Adaptive Management Strategies for Ridge to Reef Conservation

Webcast sponsored by EPA's Watershed Academy in partnership with the Coastal States Organization (CSO)

Tuesday, December 17, 2019, 2:00pm – 4:00pm Eastern

Speakers:

- **Bradley Watson**, Executive Director, Coastal States Organization (CSO)
- **Terri Johnson,** Office of Water, EPA
- **Susan Jackson,** Office of Water, EPA
- **Curt Storlazzi,** Coastal and Marine Geology Program, USGS
- **Jordan West,** Office of Research and Development, EPA

Watershed Academy Webcast

www.epa/gov/watershedacademy

- The slides for today's presentations are posted.
- A recording will be posted within the next month.

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- Established in 1970 by appointed representative from the nation's coastal states.
- Mission: Support the shared work and vision of the coastal states and territories for the protection, conservation, responsible use, and sustainable economic development of the nation's coastal resources.
- Vision: The nation's coastal areas are sustainably managed to balance economic and resource values and uses.

Learn more:

www.coastalstates.org

SUPPORTING HEALTHY COASTS & STRONG COASTAL COMMUNITIES

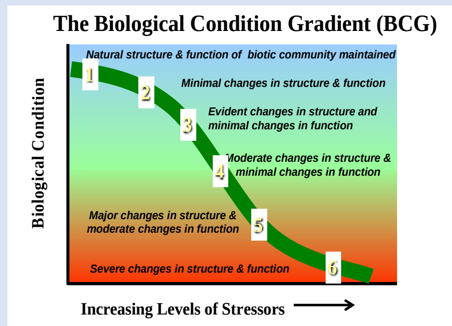

Protecting America's Coral Reefs
Presentation By Terri Johnson, Environmental Protection Agency
Access EPA's Coral Reef Story Map here:
https://epa.maps.arcgis.com/apps/Cascade/index.html?appid=1496194fa84e495dab4744b650076711

Coral Reef BCG

Susan Jackson, USEPA
Office of Water

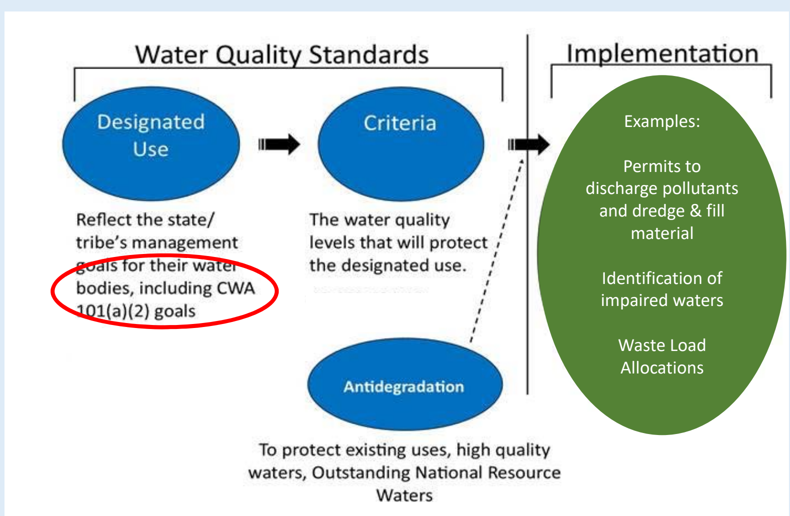
Watershed Academy

December 17, 2019



The views expressed in this presentation are those of the author and do not necessarily represent the views or policy of the US EPA.

Water Quality Standards



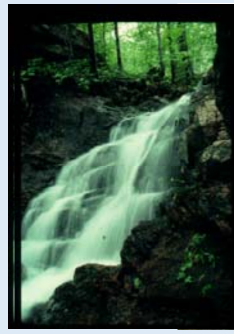
CWA Section 101

Long term goal

To restore & maintain the chemical, physical, & *biological integrity* of the nation's waters

Interim Goal

Protection and Propagation of fish, shellfish and wildlife ….





Biological Integrity

The capability [of an aquatic ecosystem] to support and maintain a balanced, integrated, adaptive community of organisms having a composition and diversity comparable to that of the natural habitats of the region (adapted from Frey 1977)

Biological Integrity

The capability [of an aquatic ecosystem] to support and maintain a balanced, integrated, adaptive community of organisms having a composition and diversity comparable to that of the natural habitats of the region.

classification

Biological Integrity

The capability [of an aquatic ecosystem] to support and maintain a balanced, integrated, adaptive community of organisms having a composition and diversity comparable to that of the natural habitats of the region.

reference

classification

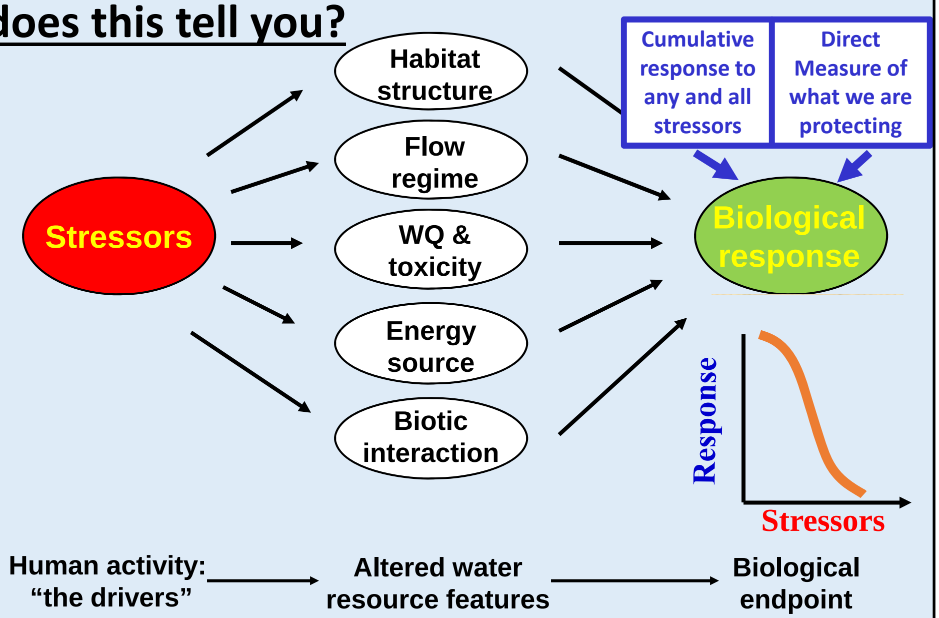
Biological Integrity

quantitative measures

The capability [of an aquatic ecosystem] to support and maintain a balanced, integrated, adaptive community of organisms having a composition and diversity comparable to that of the natural habitats of the region.

reference classification

Measuring Condition of the Biota: What does this tell you?



Courtesy of Dave Allan, Univ of MIchigan

Biologically-Based Aquatic Life Uses & Criteria

- Management Goals for protection and restoration of aquatic life

designated aquatic life uses

  ✓ Detailed biological information about the characteristics of aquatic organisms expected in a water body

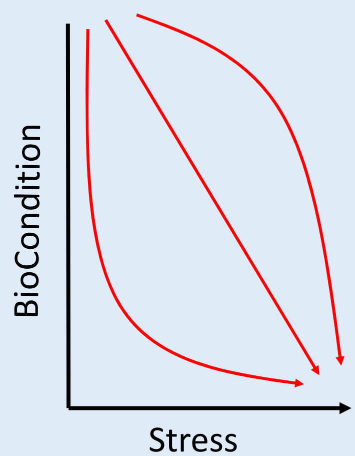
- Quantifiable thresholds

biological criteria

What is Biological Condition Gradient (BCG)?

