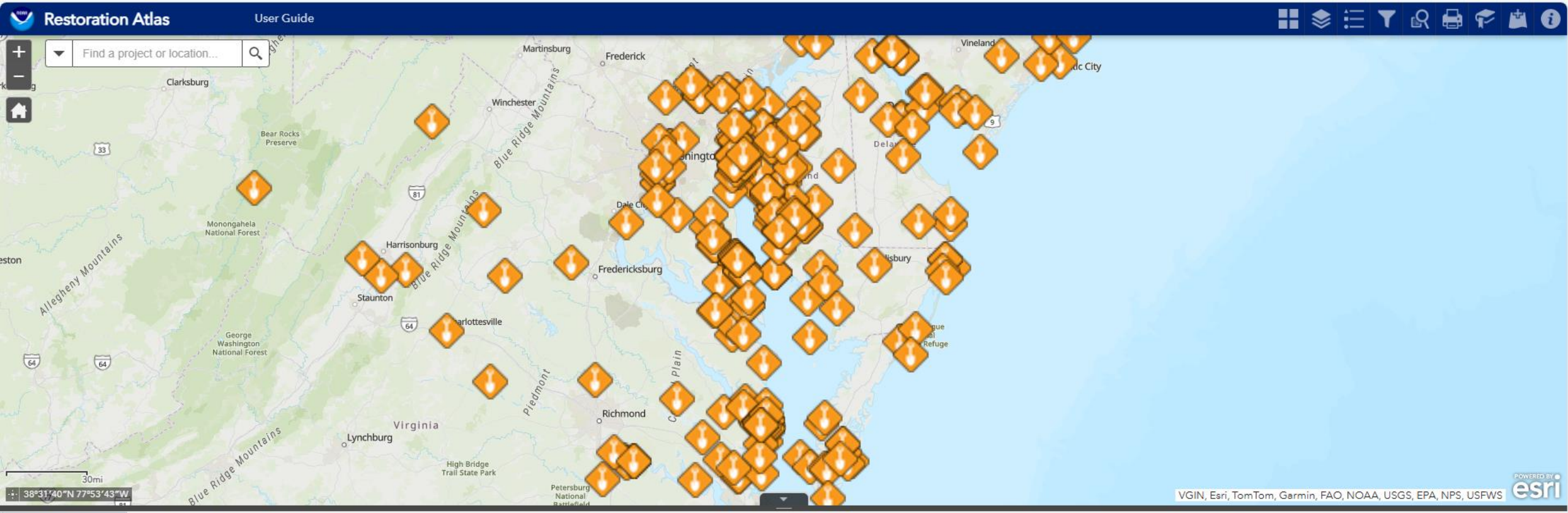
Many types of risks and many types of solutions



