APPENDIX II: MATRICES OF HABITAT CHARACTERISTICS AND PARAMETERS

When developing a restoration monitoring plan, the goals of the project and knowledge of the habitat should be used to identify potential structural and functional characteristics to be monitored. Parameters then need to be identified that can be used to appropriately determine the status of or change in each characteristic.

In some cases, it is critical to monitor the effects a restoration project has on social or economic aspects of the local human community or regional population. The parameters presented in this appendix and elsewhere in this volume, however, do not address socioeconomics. The monitoring of the effects of coastal restoration on human dimensions will be covered in *Volume Two: Tools for Monitoring Coastal Habitats.* Additionally, a stand-alone document addressing in detail the role of socioeconomics in the monitoring of coastal restoration projects is currently in development.

Through a series of matrices, this appendix establishes a three-part process that walks the reader through the selection of habitat characteristics and corresponding parameters for inclusion in a restoration monitoring plan. The three steps are: identification of appropriate structural and functional characteristics of the habitat; identification of parameters that determine the change in or status of those habitat characteristics; and determination of suitability of the potential parameters for use in a given habitat. An example of how to use this appendix follows the description of the matrices.

In using these matrices, it should be remembered that the goal of coastal restoration is to recover functioning habitat as noted earlier in this document in *The Process of Developing a Monitoring Plan.*

Matrix A. Structural and Functional Characteristics of the Habitats

The structural components of a habitat are the physical, chemical, and biological characteristics that define that habitat. The functional components are the processes occurring within and between habitats as a result of their structural components. The ultimate goal of any restoration action should be to return functions and not simply build structure[6]. Understanding the structure and function of a habitat allows for an understanding of the fundamental ecology of the system and selection of those parameters most relevant to the goals of the project.

Matrix A provides a listing of significant structural and functional characteristics for each habitat type. This listing was developed through searches of the ecological literature, published restoration efforts, and ecological monitoring studies. Additionally, ecologists, restoration researchers, and people involved with monitoring provided extensive input. Other characteristics not included on these lists may be appropriate depending on the goals of an individual restoration project. The determination of which structural and functional characteristics will be monitored for a given restoration project should be made in conjunction with experts on the local habitat, keeping in mind that the goals of a given project that directly determines the characteristics to be monitored.

Detailed habitat descriptions, as well as discussions of the habitat structural and functional characteristics and the rationale for their inclusion, are found in *Coastal Habitats: Ecology, Restoration, and Monitoring*, a chapter in *Volume Two: Tools for Monitoring Coastal Habitats*.

Matrix B. Structural and Functional Characteristics and Their Associated Parameters

Once a list of the relevant structural and functional characteristics to be monitored has been developed for a restoration project, parameters need to be identified that will appropriately determine the status of or change in those characteristics.

Matrix B provides a list of parameters associated with each structural and functional characteristic identified in Matrix A. The experts in each habitat reviewed and augmented the lists to ensure that parameters included can be used to accurately assess progress toward restoration goals. Additionally, searches of the ecological literature, published restoration efforts, and ecological monitoring studies were conducted to determine the types of parameters considered in coastal restoration projects. Matrix B should be used to develop a broad list of potential parameters that may be included in the monitoring plan. This list of potential parameters is not exhaustive, however, and should be considered a starting point. Other parameters not included on these lists may be appropriate for assessing change in or the status of a given characteristic. The determination of the parameters to be monitored should be made in conjunction with experts, including those with a background in statistics, the local habitat, and monitoring the characteristics in question.

Matrix C. Restoration Monitoring Parameters By Habitat

Once a broad list of monitoring parameters has been developed, it is important to review that list to determine those parameters that are applicable to a specific habitat. Matrix C provides a list of parameters that are significant or appropriate for monitoring in each habitat. The parameters have been sorted to reflect their relevance to either structural or functional characteristics.

As with Matrices B and C, the listing of habitat specific parameters used in restoration monitoring was developed through literature searches of restoration efforts and ecological monitoring studies and through extensive input from restoration and monitoring researchers with expertise in that particular habitat. The lists include those parameters most commonly measured in restoration monitoring in each habitat and are not to be considered exhaustive. Experts on each habitat have reviewed and augmented the lists to ensure that parameters included can be used to accurately assess progress toward restoration goals. Other parameters not included on these lists may be appropriate depending on the goals of an individual restoration project.

