Status and Trends of Wetlands

in the Coastal Watersheds of the Conterminous United States

2004 to 2009

U.S. Department of the Interior
Fish and Wildlife Service
and
National Oceanic and Atmospheric
Administration
National Marine Fisheries Service

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Conversion Table

U.S. Customary to Metric

inches (in.)	x	25.40	=	millimeters (mm)
inches (in.)	x	2.54	=	centimeters (cm)
feet (ft)	x	0.30	=	meters (m)
miles (mi)	x	1.61	=	kilometers (km)
square feet (ft^2)	x	0.09	=	square meters (m^2)
square miles (mi^2)	x	2.59	=	square kilometers (km^2)
acres (A)	x	0.40	=	hectares (ha)
Farenheit degrees (FE)		0.5556 (FE-32)	=	Celsius degrees (CE)

Metric to U.S. Customary

millimeters (mm)	x	0.04 =	=	inches (in.)
centimeters (cm)	x	0.39	=	inches (in.)
meters (m)	x	3.28	=	feet (ft)
kilometers (km)	x	0.62	=	miles (mi)
square meters (m^2)	x	10.76	=	square feet (ft^2)
square kilometers (km^2)	x	0.39	=	square miles (mi^2)
hectares (ha)	x	2.47	=	acres (A)
Celsius degrees (CE)		1.8(CE) + 32	=	Fahrenheit degrees (FE)

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Executive Summary

Coastal wetlands in the United States are diverse and include both saltwater wetlands that occur along the coastal shorelines and freshwater wetlands that extend inland within the coastal drainages. Influenced by water that connects the upper reaches of the watershed with the oceans or Great Lakes, these wetlands play a pivotal role in the watershed. Wetlands in coastal watersheds provide crucial habitat for wildlife by providing spawning grounds, nurseries, shelter, and food for finfish, shellfish, birds and other wildlife. These wetlands also help improve water quality by filtering and detoxifying runoff from residential, agricultural, and urban areas. Furthermore, there is an increasing awareness of the important role these coastal wetlands play in buffering coastlines against storm and wave damage and in stabilizing shorelines in the face of climate change impacts.

In 2008, the U.S. Fish and Wildlife Service (USFWS) in coordination with the National Oceanic and Atmospheric Administration (NOAA) released a report documenting wetland trends in the coastal watersheds of the Atlantic, Gulf of Mexico and Great Lakes (Stedman and Dahl 2008). That study did not include the wetlands in the coastal watersheds along the Pacific coast. Findings from that study indicated that there was a net loss of an estimated 361,000 acres of wetland in the coastal watersheds of the eastern U.S. between 1998 and 2004. There was considerable variation in trends among the three coastal regions studied. Watersheds of the Great Lakes experienced net gains in wetlands, whereas watersheds along the Atlantic and Gulf of Mexico coasts experienced an overall net loss of an estimated 60,180 acres annually. Attribution of these losses pointed to development and other human activities as the principle cause of loss in the Gulf of Mexico and salt water intrusion or inundation as the primary cause of the losses observed in the mid-Atlantic region. The release of that information stimulated discussion at the Federal level centering on the need for increased wetland protection and restoration measures in the coastal watersheds and the role of federal, state or local mechanisms in protecting these coastal resources.

Working in conjunction with principal Federal agencies the USFWS and NOAA have produced updated data on more recent trends of wetlands in the coastal watersheds to help prioritize conservation planning efforts and contribute additional information on coastal wetland trends.

This report updates and expands previous information on coastal wetland loss by incorporating new data for the coastal watersheds of the Atlantic, Gulf of Mexico and Great Lakes and in addition, providing information for the Pacific coast along the States of Washington, Oregon and California. It presents the latest status information on coastal wetland resources and provides estimates of losses or gains that occurred in the coastal watersheds in the conterminous U.S. between 2004 and 2009. The information presented provides data on the areal extent of wetlands but does not assess wetland condition or other qualitative changes to wetlands in coastal watersheds.

