

FREQUENT QUESTIONS



Coastal Change Analysis Program (C-CAP) High-Resolution Land Cover

NOAA Office for Coastal Management
www.coast.noaa.gov/digitalcoast/data/ccaphighres

What is land cover? And why is it important?

Land cover data document the types of features that cover the surface of the Earth. These data quantify how much of a region is covered by forests, wetlands, impervious surfaces, and agriculture—as well as these feature’s locations.

It is difficult to manage any area or land resource without having an accurate picture of existing conditions. Land cover data can help provide that big-picture view. It is also beneficial to understand how these resources have changed. Comparing land resource data from one year to the next can be used to evaluate how a community’s past land management efforts are working and can provide valuable information on trends to aid future planning initiatives. Hopefully, this information will provide better context for management decisions.

What is the difference between land cover and land use?

The two terms are often used interchangeably, but strictly speaking land cover captures the physical state of land resources. Examples of land cover include forest, grassland, wetland, and impervious or paved surfaces. Land use on the other hand, denotes how the land is being used—whether the areas are residential, commercial, or industrial development. The same types of cover can be managed or used very differently.

What is high-resolution C-CAP?

C-CAP is the Coastal Change Analysis Program (C-CAP). Through it, NOAA produces nationally standardized land cover and land change data for the coastal regions of the U.S. C-CAP products provide inventories of coastal intertidal areas, wetlands, and adjacent uplands. While [regional C-CAP data](#) capture changes in our nation’s coastal areas by updating land cover maps every five years, high-resolution C-CAP products focus on bringing NOAA’s national mapping

framework to the local level by providing data relevant for addressing site-specific management decisions.

High-resolution C-CAP land cover products provide a more spatially detailed representation of coastal regions with resolutions ranging from 1 to 5 meters, while the Landsat-derived regional products have a resolution of 30 meters. High-resolution C-CAP products can also be distinguished from their moderate-resolution counterparts by their minimum mapping units (1/10th acre for impervious surfaces and 1/4th acre for non-impervious surface features).

Using standardized data and consistent methods, NOAA is able to produce data that can be compared through time, as well as information that can be used to evaluate different areas of the country. This apples-to-apples type of comparison is not always possible with various regional products that were produced by different groups for different reasons. Higher-resolution C-CAP land cover provides more detailed analysis in select locations that can be related to the regional products.

How are these high-resolution C-CAP data related to the National Land Cover Database?

NOAA works with the U.S. Geological Survey (USGS) and several other federal programs through the [Multi-Resolution Land Characteristics \(MRLC\) Consortium](#) to incorporate regional C-CAP land cover directly into the National Land Cover Database (NLCD) product line. As such, C-CAP is considered the coastal expression of this national database. While NOAA's higher-resolution land cover products are not currently incorporated in the same way, these products are related to the national NLCD land cover in much the same way that they are to NOAA's own regional data. That is, that these products are built upon the same national standards and map essentially the same classes, but they provide an increased level of spatial detail.

What land cover types do high-resolution C-CAP products map?

High-resolution C-CAP products can include up to 23 categories of land cover. It is important to note that because of the finer resolution, some classes found in the regional product do not apply. While the regional product characterizes multiple densities of development based on percentages of constructed surfaces and vegetation occupying a pixel, high-resolution products only contain an impervious surface class. This is because the high spatial resolution source imagery does not contain a high degree of mixed pixels so that the components of the C-CAP development classes can be mapped separately.

Access our [full classification scheme and class definitions](#).

These categories are based on C-CAP's (and the NLCD's) national classification scheme standards. The upland categories are based on the Anderson Level II classification system ([Anderson and others 1976](#)). This is the same system and scheme utilized by the National Land

Cover Database (NLCD), which C-CAP data feed into (see table 1). The more detailed wetland categories are based on Cowardin’s *Classification of Wetlands and Deepwater Habitats* (Cowardin and others 1979). This is where the more detailed palustrine and estuarine wetland categories are derived and is the same national standard used by the U.S. Fish and Wildlife Service’s National Wetlands Inventory (NWI) program.

Table 1: Moderate and high-resolution C-CAP land cover classes schemes compared to Anderson, 1976 Categories.