It is a scientific framework for interpreting biological response to anthropogenic stress.

Based on bioassessments

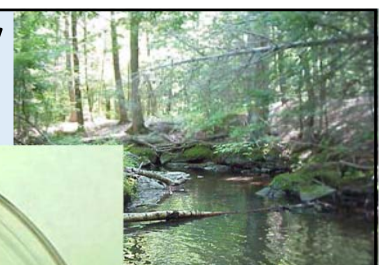


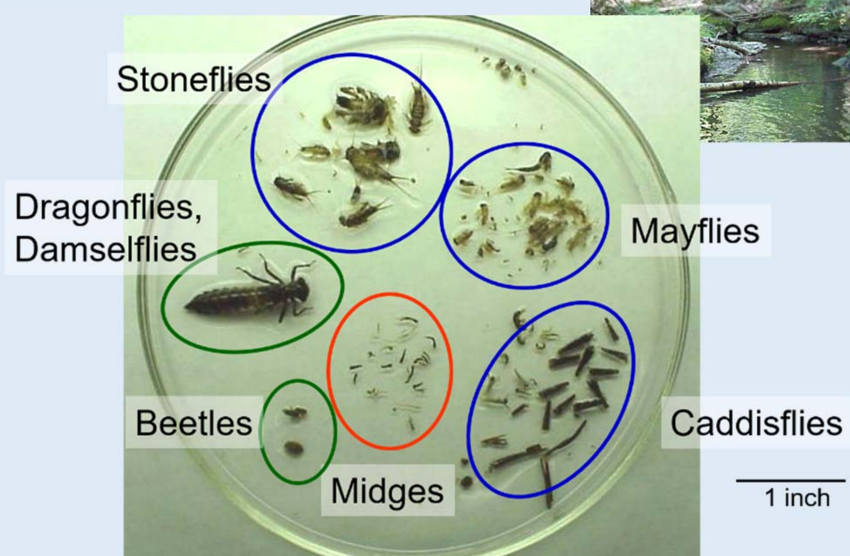
Benthic Macroinvertebrates

- Animals without backbones, living in or on the sediments, and large enough to be seen by the unaided eye.
- Are susceptible to degradation of water quality and habitat, and therefore serve as good indicators of environmental conditions.
- Serve as a primary food source for many fish.



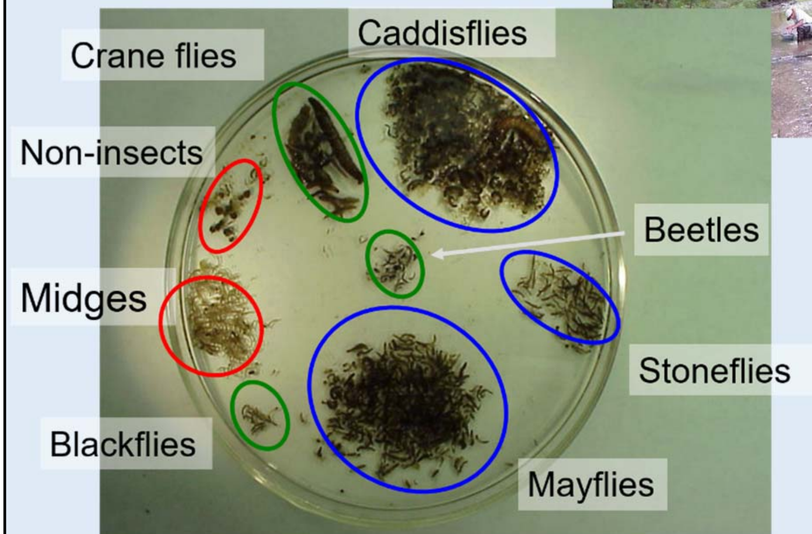
Undisturbed/Minimally Disturbed Stream





Courtesy of Susan Davies, ME DEP

Nutrient Enriched Stream



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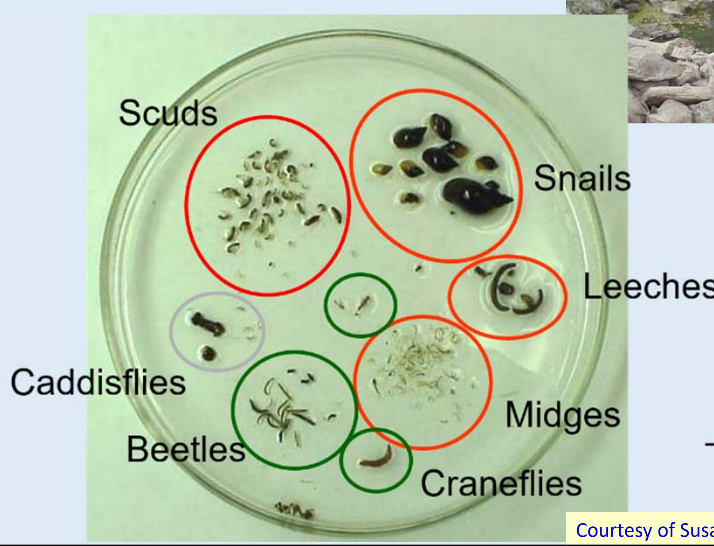
Courtesy of Susan Davies, ME DEP

Drainage from a Shopping Mall



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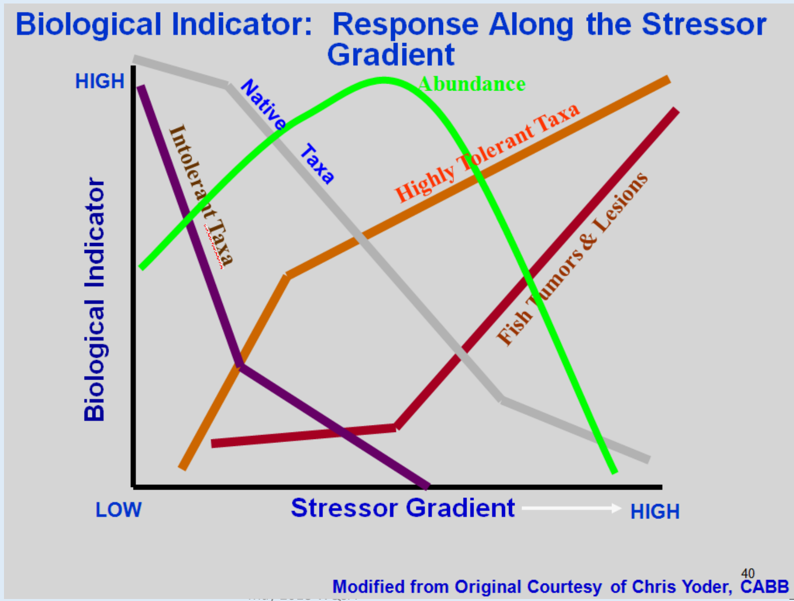
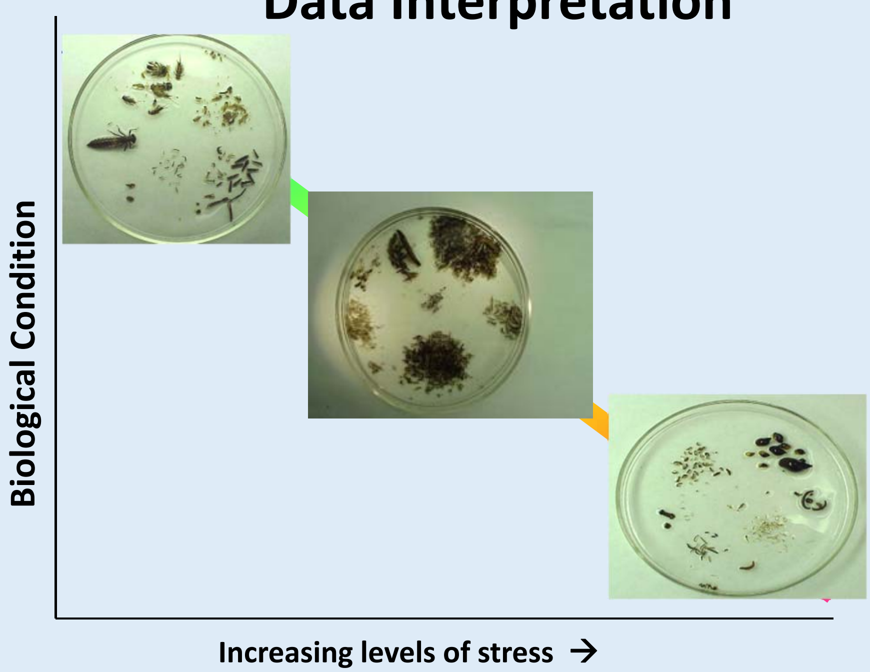
Courtesy of Susan Davies, ME DEP

