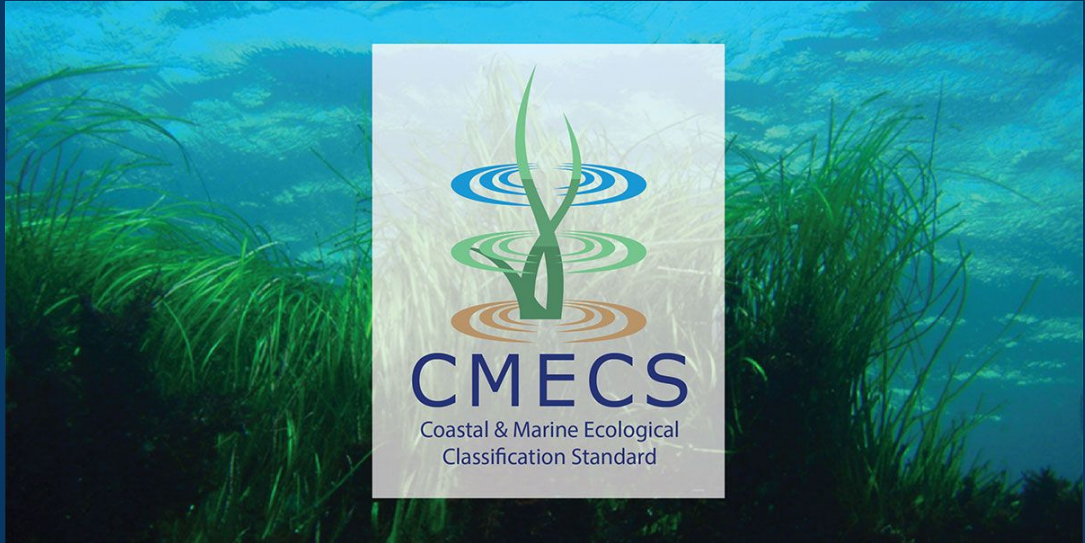
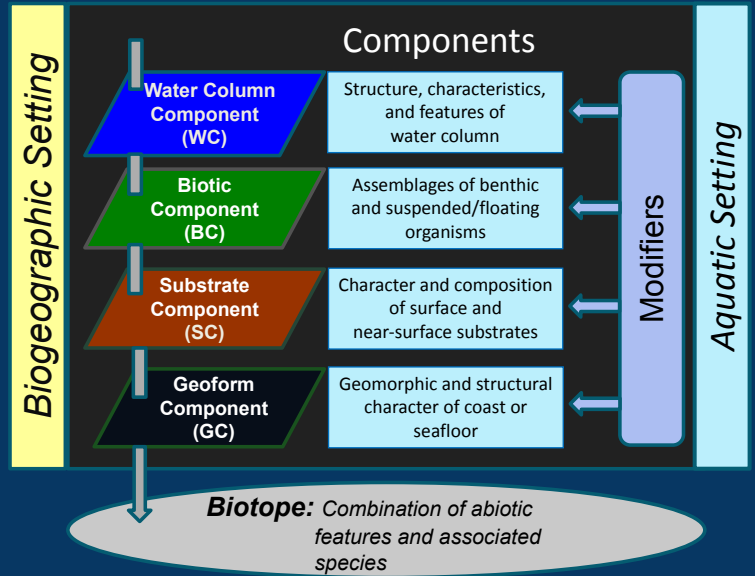


# Sample Images for Biotic and Substrate Classification



# CMECS From Images

- Images and video are often used to classify biotopes and are ideal for classifying biotic and substrate components of CMECS
- Images are not ideal for classification of water column and geoform due to the need for other sensors
- The biotic component is a listing of the visible and identifiable organisms
- The substrate component is the best approximation to be made of the visible seafloor
- Definitions of the primary biotic and substrate classifications are provided at the bottom of each example slide