Anderson Level 1 Category	C-CAP Moderate-Resolution Category	C-CAP High-Resolution Category
Urban or Built-up Land (1)	Developed, High Intensity (2)	Impervious (2)
	Developed, Medium Intensity (3)	
	Developed, Low Intensity (4)	
	Developed, Open Space (5)	Open Space Developed (5)
Agricultural Land (2)	Cultivated Crops (6)	Cultivated Land (6)
	Pasture/Hay (7)	Pasture/Hay (7)
Rangeland (3)	Grassland (8)	Grassland (8)
	Scrub / Shrub (12)	Scrub Shrub (12)
Forest (4)	Deciduous Forest (9)	Deciduous Forest (9)
	Evergreen Forest (10)	Evergreen Forest (10)
	Mixed Forest (11)	
Wetlands (6)	Palustrine Forested Wetlands (13)	Palustrine Forested Wetlands (13)
	Palustrine Scrub Shrub Wetlands (14)	Palustrine Scrub Shrub Wetlands (14)
	Estuarine Forested Wetlands (15)	Estuarine Forested Wetlands (15)
	Estuarine Scrub Shrub Wetlands (16)	Estuarine Scrub Shrub Wetlands (16)
	Palustrine Emergent Wetlands (17)	Palustrine Emergent Wetlands (17)
	Estuarine Emergent Wetlands (18)	Estuarine Emergent Wetlands (18)
Open Water (5)	Open Water (21)	Open Water (21)
	Palustrine Aquatic Bed (22)	Palustrine Aquatic Bed (22)
	Estuarine Aquatic Bed (23)	Estuarine Aquatic Bed (23)
Barren Land (7)	Unconsolidated Shore (19)	Unconsolidated Shore (19)
	Barren Land (20)	Barren Land (20)
Tundra (8)	Tundra (24)	Tundra (24)
Perennial Ice/Snow (9)	Perennial Ice/Snow (12)	Perennial Ice/Snow (25)

How are individual land cover dates and change maps produced?

High-resolution C-CAP products are developed using a variety of imagery at a spatial resolution of less than 5 meters. Unlike moderate-resolution C-CAP which relies on traditional pixel-based image processing techniques, high-resolution C-CAP is developed using object-based image analysis where high-resolution image pixels are consolidated using a process called image segmentation. The increase in spatial detail greatly increases the number of spectral classes associated with each land cover class. This issue raises the likelihood of confusion and speckle in a pixel-based land cover classification. Image segmentation recursively groups pixels based on spectral homogeneity until a user-defined criteria is met. The result is a network of polygons that are classified instead of individual pixels. C-CAP land cover is typically classified using a semi-automated approach.

Updates to these data utilize change detection analysis to compare the two dates of imagery to isolate areas that have likely changed during the time frame between these images. These areas are then classified through a combination of models, use of ancillary data, and manual edits. NOAA contracts out much of this work to private industry. The classified land cover for these areas of change is then superimposed over the land cover from the original date of analysis, to create a new wall-to-wall classification for the second time period.

Remapping only areas that contain change leads to greater efficiency and more consistent data through time than would procedures that remap the full land cover for an area for each time period. By looking only at areas that have changed, we remove any difference that could result from differences in interpretation. This method also reduces cost, since only a small percentage of the total area must be classified in the change product (i.e., typically less than 20% of any area changes in a five-year period).

Why don't you have high-res C-CAP products for my area?

High-resolution C-CAP land cover data are not available everywhere that C-CAP maps as it would be cost-prohibitive to produce such detailed products for all of the nation's coastal areas. These products are developed in "hot-spots" of need, primarily driven by partner interest, and are often developed through a cost-sharing model with our partners. The Office for Coastal Management is always interested in partnering with organizations, agencies or groups that need land cover data with more spatial or thematic detail. The Office for Coastal Management has the capacity to facilitate financial partnerships through the indefinite delivery, indefinite quantity (IDIQ) coastal geospatial services contract (CGSC). For more information about the CGSC contract, please visit the following link: <http://coast.noaa.gov/idiq/geospatial.html>

What do C-CAP change products show?

C-CAP products consist of raster-based land cover maps for the two dates of analysis, as well as a separate file that highlights what changes have occurred between these dates and where the changes were located.

It may be important to note that this analysis is performed for specific time slices (discrete observations) and is not an account of every change that has occurred during the time period being analyzed. Only the land cover at time 1 and time 2 are included. The user can only make inferences about the processes at work between these two dates.

What do we mean by "change from" and "change to" within our change files?

When calculating change, an image *changes from* one land cover type (in time 1) and *changes to* another land cover (in time 2). For example, if a forested area was cleared and a housing development was built in its place, the area's "change from" value is forest and the "change to" value is low intensity developed.

What is a change matrix?