Biological Attributes



Data Interpretation



BCG CONCEPTUAL MODEL

Levels of Biological Condition

Natural structural, functional, and taxonomic integrity is preserved.

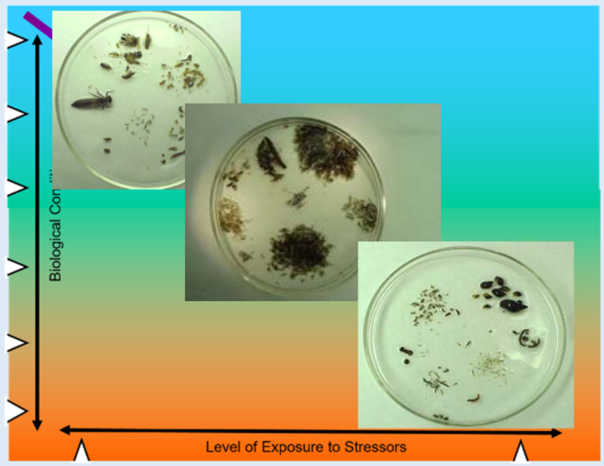
Structure & function similar to natural community with some additional taxa & biomass; ecosystem level functions are fully maintained.

Evident changes in structure due to loss of some rare native taxa; shifts in relative abundance; ecosystem level functions fully maintained.

Moderate changes in structure due to replacement of some sensitive ubiquitous taxa by more tolerant taxa; ecosystem functions largely maintained.

Sensitive taxa markedly diminished; conspicuously unbalanced distribution of major taxonomic groups; ecosystem function shows reduced complexity & redundancy.

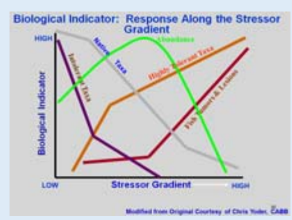
Extreme changes in structure and ecosystem function; wholesale changes in taxonomic composition; extreme alterations from normal densities.



Watershed, habitat, flow regime and water chemistry as naturally occurs.

Chemistry, habitat, and/or flow regime severely altered from natural conditions.

QUANTIFY GRADIENT - Attributes



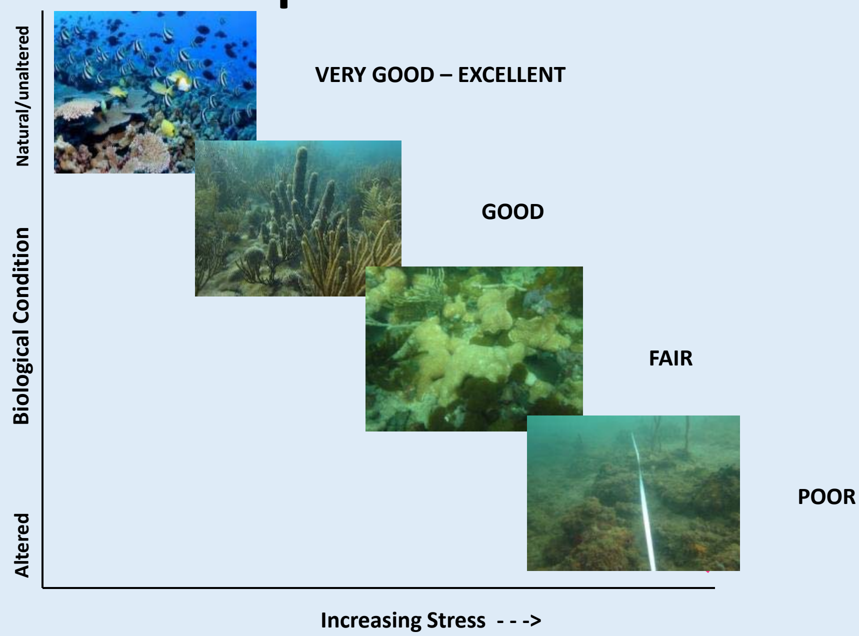
Streams

- **Sensitivity/tolerance**
- **Organism Condition**
- **Presence of native/non native species**

Estuaries Coral Reefs

Above plus habitat mosaic, connectivity, ecosystem function

Conceptual Coral Reef BCG



Example: Numeric Coral Reef BCG

BCG Level 3: Evident changes in structure of the biotic community and minimal changes in ecosystem function. Some changes in structure due to loss of some rare native taxa; shifts in relative abundance of taxa but intermediate sensitive taxa are common and abundant; ecosystem functions are fully maintained through redundant attributes of the system.

Attributes

Physical structure: Moderate to high rugosity, moderate reef built above bedrock, some irregular cover for fish habitat, water slightly turbid, low sediment, flocs or film on substrate.

Corals: Moderate coral diversity; large old colonies (*Orbicella*) with some tissue loss; varied population structure (usually old colonies, few middle aged & some recruitment); *Acropora* thickets maybe present; rare species ab- sent.

Sponges: Autotrophic species present but highly sensitive species missing.

Gorgonians: Gorgonians more abundant than in level 1.

Condition: Disease and tumor prevalence slightly above background level, more colonies have irregular tissue loss

Fish: Noticeable decline of large apex predators, groupers, snappers, etc. Small reef fish more abundant.

Vertebrates: Large, long-lived species locally extirpated (turtles, eels).

Other Invertebrates: *Diadema*, lobster, small crustaceans & polychaetes less abundant than level 1, large sensitive anemones species missing.