Strategic, Equitable, and Adaptive NNBSs



How NNBS Can Provide Multiple Benefits Regionally



NOAA Restoration Project

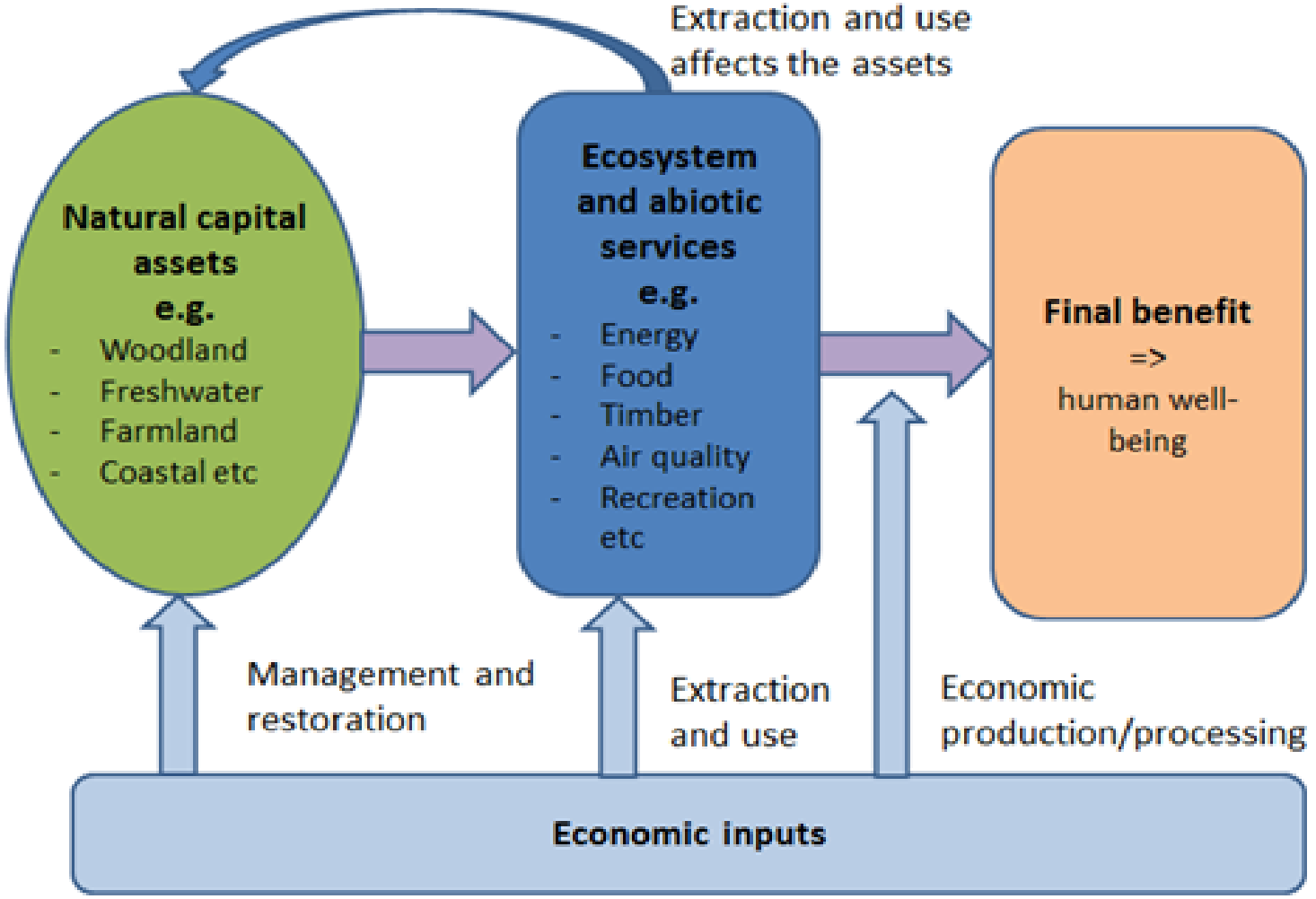
Options | Filter by map extent | Zoom to | Clear selection | Refresh

Name	Project Status	NOAA Program	DARRP ID	DARRP Case Name	Latitude	Longitude	Habitats	Species Benefited
Tampa Bay Oil Spill - Boca Ciega Bay (Cross Bayou Mangrove Restoration)	Complete	DARRP	5,141	Tampa Bay Oil Spill	27.84	-82.76	mangrove	(Buttonwood), (Cordgrass, smooth), (Mangrove, black), (Mangrove, red), (Mangrove, white)
East Timbalier Island Restoration Project (Phase 1)	Complete	CWPPRA			29.07	-90.33	dune, tidal wetland	(Cordgrass, marshhay), (Cordgrass, smooth), (Saltgrass, seashore)
Fort McHenry Wetlands Restoration	Complete	Community-based Restoration			39.26	-76.58	tidal wetland	(Alder, white), (Alkaligrass), (Bass, striped), (Cordgrass, big), (Cordgrass, smooth), (Osprey), (Pondweed, horned), (Three-square, olney)

3629 features 0 selected

What is Natural Capital Accounting (NCA)?

- A standardized method for tracking and valuing natural assets
- Helps quantify how changes in ecosystems impact our well-being and economy
- Supports data-driven decision-making for resource management



Introduction to the System of Environmental and Economic Accounting (SEEA)

1 Ecosystem Extent

The model start by identifying a natural asset, i.e., marshes, that can be measure by its changes in extent.

