

# Coastal Systems Resilience (CSR) and Regional Sediment Management

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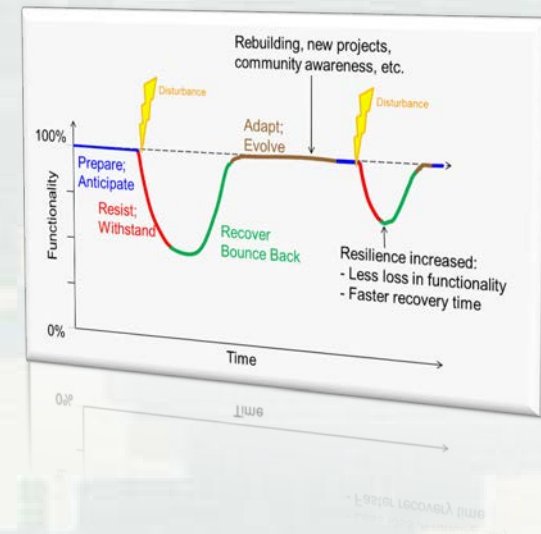


*Coastal Delaware & RSM  
Beaches, Nav, & Ecosystem Restoration  
Dover, Delaware, 29-30 August 2016*

# Outline



- What is resilience?
- What does it mean for a coastal system to be resilient?
- What is sustainability vs. resilience?
- What are some best practices for coastal resilience?
- How could we quantify coastal resilience?
- How does RSM support resilience and sustainability?
- Conclusions



# Definitions of Resilience



Study	Definition
American Society of Civil Engineers (2006) <a href="http://www.asce.org/Content.aspx?id=8478">http://www.asce.org/Content.aspx?id=8478</a>	“Resilience refers to the capability to mitigate against significant all-hazards risks and incidents and to expeditiously recover and reconstitute critical services with minimum damage to public safety and health, the economy, and national security.”
National Disaster Recovery Framework, Strengthening Disaster Recovery for the Nation (FEMA 2011) <a href="http://www.fema.gov/media-library/assets/documents/24647?fromSearch=fromsearch&amp;id=5124">http://www.fema.gov/media-library/assets/documents/24647?fromSearch=fromsearch&amp;id=5124</a>	A resilient community has . . . “the ability to respond to and recover from disasters.”
The Infrastructure Security Partnership and Society of Military Engineers (SAME). “Understanding Resilience – Disaster Resilience Begins with You” (2012)	Disaster Resilience . . . “the ability to resist, absorb, and recover from damage.”
Disaster Resilience (2012)	“Resilience is the ability to adapt to adverse conditions, bounce back from setbacks, and absorb shocks and stresses without being fundamentally altered.”
Hurricane Resilience (2012) <a href="http://www.fema.gov/pdf">http://www.fema.gov/pdf</a>	“The ability to rapidly recover from adverse conditions.”
Infrastructure Resilience (2012) <a href="http://www.fema.gov/pdf">http://www.fema.gov/pdf</a>	“Ability to resist, absorb, and recover from damage due to external forces.”
Coastal Army Resilience (2012) <a href="http://www.fema.gov/S_20">http://www.fema.gov/S_20</a>	“The ability to withstand adverse conditions and recover from damage.”
Urban Resilience (2012) <a href="http://www.fema.gov/Docu">http://www.fema.gov/Docu</a>	“The capacity to resist, absorb, and recover from an event.”
Resilience (2012) <a href="http://www.fema.gov/prepa">http://www.fema.gov/prepa</a>	“Resilience means the ability to withstand, respond to, and recover from adverse conditions and events.”
Rockefeller Foundation (2013) <a href="http://www.rockefellerfoundation.org/blog/city-resilient">http://www.rockefellerfoundation.org/blog/city-resilient</a>	“The capacity of individuals, communities, and systems to adapt, and grow in the face of changes, even catastrophic ones.”
Community and Regional Resilience Institute (CARRI) (2013) <a href="http://www.resilientus.org/wp-content/uploads/2013/08/definitions-of-community-resilience.pdf">http://www.resilientus.org/wp-content/uploads/2013/08/definitions-of-community-resilience.pdf</a>	“Community resilience is the capacity to resist impact, and bounce back rapidly through survival, adaptability, evolution, and growth in the face of turbulent change”
U.S. Army Corps of Engineers Safety of Dams, Policy and Procedures, ER 1110-2-1156 (2014) <a href="http://www.publications.usace.army.mil/Portals/76/Publications/EngineerRegulations/ER_1110-2-1156.pdf">http://www.publications.usace.army.mil/Portals/76/Publications/EngineerRegulations/ER_1110-2-1156.pdf</a>	“The ability to avoid, minimize, withstand, and recover from the effects of adversity, whether natural or manmade, under all circumstances of use.”
Intergovernmental Panel on Climate Change Fifth Assessment Report, “Climate Change 2014: Impacts, Adaptation, and Vulnerability” (2014) <a href="http://ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-Glossary_FGD.pdf">http://ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-Glossary_FGD.pdf</a>	“The capacity of a social-ecological system to cope with a hazardous event or disturbance, responding or reorganizing in ways that maintain its essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation.”