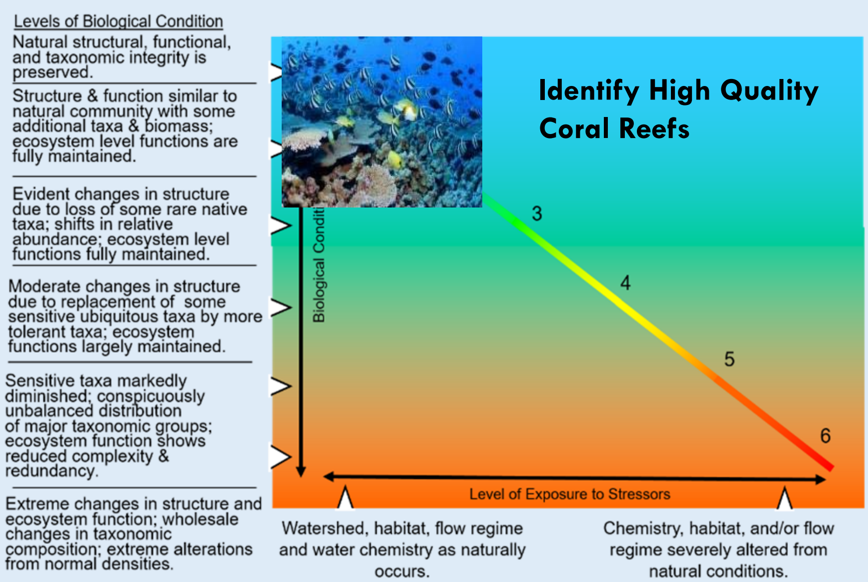
Algae/plants: Crustose coralline algae present but less, turf algae present and longer, more fleshy algae present.

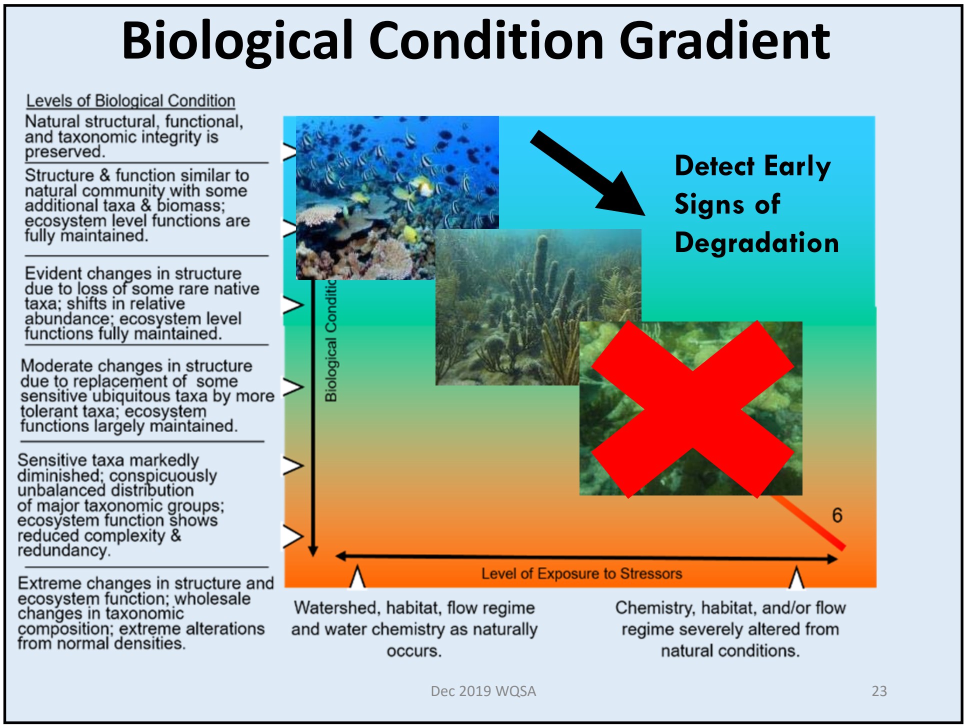
Example: Numeric Coral Reef BCG

BCG Level 3: Evident changes in structure of the biotic community and minimal changes in ecosystem function. Some changes in structure due to loss of some rare native taxa; shifts in relative abundance of taxa but intermediate sensitive taxa are common and abundant; ecosystem functions are fully maintained through redundant attributes of the system.

Narrative Rule Examples	Quantitative Rule Examples
Coral Cover is moderately high	LPI coral cover ≥ 20 (10 – 30) %
Coral are moderately diverse	LPI coral species > 4 (3 – 5) species
Sensitive coral species are represented	LPI Attribute II, III, + IV species > 2 (1 – 3) species
Cover is mostly live and healthy organisms	Bare Substrate and Algal Turf with Sediment < 30 (40 – 20) %
Live cover of Orbicella is relatively high	Live cover of Orbicella > 20 (15 – 25) %