Suisun Marsh, California

To estimate wetland extent and change, this study used randomly selected 4.0 square mile (2,560 acres or 1,036 ha) sample plots and digital high-resolution imagery to identify change in wetlands, deepwater habitats and uplands. A total of 2,614 plots were used to sample the coastal watersheds and ground verification was done for 380 plots (14.5 percent). Wetlands and deepwater habitats were described using the USFWS biological definition of wetland (Cowardin *et al.* 1979) and followed the procedural, quality control and analysis protocols as have been developed for the National Wetlands Status and Trends reporting conducted by USFWS.

In 2009, there were an estimated 41.1 million acres of wetlands in the coastal watersheds of the United States. This area represented 37.3 percent of total wetland area in the conterminous U.S. Of the wetland area in the coastal watersheds, an estimated 34.6 million acres (84.3 percent) were freshwater wetlands and 6.4 million acres (15.7 percent) were saltwater wetlands. Between 2004 and 2009, wetland area in the coastal watersheds of the U.S. declined by an estimated 360,720 acres. The average annual rate of change was an estimated loss of 80,160 acres, a 25 percent increase in the rate of wetland loss from the previous reporting period[1]. The increase in the rate of coastal wetland loss was statistically significant ($p = 0.007$) when results from this study were compared to the coastal wetland loss estimates from the 1998 to 2004 study as reported by Stedman and Dahl (2008).

The watersheds of the Atlantic and Gulf of Mexico had very similar amounts of wetland area (15.9 million and 15.4 million acres, respectively) in 2009. Watersheds of the Great Lakes had an estimated 8.5 million acres of wetland. The Pacific coastal watersheds had the least amount of wetland area with an estimated 1.3 million acres. The Atlantic, Gulf of Mexico, and Pacific coastal regions experienced net wetland losses between 2004 and 2009 of 111,960 acres, 257,150 acres and 5,220 acres, respectively. The watersheds of the Great Lakes region experienced a net gain in wetland area of an estimated 13,610 acres. Seventy one percent of the estimated wetland losses were in the coastal watersheds of the Gulf of Mexico.

[1]The average annual rate of loss for the six years between 1998 and 2004 was 59,000 acres compared to the average annual rate of loss for the 4.5 years between 2004 and 2009 being 80,160 acres.

Saltwater wetlands sustained an estimated net loss of 95,000 acres as modest gains in marine and estuarine non-vegetated wetlands (flats, shoals and bars) were overshadowed by losses of estuarine vegetated wetlands, which declined by 2.4 percent. Most of the vegetated estuarine losses were to open saltwater deepwater habitats, and virtually all of these losses occurred in the Gulf of Mexico.

In the freshwater system, emergent marshes and shrub wetlands increased in area; however, freshwater forested wetlands declined by an estimated 405,700 acres resulting in a net loss of freshwater vegetated wetland area of 328,800 acres (1.0 percent) between 2004 and 2009. Forested wetlands lost to uplands in silviculture accounted for an estimated 179,080 acres or 65 percent of the freshwater wetland losses to upland land uses. Regionally, the Pacific coast sustained a small net loss (5,180 acres) of freshwater wetlands, while the Atlantic experienced larger net losses of 112,290 acres, the Gulf of Mexico sustained net losses of 161,870, and the Great Lakes saw a modest net gain of 13,610 acres in their coastal watersheds.

The area of freshwater ponds increased by almost six percent, although many were located in urban or suburban developments as likely water detention ponds or ornamental ponds as opposed to targeted wetland reestablishment projects. The vast majority of these new ponds (99 percent) were constructed in the watersheds of the Atlantic and Gulf of Mexico.