Key words:

**Prepare**

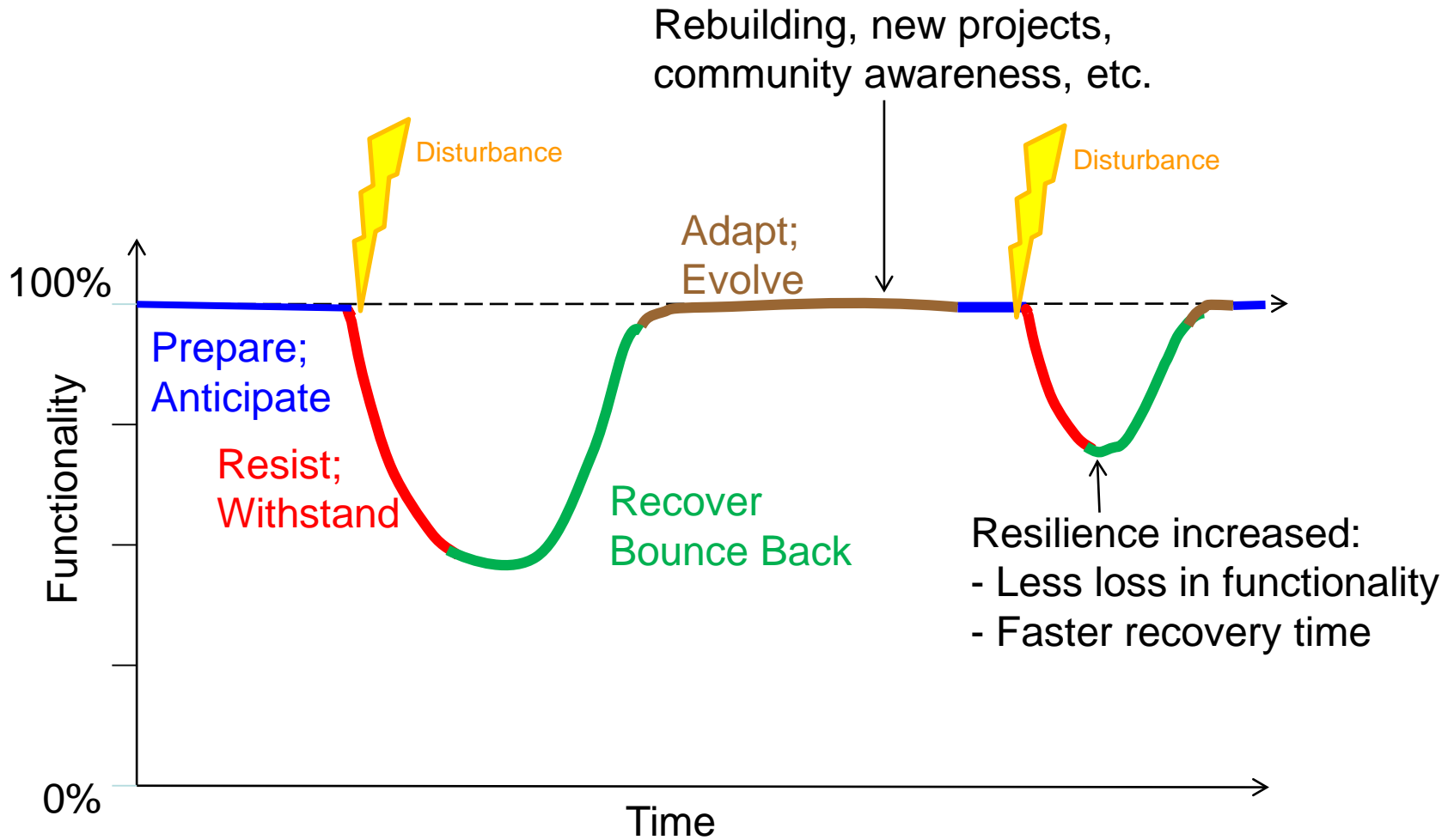
**Resist or Absorb**

**Recover**

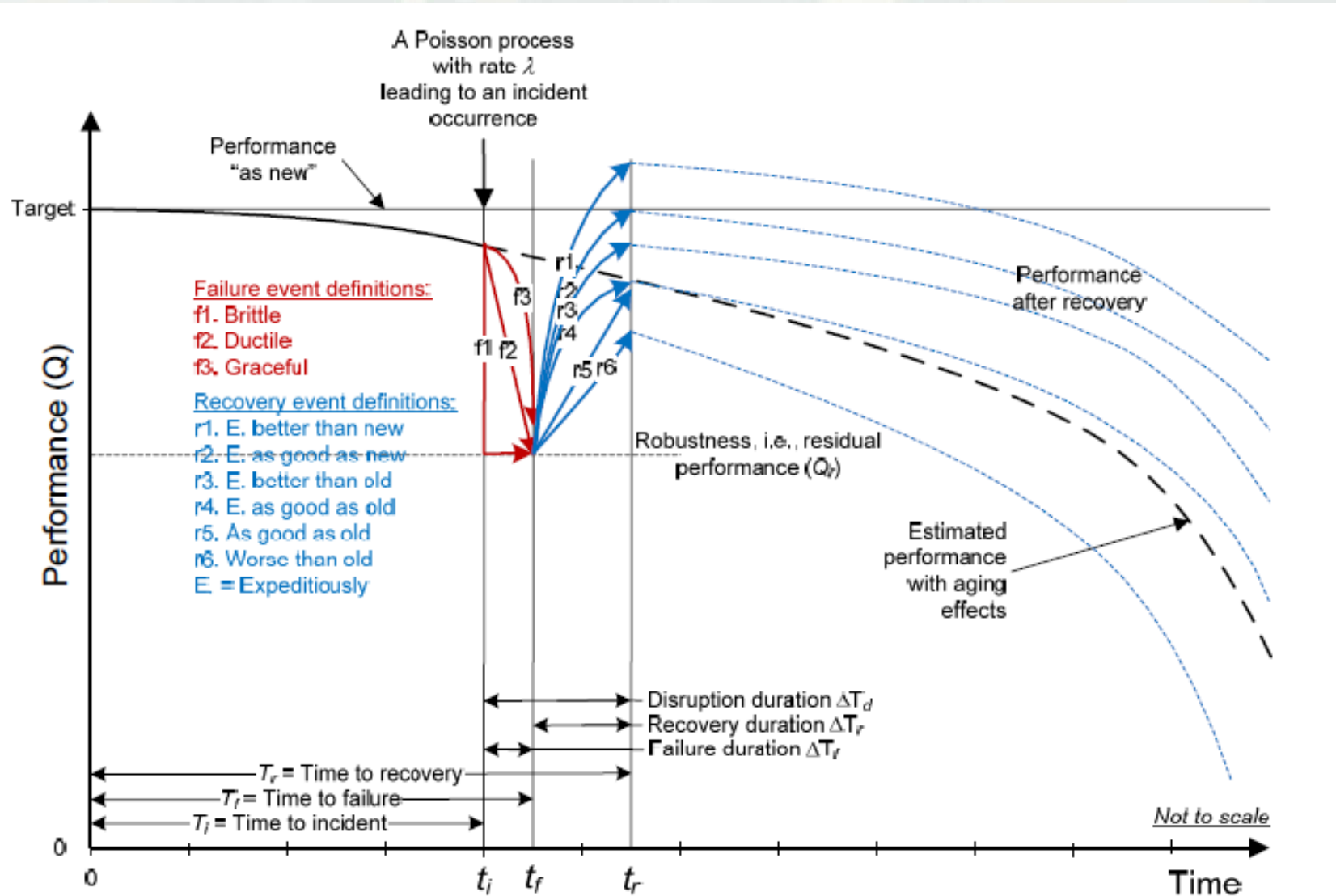