Biological Condition Gradient




Biological Condition Gradient
Levels of Biological Condition
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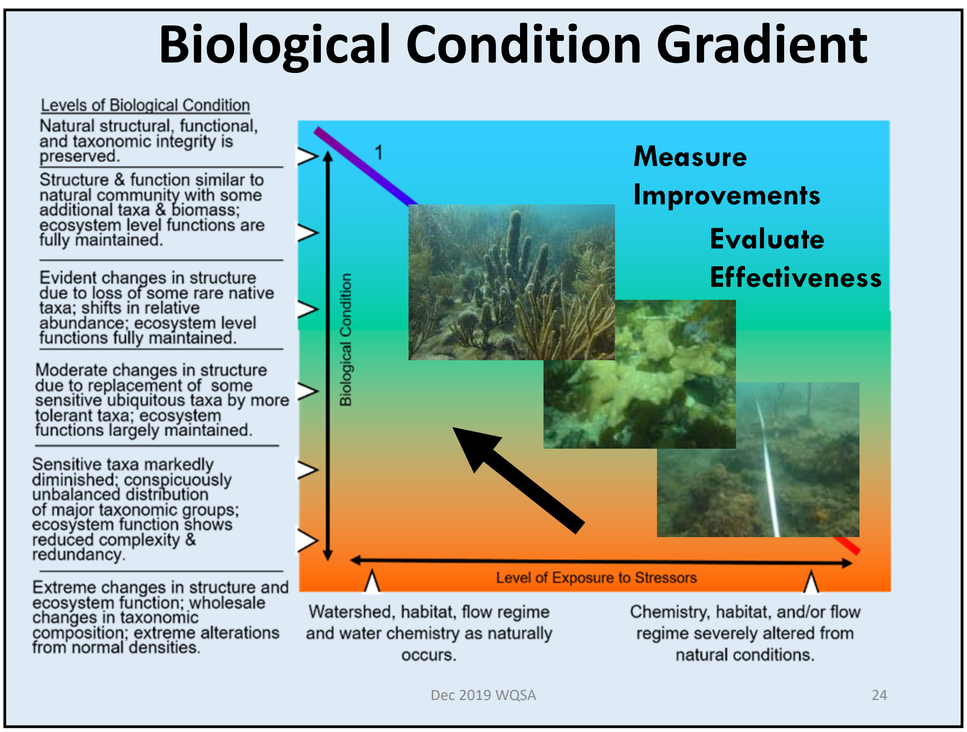
Sensitive taxa markedly diminished; conspicuously unbalanced distribution of major taxonomic groups; ecosystem function shows reduced complexity & redundancy.
Extreme changes in structure and ecosystem function; wholesale changes in taxonomic composition; extreme alterations from normal densities.
Detect Early Signs of Degradation
6
Level of Exposure to Stressors
Watershed, habitat, flow regime and water chemistry as naturally occurs.
Chemistry, habitat, and/or flow regime severely altered from natural conditions.
Dec 2019 WQSA
23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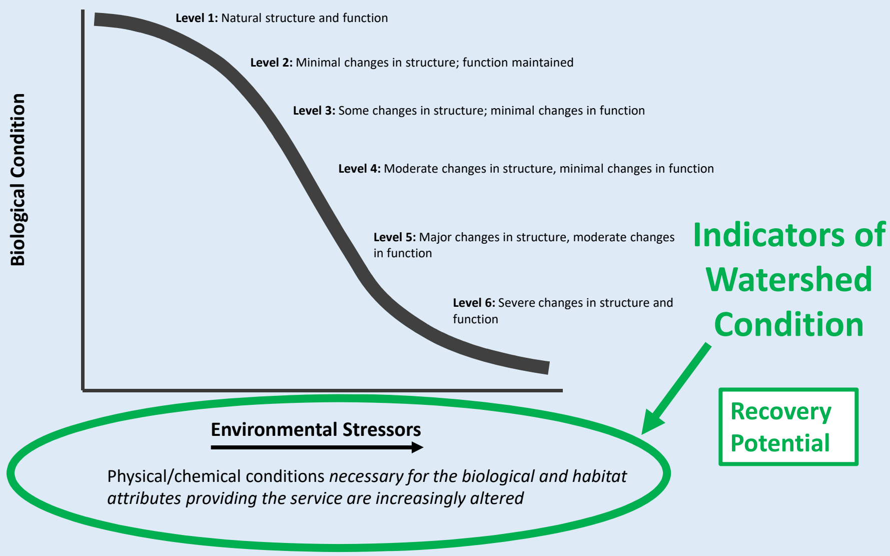
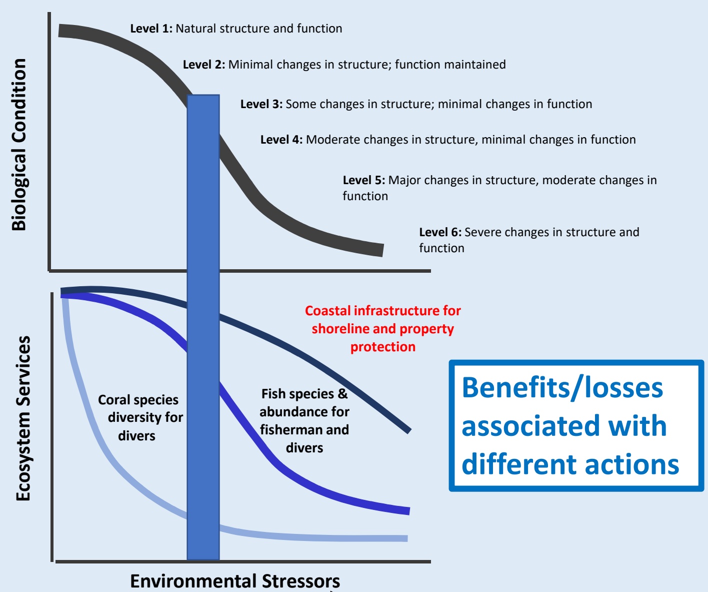
1
Measure Improvements
Evaluate Effectiveness
Biological Condition
Level of Exposure to Stressors
Watershed, habitat, flow regime and water chemistry as naturally occurs.
Chemistry, habitat, and/or flow regime severely altered from natural conditions.
Dec 2019 WQSA
24

Linking BCG with Measures of Watershed Condition



Pairing BCG with Ecosystem Services



Physical/chemical conditions *necessary for the biological and habitat attributes providing the service are increasingly altered*

What can BCG be used for?

- **Determine and communicate the current existing environmental conditions relative to natural, undisturbed conditions.**
- **Describe what environmental conditions are achievable through protection and/or restoration.**
- **Communicate what is biologically predicted to be gained, or lost, with different management decisions.**
- **Provide feedback on effectiveness of management actions by tracking incremental changes.**

CCRI

Coral Reef Experts

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Questions?

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Bill Fisher, Debbie Santavy, Christina Horstmann, Giancarlo Cicchetti, Susan Yee, Scott Leibowitz, Jordan West, Catherine Brady (ORISE)

For more information …

1) U.S. EPA 2016. A Practitioner's Guide to the Biological Condition Gradient: A Framework to Describe Incremental Change in Aquatic Ecosystems. EPA 842-R-16-001. Office of Science and Technology, Washington D.C. 20460.

https://www.epa.gov/wqc/practitioners-guide-biological-condition-gradient-framework-describe-incremental-change-aquatic

2) Flotemersch, J., S. Leibowitz, R. Hill, J. Stoddard, M. Thoms, and R. Tharme. 2015. A Watershed Integrity Definition and Assessment Approach to Support Strategic Management of Watersheds. River Research and Applications. John Wiley & Sons Incorporated, New York, NY.

3) Healthy Watersheds: Technical analysis methods, tools and reports. https://www.epa.gov/watershed-analysis

4) Yee, S., J. Bousquin, Randy Bruins, Tim Canfield, Ted DeWitt, R. DeJesus-Crespo, B. Dyson, R. Fulford, M. Harwell, J. Hoffman, C. Littles, JohnM Johnston, Bob Mckane, L. Ruiz-Green, M. Russell, L. Sharpe, N. Seeteram, A. Tashie, and K. Williams. 2017. Practical Strategies for Integrating Final Ecosystem Goods and Services into Community Decision-Making. EPA/600/R-17/266.

https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=337461

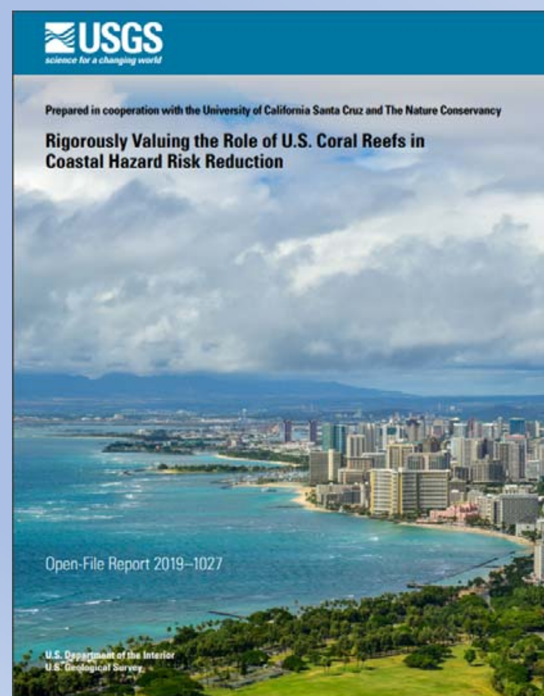
The Role of Coral Reefs in Coastal Protection

Rigorously Valuing Coral Reefs to Inform Coastal Zone Management and Create New Funding Opportunities for Reef Restoration

Presentation by Curt Storlazzi, U.S. Geological Survey.

Access the full report here:

https://pubs.er.usgs.gov/publication/ofr20191027



Adaptation Design Tool for Natural Resource Management

Jordan M. West

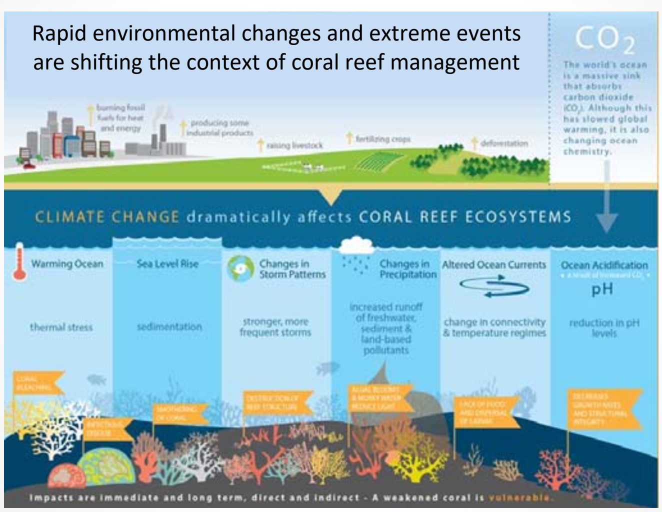
U.S. Environmental Protection Agency, Office of Research & Development

Pat Bradley

Tetra Tech, Inc.