# Associated Taxa & Co-occurring Elements

- Nature is inherently a mixture or a continuum. CMECS provides a methodology to classify nature into discrete environmental types using consistent threshold values that define primary classification units. However, in natural settings, co-occurring features and associated taxa are frequently mixed into these primary classification types.
- **The Associated Taxa modifier** is used in the Biotic Component to denote the presence of biota that are not a classification unit in CMECS; e.g., portunid crabs, groupers, gadids, barracuda, herring, all nekton, and other rapidly moving fauna.
  - Examples of Associated Taxa may include mixes such as: An observational unit where Mussel Beds on mud are the dominant Fauna, and where fish and crab predators are common.
- **The Co-occurring Elements modifier** is for identification of secondary CMECS classification units that are mixed into a primary classification unit at a level below the classification threshold. Co-occurring Elements are used in the hierarchical Biotic and Substrate Components when the primary feature and the co-occurring feature are both units in that same Component. Examples of Co-occurring Elements may include mixes such as:
  - An observational unit where Geological Substrate Origin and Anthropogenic Substrate Origin coexist (e.g., a 5% cover of large Plastic/Trash on top of a dominant Fine Sand Substrate).
  - An observational unit where two Biotic Groups are present. Consider a seafloor image with dominant Larger Deep-Burrowing Fauna, but also containing a cluster of sponges.

## Slide Directory

1. Mixed Substrates and Algae
2. Grass/Algal Garden Sand
3. Deep-Sea Bedrock
4. Cobble Field
5. Sinkhole Boulders
6. Muddy Sandy Gravel
7. Cliff Cobble Gravel
8. Sand Bed
9. Mud Volcano
10. Bacteria Mat
11. Tidal Mangrove with Seagrass
12. Sandy Algal Bed
13. Hydrate Mussel Rubble
14. *Lophelia* Reef
15. *Acropora* and Seagrass
16. Gorgonian Aggregation
17. Cobbly Muddy Sand with Biota
18. Bedrock (Scarred)

## Site 1. Mixed Substrates and Algae



### CMECS Attributes

#### Biotic

- Group:
  - Filamentous Algal Bed
- Community
  - Cladophora

#### Substrate

- Subgroup:
  - Clay
- Induration Modifier:
  - Hard

#### Co-Occurring Element:

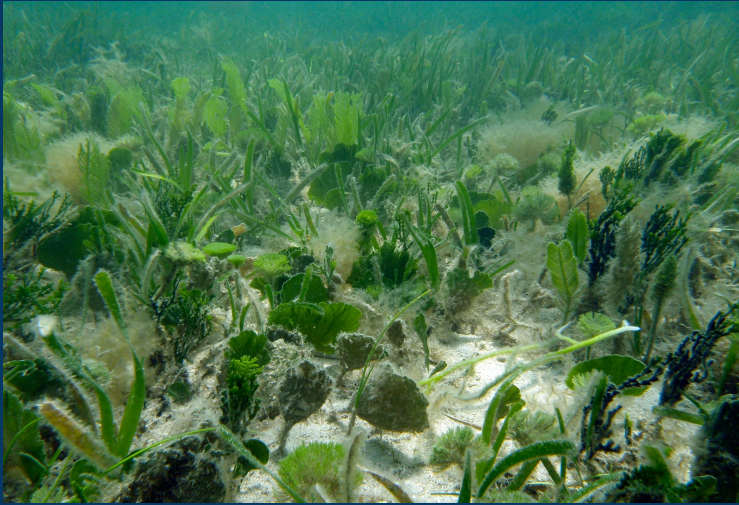
- Subgroup:
  - Mussel Rubble

**Cladophora Community:** Areas dominated by filamentous algae that have a growth form consisting of fine filaments or strands with no blades or stipes. Filaments may branch, but they lack complex structures. The strands are undifferentiated (with a growth axis in one direction). Filamentous algae can form dense mats.

**Clay:** Geologic Substrate surface layer shows no trace of Gravel and contains < 10% Sand; the remaining Clay-Silt mix is 67% or more Clay.

**Hard:** Strongly consolidated fine sediment with low water content, or rock outcrop, or bedrock.

## Site 2. Grass/Algal Garden on Sand



### CMECS Attributes

#### Biotic

- Community:
  - *Thalassia*
- Co-occurring elements
  - *Penicillus*
  - *Caulerpa*
  - *Dictyota*
  - *Padina*
  - *Halimeda*
- Associated Taxa:
  - *Grassillaria*

