

Monitoring NBS: What information do we want or need?



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CEC Nature-based Solutions to Address Flooding in Coastal
Cities: Monitoring Efficacy of NBS Workshop
May 25, 2022

Converse dyke realignment, aerial oblique DJI Phantom 4 RPAS, August 2 2019

Key Reasons for Monitoring

- Measuring & assessing changes – comparison to baseline or reference condition
- ID need for adaptive management to ensure sustainable performance of NbS over time.
- Learn from past – evidence-based decision making – modifications for future design
- Implementation costs & public perceptions
- Temporal lag in services & climate resilience

Eger et al., 2022; Sowińska-Świerkosz & Garcia, 2021; Skodra et al., 2021; Vouk et al., 2021; Bowron et al., 2012.



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European Commission, Directorate-General for Research and Innovation, *Evaluating the impact of nature-based solutions: a handbook for practitioners*, Publications Office, 2021, <https://data.europa.eu/doi/10.2777/244577>

Align Monitoring with Project Goals and Desired Outcomes

- Key performance indicators (KPIs) vary – flood mitigation and erosion protection; habitat compensation



TRURO & COLCHESTER
COSE 1 COVERAGE

Park St. flooding, Truro, Feb 25, 2022

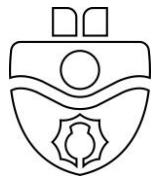
Tidal waters re-introduced Nov. 2021

Onslow-North River Managed Dyke Realignment & Tidal Wetland Restoration

<https://www.transcoastaladaptations.com/onslow-north-river>

Align Monitoring with Project Goals and Desired Outcomes

- Key performance indicators (KPIs) vary: Habitat creation – carbon sequestration



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**Making Room
for Wetlands**