**Adapt**



# Concepts: Resilience Timeline



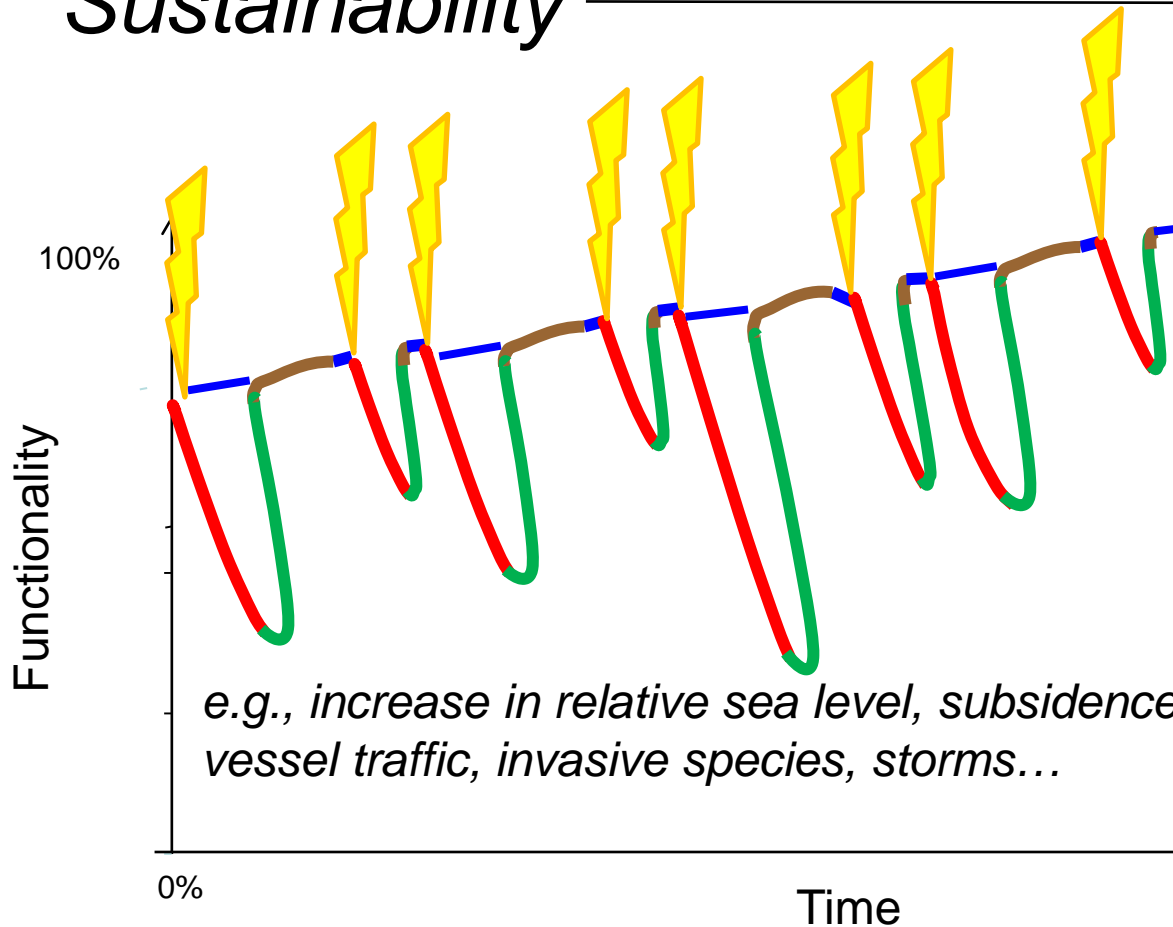
# Concepts: Resilience Timeline (Ayyub 2014)



# Sustainability: Adaptation through Time



*Sustainability* →



If stresses increase relative to strength of system, functionality will need to increase relative to that at time = 0