Although both saltwater and freshwater wetlands sustained net losses between 2004 and 2009, some coastal wetland gains occurred through reestablishment projects. These were most prevalent on agricultural lands primarily in the coastal watersheds of the Great Lakes, South Carolina, Georgia, and the upper reaches of the watersheds in central Florida. In general, wetland reestablishment in coastal watersheds has lagged behind reestablishment rates observed nationally for a variety of reasons. A strategy of achieving “no net loss” by offsetting wetland acreage losses with wetland creation or reestablishment does not appear to be effective in the coastal watersheds as wetland losses have increased in some coastal regions. Continuing losses of wetlands in coastal watersheds have direct costs for people and longer-term resource implications for fish, wildlife and other natural resources.

Black Skimmers (Rynchops niger), Laughing Gulls (Leucophaeus atricilla), Sandwich Terns (Thalasseus sandvicensis), Gulf coast of Florida

This report is the result of a cooperative effort between the U.S. Department of the Interior's Fish and Wildlife Service and the National Oceanic and Atmospheric Administration's National Marine Fisheries Service. Continuing efforts to monitor coastal wetland status and trends described in this report have been supported by the Federal Interagency Coastal Wetlands Workgroup – a multi-agency group comprised of members from the Environmental Protection Agency, NOAA, USFWS, U.S. Army Corps of Engineers, Natural Resources Conservation Service, the Federal Highway Administration and the U.S. Geological Survey.

Introduction

Coastal wetland ecosystems include not only the wetlands adjacent to the ocean coast or Great Lakes but also those within the coastal watershed boundary (NOAA 2012). Thus coastal wetlands included in the study can be described as all wetlands in each 8-digit hydrologic unit code[2] watershed that drains directly to the ocean coast and contain a tidal waterbody, as well as watersheds that drain directly to one of the Great Lakes. Both saltwater and freshwater wetlands are included within this watershed-based ecosystem concept. Mangrove forests, fresh and saltwater marshes (Figure 1), forested and shrub wetlands, coastal shoals, tidal mud flats, sand spits (bars), beaches, tidal pools and freshwater ponds occur in coastal wetland ecosystems.

The Federal Government, working closely with States, other partner organizations, and the public has a crucial role to play in identifying stressors facing coastal environments and in developing and implementing actions that ensure the continued health and availability of our Nation's ocean, coastal, and Great Lakes resources. The U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries) have collaborated in a number of efforts to produce information on coastal wetland habitats as they influence fish and wildlife species distribution, enhance the physical or ecological condition of coastal areas (e.g. storm surge protection and water quality improvement) and provide socioeconomic benefits to many Americans.

In 2008, USFWS in conjunction with NOAA released a report documenting wetland trends in the coastal watersheds of the Atlantic, Gulf of Mexico and Great Lakes (Stedman and Dahl 2008). The findings from that study indicated that an estimated 38 percent of all wetland acreage in the conterminous United States was found in these coastal watersheds. Coastal watersheds had sustained an estimated 361,000 acres of wetland loss between 1998 and 2004 or an average of nearly 60,000 acres each year. The loss of these coastal habitats diminished the health of these ecosystems and reduced their ability to provide environmental and socioeconomic services (Wolanski *et al.* 2009). The release of that report stimulated discussion at the Federal level centering on increased wetland protection and restoration measures in the coastal watersheds. Monitoring of coastal indicators including wetland loss has shown that coastal planning and management policies over the past 30 years have limited, but not curtailed, harmful cumulative impacts on coastal ecosystems (USEPA 2012). As a result, there is continuing interest in the effectiveness as well as the limitations of federal, state or local mechanisms to protect these coastal resources.