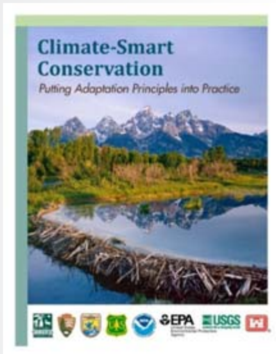
17 December 2019

Why is adaptation important?



Source: Adaptation Design Tool user guide (https://www.coris.noaa.gov/activities/CCAP_design/)

Adaptation planning framework



Stein et al. (2014)

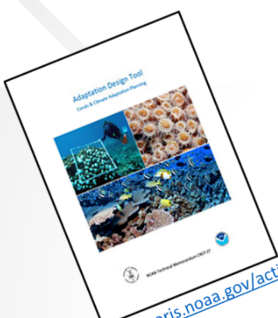
Coral Reef Application

West et al. (2017, 2018):

doi 10.1007/s00267-016-0774-3

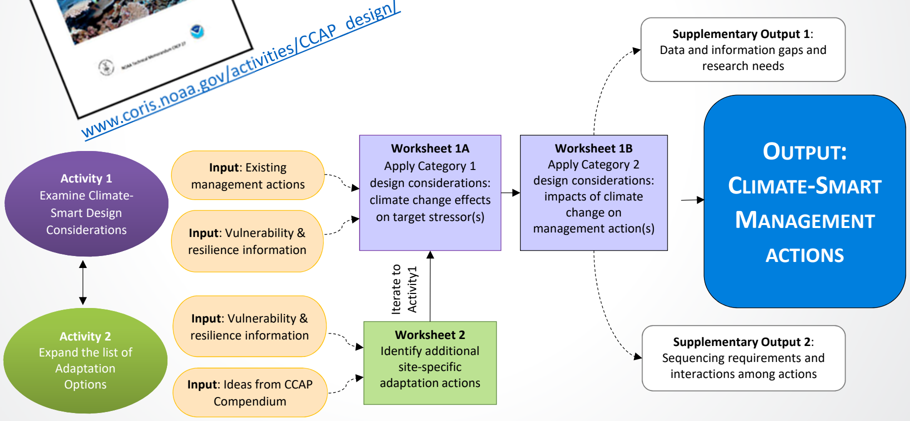
doi 10.1007/s00267-018-1065-y

Adaptation Design Tool



Breaking down a complex process . . .

www.coris.noaa.gov/activities/CCAP_design/

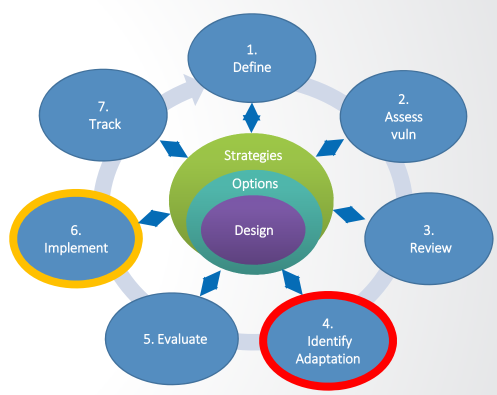


What does the tool do?

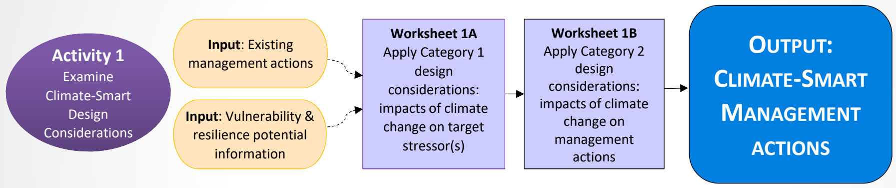
- Helps you apply climate-smart design to your management activities
- Supports brainstorming of additional adaptation activities that may be critically needed
- Generates insights on:
  - information gaps & research needs
  - synergies, conflicts & sequencing considerations

What does it NOT do?

- Provide a vulnerability assessment
  (But it does reveal the form & content needed)
- Make evaluation & selection decisions for you
  (But it does support a more robust decision process)
- Produce your project implementation plan
  (But it does provide the technical basis for climate-smart implementation)



Activity 1: Examine Design Considerations



Activity 1 helps you:

- Consider how climate change will affect stressors of concern relevant to your management action (Worksheet 1A)
- Analyze how the management action can then be adapted in order to be most effective given those changes (Worksheet 1B)

West Maui, Hawai'i example

Original Action:
Install terraces adjacent to dirt roads in agricultural areas to reduce sediment runoff onto reefs.

How will increasingly severe storms affect the volume, pattern and timing of runoff into terraces?

How can the terraces be designed (number, durability, dimensions) and located (placed in the landscape) to account for these effects?

Climate-Smart Action:
Install terraces resistant to extreme events, adjacent to roads targeted as contributing the largest percent sediment outflows to reefs; design terraces of sufficient dimension, number and step-series appropriate to the location; increase maintenance frequency to shorter time intervals and after heavy rainfall events.

How does this relate to our previous talks?

Guánica Bay, Puerto Rico example

A1	A2	A3	A4	A5	A6	A7
Action number	Existing management action	Stressor(s) of concern	Climate change effects on stressor(s): direction, magnitude, mechanism, uncertainty	Timing of climate change effects	Implications for effectiveness metrics and how to measure them	Notes
3	Outplant aquarium-grown corals on reefs surrounding the bay mouth to enhance coastal protection and reduce coastline erosion	• Warmer ocean water • Lower pH ocean water • Terrestrial sediment and nutrients • Sea level rise (SLR) • Disease • Acute impacts from storms other than sediment and turbidity (i.e., breakage and scouring • Acute anthropogenic impacts (e.g., vessel groundings)	• Warmer waters may increase bleaching episodes and disease outbreaks. Longer periods of heat stress, as well. High magnitude, low uncertainty. • More intense storms may produce runoff carrying more sediment and nutrients. Percent increase in erosion and runoff will likely be greater than percent increase in precipitation. High magnitude, low uncertainty. • Stormwater plumes may extend further into the ocean, impacting more coral reefs. High magnitude, low unc… [illegible] • Sed… (m… unc… [illegible] • Sto… and… ree… ma… [illegible] • Inc… systems due to warmer water. Medium magnitude, medium uncertainty. • Sea level rise may occur faster than reef accretion, leading to "sinking reefs". Medium magnitude, low uncertainty. • Ocean acidification may decrease colony growth rates, reproduction, and successful recruitment if corals cannot chemically cue to settlement sites, put energy into gamete production, or calcify (due to acidic conditions). High magnitude, medium-high uncertainty.	• Temperature effects have already occurred, with increasing magnitude through mid-century. • Increasingly violent storms are already occurring. • Storm intensity will likely continue to increase over coming decades. • Acidification beyond coral optima may have already occurred for some taxa and is expected to worsen.	**Effectiveness metrics:** • Survival and growth rates of outplanted colonies, including genetic diversity. Sexual and asexual reproduction of colonies. • Reduced wave height inshore. • Reduced erosion rate onshore. **Implications for effectiveness metrics:** • Survival rates over longer time periods (multiple years) may decrease due to episodic events, like … [illegible] **… metrics:** • Monitor survival for longer after outplanting because of more episodic climate change-associated events, like bleaching or storms. Monitor longer for reproduction because of delayed sexual maturity. • Monitor rugosity, the roughness of the reef that creates friction and thus wave attenuation • Monitor wave height and/or erosion rate	• Is a certain level of rugosity of outplants desirable? • Some micro-fragging is being used to "re-sheet" dead boulder colonies, like *Orbicella*. • Since this action is so closely related to the nursery action, it will be important to adjust nursery rearing practices in response to outplanting results. Effects of ocean acidification on different coral life stages are particularly unknown.

