CMECS Classification Definitions

Hierarchical Classes

SYSTEM (requires information on salinity, enclosure and depth class)

Estuarine (definition from Cowardin et al, 1979)
The Estuarine System consists of deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which freshwater runoff from the land decreases salinity for at least two months at a level below 30 PSU anywhere in the waterbody. The salinity may be periodically increased above that of the open ocean by evaporation. Along some low-energy coastlines there is appreciable dilution of sea water. Offshore areas with typical estuarine plants and animals, rush as mangroves and oysters are also included in the estuarine system.

Limits: the Estuarine System extends (1) upstream and landward to where ocean-derived salts measure less than 0.5 PSU during the period of average annual low flow; (2) to an imaginary line closing the mouth of a river, bay or sound; and (3) to the seaward limits of wetland emergents, shrubs, or trees where they are not included in (2). The Estuarine System also includes offshore areas of continuously diluted sea water.

Nearshore Marine
Nearshore marine regimes are those coastal waters that are truly marine in character (> 30 PSU throughout the year). The nearshore marine regime extends from the land margin to the 30 m depth contour. In these waters, benthic processes can strongly influence the ecology and biology throughout the water column and the water column interacts strongly with the benthos. The photic zone, defined as the upper part of the water column where the average light level exceeds 2% of surface light intensity during daylight hours, generally extends through the entire water column. This often supports the growth of vegetation on the bottom, and so seagrass and kelp beds are found in this regime. The vertical circulation of the water column generally distributes bottom nutrients and sediments throughout the water column.

Neritic
The neritic regime is the region of marine waters (> 30 PSU year round) between the 30 m depth contour and the continental shelf break, which occurs at approximately at 200 m water depth. Depending on shelf morphology, waters at the 30 m isobath can be quite distant from the continent or they may lie quite close to land. The depth criterion is a more important ecological criterion than the distance from land. An example of a neritic regime that begins far from the coast is found in the South Atlantic Bight offshore of South Carolina and Georgia, where the 30 m isobath is over 30 mi offshore in places. In comparison, the neritic regime along the California coast can occur within a few hundred meters of the coast.

Oceanic

The oceanic regime represents the marine realm beyond the continental shelf break, generally occurring at 150m-300m of water depth at the edge of the continental shelf. These waters can range to several thousands of meters depth. The boundary created by the depth discontinuity at the shelf break establishes strong and identifiable constraints on the processes in the regime and represents a logical breakpoint for the division of major marine regimes between neritic and oceanic. In the case of large oceanic islands where a continental shelf is absent, the island itself possesses a nearshore regime to a depth of 30 m and a neritic regime to a depth of 200 m. The oceanic regime is defined in the case of steep-sided islands to begin where water depth exceeds the 200 m depth contour.

The marine waters of the oceanic regime are sufficiently distant from land and they receive little or no influence of fresh water, nutrient and sediment inputs, except around large islands. Due to the great water depths, there is little or no interaction of ocean bottom with the vast majority of the overlying water column. The sea bottom diminishes in importance in influencing pelagic processes. Light is greatly attenuated within the water column and does not reach the bottom. The upper water layer does not mix to the bottom and the mixing zone is separated from bottom waters by a density gradient or pycnocline generated by a temperature or salinity differential.

Freshwater-influenced

Fresh water-influenced regimes are waters that have no distinctly enclosing morphology, yet receive a significant amount of fresh water input from land during at least part of the year. In such cases, an unenclosed marine water column may be influenced by fresh water in the form of an active river plume, an overlying fresh water lens or a ground water seep discharge. As with the estuary, the Freshwater-influenced regime can occur in nearshore, neritic or oceanic depths, provided the region is influenced by fresh water input that reduces salinity to below 30 PSU during at least two months of the year. These regimes tend to be less well defined spatially and temporally variable, determined by ocean currents and by wet season outflow from true estuaries. They often may have surface characteristics of estuaries, but deeper waters may be completely marine. Because of the highly stratified nature of waters in this class, with freshwater generally concentrated at the surface, the water can be vertically diverse in terms of classification, switching from one branch in the classification to another with increasing depth. For example an area may map as a freshwater-influenced surface layer and a marine benthic zone, if the characteristics of the fresh surface layer do not impact the bottom, as may be the case in very deep waters. However, often there is strong synchronization between the water column and the bottom. For example, the Mississippi River plume impacts the benthos of the Gulf of Mexico 30 meters deep by depositing sediments and organic material over vast areas, annually creating a high oxygen demand, bottom hypoxia and the widely-known benthic "dead zone." A similar phenomenon has been observed off the coast of Oregon in depths of 45-50 m.

SUBSYSTEM

Subtidal – The substrate is continuously submerged.

