“A Practical Guidebook for Measuring the Effectiveness of Coastal Nature-Based Solutions”

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Why This Project Matters

The Challenge

Coastal ecosystems—tidal wetlands, salt marshes, seagrass beds—are degrading at an accelerated pace due to land subsidence, sea-level rise, and extreme weather, reducing essential services like shoreline protection, fisheries support, and water quality.

The Barrier to NbS Adoption

Despite their promise, nature-based solutions face limited uptake due to preference for conventional engineering, uncertainty about long-term effectiveness, and a "paradox of choice"—numerous metrics without clear guidance on how they relate to performance.

Main Gap

Harmonize performance indicators and their underlying metrics for tracking coastal NbS effectiveness, enabling clearer assessment, improving comparability across projects, and supporting strategic investments

Project Goal

Catalyze the adoption of coastal NbS by developing a unified guidebook of performance indicators—supported by clearly identified metrics—that communities can use to consistently evaluate NbS effectiveness.

Key Challenges Addressed

A

Limited clarity about the specific problems NbS are intended to address

B

Absence of consistent, actionable guidance on how to track and measure performance over time

Objectives & Approach

1 Targeted Literature Review

Synthesize existing NbS frameworks, performance indicators, and metrics spanning environmental, social, and economic outcomes related to the Chesapeake Bay.

2 Document Practitioner Monitoring Practices

Characterize real-world data collection capacities, constraints, and priorities used by coastal managers across the Chesapeake Bay region.

3 Integrating Science & Practice

Merging established frameworks and tools with practitioner insights to identify indicators that are scientifically robust, locally feasible, and compatible with national and global assessment efforts.

Research Plan: Tasks 1 & 2

Task 1: Frameworks/Tools Synthesis

Targeted review of existing NbS frameworks/Tools applicable to Chesapeake Bay coastal systems and management priorities.

Key Deliverables

- Consolidated inventory of performance indicators
- Documentation of metrics and data requirements
- Gap analysis of current NbS measurement approaches

Task 2: Stakeholder Engagement

Structured outreach to coastal managers and partner organizations to document monitoring practices and resilience priorities.

Methods & Focus

- 2 Charrette Workshops
- Identify operational constraints and opportunities
- Ensure framework reflects local context and implementation realities

Research Plan: Task 3 — Guidebook Development

A user-friendly guidebook and decision-support flowchart outlining a general protocol for quantifying NbS effectiveness, synthesizing Chesapeake Bay–relevant information with stakeholder-informed monitoring practices.

Select Indicators

Choose appropriate performance indicators based on project goals, site conditions, and monitoring capacity to focus on feasible metrics.

Organize Existing Data

Identify available data metrics—shoreline change, vegetation surveys, water quality—and how they can be used to assess NbS performance.

Communicate Outcomes

Link indicators to intended results such as shoreline stability, habitat condition, and water quality improvement for clear reporting.

Track Changes Over Time

Apply repeatable, easy-to-use methods that support adaptive management and inform future monitoring needs.

Guidebook Structure

Ecosystem services and benefits provided by coastal NbS, organized across four outcome dimensions

Coastal Hazard Risk Reduction

Wave energy reduction, storm surge buffering, erosion control, and flood risk mitigation provided by coastal NbS

Climate Mitigation

Carbon sequestration, greenhouse gas regulation, and blue carbon storage capacity of restored coastal ecosystems

Ecosystem Integrity & Function

Habitat quality, biodiversity support, water quality improvement, and ecological connectivity maintained by NbS

Social & Economic Benefits

Recreation, livelihoods, property value protection, cultural services, and equitable community access to NbS benefits

20 indicator topics nested across the 4 outcome dimensions, enabling targeted analysis and monitoring of different coastal NbS outputs

Guidebook Structure

Outcome 1	**Coastal Hazard Risk Reduction**	Indicator Topic 1 2 3 4 5	Optional approaches: Basic/Advanced Alternatives	Metrics	Trend ++ pos + pos • baseline - neg -- no data
Outcome 2	**Climate Mitigation**				
Outcome 3	**Ecosystem Integrity & Function**				
Outcome 4	**Social & Economic Benefits**				

The Guidebook is organized hierarchically:

Outcome → Indicator → Metric → Trend

- **Outcomes**: Broad outcome dimensions that capture ecosystem services and benefits
- **Indicators**: Specific measurable components under each outcome
- **Metrics**: Quantitative or qualitative data points
- **Trend**: Standardized method to track changes over time

Guidebook Overview: How to Use This Resource

The guidebook walks practitioners through three steps: from understanding context and capacity, to selecting the right metrics, to reporting meaningful trends over time.

1 Identify Priorities & Capacity

- **Existing pressures & site priorities**
  - Flood risk, erosion, habitat loss, community needs
- **Institutional capacity & resources**
  - Staff, budget, partnerships, technical expertise
- **Capacity to measure**
  - Data access, equipment, monitoring frequency

2 Assess & Prioritize

- **Select indicators by outcome domain**
  - Coastal resilience, biodiversity, community benefits
- **Choose context-appropriate metrics**
  - Match metric to NbS type and site conditions
- **Select measurement methods**
  - Field surveys, remote sensing, existing datasets

3 Report the Trend

- **Classify directional change**
  - ↓ Negative, → Unchanged, ↑ Positive, ↑↑ Multi-year positive
- **Report at consistent intervals**
  - Annual or multi-year monitoring cycles
- **Communicate to decision-makers**
  - Adaptive management & stakeholder reporting

Each step builds on the last — context shapes metric choice, which in turn shapes how trends are interpreted and communicated.