USGS study validates coastal protection function as priority objective driving this action and supports creation of appropriate effectiveness metrics

BCG work provides information on site functional levels that help identify effectiveness metrics for meeting condition targets

How does this relate to our previous talks?

Guánica Bay, Puerto Rico example

B1	B2	B3	B4	B5	B6	B7	B8
Action number	Existing management action	Changes in effectiveness of management action due to: climate impacts on target stressor	Changes in effectiveness of management action due to: climate impacts on management action	Time frame or constraint for using the action and implementation (e.g., urgency, longer or shorter term)	What changes are needed to adapt the action (place, time, and engineering design)	Climate-Smart Management Action	Notes
3	Outplant aquarium-grown corals on reefs surrounding the bay mouth to enhance coastal protection and reduce coastline erosion	• Areas suitable for outplanting may change due to extended sediment plumes from rivers. • Decreased growth and reproduction rates of outplants from ocean acidification. • Above stressor effects may reduce the genetic diversity of outplanted colonies … [illegible] outplanted colonies from bleaching, diseases and storms.	• Fewer boat and diving days available for outplanting corals due to an increase in storms. • Meth… for a… subs… with… storm… [illegible] • Prefe… seas… [illegible] • Incre… damage to aquarium nursery facilities. • SLR may offset any wave height/erosion redu… cora… [illegible]	• The sooner this is initiated, the better. • Outplanting may … e a … , long- … rt. [illegible]	• Focus on outplanting coral strains with a variety of types of tolerance to climate-change effects, including being bred to tolerate multiple stressors (stress-harden corals). • Stronger attachment methods (e.g., … [illegible] • Time outplanting to avoid periods with more runoff and land-based pollution. • Factor changes in sediment plume location and direction into outplanting site selection. • Extend monitoring longer after outplanting to include observation of how outplants handle extreme events and to what extent they reproduce. • Establish more than one coral growing facility to reduce risk of losing all stock.	Using species that effectively protect the coastline, outplant colonies that are heat, disease-, sediment-, and low pH-tolerant. Avoid outplanting during high sediment or precipitation periods to reduce initial stressor exposure to outplants. Colonies should be affixed to reefs using stronger attachment methods due to larger storms. Site selection should be adjusted for shifting plumes of land-based pollutants from the bay. Because survival through extreme events is an important part of the nursery program, colonies should be monitored through extreme events such as high temperatures and large storms. Monitoring periods for outplants should be extended to do this. Site more than one growth facility to spread risk of total loss.	• Reefs to the west of Guanica Bay receive more sedimentation than those to the east. Reef resilience assessment shows some potentially suitable sites to the east of the bay. • Need to focus on other activities that are important for improving the outplanting environment. • How can multiple colonies be attached to the bottom simultaneously?

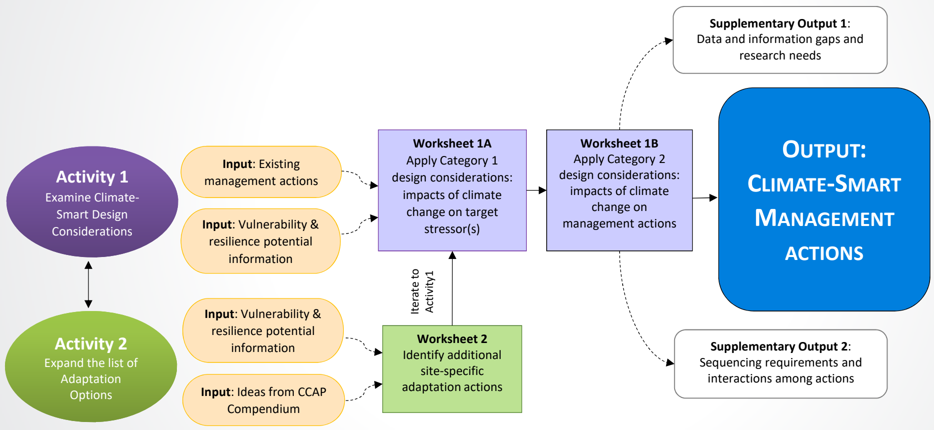
BCG information on site functional levels informs site selection considerations

BCG attribute: Growth rate

BCG attributes:
-Bleaching susceptibility
-Disease susceptibility
-Pathogenic diseases

BCG attribute: Sediment tolerance

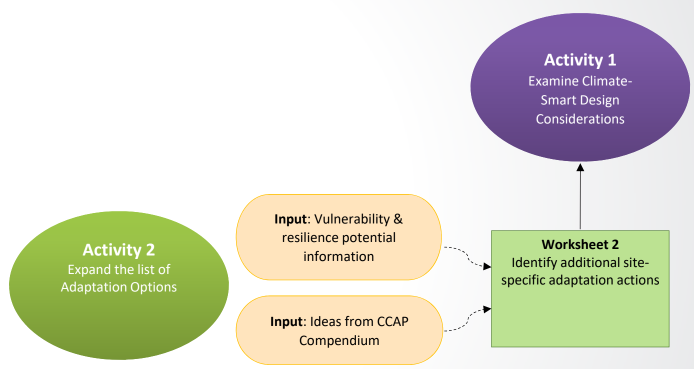
Adaptation Design Tool



Activity 2: Expand your list of potential actions

Activity 2 helps you:

- Identify additional actions that address climate-related vulnerabilities not sufficiently addressed in your existing plan
- Start building a list of potential adaptation actions if you are starting a plan from scratch



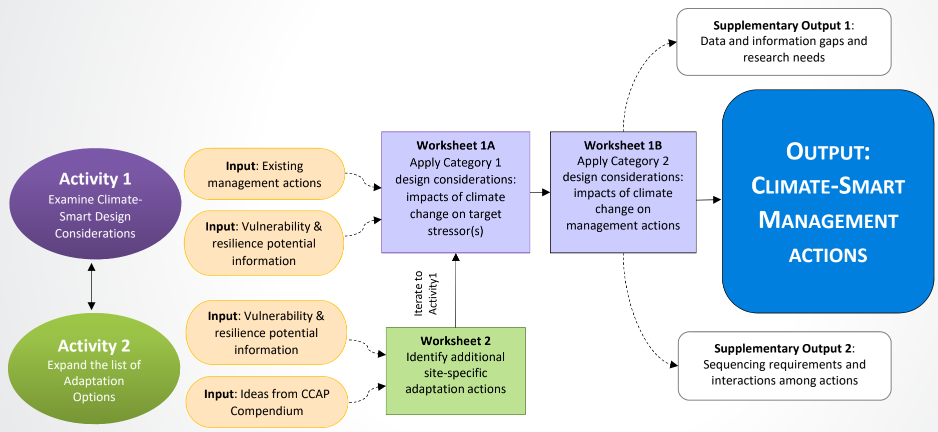
Guánica Bay, Puerto Rico example

Management Action	A. Reduce Non-Climate Stresses	B. Protect Key Ecosystem Features	C. Ensure Connectivity	D. Restore Structure and Function	E. Protect Refugia	F. Relocate Organisms	G. Support Evolutionary Potential
Plant riparian buffers along the Rio Loco where it passes through farms	X						
Plant cover crops in Guánica Valley farms	X						