Intertidal – The substrate is exposed and flooded by tides: includes the associated splash zone.

COVER

For vegetation and faunal distribution within a particular habitat the following cover type classifiers are available:

Colonized: A substrate containing both/either vegetation and epifauna which together have a total cover greater 10% (e.g., not bare/sparse).

Bare/Sparse: Abiotic substate features are dominant. Less than 10% of the substrate is covered with either vegetation or epifauna (infauna may be present at any density).

CLASS (adapted from Cowardin et al., 1979)

Coral Reef – Ridge-like or mound-like structures formed by the colonization and growth of hard coral species.

Mollusc reef - Ridge-like or mound-like structures formed by the colonization and growth of mollusks.

Worm Reef - Ridge-like or mound-like structures formed by the colonization and growth of Sabellariid worm species.

Rock Bottom – Subtidal benthic substrates having a cover of large rocks, boulders, pavement or bedrock 75% or greater and vegetative cover of less than 10%.

Unconsolidated Bottom – Subtidal benthic substrates having at least 25% cover of particles smaller than stones, and a vegetative cover less than 10%

Rocky Shore - Exposed intertidal shoreline characterized by bedrock, large rocks, or boulders which singly or in combination have an aerial cover of 75% or more and an aerial coverage by vegetation of less than 10%

Unconsolidated Shore – Exposed intertidal unconsolidated shoreline having at least 25% cover of particles smaller than stones, and a vegetative cover less than 10%

Aquatic Bed – Substrate dominated by plants and attached, non reef-forming, sessile animals that grow principally at or below the surface of the water for most of the growing season in most years and require surface water for optimum growth and reproduction. Plant/animal cover is greater than 10%. Plants may be admixed with non-reef forming attached invertebrates (eg. seagrasses mixed with sponges or soft corals).

Emergent/Shrub Wetland – Wetland characterized by erect, rooted, herbaceous hydrophytes excluding mosses and lichens. Short shrubs, not significantly higher than the emergent vegetation may also be included. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants.

Forested Wetland – Wetlands characterized by predominantly woody vegetation – Trees or shrubs and saplings such as stunted or sapling mangroves are included in this group.

SUBCLASS (adapted from Cowardin et al, 1979)

Spur and Groove Reef -- a system of shallow ridges (spurs) separated by deep channels (grooves) oriented perpendicular to the reef crest and extending down the upper seaward slope

Patch Reef(s): Coral formations that have no organized structural axis relative to the contours of the shore or shelf . A surrounding halo of sand is often a distinguishing feature of this habitat type when it occurs adjacent to submerged vegetation.

Linear Reef - A linear coral formation that is oriented parallel to the shore or the shelf edge.

Reef Rubble - Dead, unstable coral pieces. This habitat often occurs landward of well-developed reef formations in the reef crest or back reef zone

Deep Coral Reef- non-photosynthetic coral formed in deep waters averaging 70-1000 m. Deep-water coral reefs typically consist of thickets of live coral atop unconsolidated sediment and coral rubble, usually on an underlying rock base structure. Deep reefs are found in strong currents or upwelling zones.

Aggregate Reef – High relief coral reef lacking sand channels of spur and groove.

Scattered Coral/rock in unconsolidated sediment - Primarily sand or seagrass bottom with scattered rocks or small, isolated coral heads that are too small to be delineated individually (i.e., smaller than individual patch reef).

Coral Garden- high density of a diverse group of hard coral, soft coral, sponges and other sedentary or attached macro-invertebrates on a hard substrate.

Solid Rock – Substrate with bedrock or pavement covering 75% or more of the surface and less than 10% aerial coverage of macrophytes.

Boulder/Rubble – Substrate has less than 75% aerial cover of bedrock, but larger rocks and boulders (>257 mm) alone or in combinations with bedrock cover 75% or more of the area. Coverage of macrophytes is less than 10%.

Pavement - Flat, low relief, mostly solid rock substrate.

Cobble/gravel - The unconsolidated particles smaller than stones are predominantly cobble/gravel (grain size 2-257 mm). Shell fragments, sand and silt often fill the spaces between the larger particles. Stones and boulders may be found scattered on some cobble-gravel shores or benthos.

Sand – The unconsolidated particles smaller than stones are predominantly sand (particles 0.07-2mm) which may be either calcareous or terrigenous in origin.

Mud – The unconsolidated particles smaller than stones are predominantly silt and clay or carbonate mud (grain size <0.07 mm). Anaerobic conditions often exist below the surfaces and often have a higher organic content than cobble-gravel or sand shores or benthos.

Clay: fine mineral particulates of kaolin with high cohesiveness
Silt: very fine mud particles laid down after water transport and deposition
Carbonate muds: fine particulates of calcium carbonate with high cohesiveness

Organic–Unconsolidated substrate largely comprised of decomposing particles of dead plant and animal tissue.