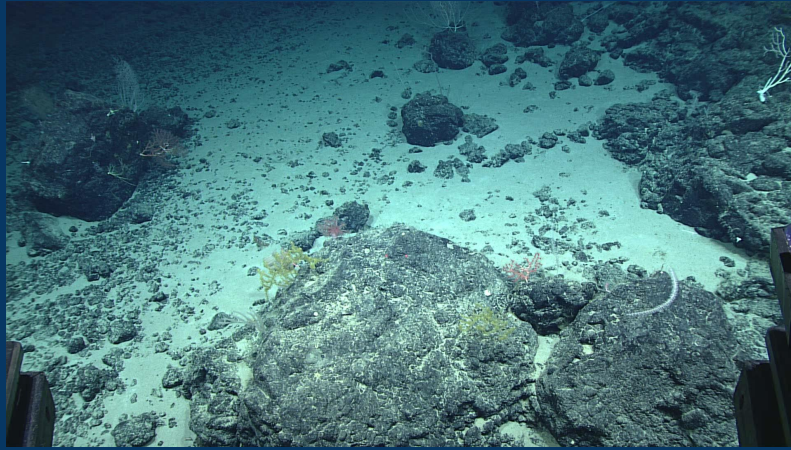
#### Substrate

- Subclass:
  - Sandy Unconsolidated

**Thalassia testudinum**: Tidal aquatic vegetation beds dominated by any number of seagrass or eelgrass species, including *Cymocedea* sp., *Halodule* sp., *Thalassia* sp., *Halophilla* sp., *Vallisneria* sp., *Ruppia* sp., *Phyllospadix* sp., and *Zostera* sp. The list of biotic communities for this group is long: a few examples are provided below, and the complete list is available in Appendix F.

**Sandy Unconsolidated**: Geologic Substrate surface contains no trace of Gravel and is predominantly Sand (particles 0.0625 millimeters to < 2 millimeters in diameter) with the remainder composed of Mud (particles < 0.0625 millimeters in diameter).

## Site 3. Deep-Sea Bedrock



### CMECS Attributes

#### Biotic

- Group:
  - Attached Corals

#### Substrate

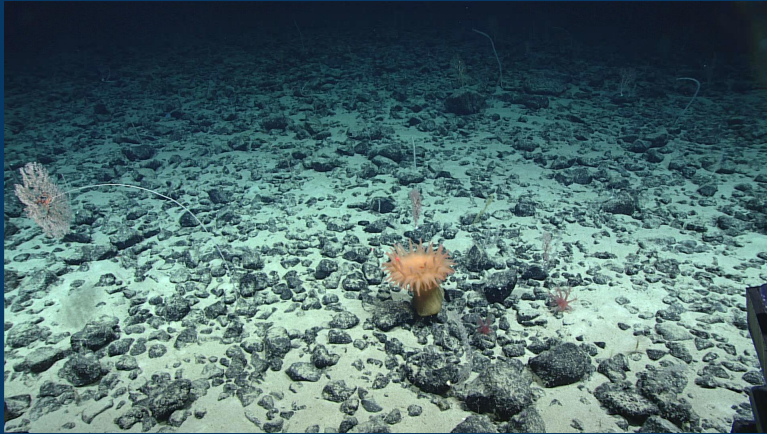
- Subclass:
  - Bedrock
- Co-Occurring Element:
  - Sandy with Coarse Unconsolidated

**Attached Corals:** Subtidal (and deeper) substrates that are dominated by non-reef-forming corals. These include hexacorals such as black corals (Order Antipatharia) and gold corals (Order Zoanthidea, family Gerardiidae); all octocorals including gorgonian sea fans and sea whips (Order Alcyonacea); and bamboo corals. Most species require a hard substrate for attachment, which may range from bedrock to a single pebble. Octocorals in the order Pennatulacea (sea pens, sea pansies, and sea feathers) are in general specialized for life on soft substrates, and are addressed in the Soft Sediment Fauna subclass.

**Bedrock:** Substrate with mostly continuous formations of bedrock that cover 50% or more of the Geologic Substrate surface.

**Sandy with Coarse Unconsolidated:** Geologic Substrate surface is 0.01% (a trace) to < 5% Gravel (particles 2 millimeters to < 4,096 millimeters in diameter) and the remaining Sand/Mud mix is > 50% Sand.

## Site 4. Cobble Field



### CMECS Attributes

#### Biotic

- Group:
  - Attached Anemones
- Co-occurring element
  - Attached Corals

#### Substrate

- Subgroup:
  - Cobble Gravel

**Attached Anemones:** Hard substrate areas dominated by attached anemones (coelenterates which secure themselves to a hard substrate with a pedal disc). These assemblages are common in certain rocky, coastal areas.

**Very Coarse Unconsolidated:** Geologic Substrate surface is  $\geq 80\%$  Gravel, with a Gravel size of 64 millimeters to  $< 4,096$  millimeters.