The parameters included in this matrix are classified into two groups. Parameters marked with a filled circle are those indicated by experts as critical for inclusion in the monitoring of most restoration projects in this habitat. Parameters marked by an open circle are those that may be considered for inclusion in a monitoring plan, depending on the goals of the restoration project but are not considered critical for all monitoring projects.

How to Use the Matrices

The example provided below walks readers through the process of identifying potential parameters to be measured in the monitoring of a coastal restoration project. Although most projects will have multiple goals, this example will pertain to a single goal.

Project goal: To increase the acreage of marsh habitat within the project area as a means of supporting an endangered terrapin population.

Matrix A: There are a wide variety of structural and functional characteristics associated with marshes. When reading through this list, the intent and constituent parts of the specific goal should be kept in mind. Given that the goal above involves creating marsh with the specific idea of supporting terrapins, the long list of characteristics can be reduced to these items:

- Habitat created by plants
- Provides breeding grounds
- Provides nursery area
- Provides feeding grounds
- Supports a complex trophic structure
- Supports biomass production

Matrix B: For each characteristic identified in Matrix A, a set of potential parameters is then identified. This example walks through the parameter selection process for one of the characteristics from the above list. The long list of parameters generated in this step of the process will be tailored to the habitat in question through the use of Matrix C and knowledge of the intent of the specific goal.

Parameters associated with the functional characteristic "Provides feeding grounds":

Geographical

- Acreage of habitat types

Biological

Plants

- Species, composition, and % cover of:
  - Algae
  - Epiphytes
  - Herbaceous vascular
  - Invasives
  - Woody
- Canopy extent and structure
- Interspersion of habitat types
- Litter fall
- Mast/seed production
- Phytoplankton diversity and abundance
- Plant health (herbivory damage, disease)
- Plant weight (above and/or below ground parts)
- Woody debris (root masses, stumps, logs)

Animals

- Species, composition, and abundance of:
  - Amphibians
  - Birds
  - Fish
  - Invasives
  - Invertebrates

    - Mammals
    - Reptiles
  - Coral growth rate
  - Coral recruitment and survivorship
  - Vertical relief of reef

Hydrological

Physical

- Trash
- Water level fluctuation over time

Chemical

- Chlorophyll concentration
- Salinity (in tidal areas)
- Toxics

Soil/Sediment

Physical

- Basin elevations
- Geomorphology (slope, basin cross section)

Chemical

- Organic content in sediment

Matrix C: This matrix assists readers in reducing the long list of potential parameters down to those appropriate for the habitat and goal in question.

Using Matrix C and knowledge of terrapin biology, the list of parameters for the functional characteristic "provides feeding grounds" becomes:

- Acreage of habitat types (associated with the structural element of the goal)
- Interspersion of habitat types (allows access to marsh habitat)
- Herbaceous species composition and percent cover (type and density of marsh plants is one aspect of the quality of the habitat)
- Species composition and abundance of:
  - Fish (potential prey items)
  - Invertebrates (potential prey items)
  - Reptiles (terrapins)
- Water fluctuation over time (important for marsh health, as well as aspects of terrapin biology including breeding and feeding)
- Basin elevations (important aspect of habitat quality and accessibility)
- Geomorphology, including slope and cross section (important for marsh diversity and accessibility)

This process provides a convenient means of identifying habitat characteristics and their associated parameters. It is critical, however, that the process be augmented with a thorough knowledge of local habitats and a strong understanding of the intent of the project goals. Use the characteristics and parameters identified through the use of these matrices as a starting point for discussion for a group that includes managers, statisticians, and scientists such as ecologists, hydrologists, geologists, physical oceanographers, and fisheries biologists.