Guánica Bay, Puerto Rico example

Management Action	A. Reduce Non-Climate Stresses	B. Protect Key Ecosystem Features	C. Ensure Connectivity	D. Restore Structure and Function	E. Protect Refugia	F. Relocate Organisms	G. Support Evolutionary Potential
Plant riparian buffers along the Rio Loco where it passes through farms	X						
Plant cover crops in Guánica Valley farms	X						
Outplant corals from nurseries onto reefs for coastal protection				X		X	X
Eliminate invasive lionfish				X			
Protect mangroves adjacent to key reef areas	X	X	X				
Establish MPAs targeting resilient reefs as recruitment sources as well as destinations for migrants		X	X		X		X

Adaptation Design Tool



Supplementary outputs

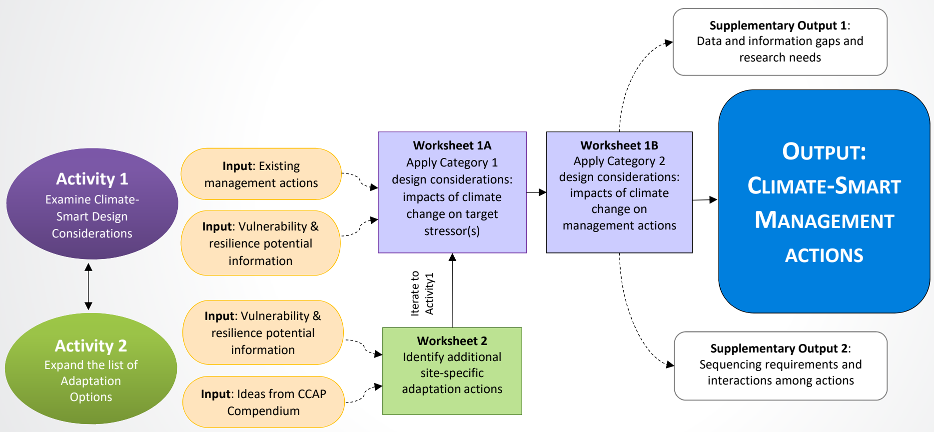
SO #1: Information on Key Data and Information Gaps and Research Needs

1	2	3	4	5	6	7
Action number	Existing management action	Understanding of watershed processes (historical and current)	Understanding patterns of climate change drivers	Understanding climate change effects on stressors of concern	Understanding stressor effects on biota	Understanding climate change effects on effectiveness of management action
1	Switch from sun-grown to shade-grown coffee	• How drought tolerant are shade-grown coffee plants? • Need to understand defoliation and its triggers (for guava, Guama, capa, mocha, etc.) to determine possible impacts of coffee shade trees on coffee plants.	• Is there information on the projected increase in wind speeds in general? • Will there be changes in circulation patterns that would impact sediment delivery to Puerto Rico's coral reefs?	• Need to do a geospatial analysis of the flooding in Lajas Valley to document aerial extent	• Need to better understand the sensitivity of reef species to various stressors • Conduct a gap analysis to identify where improvements might be made to the Guanica Dry Forest and the upper watershed forests, as well as connections between the forests (upper and lower)	• How wide do buffers need to be in the Caribbean sub-tropics? • How much larger a buffer is needed to accommodate the larger rain events and flooding?

SO #2: Analyzing sequencing and interactions among actions

1	2	3	4	5	6
Action number	Existing Management Action (Original)	Climate-Smart Management Action	Interactions (interdependency, redundancy, conflict, + synergy)	Sequencing (overlap requirements, prerequisites, temporal implementation)	Notes
1	Switch from sun-grown to shade-grown coffee	Plant shade-tolerant coffee with heat-tolerant shade plants. Plant understory/secondary canopy plants that will effectively use or provide nutrients (e.g., n-fixation) and stabilize soil during more intense storms.	Interdependency: with farm inventory Redundancy: cover crops in coffee farm Conflict: ? + Synergy: with treatments and standards for dirt roads	Continue to implement, but need to conduct a farm inventory to assist in prioritization of future conversions; continue to develop treatments and standards for dirt roads on coffee farms (concurrent action).	Conduct a farm inventory for the upper watershed to determine additional farms for conversion to shade-grown coffee and also identify farms with active erosion issues; include crops grown, BMPs, fertilizer/pesticide/herbicide application rates and production

Adaptation Design Tool



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What is the value-added in using the tool?

- Structures and clarifies a complex thought process
- Provides transparency and credibility for decisions
- Looks at uncertainty without being paralyzed by it
- Supports consideration of spatial and temporal scales in planning
- Provides a practical basis for higher level strategic planning

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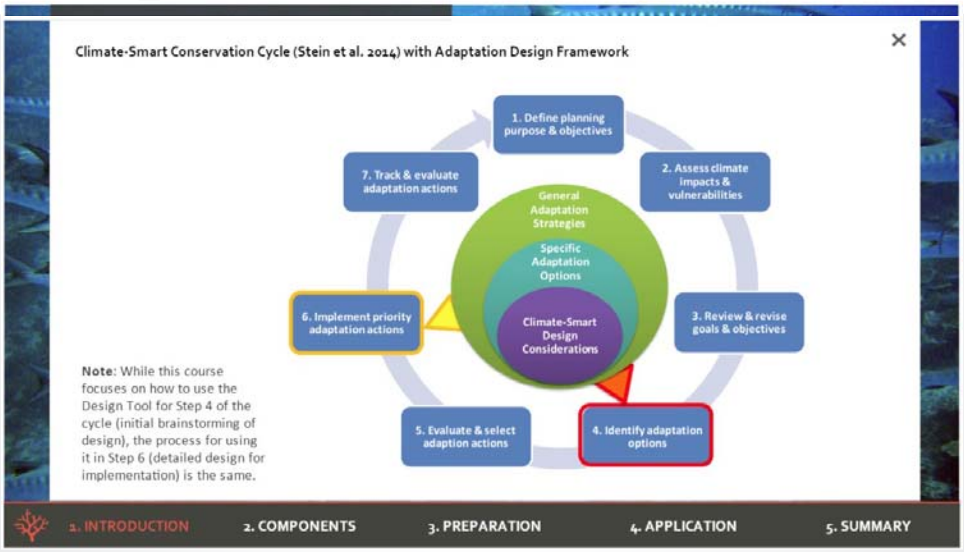
Reef Resilience Network online course



https://reefresilience.org/community-based-climate-adaptation/climate-adaptation-tools/ccap-adaptation-design-tool/

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Watershed Academy Webcast

More webcasts coming soon!

www.epa/gov/watershedacademy

The slides from today's presentations are posted.
A recording will be posted within the next month.

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Thank You!