

C-CAP High-Resolution Land Cover Classification Schemes



Definitions and Guidance for Mapping Production and Data Use

NOAA Office for Coastal Management
coast.noaa.gov

NOAA Digital Coast
coast.noaa.gov/digitalcoast/data/ccaphighres.html

The following information provides a description of land cover classes used within NOAA's [High-Resolution Coastal Change Analysis Program](#) (C-CAP) land cover products. These classes are key indicators of coastal ecosystems and are identified as features that can be consistently and accurately derived through remote sensing classification methods.

These categories and descriptions refine those used in Regional C-CAP land cover. The updates reflect differences due to the increased spatial resolution of these high-resolution products and the more limited spectral information typically available in imagery datasets at that scale.

C-CAP categories align with those used in the National Land Cover Database (NLCD), with major differences stemming from the additional wetland detail in C-CAP products. This detail follows Cowardin's *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al. 1979).

-  Impervious Surface
-  Impervious Under Canopy
-  Developed Open Space
-  Cultivated
-  Pasture/Hay
-  Grassland
-  Deciduous Forest
-  Evergreen Forest
-  Mixed Forest
-  Scrub/Shrub
-  Palustrine Forested Wetland
-  Palustrine Scrub/Shrub Wetland
-  Palustrine Emergent Wetland
-  Estuarine Forested Wetland
-  Estuarine Scrub/Shrub Wetland
-  Estuarine Emergent Wetland
-  Unconsolidated Shore
-  Bare Land
-  Water
-  Palustrine Aquatic Bed
-  Estuarine Aquatic Bed
-  Snow/Ice



Background (0)

Background or “no data” values indicate areas within the file extent that are not classified because they were not included in the geographic scope of the mapping.



Unclassified (1)

Unclassified pixels represent areas within the project mapping boundary where the exact land cover type could not be determined (e.g., due to cloud cover). This category rarely exists in C-CAP products.



Impervious Developed (2)

Impervious surfaces include anthropogenic features which do not allow infiltration from precipitation. These include buildings, parking lots, and roads developed from asphalt, concrete, or other constructed surfaces. Impervious surfaces can also include unpaved roads and similar features (driveways, parking areas, etc.) that are highly trafficked and often compacted and function like a paved, impervious surface.

Minimum Mapping Units:

- Buildings with a footprint greater than 200 square feet
- Roads greater than 8 feet wide and 100 feet long
- Other paved surfaces that exceed 400 square feet
- While the minimum mapping unit for the “other paved surface” category is 400 square feet, these features (e.g., driveways and sidewalks) are often comprised of smaller, interconnecting impervious features. Due to their connection to one another, or to features like buildings or roads, these paved surfaces should be mapped.

Definition Details:

- Artificial turf and in-ground swimming pools are typically included in the impervious class.
- Railways are generally not included as part of the impervious class; they are usually considered bare ground. Exceptions include railways running through highly urbanized areas, over pavement, or crossed road features.
- Infrequently traveled unpaved roads (e.g., two tracks, agricultural fields access roads, and forest access roads, like logging roads, not used as through roads) are typically not captured as impervious. However, unpaved but highly trafficked and compacted surfaces may be included as impervious features.
- Solar panel installations are generally not included as impervious; C-CAP tries to map these as part of its open space developed class.



Impervious Under Canopy (4)

Impervious Under Canopy represents the intersection of impervious surface and tree canopy features that coexist within the same space but at different heights. This category is typically derived from an independent mapping of impervious and canopy features (such as those produced in phase I products) and is not usually mapped explicitly.

Minimum mapping unit is based on the impervious and tree canopy classes (as described in this document for those categories).



Open Space Developed (5)

Open Space Developed (OSD) includes grass and other non-woody vegetation (mostly managed grasses or low-lying vegetation) associated with developed or recreational areas, planted for purposes such as recreation, erosion control, or aesthetics. These areas are maintained by human activity (e.g., fertilization, irrigation, or mowing) and often located within or adjacent to other developed features, such as neighborhoods, golf courses, airports, cemeteries, or sports fields.

Minimum Mapping Units:

- Area is > 0.1 acre (400 square meters)

Definition Details:

- These areas are typically thought of as herbaceous grasslands, though there can be instances where bare features (within urban areas) might also be included.
- Solar panel installations are generally included as impervious; C-CAP tries to map these as part of its open space developed class.
- Artificial turf is not typically included in OSD; it is expected to be mapped as an impervious surface.
- Transmission line rights-of-way should be excluded from OSD, as they are considered unmanaged, and should be mapped as grassland.



Cultivated Crops (6)

Cultivated crops include areas intensely managed for the production of annual crops, all actively tilled land, orchards, vineyards, nurseries, cranberry bogs, and aquaculture.

Minimum Mapping Units:

- Cultivated area > 0.5 acre (2,000 square meters)

Definition Details:

- These areas include vegetated crop features and field areas that are fallow or recently tilled (that might otherwise be considered bare).