In response to concerns about the rate of wetlands loss in coastal watersheds, the Environmental Protection Agency (EPA) has been leading an interagency effort to examine wetland losses in coastal watersheds and identify stressors, strategies, policies and information to protect and restore coastal wetland resources. This interagency effort has a goal to raise awareness of coastal wetland functions, threats and conservation opportunities to reverse losses of wetlands in coastal watersheds. The Interagency Coastal Wetlands Workgroup (ICWWG) established by EPA also includes NOAA, USFWS, U.S. Army Corps of Engineers, Natural Resources Conservation Service, Federal Highway Administration and the U.S. Geological Survey. With the support of the ICWWG, EPA and NOAA held a series of seven workshops in coastal watersheds[3], soliciting information and views from those most familiar with wetland issues in those watersheds regarding wetland stressors, effective tools and strategies for reducing wetland loss in coastal watersheds. The results of those workshops have been published in a set of regional reports available on the EPA and NOAA web sites (USEPA 2013a; 2013b).

At roughly the same time, USFWS embarked on a national update of the National Wetlands Status and Trends Study for the time period from 2004 to 2009. Working in conjunction with principal Federal agencies,[4] that study formed the basis for this update on the status and

[2] Drainage basins in the United States have been divided and sub-divided at four different levels and each assigned a unique hydrologic unit code consisting of eight digits based on these four levels.

[3] Workshops were conducted in the following watersheds: Cape Cod, Delaware Estuary, York River (VA), Lower and Middle Neuse River (NC), Indian River (FL), Mississippi Coastal, and Galveston Bay.

[4] Funding or technical assistance for the National Wetlands Status and Trends study was provided by the Environmental Protection Agency, Department of Agriculture (Natural Resource Conservation Service), Department of the Army (Army Corps of Engineers), National Oceanic and Atmospheric Administration (National Marine Fisheries Service) and the Department of the Interior (Fish and Wildlife Service). Additional support for work in the coastal watersheds was provided by EPA and NOAA.

Figure 1. Aerial view of saltwater (intertidal) wetlands that include emergent salt marsh and non-vegetated shoals and sandbars (foreground). Atlantic coastline of Virginia, 2008.

more recent trends of wetlands in coastal watersheds. This report expands the information for the coastal watersheds of the conterminous U.S. by updating data for the coastal watersheds of the Atlantic, Gulf of Mexico and Great Lakes, which were included in the previous coastal watersheds report, and adding information for the Pacific Coast along the States of Washington, Oregon and California.

This report presents the latest status information on coastal wetland resources and provides estimates of losses or gains[5] that occurred in the coastal watersheds in the conterminous U.S. between 2004 and 2009.

[5] Wetland loss or gain as used in this report is defined as a decline or increase in wetland area.

The information presented provides data on the areal extent of wetland types, both past and present, to help prioritize conservation planning efforts for coastal wetland resources and contribute additional information to the ICWWG to facilitate strategy and policy development. Additional wetland impacts have occurred in non-coastal watersheds which cumulatively drain to coastal waters and thus have an additive influence on coastal ecosystems (Dahl 2011). This increases the importance of coastal wetlands in ecosystem interchange and function. This study does not assess wetland condition or other qualitative changes to wetlands in coastal watersheds. Readers are referred to the National Coastal Condition Report IV (USEPA 2011) for information on the qualitative aspects of coastal resources.

Coastal Wetlands

Wetlands in coastal watersheds are part of a diverse and complex set of ecosystems that are vital to the Nation's economy and an important part of our natural heritage. Centuries ago, coastal wetlands and estuaries provided the fish, waterfowl and building materials that supported native populations and European settlers. That vital role continues today, with more than half of the fish caught for recreational or commercial purposes in the U.S. depending on estuaries and their coastal wetlands at some point in their life cycles (Lellis-Dibble *et al.* 2008). Other wetlands in the coastal watersheds provide nurseries, shelter and food for finfish (Figure 2), shellfish, shorebirds and marine mammals (Twilley *et al.* 1996; Spalding *et al.* 2010). Coastal wetlands also provide resting, feeding and breeding habitat for 75 percent of the Nation's waterfowl and other migratory birds (USEPA 2005; 2012). Healthy coastal wetlands are among the most productive ecosystems on the planet, comparable to rainforests and coral reefs. That productivity is particularly important to the nearly 45 percent of the Nation's endangered and threatened species that depend on wetland habitats (USFWS 1995).