Matrix A: Structural and Functional Characteristics of the Habitats

Structural Characteristics	Habitats												
	Water Column	Rock Bottom	Coral Reef	Oyster Reef	Soft Bottom	Kelp and Macroalgae	Rocky Shore	Soft Shore	SAV	Marsh	Mangroves	Deepwater Swamps	Riverine Forests
Biological													
Habitat created by animals			x	x									
Habitat created by plants[1]						x			x	x	x	x	x
Physical													
Sediment grain size		x		x	x	x	x	x	x	x	x	x	x
Topography/Bathymetry		x	x	x	x		x	x	x	x	x	x	x
Turbidity	x					x			x				
Hydrological													
Current velocity	x	x		x	x	x	x		x	x	x	x	
Tides/Hydroperiod[2]	x			x	x	x	x	x	x	x	x	x	x
Water sources	x	x	x	x	x	x			x	x	x	x	x
Wave energy	x	x	x	x	x	x	x	x	x	x	x		
Chemical													
Nutrient concentration	x		x	x					x	x	x		
pH, salinity, toxics, redox, DO	x	x	x	x	x	x	x		x	x	x	x	x
Functional Characteristics													
Biological													
Contributes to primary productivity	x					x		x	x	x	x	x	x
Exhibits symbiotic species interactions			x										
Produces wood											x	x	x
Provides breeding grounds	x	x	x	x	x	x	x	x	x	x	x	x	x
Provides feeding grounds	x	x	x	x	x	x	x	x	x	x	x	x	x
Provides nursery areas		x	x	x		x			x	x	x	x	x
Provides refuge from predation		x	x	x		x	x	x	x	x	x		
Provides substrate for attachment		x	x	x		x	x		x	x	x		
Supports a complex trophic structure			x	x		x			x	x	x	x	x
Supports biodiversity			x	x		x			x	x	x		
Supports biomass production	x		x	x		x			x	x	x	x	x
Hydrological													
Physical													
Affects transport of suspended/dissolved material	x	x							x	x	x	x	x
Alters turbidity		x		x	x			x	x	x	x	x	x
Modifies water temperature									x		x	x	x
Provides temporary flood water storage										x	x	x	x
Reduces erosion potential		x	x	x		x	x		x	x	x	x	
Reduces wave energy		x	x	x		x	x		x	x	x		
Chemical													
Modifies chemical water quality	x			x	x	x			x	x		x	x
Modifies dissolved oxygen					x	x			x				
Supports nutrient cycling	x		x	x	x	x			x	x	x	x	x

[1] When present, plants are always important even if they are not a defining structural feature of the habitat.
[2] Refers to the timing, height, and duration of water level fluctuations
X = a defining structural or functional characteristic of a particular habitat

Matrix B: Parameters to Monitor Structural and Functional Characteristics

Parameters to Monitor	Structural Characteristics: Biological		Physical				Hydrological					Chemical		
		Habitat created by animals	Habitat created by plants		Sediment grain size	Topography Bathymetry	Turbidity		Current velocity	Tides Hydroperiod	Water Sources	Wave energy		Nutrient concentration	pH, salinity, toxics, redox, DO[1]
Geographical															
Acreage of habitat types		◆	◆				◆								
Biological															
Plants															
Species, composition, and % cover of:															
Algae			◆												
Epiphytes			◆												
Herbaceous vascular			◆												
Woody			◆												
Basal area			◆												
Canopy extent and structure[2]			◆												
Interspersion of habitat types		◆	◆			◆									
Phytoplankton diversity and abundance			◆				◆							◆	
Plant height			◆												
Seedling survival			◆												
Stem density			◆												
Woody debris (root masses, stumps, logs)			◆			◆									
Animals															
Vertical relief		◆				◆									
Hydrological															
Physical															
Chlorophyll concentration							◆								
PAR[3]							◆								
Secchi disc depth							◆								
Shear force at sediment surface									◆			◆			
Sheet flow									◆						

[1] Dissolved oxygen
[2] Applies to forest, submerged aquatic vegetation (SAV), and kelp habitats
[3] Photosynthetically active radiation, measured at canopy height and substrate surface

◆ = a pairing between a habitat characteristic and a measured parameter

Matrix B: Parameters to Monitor Structural and Functional Characteristics (cont.)