**Cobble Gravel:** Geologic Substrate surface is  $\geq 80\%$  Gravel, with a Gravel size of 64 millimeters to  $< 256$  millimeters.



## Site 5. Sinkhole Boulders

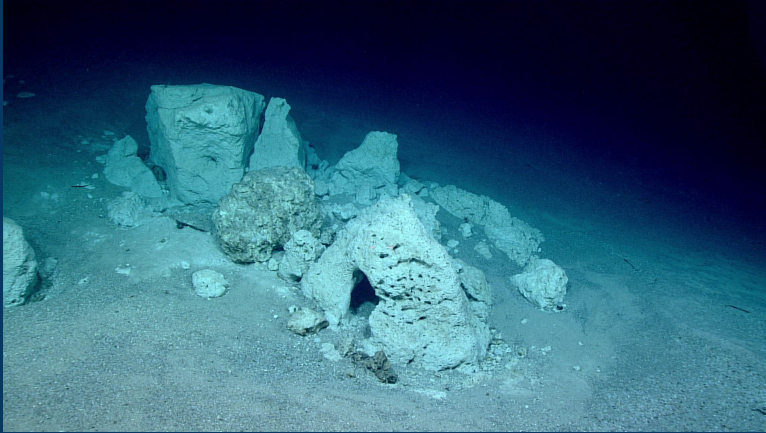
### CMECS Attributes

#### Biotic

- NA

#### Substrate

- Subgroup:
  - Boulder Gravel
- Co-Occurring Element:
  - Pteropod Ooze



**Very Coarse Unconsolidated:** Geologic Substrate surface is  $\geq 80\%$  Gravel, with a Gravel size of 64 millimeters to  $< 4,096$  millimeters.

**Boulder Gravel:** Geologic Substrate surface is  $\geq 80\%$  Gravel, with a Gravel size of 256 millimeters to  $< 4,096$  millimeters.

**Pteropod Ooze:** Oozes that are formed primarily from the shells of pteropods (a group of planktonic mollusks)

## Site 6. Muddy Sandy Gravel

### CMECS Attributes

#### Biotic

- NA

#### Substrate

- Subgroup
  - Muddy Sandy Gravel



**Mixed Coarse Unconsolidated:** Geologic Substrate surface is 5% to < 80% Gravel (particles 2 millimeters to < 4,096 millimeters in diameter) with the remaining mix composed of Sand and/or Mud.

**Muddy Sandy Gravel:** Geologic Substrate surface is 30% to < 80% Gravel, with Sand composing from 50% to < 90% of the remaining Sand-Mud mix.

## Site 7. Cliff Cobble Gravel

### CMECS Attributes

#### Biotic

- NA

#### Substrate

- Subgroup:
  - Cobble Gravel
- Co-Occurring Elements:
  - Bedrock
  - Sand



**Very Coarse Unconsolidated:** Geologic Substrate surface is  $\geq 80\%$  Gravel, with a Gravel size of 64 millimeters to  $< 4,096$  millimeters.

**Cobble Gravel:** Geologic Substrate surface is  $\geq 80\%$  Gravel, with a Gravel size of 64 millimeters to  $< 256$  millimeters.

## Site 8. Sand Bed

### CMECS Attributes

#### Biotic

- NA

#### Substrate

- Subgroup:
  - Sand

#### Co-Occurring Element:

- Shell Sand



**Sandy Unconsolidated:** Geologic Substrate surface contains no trace of Gravel and is predominantly Sand (particles 0.0625 millimeters to < 2 millimeters in diameter) with the remainder composed of Mud (particles < 0.0625 millimeters in diameter).

**Sand:** Geologic Substrate surface has no trace of Gravel and is  $\geq 90\%$  Sand (particles 0.0625 millimeters to < 2 millimeters in diameter).

**Shell Sand:** Biogenic Substrate layers that are dominated by Sand. Shells or remains are generally broken and difficult to identify. For this reason, only substrate-forming taxa that produce distinctive Sand types are listed as substrate groups. When the composition and origin of Sand is unclear, it is assumed to be mineral Sand and is classified as a Geologic Origin substrate.

## Site 9. Mud Volcano

### CMECS Attributes

#### Biotic

- NA

#### Substrate

- Subgroup:
  - Silt-Clay



**Muddy Unconsolidated:** Geologic Substrate surface has no trace of Gravel and is predominantly Mud (particles < 0.0625 millimeters) with the remainder composed of Sand (0.0625 millimeters to < 2 millimeters).