Belcher St. Tidal Wetland Restoration

<https://www.transcoastaladaptations.com/making-room-for-wetlands>




CHEVERIE CREEK
2005 · Culvert replacement · Upper Bay of Fundy



COGMAGUN RIVER
2009 · Impoundment Dyke Breach · Upper Bay of Fundy

THREE FATHOM HARBOUR
2015 · Culvert replacement
Atlantic Coast

ANTIGONISH NORTH & PONDS
2015 · Culvert Replacement
Northumberland Strait



CONVERSE MARSHLAND
2018 · Dyke Realignment · Upper Bay of Fundy



TRURO/NORTH ONSLOW
Dyke Realignment · Upper Bay of Fundy




WALTON RIVER
2005 · Impoundment Dyke Breach · Upper Bay of Fundy

SMITH GUT
2006 · Culvert replacement
Northumberland Strait


LAWRENCETOWN
2007 · Culvert replacement
Atlantic Coast



ST. CROIX RIVER
2009 · Agricultural dyke breach · Upper Bay of Fundy

MAVILLETTE
2018 · Bridge Replacement
Lower Bay of Fundy

ABRAMS RIVER
2018 · Bridge Replacement
Lower Bay of Fundy

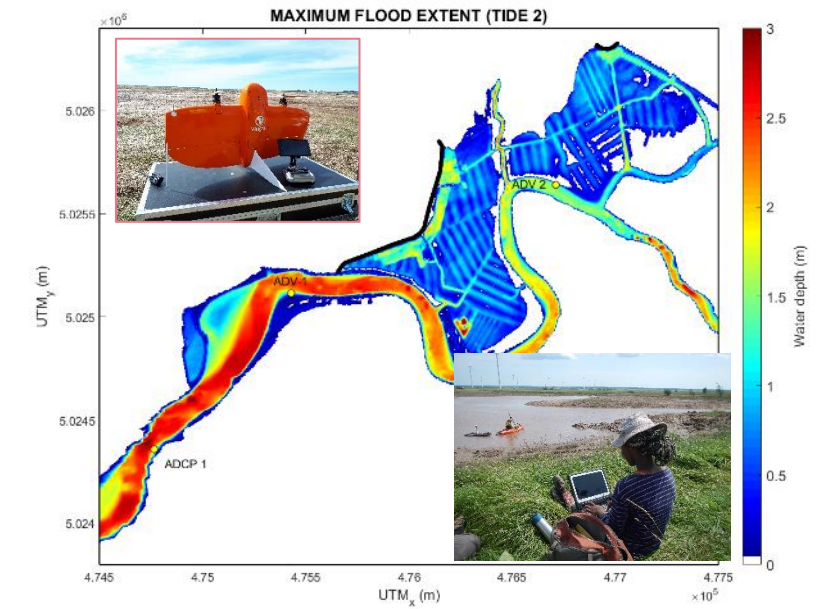


BELCHER ST. MARSHLAND
2018 · Dyke Realignment · Upper Bay of Fundy



17 years of academic, industry and government collaboration

- 4 key processes (variables) for tidal wetland assessment and functioning



Delft3D modelling J. Purcell 2021

Standardized Methods

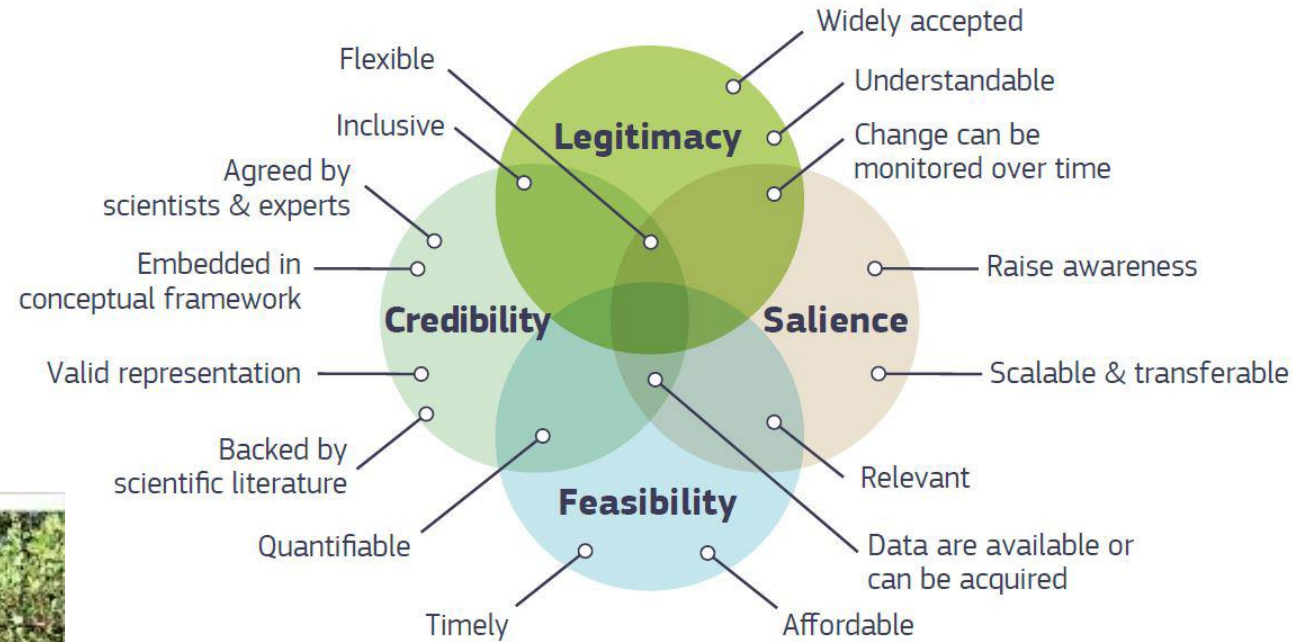
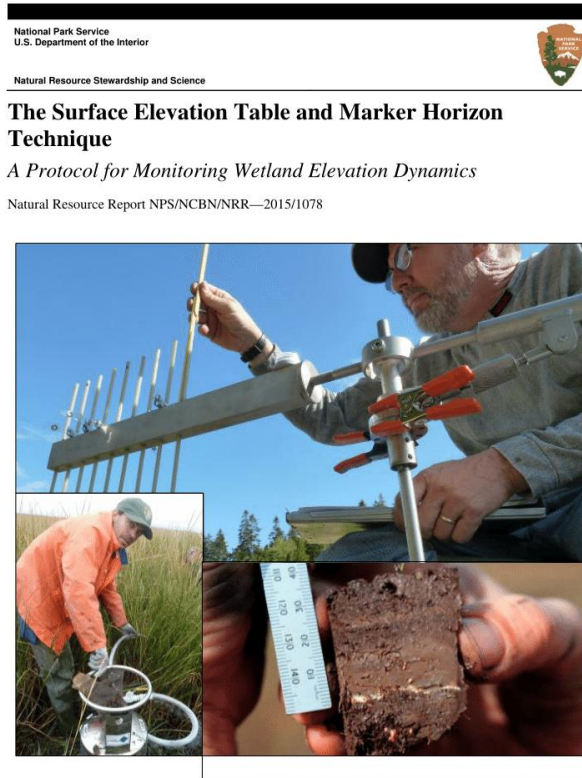


Figure 2-5. Criteria for developing ecosystem service indicators (adapted from Van Oudenhoven et al., 2018)









Questions to ask: (Sowinka and Garcia, 2021)

- Is it reliable?
- Is it measurable?
- Is the indicator stable?