Selecting Context-Appropriate Metrics by NbS Type

For each indicator topic, practitioners select the most feasible metric given site conditions and monitoring capacity to track effectiveness over time

Example: Coastal Flood Hazard Reduction — Metric Selection by NbS Type

NbS Type	Suggested Metric	Monitoring Approach
Living Shoreline	% wave height reduction	Paired pressure sensors (pre- and post-construction)
Marsh Terrace	Vertical accretion rate (mm/yr)	Sediment pins or Surface Elevation Tables (SET)
Oyster Reef	Shoreline position change (m/yr)	Annual aerial imagery or GPS transect survey
Riparian / Upland Buffer	Peak flow reduction (%)	Paired rain gauge and streamflow gauge (pre/post)

Metric selection prioritizes feasibility and relevance to site-level change detection — enabling trend monitoring with available resources

Improvement-Oriented Monitoring: Tracking Change Over Time

Each metric is assessed for directional change across monitoring periods — generating a trend that indicates whether the NbS is improving, stable, or declining.

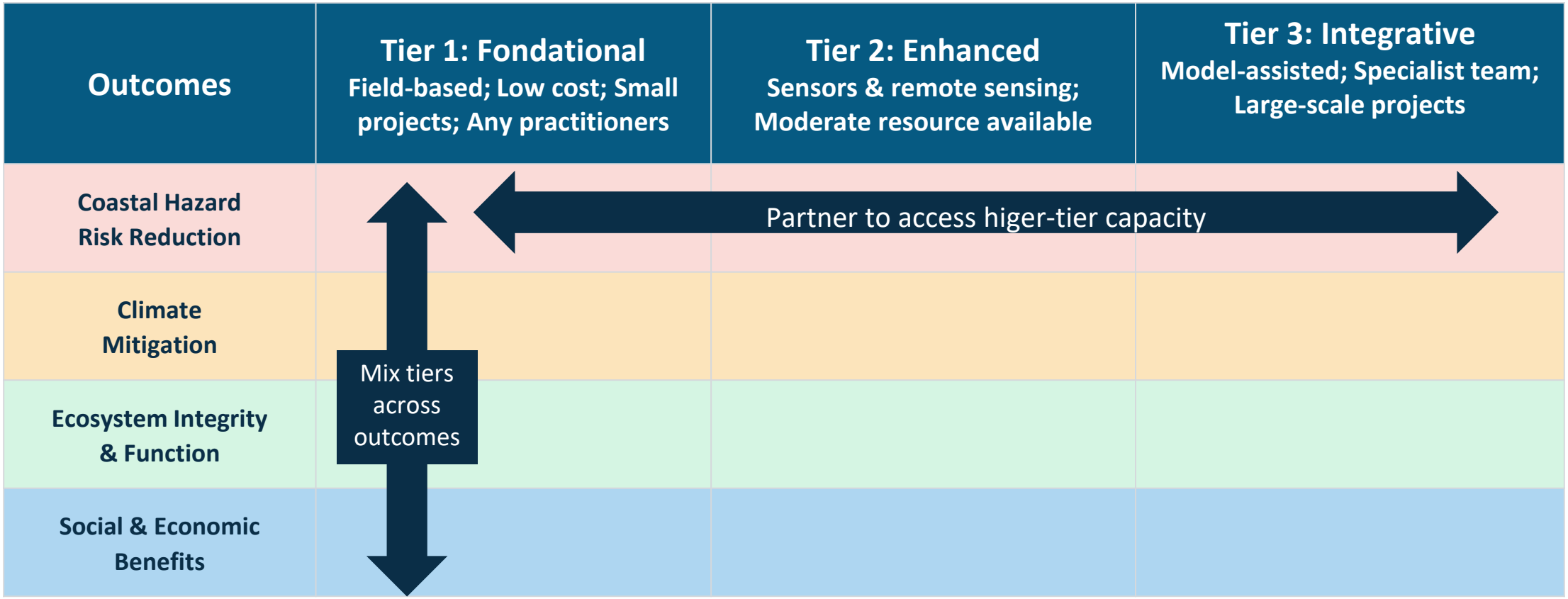
Example: Wave Energy Reduction — Trend Classification

Observed Pattern	Trend	What It Means
Declining or no measurable improvement (Negative)	↓	NbS effectiveness declining; investigate site conditions or design
Variable — no consistent direction across periods	→	No detectable progress; reassess monitoring approach or intervention
Consistent improvement over 2+ periods (Positive)	↑	NbS is providing increasing wave attenuation over time
Sustained improvement across 3+ years (Multi-year Positive)	↑↑	Strong evidence of long-term NbS effectiveness established

Trend-based assessment enables progress monitoring- track effectiveness over time

Multi-Tier Monitoring Approach

Monitoring organized by capacity, cost and data complexity



Monitoring tiers should be match to project scale and resource available

Novelty of Our Guidebook

Core Innovations

Flexible

Adapts to different NbS types, coastal settings, and data availability — not a one-size-fits-all approach

Multi-Dimensional

Evaluates NbS across environmental, social, and economic outcomes simultaneously within a single framework

Modular

Users select relevant outcomes and indicator topics based on their specific project goals and monitoring capacity

Improvement Oriented

Designed to track performance over time — supporting adaptive management, not just one-time assessment

Next Steps

Analysis

Compiling list of relevant frameworks and tools

Stakeholder Engagement

First Charrette Workshop
April 3rd

Stakeholder Engagement

Second Charrette Workshop
First week of June

Where we need your help

- Provide information/links on any data tools, NbS indicator frameworks, or guides that you use or know of to include in the review.

- Recommend coastal restoration practitioners or NbS experts to participate in the Charrette (April 3rd).

Questions or Comments

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