**Silt-Clay:** Geologic Substrate surface has no trace of Gravel and is < 10% Sand; the remaining Silt-Clay mix is < 33% to 67% Silt.

**Bonus Geoform:** Mud Volcano

## Site 10. Bacteria Mat

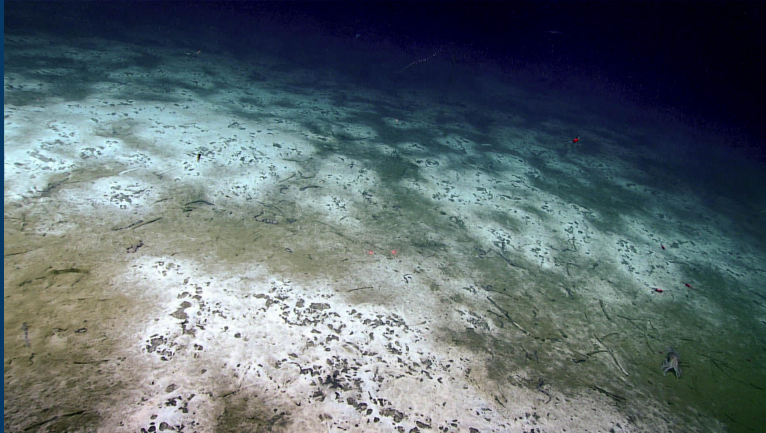
### CMECS Attributes

#### Biotic

- Group:
  - Bacteria Mat/Film

#### Substrate

- Subclass:
  - Muddy Unconsolidated



**Bacteria Mat/Film:** Areas dominated by colonies of bacterial decomposers and other decay organisms. These colonies can range in appearance from delicate and filamentous to a dense mass that may blanket the sediment surface. See Figure 8.12 for an example of a bacterial mat.

**Muddy Unconsolidated:** Geologic Substrate surface has no trace of Gravel and is predominantly Mud (particles < 0.0625 millimeters) with the remainder composed of Sand (0.0625 millimeters to < 2 millimeters).

## Site 11. Tidal Mangrove w/ Seagrass



### CMECS Attributes

#### Biotic

- Group:
  - Tidal Mangrove Forest
- Co-occurring element
  - *Thalassia testudinum*

#### Substrate

- Subclass:
  - Sandy Unconsolidated

**Tidal Mangrove Forest:** Tidally influenced, dense, tropical or subtropical forest with a shore zone dominated by true mangroves that generally are 6 meters or taller. Dwarf shrub/short mangroves are placed in the Tidal Mangrove Shrubland Biotic Group. Mangrove Forests occur along the sheltered coasts of tropical latitudes of the Earth, and are commonly found on the intertidal mud flats along the shores of estuaries, usually in the region between the salt marshes and seagrass beds and may extend inland along river courses where tidal amplitude is high. Also, mangrove cays may occur within the lagoon complex of barrier reefs. The list of biotic communities for this group is long: the complete list is available in Appendix F.

**Sandy Unconsolidated:** Geologic Substrate surface contains no trace of Gravel and is predominantly Sand (particles 0.0625 millimeters to < 2 millimeters in diameter) with the remainder composed of Mud (particles < 0.0625 millimeters in diameter).

## Site 12. Sandy Algal bed

### CMECS Attributes

#### Biotic

- Community:
  - *Halimeda* Communities

#### Substrate

- Subclass:
  - Sandy Unconsolidated



**Halimeda Communities:** Areas dominated by calcareous algae that incorporate calcium carbonate into their tissues, support their own weight, and have an upright growth form. Calcareous algae can form carpets on the bottom, and—as they decay—the calcareous skeletons remain behind, occasionally forming loose accumulations on the bottom resembling chips. Calcareous algae that occur in a reef setting are included in the Colonized Shallow and Mesophotic Reef biotic group.

**Sandy Unconsolidated:** Geologic Substrate surface contains no trace of Gravel and is predominantly Sand (particles 0.0625 millimeters to < 2 millimeters in diameter) with the remainder composed of Mud (particles < 0.0625 millimeters in diameter).