# What does it mean for a coastal system to be resilient?



Prepare,  
Anticipate

- *Build partnerships*
- *Assess existing and future vulnerabilities in system*
- *Develop strategies & contingency plans*

Resist,  
Absorb

- *Utilize features with adaptive capacities that can be modified and will absorb impacts and resist damage*
- *Provide diverse and redundant protection*

Recover,  
Bounce  
Back

- *Ensure availability of alternate networks –components are independent of, and complement each other*
- *Implement operations for rapid recovery*

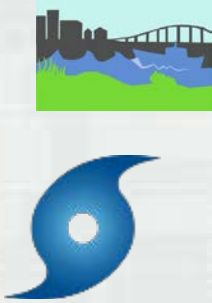
Adapt,  
Evolve

- *Foster natural and human actions for natural, nature-based, and hybrid features to facilitate adaptation*
- *Consider non-structural measures (e.g., relocation, zoning, education and advanced alerts, etc.)*

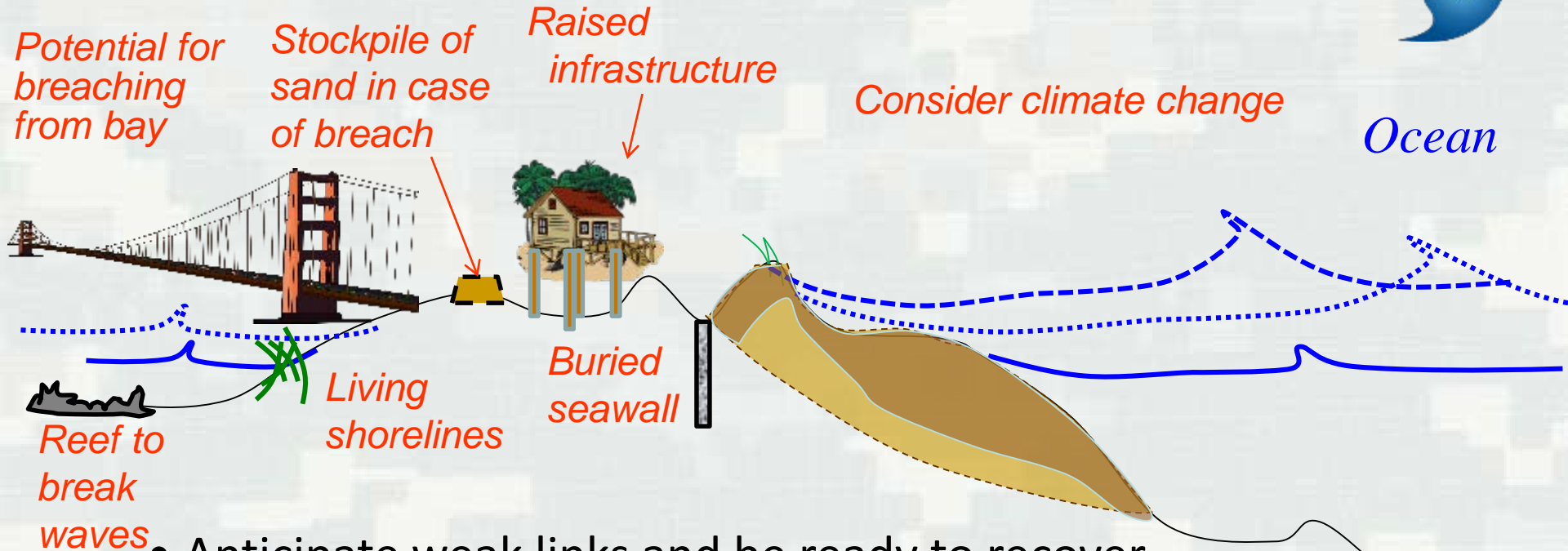
# Best Practices: CSR

## Example barrier island cross-section

Bay



Ocean



- Anticipate weak links and be ready to recover.
- Provide diverse and redundant protection.
- Ensure availability of alternate networks –components are independent of, and complement each other.
- Provide accessible information for rapid decision-making.