2 Ecosystem Condition

Identify the condition of natural asset (marshes) in terms selected characteristics.

3 Ecosystem Services

Record the supply of ecosystem services and the use of those services by economic units, including local communities and business

4 Monetary Account

Model stocks growth and changes in stocks of natural assets

The Need for Natural Capital Accounting

Support local communities and businesses in understanding their dependencies on natural assets

Quantify how impacts on nature relate to monetary investments

Support nature-based adaptation strategies

Support private sector to identify and manage nature-related risks, turning them into opportunities

Why NCA Matters for Chesapeake Bay

- Coastal populations rely on the ecosystem services and benefits provided by coastal ecosystems
  - flood protection, water filtration, biodiversity, and tourism opportunities.
- Habitat degradation and biodiversity affect ecosystem service provision
- NCA can inform how to manage these assets while balancing economic growth and ecological trade-offs.
- Promote a financial governance to support nature-based adaptation

Contribution to STAC mission

- Building on existing research, tools, data, and methods to address gaps in the assessment and monitoring of NNBS.
- Practical guide for local communities, equipping policymakers and coastal zone managers with evidence-based tools to make informed decisions.
- Enhance resilient adaptation strategies in Chesapeake Bay, maximizing economic and environmental benefits of future NNBS projects.

Objective 1: Synthesis of Tools & Data

Task 1

- Systematic review of:
  - Chesapeake Bay modeling tools
  - Literature & existing metrics
  - Partner datasets
  - Creation of NNBS classification matrix
- Quantitative data (water quality, wave energy, marsh elevation, sediment accretion)
- Qualitative data (aerial imagery, habitat connectivity, field evaluation and community feedback)

Expected Outcome

- Develop a comprehensive matrix to categorize:
  - geographical areas
  - environmental conditions
  - NNBS types
  - monitored variables
- Highlight the interdependencies between community-economic, biophysical-ecological, and technological-engineered systems

Objective 2: Identification of Gaps in aiding NCA

Task 2

- Identify Gaps based on data from Task 1
  - Assessment of Geographical & environmental gaps
  - Types of NNBS and variables monitored
  - Community participation and benefit distribution
- Inform Natural Capital Accounting

Expected Outcome

- Workshop with stakeholders including (landowners, municipalities, nonprofits, academics and coastal zone managers)
- Tailor the metrics to meet community and environmental needs, ensuring that the metrics resonate with various participant perspectives and objectives.

Objective 3: Development of NCA

Task 3

- Literature-informed, coastal zone community-guided framework to integrate the identified metrics into the ongoing NCA project for the Chesapeake Bay
- Propose a comprehensive post-implementation monitoring approach for future NNBS projects

Expected Outcome

- Step-by-step guidebook and flowchart with a general protocol to quantify the effectiveness of coastal NNBS based on available data and tools
- Final workshop
- National Conferences
- Scientific publications

Expected Outcomes and Broader Impacts

Expected Outcomes

- Standardized metrics framework
- Integration with NCA in Chesapeake Bay
- Increased adoption of NNBS
- Peer-reviewed publications and national presentation venues