A change matrix is a table, similar to a spreadsheet, that quantifies the amount of change that occurs between all the land cover types (figure 6). The matrix shows the “From” classes as rows and the “To” classes as columns. The number of rows and columns is determined by the number of classes in the land cover image. Each cell represents the area (in acres) of the land cover change. In addition, the matrix can be used during data development to identify changes that are unlikely to occur (e.g., high density developed changed to a forest) for re-evaluation.

		Time 2				
		Developed	Agriculture	Forest	Wetland	Total
Time 1	Developed	200	0	0	0	200
	Agriculture	15	100	5	0	120
	Forest	17	12	500	0	527
	Wetland	2	5	0	25	32
	Total	234	117	505	25	879

Figure 6: Sample change matrix (numbers are square miles).

In the above matrix, the user can see that between time 1 and time 2 there were a total of 34 square miles of new development (red cells): 15 from agriculture, 17 from forest, and 2 from wetlands. Yellow cells indicate areas of no land cover change.

Use this [spreadsheet to help analyze C-CAP change data](#).

How should I interpret this change?

Change can be seen as the change in total area of a given land cover type between two dates (seen as the difference between each category’s bar in figure 7 below). This total area difference is referred to as net change. But net change can be deceiving, since there may have been a gain within a particular class in one area, but also losses in the same class elsewhere. The combined gains and losses offset each other, making it appear as if there was no net change. To see the total amount of change in a particular class, it’s best to use a graphic depicting losses and gains (figure 8).

$$\text{Area Gained} - \text{Area Lost} = \text{Net change}$$

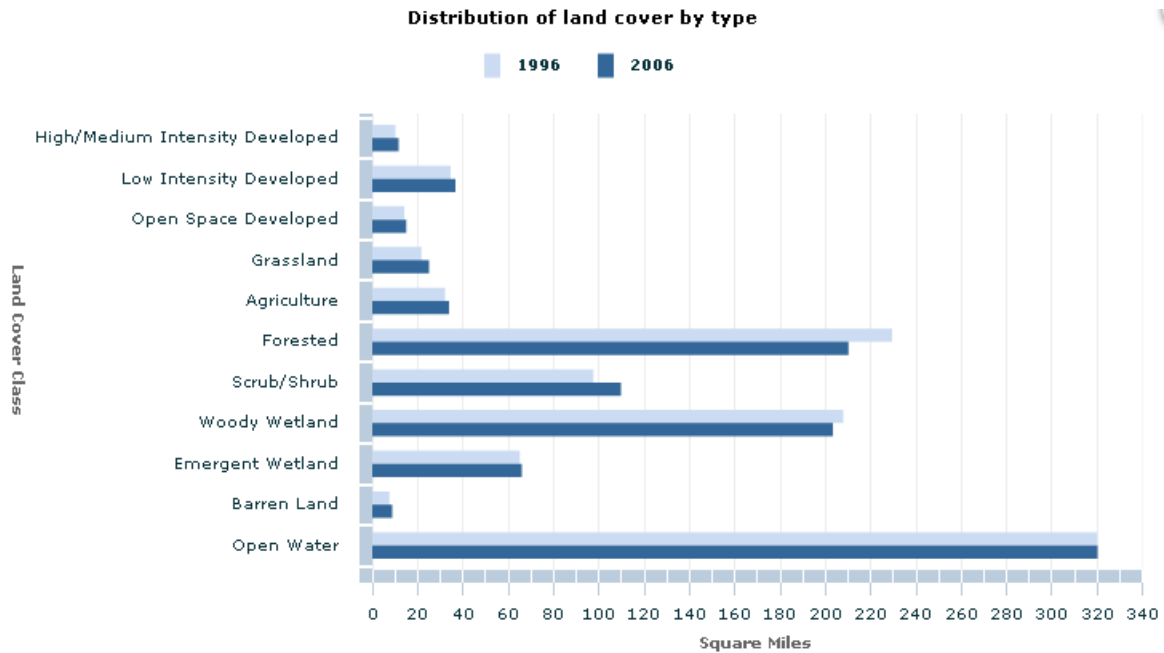


Figure 7: The above example was taken from the C-CAP Land Cover Atlas (www.coast.noaa.gov/digitalcoast/tools/lca) and highlights the distribution of each land cover class mapped by C-CAP for Jackson County, Mississippi, in 1996 and 2006. The net change in any class can be seen as the difference in the bars between the two dates. For example, over this period there was a net loss of about 19 square miles of forested land.