Parameters to Monitor	Structural Characteristics												
	Biological	Habitat created by animals	Habitat created by plants	**Physical**	Sediment grain size	Topography Bathymetry	Turbidity	**Hydrological**	Current velocity	Tides Hydroperiod	Water Sources	Wave energy	**Chemical**	Nutrient concentration	pH, salinity, toxics, redox, DO
Hydrological (cont.)															
Physical (cont.)															
Temporary water										◆					
Temperature										◆	◆				
Upstream land use											◆				
Water column current velocity									◆						
Water level fluctuation over time										◆	◆				
Chemical															
Dissolved oxygen															◆
Groundwater indicator chemicals[4]											◆				
Nitrogen and phosphorus														◆	
pH															◆
Salinity (in tidal areas)										◆	◆				◆
Silicon														◆	
Toxics											◆				◆
Soil/Sediment															
Physical															
Basin elevations						◆									
Bulk density					◆										
Depth of mottling										◆					
Geomorphology (slope, basin cross section)						◆				◆					
Moisture levels and drainage										◆					
Organic content					◆					◆				◆	
Percent sand, silt, and clay					◆									◆	
Sedimentation rate and quality					◆	◆			◆	◆				◆	
Chemical															
Pore water nitrogen and phosphorus														◆	
Pore water salinity (in tidal areas)															◆
Redox potential															◆

[4] Calcium and magnesium

◆ = a pairing between a habitat characteristic and a measured parameter

Matrix B: Parameters to Monitor Structural and Functional Characteristics (cont.)

Functional Characteristics

Parameters to Monitor	Biological: Contributes primary production	Exhibits symbiotic species interactions	Produces wood	Provides breeding grounds	Provides feeding grounds	Provides nursery areas	Provides refuge from predation	Provides substrate for attachment	Supports a complex trophic structure	Supports biomass production	Supports biodiversity	Physical: Affects transport of suspended/dissolved material	Alters turbidity	Modifies water temperature	Provides temporary floodwater storage	Reduces erosion potential	Reduces wave energy	Chemical: Modifies chemical water quality	Modifies dissolved oxygen	Supports nutrient cycling
Geographical																				
Acreage of habitat types	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆
Biological																				
Plants																				
Species, composition, and % cover of:																				
Algae	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆			◆	◆	◆	◆	◆
Epiphytes	◆	◆			◆				◆	◆	◆	◆							◆	◆
Herbaceous vascular	◆			◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆
Invasives				◆	◆	◆	◆		◆		◆									
Woody	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆			◆
Basal area	◆		◆							◆										
Canopy extent and structure[5]			◆	◆	◆	◆	◆	◆		◆	◆	◆	◆	◆			◆			
Interspersion of habitat types				◆	◆	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆
Litter fall	◆				◆				◆	◆			◆							◆
Mast/seed production	◆				◆					◆										
Phytoplankton diversity and abundance	◆				◆				◆	◆	◆		◆					◆	◆	◆
Plant health (herbivory damage, disease[6])					◆															
Plant height	◆									◆				◆						
Plant weight (above and/or below ground parts)	◆		◆		◆					◆										
Nutrient levels in algal tissues (N and P)																		◆		◆
Rate of canopy closure	◆		◆							◆				◆						

[5] Applies to forest, submerged aquatic vegetation, and kelp habitats

[6] If the whole community is destroyed by disease or lack of seedling survival, all vegetation-related functions will be impaired

◆ = a pairing between a habitat characteristic and a measured parameter

Matrix B: Parameters to Monitor Structural and Functional Characteristics (cont.)

Parameters to Monitor	Functional Characteristics																				
	Biological											**Physical**							**Chemical**			
	Contributes primary production	Exhibits symbiotic species interactions	Produces wood	Provides breeding grounds	Provides feeding grounds	Provides nursery areas	Provides refuge from predation	Provides substrate for attachment	Supports a complex trophic structure	Supports biomass production	Supports biodiversity	Affects transport of suspended/dissolved material	Alters turbidity	Modifies water temperature	Provides temporary floodwater storage	Reduces erosion potential	Reduces wave energy		Modifies chemical water quality	Modifies dissolved oxygen	Supports nutrient cycling
Biological (cont.)																					
Plants (cont.)																					
Seedling survival[7]			◆													◆					
Stem density						◆	◆	◆	◆			◆	◆	◆		◆	◆				
Woody debris (root masses, stumps, logs)			◆	◆	◆	◆	◆	◆	◆		◆					◆	◆				
Biological																					
Animals																					
Species, composition, and abundance of:																					
Amphibians				◆	◆	◆	◆		◆	◆	◆										
Birds				◆	◆	◆	◆		◆	◆	◆										
Fish				◆	◆	◆	◆		◆	◆	◆										
Invasives					◆	◆	◆			◆	◆	◆	◆								
Invertebrates				◆	◆	◆	◆		◆	◆	◆										
Mammals				◆	◆	◆	◆		◆	◆	◆										
Reptiles				◆	◆	◆	◆		◆	◆	◆										
Coral growth rate	◆	◆		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆								
Coral recruitment and survivorship	◆	◆		◆	◆	◆	◆	◆	◆			◆	◆								
Fecal coliforms																			◆	◆	
Grazer density	◆					◆	◆														
Vertical relief of reef	◆			◆	◆	◆	◆	◆	◆			◆	◆			◆	◆				