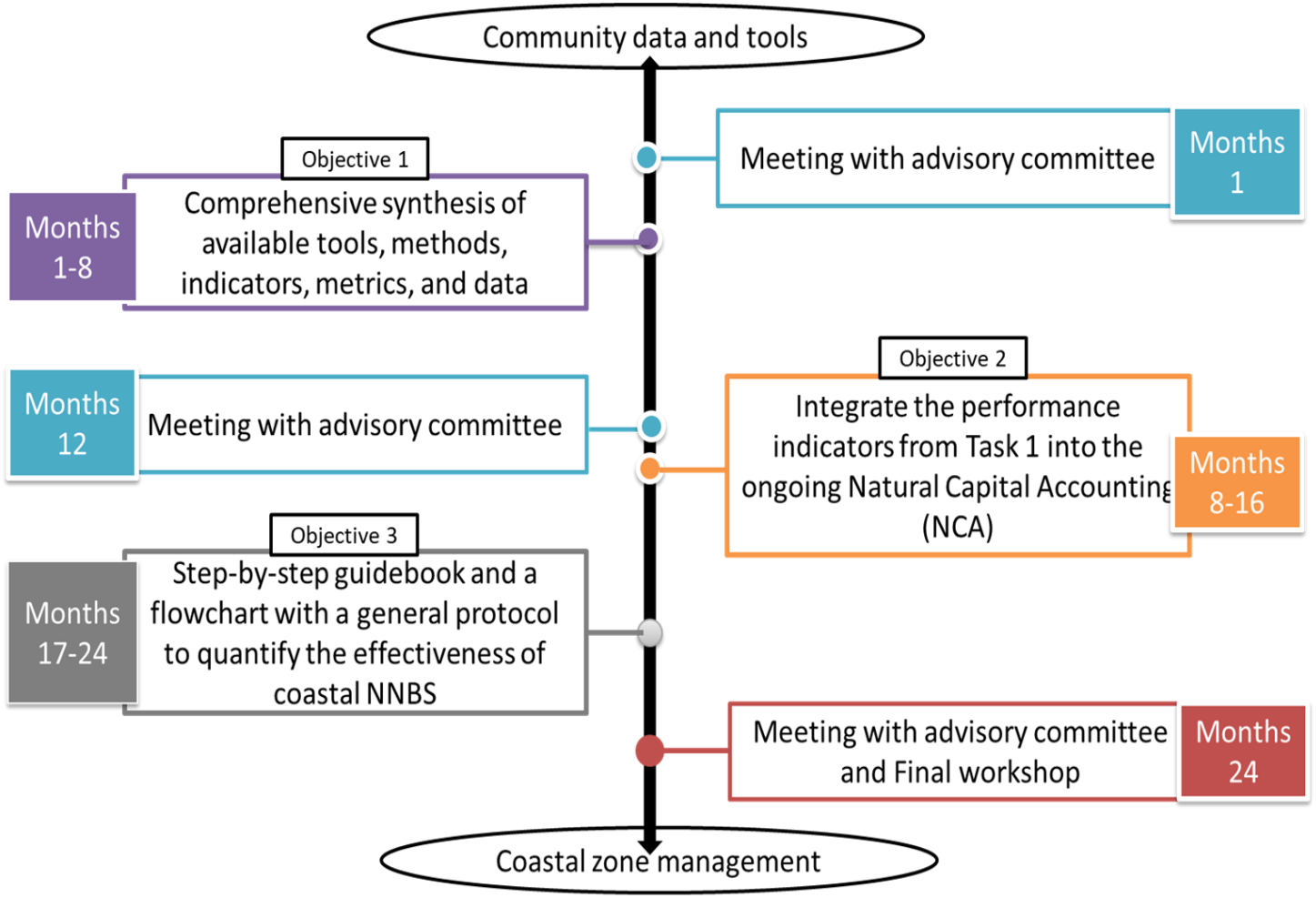
Broader Impacts

- Benefits to policymakers and coastal managers
- Student hybrid academia-industry experience
- Transferable model beyond Chesapeake Bay

Progress To Date

Technical Advisory Board

- Diverse advisory committee includes experts from federal, local, academic, and defense sectors (e.g., NMFS, USGS, City of Norfolk, Navy, VIMS, UMCES).
- Committee provides input at key stages: framework design, mid-project peer review, and final results dissemination.



Graduate Student

- Review and synthesize metrics and monitoring tools for NNBS effectiveness.
- Build a comprehensive database of NNBS performance indicators and benefits.
- Create a matrix linking environmental conditions, design, and outcomes; identify knowledge gaps.
- Support development of a metrics framework integrated with Natural Capital Accounting.
- Explore AI and network models to visualize NNBS benefit pathways.
- Engage with stakeholders through workshops and interviews.
- Assist in producing scientific outputs and policy-relevant deliverables.