- Repeatable
- Comparable across sites
- Comparison to reference or baseline conditions
- Align with policy, principles & reporting obligations

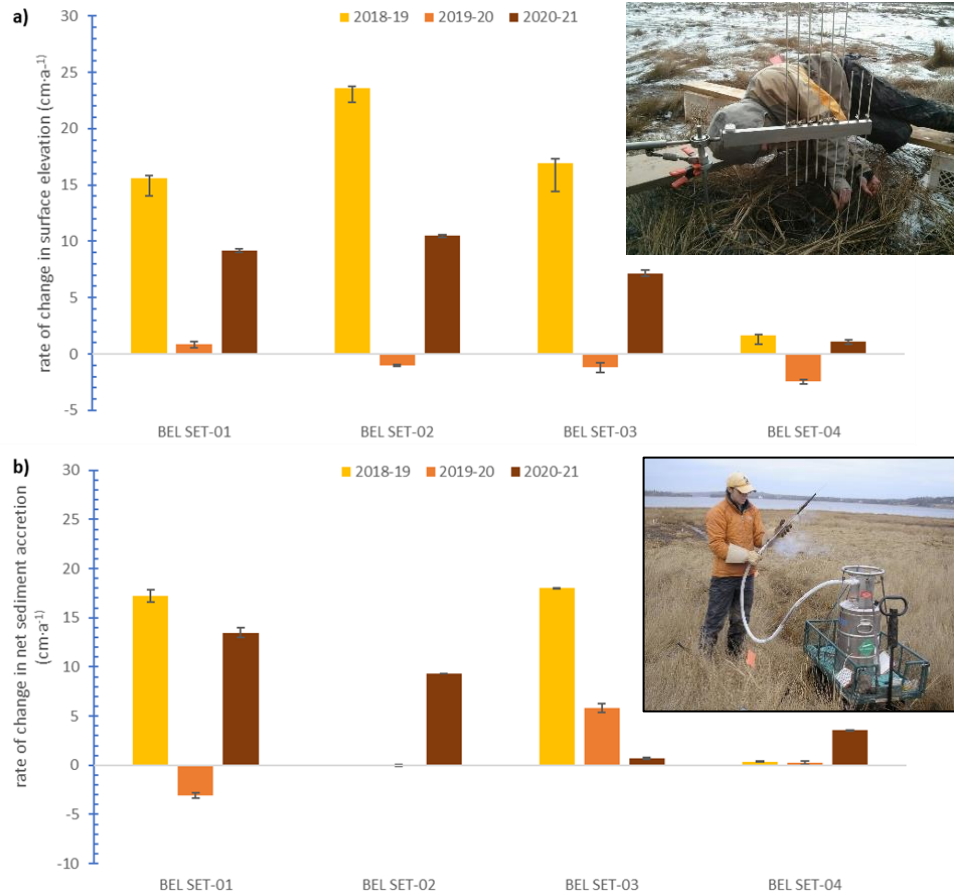
Pillars of Evaluation Framework: Indicators & Metrics

Health	Typical Characteristics	Indicators
Poor	<ul style="list-style-type: none"> Inappropriate species abundance and diversity for location in estuary (saltmarsh has low diversity, but brackish and tidal fresh have high) Lack of appropriate zonation Inhospitable microclimates for vegetation to establish Stressed vegetation Invasive and exotic species 	<ul style="list-style-type: none"> Sparse vegetation or extensive bare ground Stunted or yellowing vegetation Visible exotic or invasive species such as <i>Phragmites</i> Extensive <i>S. alterniflora</i> growing up through high marsh species (with no room for high marsh to migrate) Upland encroachment Widespread rotting roots of vegetation
Stressed	<ul style="list-style-type: none"> Appropriate but low species abundance and diversity for zone (saltmarsh has low diversity, but brackish and tidal fresh have high) Moderate species abundance Potential exotic species present but not invasive 	<ul style="list-style-type: none"> Vegetation stable or marginally stressed Some areas that may not be vegetated Exotic species in area, but not in wetland
Healthy	<ul style="list-style-type: none"> Appropriate Species Diversity and Abundance High, mid, and low marsh zonation where appropriate (i.e., excluding tidal fresh wetland) No invasive or exotic species 	<ul style="list-style-type: none"> Visible zonation of plant species Diversity of species, including common and possible rare species Stable or Vigorous growth Colonization of prograding areas where appropriate