[7] If the whole community is destroyed by disease or lack of seedling survival, all vegetation-related functions will be impaired

◆ = a pairing between a habitat characteristic and a measured parameter

Matrix B: Parameters to Monitor Structural and Functional Characteristics (cont.)

Parameters to Monitor	Functional Characteristics: Biological											Physical							Chemical		
	Contributes primary production	Exhibits symbiotic species interactions	Produces wood	Provides breeding grounds	Provides feeding grounds	Provides nursery areas	Provides refuge from predation	Provides substrate for attachment	Supports a complex trophic structure	Supports biomass production	Supports biodiversity	Affects transport of suspended/dissolved material	Alters turbidity	Modifies water temperature	Provides temporary floodwater storage	Reduces erosion potential	Reduces wave energy	Modifies chemical water quality	Modifies dissolved oxygen	Supports nutrient cycling
Hydrological																				
Physical																				
Fetch												◆	◆			◆	◆		◆	
PAR	◆									◆		◆	◆							
Secchi disc depth	◆									◆		◆	◆							
Shear force at sediment surface												◆	◆			◆	◆			
Sheet flow												◆	◆		◆	◆		◆	◆	◆
Temperature				◆		◆								◆				◆	◆	
Temporary water															◆			◆	◆	◆
Trash					◆							◆	◆							
Upstream land use												◆	◆					◆		
Water column current velocity												◆	◆			◆				
Water level fluctuation over time				◆	◆	◆	◆					◆	◆		◆	◆			◆	◆
Chemical																				
Chlorophyll concentration	◆				◆					◆		◆	◆					◆	◆	◆
Dissolved oxygen				◆		◆			◆		◆							◆	◆	◆
Nitrogen and phosphorus	◆									◆			◆					◆		◆
pH																		◆		
Salinity (in tidal areas)				◆	◆						◆							◆	◆	

◆ = a pairing between a habitat characteristic and a measured parameter

Matrix B: Parameters to Monitor Structural and Functional Characteristics (cont.)

Parameters to Monitor	Functional Characteristics: Biological											Physical							Chemical			
	Contributes primary production	Exhibits symbiotic species interactions	Produces wood	Provides breeding grounds	Provides feeding grounds	Provides nursery areas	Provides refuge from predation	Provides substrate for attachment	Supports a complex trophic structure	Supports biomass production	Supports biodiversity	Affects transport of suspended/dissolved material	Alters turbidity	Modifies water temperature	Provides temporary floodwater storage	Reduces erosion potential	Reduces wave energy	Modifies chemical water quality	Modifies dissolved oxygen	Supports nutrient cycling
Hydrological (cont.)																				
Chemical (cont.)																				
Silicon	◆									◆								◆		
Toxics				◆	◆	◆												◆		
Soil/Sediment																				
Physical																				
Basin elevations				◆	◆	◆	◆	◆			◆	◆		◆	◆					
Bulk density											◆									◆
Depth of mottling															◆					◆
Geomorphology (slope, basin cross section)				◆	◆	◆	◆	◆			◆	◆	◆	◆	◆	◆		◆	◆	
Moisture levels and drainage											◆				◆					◆
Sediment grain size (OM[8]/sand/silt/clay/gravel/cobble)								◆		◆		◆	◆			◆	◆	◆	◆	◆
Sedimentation rate and quality											◆	◆	◆			◆				
Chemical																				
Organic content in sediment					◆				◆	◆	◆	◆	◆					◆	◆	◆
Pore water nitrogen and phosphorus										◆								◆		◆
Pore water salinity (in tidal areas)											◆								◆	
Redox potential																		◆		◆