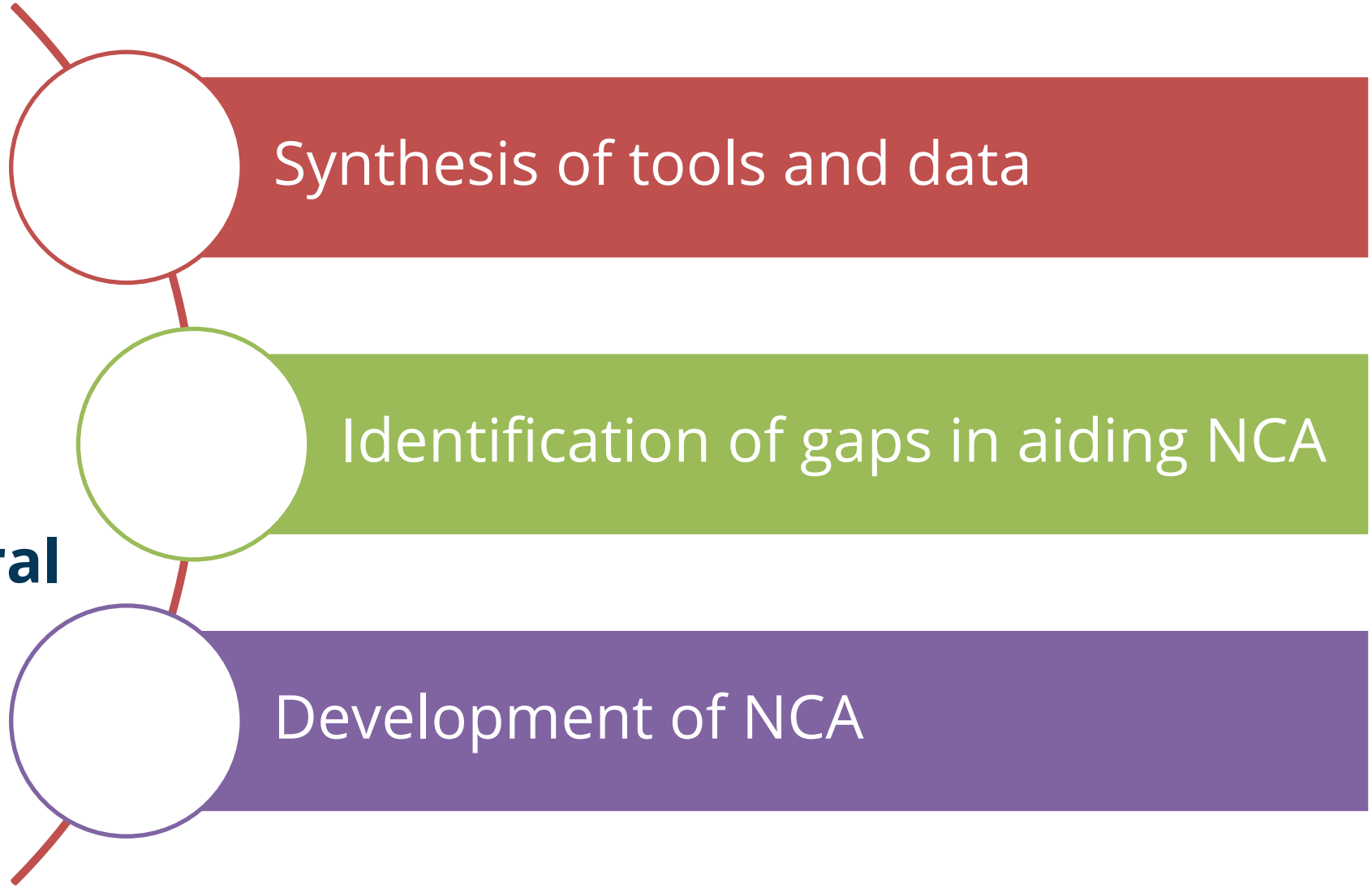
Conclusions: Goals

Evaluating the Performance of Nature-Based Coastal Protection Solutions for Natural Capital Accounting

- Develop a guiding framework of metrics
- Enhance strategic, equitable, and adaptive NNBS implementation
- Support Natural Capital Accounting (NCA)