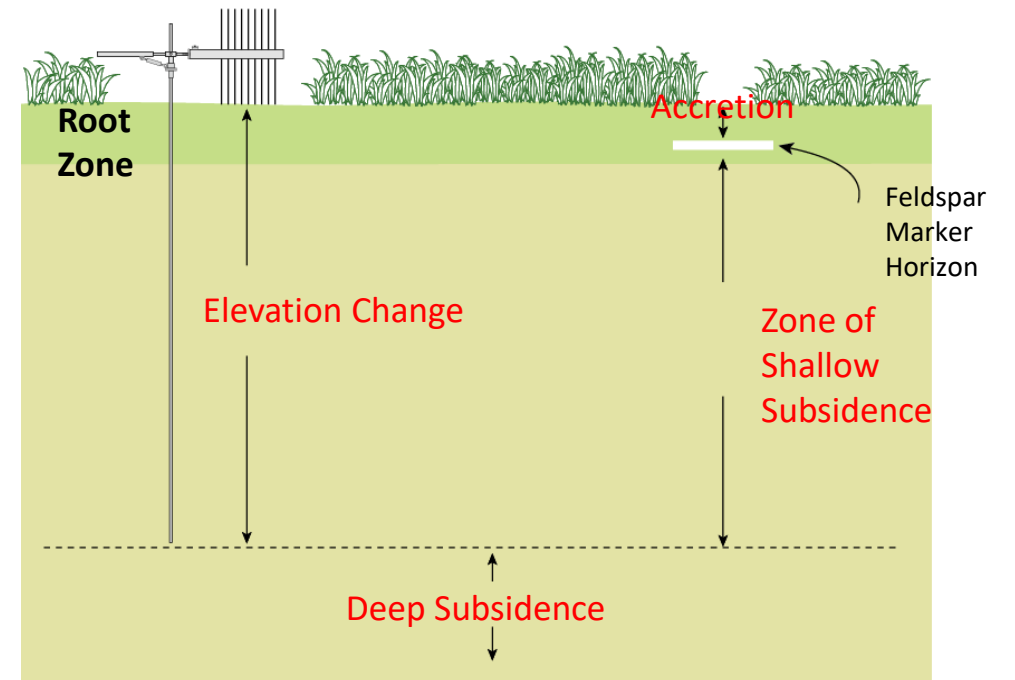
	Poor	Stressed	Healthy
Hydrology	 Eddy due to tidal restriction, stressed vegetation	 Partially connected pannes, stressed vegetation	 Pannes connected, vegetation healthy, no scour
Geomorphology	 Cliffed eroding marsh edge	 Ramped edge with stunted vegetation	 Stable bank with healthy vegetation
Sediments and Soils	 waterlogged, anoxic soils	 subsiding marsh platform, expanding pannes	 accreting marsh platform with influx of sediment
Vegetation	 Stunted <i>S. alterniflora</i> growing through dying <i>S. patens</i>	 Healthy <i>S. patens</i> high marsh	 Healthy <i>S. pectinata</i> , vigorous growth
Habitat Use (Fauna)	 Very little fauna usage and/or evidence of mass kills (e.g. fish kills). Pannes and channels lack or have very low presence of resident fish species.	 Low to medium levels of faunal usage, but usage is only by generalist species, such as raccoons or eagles.	 Medium to high levels of faunal usage, with a diverse range of species usage, and usage by specialist species, such as turtles or shorebirds (e.g. plovers).



Incorporating Climate Resilience



- Surface Elevation Change & Sediment Accretion
- Carbon Density
- Carbon Sequestration
- Time lag for regulating services



Incorporation of Social Dimension



- Community perceptions & concerns – opportunity for education & confidence
- Co-design, engagement & citizen science
- Cultural & non-material services
- Trade-offs

Rahman, T.; Bowron, T.; Pett, B.; Sherren, K.; Wilson, A. and D. van Proosdij. 2021. *Navigating Society and Natural Resources*. 34(9):1268-1285
doi.org/10.1080/08941920.2021.1940405

Chen Y, Caesemaeker C, Rahman HT, Sherren K. 2020 *Ocean & Coastal Management*. 1;193:105254.

van Proosdij, D; Manuel, P.; Sherren, K.; Rapaport, E; McFadden, C.; Rahman, T.; & Reeves, Y. 2021. NRCAN final report, 139 pp.