Pasture/Hay (7)

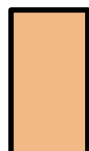
Pasture/Hay features include areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops. This cover type is typically perennial (i.e., not tilled on an annual basis) but is generally managed more intensively than natural grasslands.

Minimum Mapping Units:

- Area of grassland > 0.5 acres (2,000 square meters)

Definition Details:

- The presence of livestock or supporting features (such as ponds or feed sheds) indicates pasture, while hay bales or clear indications of mowing indicate hay.
- Scrub/shrub vegetation within pasture fields is often mapped separately.

**Grass/Herbaceous (8)**

Herbaceous grassland areas are dominated by graminoid or herbaceous vegetation, typically covering greater than 80 percent of the total area. These areas are not subject to intensive management such as tilling but may be utilized for light grazing.

Minimum Mapping Units:

- Area of grassland > 0.25 acres (1,000 square meters)

Definition Details:

- Herbaceous features that are not mapped as open space developed, cultivated, pasture/hay, or an emergent wetland category are considered grasslands.

**Upland Tree/Forest (11)**

Upland forest are areas dominated by woody vegetation (i.e., trees) greater than 15 feet (5 meters) in height. This includes individual trees, groups of trees, or larger forested areas where tree cover exceeds 20 percent. Tree features that meet these height and cover criteria but are determined to be wetlands are instead classified as either Palustrine or Estuarine Forested Wetlands (as defined below). Forested features determined to be wetlands are classified as either Palustrine or Estuarine Scrub/Shrub Wetlands (as defined below).

Minimum Mapping Units:

- Tree Area > 0.1 acre (400 square meters) and a minimum of 7 feet wide

Definition Details:

- This single category of undifferentiated upland trees or forest is the default for standard high-resolution C-CAP products; however, deciduous and evergreen forest types may be separated depending on available imagery. This additional mapping requires additional effort and cost. Interested users should contact NOAA for more details. If performed, deciduous and evergreen mapping would be represented by classes 9 and 10 and would replace any preexisting, undifferentiated upland tree pixels.

**Upland Scrub/Shrub (12)**

Upland scrub/shrub areas are dominated by woody vegetation less than 15 feet (5 meters) in height. This class includes woody vegetation consisting of shrub species, as well as tree species in early successional stages of regrowth or stunted from environmental conditions. These features are not distinguished between deciduous and evergreen species. Scrub/Shrub

features determined to be wetlands are classified as either Palustrine or Estuarine Scrub/Shrub Wetlands (as defined below).

Minimum Mapping Units:

- Shrub area > 0.1 acres (400 square meters) and a minimum of 7 feet wide.



Palustrine Forested Wetlands (13)

Palustrine forested wetlands include tidal and nontidal wetlands dominated by woody vegetation greater than 15 feet (5 meters) in height and occurring in tidal areas in which salinity due to ocean-derived salts is below 0.05 percent (0.5 parts per thousand). Total vegetation coverage is typically greater than 20 percent.

Minimum Mapping Units:

- Tree area > 0.1 acre (400 square meters) and a minimum of 7 feet wide
- Within wetland areas that are > 0.25 acres (1,000 square meters)



Palustrine Scrub/Shrub Wetlands (14)

Palustrine scrub/shrub wetlands include tidal and nontidal wetlands dominated by woody vegetation less than 15 feet (5 meters) in height and occurring in tidal areas in which salinity due to ocean-derived salts is below 0.05 percent (0.5 parts per thousand). Total vegetation coverage is typically greater than 20 percent.

Minimum Mapping Units:

- Shrub area > 0.1 acre (400 square meters) and a minimum of 7 feet wide
- Within wetland areas that are > 0.25 acres (1,000 square meters)

Definition Details:

- Species present could be true shrubs, young trees and shrubs, or trees that are small or stunted due to environmental conditions.



Palustrine Emergent Wetlands (15)

Palustrine emergent wetlands include tidal and nontidal areas dominated by persistent emergent vascular plants, mosses, or lichens. These wetlands occur in tidal areas in which salinity due to ocean-derived salts is below 0.05 percent (0.5 parts per thousand). Total vegetation coverage is typically greater than 20 percent.

Minimum Mapping Units:

- Herbaceous area > 0.1 acre (400 square meters)
- Within wetland areas that are > 0.25 acres (1,000 square meters)



Estuarine Forested Wetlands (16)

Estuarine forested wetlands include tidal wetlands dominated by woody vegetation greater than 15 feet (5 meters) in height and occurring in tidal areas in which salinity due to ocean-derived salts is equal to or greater than 0.05 percent (0.5 parts per thousand). Total vegetation coverage is typically greater than 20 percent.

Minimum Mapping Units:

- Tree area > 0.1 acre (400 square meters) and a minimum of 7 feet wide
- Within wetland areas that are > 0.25 acres (1,000 square meters)

Definition Details:

- Mangrove features, depending upon their height, may be captured in this class or in the Estuarine Scrub/Shrub class.