[8] Organic matter

◆ = a pairing between a habitat characteristic and a measured parameter

Matrix C: Restoration Monitoring Parameters by Habitats

Structural Parameters to Monitor	Habitats: Water Column	Rock Bottom	Coral Reef	Oyster Reef	Soft Bottom	Kelp and Macroalgae	Rocky Shore	Soft Shore	SAV	Marsh	Mangroves	Deepwater Swamps	Riverine Forests
Geographical													
Acreage of habitat type	●	●	●	●	●	●	●	●	●	●	●	●	●
Biological													
Plants													
Species, composition, and % cover of:													
Algae		❍	❍	❍		●	●	●	❍		❍		
Epiphytes			●		❍	❍	●		❍		❍		
Herbaceous vascular							●	●	●	●	❍	❍	❍
Woody											●	●	●
Basal area												❍	❍
Canopy extent and structure						❍			❍		❍	❍	❍
Interspersion of habitat types						●			❍	●			
Phytoplankton diversity and abundance	❍	❍		❍									
Plant height						❍			❍	❍	❍	❍	❍
Seedling survival						❍			❍	❍	❍	●	●
Stem density									❍	❍	❍	●	●
Woody debris (root masses, stumps, logs)												❍	❍
Animals													
Vertical relief			●	●									
Hydrological													
Physical													
Chlorophyll concentration	●				❍			❍					
PAR	❍					●			●				
Secchi disc depth	❍					●			●				
Shear force at sediment surface	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍			
Sheet flow										❍		●	
Temperature	❍	❍	●			●			❍		❍	❍	❍
Temporary water													❍
Upstream land use	●		❍	❍					❍	❍	●	●	●
Water column current velocity	❍	❍		❍	●	●	❍		●				
Water level fluctuation over time	●	●		●		❍	●	●	●	●	●	●	●
Chemical													
Dissolved oxygen	●			❍	❍	❍			❍				
Groundwater indicator chemicals	❍								❍	❍			❍
Nitrogen and phosphorus	❍		❍	❍	❍				❍	❍	❍		❍
pH	❍			❍		❍				❍			
Salinity (in tidal areas)	●	●		●	●	❍	❍	❍	●	●	●	❍	❍
Silicon	❍												
Toxics	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Soil/Sediment													
Physical													
Basin elevations		❍	❍		❍		❍	❍	❍	❍		❍	❍
Bulk density										❍		❍	❍
Depth of mottling													❍
Geomorphology (slope, basin cross section)		●	●	●	●	●	●	●	●	●	●	●	●
Moisture levels and drainage												❍	❍

● Represents a parameter that is recommended for measurement in most restoration monitoring projects
❍ Represents a parameter that might be useful to monitor depending on the goals of the project but is not considered critical for all monitoring programs

Matrix C: Restoration Monitoring Parameters by Habitats (cont.)

Structural Parameters to Monitor (cont.)	Habitats												
	Water Column	Rock Bottom	Coral Reef	Oyster Reef	Soft Bottom	Kelp and Macroalgae	Rocky Shore	Soft Shore	SAV	Marsh	Mangroves	Deepwater Swamps	Riverine Forests
Soil/Sediment													
Physical													
Organic content		❍		❍	●	❍	❍	●	❍	●	❍	❍	❍
Percent sand, silt, and clay		❍			●	❍	●	●	❍	❍	❍	❍	❍
Sedimentation rate and quality		❍	❍	❍	●		❍	❍	❍	●	❍	❍	❍
Chemical													
Pore water nitrogen and phosphorus		❍		❍	❍	❍		❍	❍	❍			❍
Pore water salinity (in tidal areas)										●		❍	
Redox potential									❍	❍		❍	