# How do we know if an engineering action is resilient? <sup>(1/2)</sup>



## Philly Example: Stone Harbor and Avalon Marsh Restoration

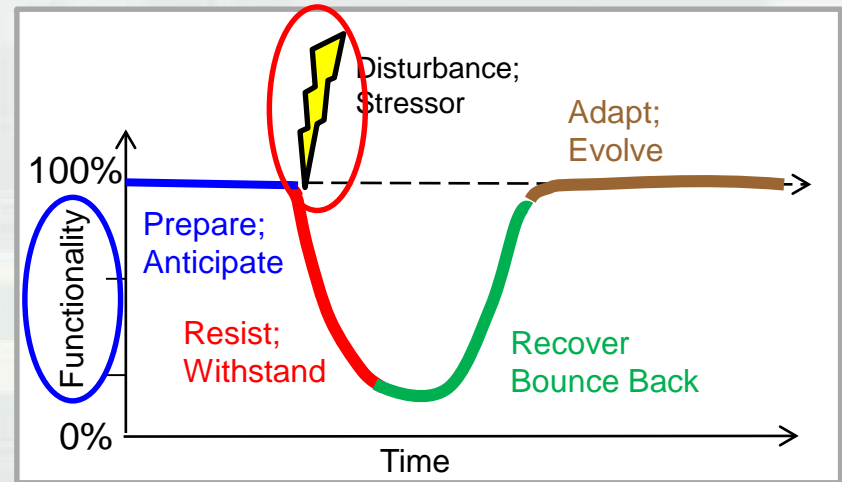


Photo: NJ Fish & Wildlife

*Restored degraded marsh  
and created habitat for  
birds near Stone Harbor,  
New Jersey*

To understand resiliency, need to establish:

- **System Framework** - Wetlands, navigation channels, inlet and barrier islands
- **Purpose(s) or Function(s) of Project** – ENV and NAV  
Provide bird habitat **WITHOUT** inducing channel shoaling
- **System Stressors and Vulnerabilities** – ....Currents, vessel wake, subsidence, storms, invasive species, dredging, sea level rise, +....



# How do we know if an engineering action is resilient? (2/2)



**System Framework** - Wetlands, navigation channels, inlet and barrier islands

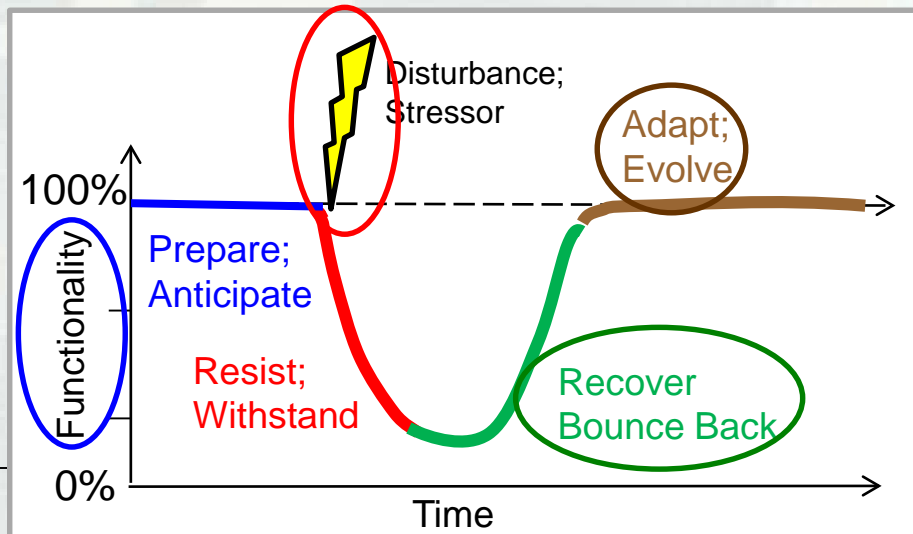
**Function** → Bird habitat 0.5 acre; maintain existing dredging 100 cy/year

**Disturbance or Stressor** → ? ....Currents, vessel wake, subsidence, storms, invasive species, dredging, sea level rise, ... **Define magnitudes**

**Recover** → Can natural and/or humans actions restore habitat acreage in time required, say 6 months?

→ Will storms increase dredging, and if so, will channel depth & width be restored within 1 month?