Estuarine Scrub/Shrub Wetlands (17)

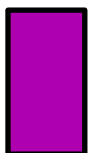
Estuarine scrub/shrub wetlands include tidal wetlands dominated by woody vegetation less than 15 feet (5 meters) in height and occurring in tidal areas in which salinity due to ocean-derived salts is equal to or greater than 0.05 percent (0.5 parts per thousand). Total vegetation coverage is typically greater than 20 percent.

Minimum Mapping Units:

- Shrub area > 0.1 acre (400 square meters) and a minimum of 7 feet wide
- Within wetland areas that are > 0.25 acres (1,000 square meters)

Definition Details:

- Species present could be true shrubs, young trees and shrubs, or trees that are small or stunted due to environmental conditions.
- Mangrove features, depending upon their height, may be captured in the Estuarine Scrub/Shrub class.

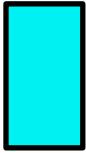


Estuarine Emergent Wetlands (18)

Estuarine emergent wetlands include tidal wetlands dominated by erect, rooted, herbaceous hydrophytes (excluding mosses and lichens). These wetlands occur in tidal areas in which salinity due to ocean-derived salts is equal to or greater than 0.05 percent (0.5 parts per thousand) and present for most of the growing season in most years.

Minimum Mapping Units:

- Herbaceous area > 0.1 acre (400 square meters)
- Within wetland areas that are > 0.25 acres (1,000 square meters)



Unconsolidated Shore (19)

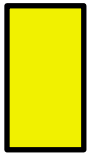
Unconsolidated shore features include intertidal areas composed of material such as silt, sand, or gravel, which are subject to inundation and redistribution by water. Substrates lack vegetation, except for pioneering plants that are established during brief periods when growing conditions are favorable.

Minimum Mapping Units:

- Area of unconsolidated shore has a width > 20 feet wide
- Total area of unconsolidated shore > 0.1 acres (400 square meters)

Definition Details:

- The distinction between bare land and unconsolidated shore along coastlines should be located at the mean higher high water (MHHW) level.
- The distinction between water (or benthic habitats) and unconsolidated shore should be located at the mean lower low water (MLLW) level.
- Corals, seagrass beds, and oyster reefs would not be included.



Bare Land (20)

Bare land contains areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits, and other accumulations of earth material. Generally, vegetation accounts for less than 10 percent of total cover. This category includes permanently unvegetated features but often captures features in states of transition, such as exposed soil at construction sites (including new development) or in recent forest clear cuts. This category can also include unpaved, infrequently traveled roads; recently tilled areas of exposed soils in agricultural settings; and railroad features.

Minimum Mapping Units:

- Barren area > 0.1 acres (400 square meters)
- Railroad features longer than 100 feet and clearly visible should be mapped to this class.



Open Water (21)

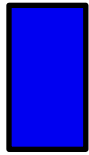
Open water features include water-covered areas with less than 25 percent vegetation cover.

Minimum Mapping Units:

- Area of water is > 0.1 acre (400 square meters)
- Visible river features greater than 10–15 feet wide should be mapped.

Definition Details:

- Docks should be classified as open water. More substantial features, such as piers and bridges, are not mapped as water but rather as impervious surfaces.
- Subtidal features, such as oyster or coral reefs, are included in the water category. However, this subtidal habitat mapping is not part of the standard C-CAP products.

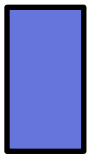


Palustrine Aquatic Bed (22)

Palustrine aquatic beds include tidal and nontidal wetlands and deepwater habitats in which salinity due to ocean-derived salts is less than 0.05 percent (0.5 parts per thousand). These environments are dominated by plants that grow and form a continuous cover principally on or at the water surface and include algal mats, detached floating mats, and rooted vascular plant assemblages. Total vegetation cover is greater than 80 percent.

Minimum Mapping Units:

- Area of aquatic bed > 20 feet wide
- Total area of aquatic bed > 0.1 acres (400 square meters)

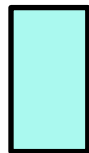


Estuarine Aquatic Bed (23)

Estuarine aquatic beds include tidal wetlands and deepwater habitats in which salinity due to ocean-derived salts is equal to or greater than 0.05 percent (0.5 parts per thousand). These environments are dominated by plants that grow and form a continuous cover principally on or at the water surface and include algal mats, kelp beds, and rooted vascular plant assemblages. Total vegetation cover is typically greater than 80 percent.

Minimum Mapping Units:

- Area of aquatic bed > 20 feet wide
- Total area of aquatic bed > 0.1 acres (400 square meters)



Perennial Ice/Snow (25)

Perennial ice/snow includes areas characterized by a perennial cover of ice or snow, generally greater than 25 percent of total cover.

Minimum Mapping Units:

- Area of snow or ice > 0.25 acre (1,000 square meters)

Definition Details:

- The extent of mapped area is based on what is visible in the imagery used as a mapping baseline (or an alternative imagery source, if available).