## Site 13. Hydrate Mussel Rubble

### CMECS Attributes

#### Biotic

- Group:
  - Attached Mussels
- Co-occurring element
  - Attached Urchins

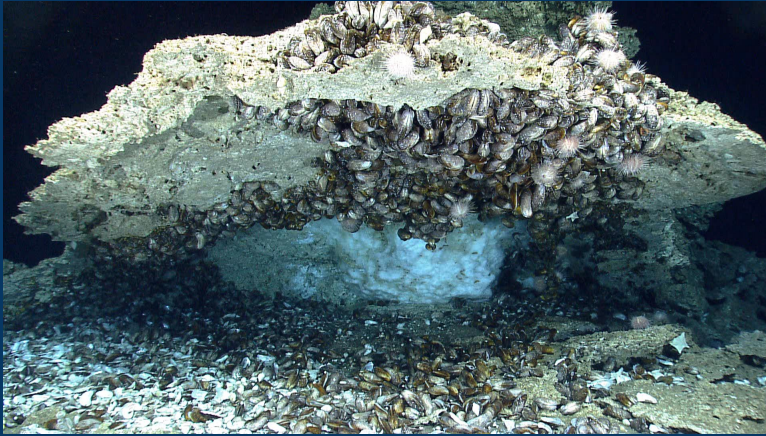
#### Substrate

- Subgroup:
  - Mussel Rubble

#### Co-Occurring Element:

- Megaclast

Precipitate substrates: *Stay Tuned!*



**Attached Mussels:** Areas dominated by dense accumulations of mussels attached to a substrate other than conspecifics. This group includes associated faunal communities and predators on mussels (e.g., starfish), which may be highly conspicuous.

**Mussel Rubble:** Shell Rubble (with a median particle size of 64 millimeters to < 4,096 millimeters) that is primarily composed of self-adhered or conglomerated mussel shells.

**Megaclast:** Substrate where individual rocks—with particle sizes greater than or equal to 4.0 meters (4,096 millimeters) in any dimension—cover 50% or more of the Geologic Substrate surface.

## Site 14. *Lophelia* Reef

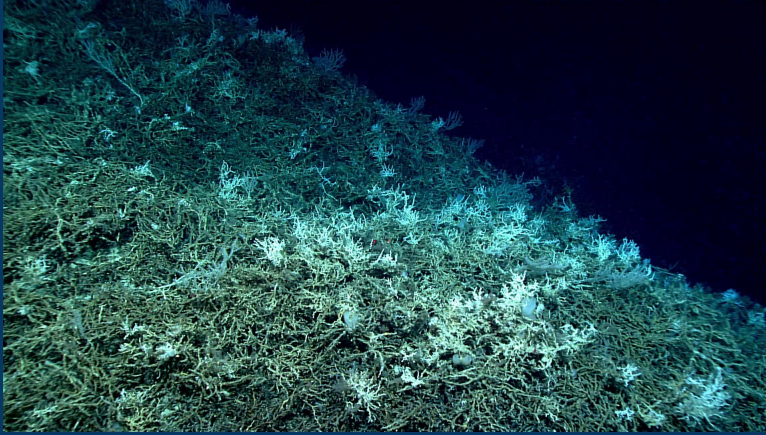
### CMECS Attributes

#### Biotic

- Community:
  - *Lophelia* Reef
- Co-occurring element
  - Attached Sponges

#### Substrate

- Subclass:
  - Coral Reef Substrate



**Lophelia Reef:** Areas dominated by deepwater stony corals. There are 17 known species of deepwater, azooxanthellate, stony corals (Class: Anthozoa; Order: Scleractinia) that form larger, branching colonies and contribute to reef frameworks. Six of these are particularly widespread or important, and these are major contributors to the framework of their respective habitats. These species form branching colonies (generally less than 1 - 2 meters in size), and aggregations of these living colonies—and their immediately adjacent dead framework and rubble—are important habitats for numerous other sedentary and mobile species.

**Coral Reef Substrate:** Substrate that is dominated by living or non-living coral reefs with a median particle size of 4,096 millimeters or greater in any dimension.

## Site 15. *Acropora* and Seagrass

### CMECS Attributes

#### Biotic

- Community:
  - Branching *Acropora* Reef
- Co-occurring element
  - *Thalassia testudinum* Herbaceous Vegetation

#### Substrate

- Subclass:
  - Sandy Unconsolidated



**Branching Acropora Reef:** Reefs in shallow or mesophotic situations dominated by branching corals (includes arborescent, arboreal, digitate, corymbose, ramose, and elkhorn corals) that grow in a tree-like shape and have numerous branches, some with secondary branches. This group includes both fragile, branching corals and more robust, branching corals that have exceptionally thick and sturdy antler-like branches (such as elkhorn corals).