Functional Parameters to Monitor													
Geographical													
Acreage of habitat types	●	●	●	●	●	●	●	●	●	●	●	●	●
Biological													
Plants													
Species, composition, and % cover of:													
Algae		❍	❍	❍		●	❍	❍	❍		❍		
Epiphytes			●		❍	❍	❍		❍		❍		
Herbaceous vascular							❍	❍	●	●	❍	❍	❍
Invasives		❍			❍		❍	❍	❍	❍	❍	❍	❍
Woody											●	●	●
Basal area												❍	❍
Canopy extent and structure						❍			❍			❍	❍
Interspersion of habitat types	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Litter fall											❍	❍	❍
Mast/seed production													❍
Nutrient levels in algal tissues (N and P)	❍		❍										
Phytoplankton diversity and abundance	❍	❍		❍									
Plant health (herbivory damage, disease)		❍			❍	❍	❍	❍	❍	❍	❍	❍	❍
Plant height						❍			❍	❍		❍	❍
Plant weight (above/ below ground parts)						❍			❍	❍			
Rate of canopy closure						❍			❍		❍	❍	❍
Seedling survival						❍			❍	❍	❍	●	●
Stem density						❍			❍	❍		❍	❍
Woody debris (root masses, stumps, logs)												❍	❍
Animals													
Species, composition, and abundance of:													
Amphibians										❍	❍		❍
Birds		❍		❍		❍	●	●	❍	❍	●	❍	❍
Fish	❍	●	●	❍	❍	❍	❍	❍	❍	❍	❍	❍	
Invasives	❍	❍	❍	●	❍		❍	❍	❍	❍		❍	
Invertebrate	❍	●	●	❍	●	❍	●	●	❍	❍	❍	❍	❍
Mammals										❍	❍	❍	❍
Reptiles										❍	❍	❍	❍

● Represents a parameter that is recommended for measurement in most restoration monitoring projects
❍ Represents a parameter that might be useful to monitor depending on the goals of the project but is not considered critical for all monitoring programs

Matrix C: Restoration Monitoring Parameters by Habitats (cont.)

Functional Parameters to Monitor (cont.)	Habitats												
	Water Column	Rock Bottom	Coral Reef	Oyster Reef	Soft Bottom	Kelp and Macroalgae	Rocky Shore	Soft Shore	SAV	Marsh	Mangroves	Deepwater Swamps	Riverine Forests
Biological (cont.)													
Animals (cont.)													
Animal health (disease)				●									
Coral growth rate			❍										
Coral recruitment, and survival			❍										
Fecal coliforms	❍				❍								
Grazer density			❍				❍						
Vertical relief of reef			●	●									
Hydrological													
Physical													
Fetch	❍						❍	❍	❍	❍	❍	❍	
PAR				●		●			●	❍	❍	❍	❍
Secchi disc depth	❍			●		●			●	❍	❍	❍	❍
Shear force at sediment surface					❍			❍	❍	❍			
Sheet flow										❍		❍	❍
Temperature									❍			❍	❍
Temporary water													❍
Trash	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Upstream land use	●		❍	❍					❍	❍		●	●
Water column current velocity	❍		❍	❍		❍	❍		❍		❍	❍	
Water level fluctuation over time	●	●		●		❍	●	●	●	●	●	●	●
Chemical													
Chlorophyll concentration	●				❍			❍					
Dissolved oxygen	●			❍	❍	❍			❍				
Nitrogen and phosphorus	❍			❍	❍				❍	❍	❍	❍	❍
Salinity (in tidal areas)	❍								❍	❍		❍	
Silicon	❍												
Toxics	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Soil/Sediment													
Physical													
Basin elevations			❍	❍	❍				❍	❍		❍	
Bulk density										❍		❍	❍
Depth of mottling													❍
Geomorphology (slope, basin cross section)		●	●	●	●	●	●	●	●	●	●	●	●
Moisture levels and drainage												❍	❍
Sediment grain size (OM/sand/silt/clay/gravel/cobble)		❍	❍	❍	●	❍	❍	❍	❍	❍	❍	❍	❍
Sedimentation rate and quality		❍	❍	❍	●		❍	❍	❍	❍	❍	❍	❍
Trash		❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍
Chemical													
Organic content in sediment					❍			❍	❍	❍		❍	❍
Pore water nitrogen and phosphorus										❍		❍	❍
Pore water salinity (in tidal areas)										❍		❍	
Redox potential										❍		❍	❍

● Represents a parameter that is recommended for measurement in most restoration monitoring projects
❍ Represents a parameter that might be useful to monitor depending on the goals of the project but is not considered critical for all monitoring programs