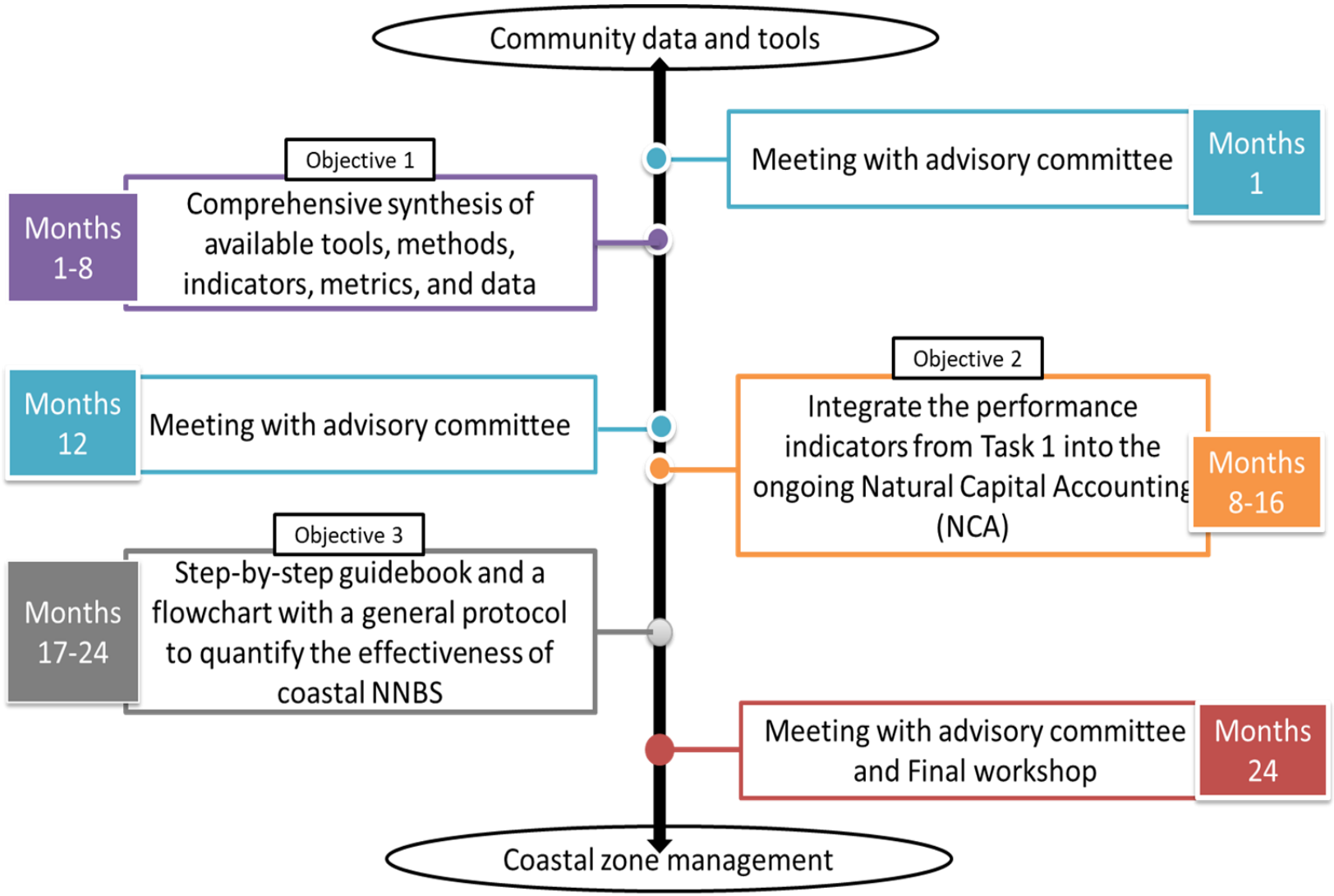
Conclusions: Objectives

Evaluating the Performance of Nature-Based Coastal Protection Solutions for Natural Capital Accounting



Conclusions: Tasks and Timelines

Evaluating the Performance of Nature-Based Coastal Protection Solutions for Natural Capital Accounting



Thank You

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