**Sandy Unconsolidated:** Geologic Substrate surface contains no trace of Gravel and is predominantly Sand (particles 0.0625 millimeters to < 2 millimeters in diameter) with the remainder composed of Mud (particles < 0.0625 millimeters in diameter).

## Site 16. Gorgonian Aggregation



### CMECS Attributes

#### Biotic

- Group:
  - Attached Gorgonians
- Associated Taxa:
  - Angelfish (Gray)
  - Surgeonfish

#### Substrate

- Subclass:
  - Megacラスト

#### Co-Occurring Element:

- Sandy Unconsolidated

**Attached Gorgonians:** Subtidal (and deeper) substrates that are dominated by non-reef-forming corals. All octocorals are non-reef forming, including soft corals and gorgonian sea fans and sea whips (Order Alcyonacea). None of the octocorals produce the calcium carbonate structures associated with coral reefs, but octocorals can form important habitat areas. Most species require a hard substrate for attachment, which may range from bedrock to a single pebble.

**Megacラスト:** Substrate where individual rocks—with particle sizes greater than or equal to 4.0 meters (4,096 millimeters) in any dimension—cover 50% or more of the Geologic Substrate surface.

## Site 17. Cobbly Muddy Sand with Biota

### CMECS Attributes

#### Biotic

- Group:
  - Attached Sponges
- Co-occurring elements
  - Attached Anemones
  - Attached Corals

#### Substrate

- Subgroup:
  - Cobbly Muddy Sand



**Attached Sponges:** Hard or mixed substrate areas that are dominated by sponges and their associated communities, e.g., where non-reef building sponge species grow attached to hard substrate or are nestled among hard substrate, or where reef-building sponges grow on hard substrates in densities that are not judged sufficient to constitute a reef.

**Mixed Course Unconsolidated:** Geologic Substrate surface is 5% to < 30% Gravel (particles 2 millimeters to < 4,096 millimeters in diameter). For more specificity in this group and in the following three substrate subgroups, the size of “Gravelly” may be substituted in, e.g., “Bouldery”, “Cobbly Sand”, “Pebbly Muddy Sand”, and “Granuley Mud”.

## Site 18. Bedrock (Scarred)

### CMECS Attributes

#### Biotic

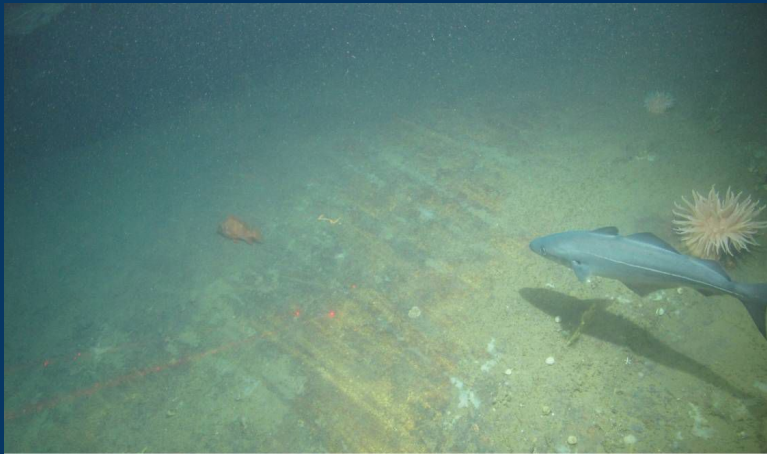
- Group:
  - Attached Anemone
- Associated Taxa:
  - Cod
  - Red fish

#### Substrate

- Subclass:
  - Bedrock
- Modifier:
  - Scarred

#### Co-Occurring Element:

- Sandy Unconsolidated



**Attached Anemone:** Hard substrate areas dominated by attached anemones (coelenterates which secure themselves to a hard substrate with a pedal disc). These assemblages are common in certain rocky, coastal areas.

**Bedrock:** Substrate with mostly continuous formations of bedrock that cover 50% or more of the Geologic Substrate surface.

**Scarred:** Roughness appears due to localized sediment disturbance resulting either from natural causes (e.g., slumps) or anthropogenic causes (e.g., anchor scars, propeller scars, trawl scars, or other fishing gear scars), but not as an artifact of camera or sampling gear deployment.

Thanks!