Peat: organic material laid down and consolidated into sediment

Ooze: decomposed tests of sedimented microscopic organisms deposited on the bottom. Types of oozes include globagarina, diatomaceous and siliceous.

Shell - Substrate that is dominated by composed of small bits of broken shell remnants.

Algal – Aquatic bed dominated by algae species.

Attached Macroalgae - Habitat with 10 percent or more cover of mixed or monospecific macroalgae attached to the substrate with holdfasts, rhizomes, or other morphological feature.

Drift Macroalgae - Habitat with 10 percent or more cover of mixed or monospecific macroalgae that is not attached to the substrate. Drift algae may move constantly with wind or wave forces or may be observed in one location for long periods of times (possibly months) because of lack of energy forces or due to becoming entangled on substrate features.

Rooted Vascular – Aquatic beds dominated by rooted vascular species such as seagrasses.

Floating Vascular – Aquatic beds dominated by floating vascular species such as pondweeds. These mostly occur in the oligohaline areas of estuaries.

Persistent – Vascular plants remain visible above the surface during the dormant season

Non-Persistent – Vascular plants fall to the surface of the substrate or below the surface of the water at the end of the growing season – so there is no sign of emergent vegetation during the dormant season.

Broad-leaved Deciduous – Dominated by broad-leaved deciduous plants (eg. Alder)

Broad-leaved Evergreen – Dominated by broad-leaved evergreen plants (eg. Mangroves).

Needle-leaved Evergreen – Dominated by needle-leaved evergreen plants (eg. Juniper).

Needle-leaved Deciduous – Dominated by needle-leaved deciduous plants. (eg. Tamarack)

Descriptive Classes

ENCLOSURE

Enclosure represents the degree of isolation of a water body from other waters due to enclosure by a land mass. In estuaries, enclosure determines the degree of exchange of water, materials, energy and biota between the estuary and the sea. More enclosed waterbodies have longer water residence times, can tend to be more evaporative and hypersaline, and can more readily trap and retain materials within them.

Enclosure	Degree
Unenclosed	no detectable isolation of a water mass by land form
Semi-enclosed	25%-50% of the area of the water body is encircled by land
Partially enclosed	50%-75% of the area of the water body is encircled by land
Largely enclosed	75%-90% of the area of the water body is encircled by land
Enclosed	Essentially cut off from ocean (>90% encircled by land)

COVER CLASS

The degree of vegetative cover for each is assessed using the following classes (after the Scheme classification of Madley et al. 2003):

Bare/Sparse: <10% cover
Moderately sparse cover: cover of 10- 25%
Moderate cover: a cover of 25-75 %
Dense cover: a cover of 75%-90%
Complete cover: a cover of 90-100%

MODIFIERS

ENERGY TYPE

Energy Type	Intensity
Wind	coherent directional motion of the atmosphere
Current	coherent directional motion of the water
Surface wave	vertical and transverse oscillating surface water motion due to wind or seismic energy
Internal wave	vertical and transverse oscillating water motion below the surface due to seismic energy or pressure differential
Tide	periodic horizontally oscillating water motion

ENERGY INTENSITY

Energy	Intensity
No energy	no detectable waves or current motion
Low energy	very weak currents (0-2 kn) or wave action (gentle swell)
Moderate energy	wind waves or moderate tidal currents (2-4 kn)
High energy	strong currents (>4 kn), oceanic swell, breaking waves

TIDE CLASS

The tide class descriptor refers to the difference between mean high tide and mean low tide at the coast. While the intertidal subzone is defined by the area submerged by tide between the extreme high and low tides, the mean range gives a more consistent idea of the energy and amplitude of the average tide. Tide range is classed as:

Tide Class	Range
Microtidal	<0.1 m
Small tide range	0.1- 1 m
Moderate tide range	1-5 m
Large tide range	>5 m

DEPTH CLASSES (For Estuarine, Nearshore And Neritic Systems)

It is often useful to apply a descriptor that refers to a specific depth or range of depths in the water column or on the bottom. Dethier (1990) introduced depth as a classifier in nearshore systems and that use is adopted here for the littoral and infralittoral zones. The descriptor has been expanded with two additional classes in CMECS: "exposed," meaning exposed to air on a regular basis and "very shallow." Depth classes for shallow water columns are as follows:

Depth Class	Range
Exposed	< 0
Very shallow	0-5 m
Shallow	5-15 m
Deep	>15 m

These depths are relevant only for small scale features in shallow water columns for all regimes. In the oceanic regime these classes are only applicable to littoral zones around island-like features. Another set of depth descriptors is used for the oceanic regime that accounts for the scale of great depths associated with that regime exclusive of islands and other small oceanic surface features.