**Adapt** → Will recovery actions continue to keep pace with future stressors: e.g., sea level rise - ~3 mm/year?



Philly Example: Stone Harbor and Avalon Marsh Restoration



# R&D: Assessing CSR

*Environmental, Engineering, Community*



4. What is the capacity of the system to adapt in advance of future hazards?

1. How prepared is the system to withstand a disturbance?



3. Has recovery been adequate to restore functioning in a desirable timeframe?

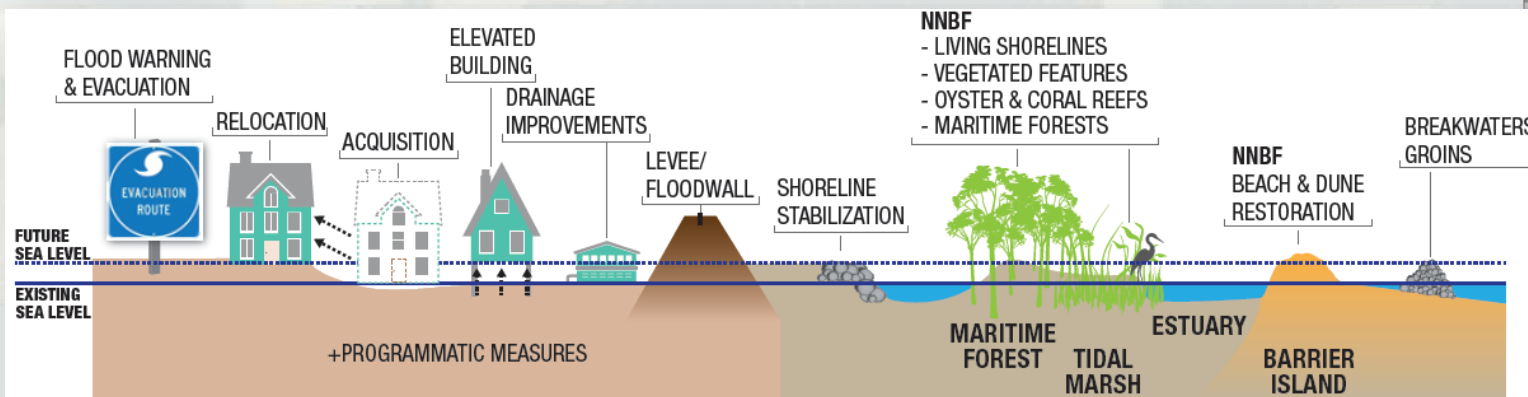
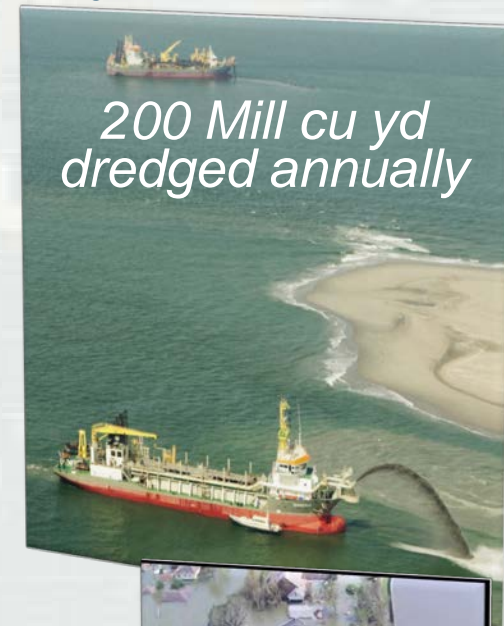
2. Has the system been able to absorb damages and resist loss in functioning during disturbances?

# Integrated Solutions: Coastal Restoration

## *Environmental, Engineering, Community*



- Coastal Flood & Storm Damage Reduction
  - ▶ Beaches & Dunes; Coastal Structures; Islands; Levees; Floodwalls
- Navigation
  - ▶ Dredging & placing 200 Mill cu yd/year; Coastal navigation structures
- Environmental Restoration
  - ▶ Wetlands; Living shorelines; Reefs; Maritime forests





# Conclusions

- Determining resiliency requires understanding *\*system context, function and purpose, present and future stressors, time required and potential for recovery, and the capacity for adaptation*
- Many RSM engineering actions and projects can increase resiliency
- Demonstration studies with defined parameters and forcing data are required to refine and validate methods

**Feedback and Discussion:** Julie Rosati, Katherine Touzinsky; Alex Renaud