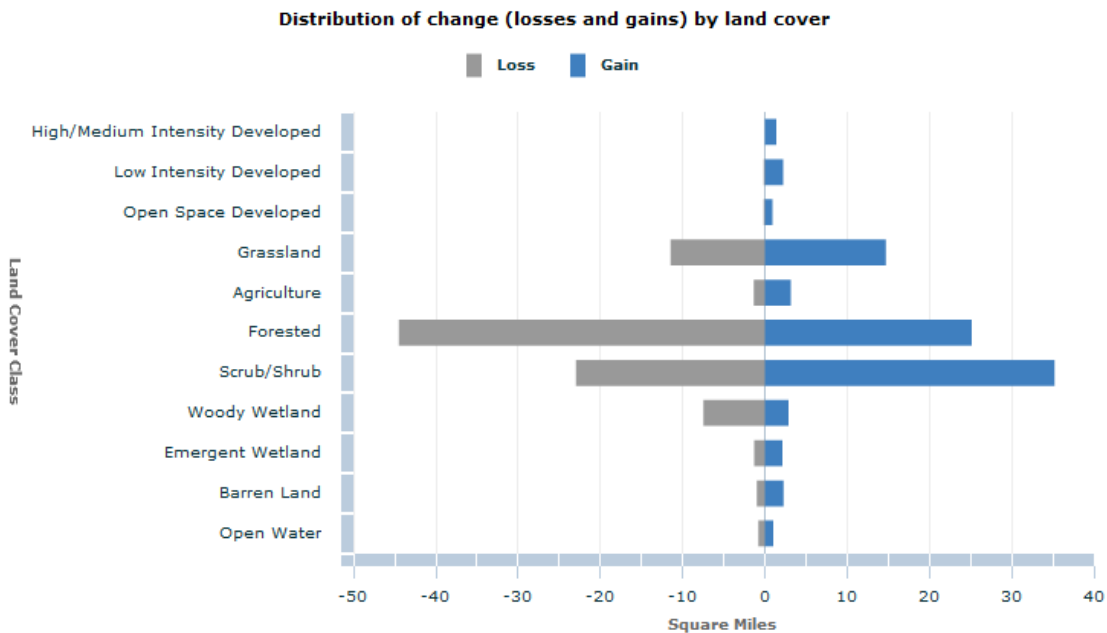


Figure 8: The above example was taken from the C-CAP Land Cover Atlas (www.coast.noaa.gov/digitalcoast/tools/lca) and highlights offsetting losses and gains in land cover for Jackson County, Mississippi, from 1996 to 2006. For example, over this period there was a net loss of about 19 square miles of forested land (also seen in figure 7), but this number may be deceiving because there was actually over 44 square miles lost and 25 square miles gained. Offsetting losses and gains are common with forest, grassland, and shrub, since these classes tend to represent a timber cycle from harvest through regrowth.

What is the smallest feature that C-CAP products map? Or what is the minimum mapping unit of C-CAP products?

High-resolution C-CAP data are developed using imagery collected by either aerial or satellite-based platforms. The range of spatial resolutions from which we map is between 1 and 5 meters. The amount of spatial detail available in C-CAP high-resolution products is determined by the minimum mapping unit (MMU). The defined MMU is 1/10th acre for impervious surface features and 1/4th acre for all other land cover types. While smaller features may be mapped, the accuracy of the product is based on features that meet or exceed the MMU.

At what scale are C-CAP data applicable?

Raster data are not typically characterized by a specific scale but by their spatial resolution. In terms of the appropriate scale of application, high-resolution C-CAP data are best suited for addressing local level issues at scales between 1:8000 and 1:12000.

What is the accuracy of C-CAP products?

C-CAP products are developed with a target overall accuracy of 85%. Accuracy assessments have not been performed for all high-resolution C-CAP products. Accuracies may vary depending upon the complexity of land cover types within the geography as well as the need of the intended users of the data. Overall product accuracies reported to date have ranged between 80 and 90%.

What is the correct or preferred citation for using Coastal Change Analysis Program data?

“Correct” citation style depends entirely on the style manual chosen by your organization. That said, here is a generic citation that includes the basic information that you can shape to your needs:

National Oceanic and Atmospheric Administration, Office for Coastal Management. “[Name of Data Set.](#)” Coastal Change Analysis Program (C-CAP) High-Resolution Land Cover. Charleston, SC: NOAA Office for Coastal Management. Accessed [Month Year](#) at www.coast.noaa.gov/ccapftp.