PRIMARY WATER SOURCE

The primary water source descriptor refers to the provenance of water flowing through or into a formation. This can range from freshwater inputs from river watersheds or sloughs to local exchanges through tidal passes. The classes are as follows:

Primary Water Source	Provenance
Watershed	for flowing freshwater, the upstream watershed
Local estuary exchange	tidal exchange that is primarily estuarine water
Local ocean exchange	tidal exchange that is primarily marine water
River	tidal exchange or plume flow that is primarily river water
Estuary	plume flow that is from the estuary
Marine	unidirectional flow that is primarily marine

PROFILE

Profile refers to the elevation of the feature relative to surrounding level of the water or bed:

Profile	Relative Height
None	0
Low	0-2 m
Medium	2-5 m
high	>5 m

SLOPE

Slope refers to the angle of the substrate; Greene's (1999) geological classification is followed here to characterize slope as:

Slope	Vertical Angle
Flat	0-5°
Sloping	5-30°
Steeply sloping	30-45°
Vertical	45-90°
Overhang	>90°

TEMPERATURE CLASS

Temperature classes are established in intervals of 10°C, deemed sufficient in range and resolution to provide meaningful differences yet yielding a parsimonious number of classes. Temperature categories are based on the BCMEC classification for Canada (Howes, 1994, 2002; Zacharias et al., 1998), modified to add the higher temperature ranges typical of the subtropics and tropics. The caveat that differential surface and bottom characteristics occur in the water column holds for temperature as well as salinity. Classes for water mass temperature are established as follows:

Temperature Class	Degrees
Frozen	≤ 0° C with surface ice
Superchilled	≤ 0° C without ice
Cold	0-10° C
Temperate	10-20° C
Warm	20-30° C
Hot	>30° C

RELIEF

Relief is a qualitative variable that refers to the texture or roughness of the geomorphic structure. The quality is somewhat scale dependent because the method of perception, the resolution and the spatial scale will bear on the apparent relief. However, in practice, the roughness will be most applicable at the lowest levels of the hierarchy where it will impact the behavior of individual organisms. Therefore, the definitions of relief are set to the spatial context of a 1-1000 m^2 scale:

Smooth: no perceptible texture
Irregular: perceptible texture or feature that is heterogeneous and non-regular in either frequency, direction, or amplitude
Variable: perceptible texture or feature that is regular in either frequency pattern but irregular in direction and/or amplitude
Rippled: closely spaced, regular, repeating vertical variations in height of a sandy or muddy bottom with a very short wavelength (cm)
Waves: regular, repeating vertical variations in height of a sandy or muddy bottom with an intermediate wavelength (<1m)
Undulating: regular, repeating vertical variations in height of a sandy or muddy bottom with a long wavelength (>5 m)

LARGE SCALE RELIEF

Relief on a large scale for formations is a qualitative variable that refers to the aspect ratio of the

geomorphic structure. The classifier is used to distinguish those units that are tall with respect to their "footprint" such as a seamount, from those that are flat, such as the abyssal plain. The categories in this classifier for features that are >1000 m^2 scale:

Large Scale Relief	**Aspect of height:width**
Flat	~0
low	0.1
moderate	0.5
high	1
extreme	>1

TEMPORAL PERSISTENCE

The temporal persistence descriptor describes the permanency or variability of a hydromorphic or geomorphic feature. Though qualitative and relative, it is useful is distinguishing between features that are similar in morphology but are temporally diverse in terms of stability. An example is a mud shoal versus a mudbank. The former tends to be moved by changing currents or storms, while the latter is more stable and persistent. Classes are:

Persistence	**Stability**
low	weeks to months
medium	months to years
high	decadal
permanent	stable
variable	varies regularly
stochastic	varies stochastically

ANTHROPOGENIC IMPACT

Development: coastal or marine areas that have been modified by construction of durable and persistent human constructions (e.g., artificial reef, pier, seawall, marina, residence, drilling platform).

> **Impoundment/Diversion:** artificial constructions that impede, redirect or retain hydrological flow by building or placing barriers such as levees or dams, either to retain water or to prevent inundation (e.g., dam, levee, dike, berm, seawall, pier).

Dredged area/Channel: Landscape that is mechanically altered by the removal of sediments or other materials (e.g. shell), for deepening or widening channels (e.g. for navigation or alteration to hydrology), or for other bathymetric modification.

Deposition: materials such as sand or shell that are placed on or in an area of coast or a water body.

Contamination: discharge of unnatural compounds or levels of nutrient, sewage, metals or pesticide to coastal waters or substrates from anthropogenic sources significantly above natural loading levels.