Requires RE-IMAGING
coastal use & function

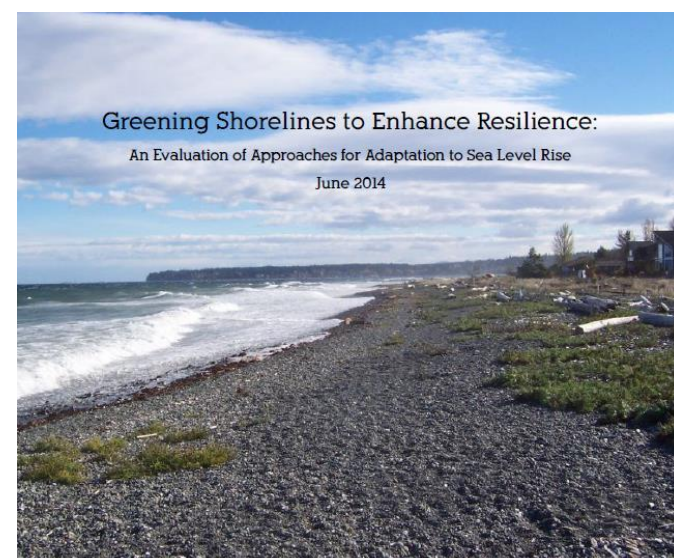
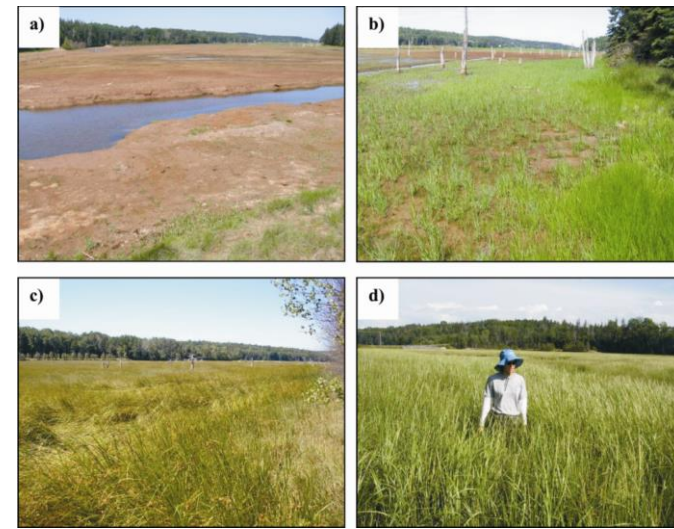
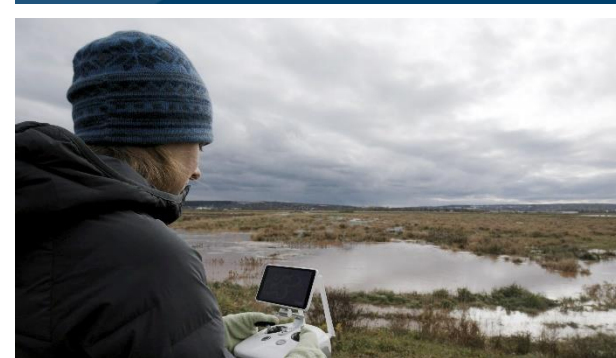
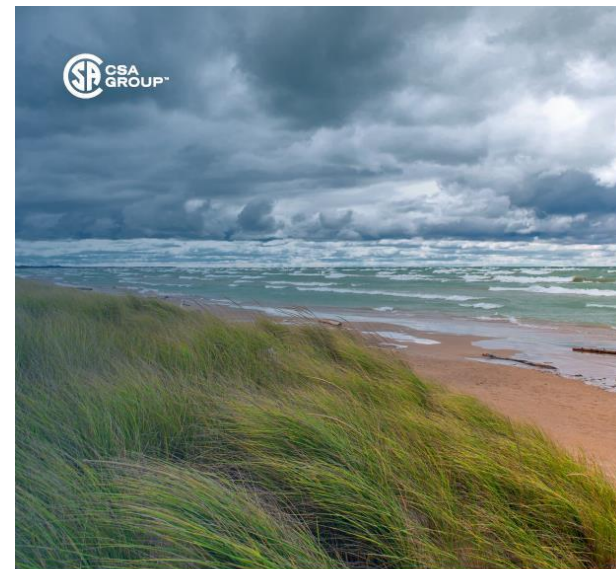


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Take Home Messages

- Align monitoring variables with key performance indicators
- Importance of standardized of core metrics
- With regional considerations - flexible & adaptable
- Alignment with regulatory, policy requirements & public perceptions
- Importance of long term monitoring & data management





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Life returns to Converse- Managed Realignment Site, Aug 2019