In addition to providing habitat for fish and wildlife, wetlands in the coastal watersheds benefit humans by improving water quality (through the filtering and detoxifying of runoff), protecting coastal communities against damage from erosion and flooding, and providing recreational opportunities for wildlife viewing and exploration, hunting, fishing and tourism. The overall level of economic activity generated in all coastal counties in the U.S. is over $6.6 trillion or just under half of the Nation's gross domestic product in 2011 (NOAA 2012). Because they provide such crucial services it is in our national interest to responsibly use, conserve and protect these coastal resources.

Coastal wetland types are diverse and include salt marshes (Figure 3), mangrove swamps, freshwater forested swamps (Figure 4), flat-woods, freshwater marshes, shrub depressions and wetlands adjacent to tidal rivers. The definitive factor in describing coastal wetlands is the tidal influence and hydrologic connection of the watershed with the ocean (or the Great Lakes). For this reason, coastal wetlands can be described as all wetlands in watersheds that drain to the Atlantic Ocean, Gulf of Mexico or Pacific Ocean, and contain a tidal waterbody; as well as wetlands that drain directly to one of the Great Lakes.[6] All wetlands in these coastal watersheds formed the target population included in this study.[7] This landscape-level or ecosystem-based approach encompasses concepts fundamental to working toward integrated, comprehensive policy development, management and conservation of our coastal resources.

The distribution and condition of wetlands in coastal watersheds are strongly influenced by natural processes. Both man-made and natural stressors influence wetland abundance, type, distribution and vulnerability to changes. Saltwater wetlands are found at the interface of land and sea where they form linkages between inland landscapes and the ocean. These intertidal wetlands experience oceanic influences in areas of high energy where tides, winds, waves and currents alter shorelines and inundate coastal landscapes (Figures 5 and 6). Wetlands along this interface are subject to erosion, saltwater inundation, salinity changes, land subsidence and changes in sediment deposition patterns. Coastal wetlands in the upper parts of a watershed are subject to less erosion, but may still be affected by the other factors mentioned. In some situations coastal wetlands can adapt to these changes in a number of ways, such as moving inland with rising sea level, changing vegetation composition or distribution in response to salinity changes, or colonizing new areas when spits or barrier islands change location. However, human impacts on the landscape can impede the ability of coastal wetlands to adapt to their dynamic environment.

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[6] NOAA has used a specific methodology to identify coastal watersheds using hydrologic unit boundaries that contain tidal water bodies. This excludes several areas that actually drain to one of the coastlines (i.e. surrounded by coastal watersheds) but do not contain tidal water bodies. There may also be limitations due to the precision of watershed boundary demarcation.

[7] The Pacific coast included watersheds in Washington, Oregon and California.

Figure 3. Intertidal (saltwater) marshes of a coastal watershed along the Gulf of Mexico, Louisiana.

Figure 2. Mangroves colonize intertidal areas along the coast of the southern United States.

Figure 4. Freshwater wetlands of a coastal watershed, Alabama.

Figure 5. Storm damage and saltwater inundation resulting from Hurricane Irene along the coast of North Carolina, 2011.[8] In addition to the property damage and threats to coastal residents, the frequency and intensity of coastal storms can also influence coastal wetland types and distribution through erosion, deposition of sediments or by increasing salinity.

Figure 6. Tidal waters flood a city street in Key West, Florida. Rising sea levels, saltwater inundation or coastal storms are a concern along certain coastlines.

[8] The impacts of Hurricane Irene (2011) or Hurricane Sandy (2012) were not included in this study timeframe.

Losses and degradation of wetlands in coastal watersheds can be directly traced to population pressures and conversion of wetlands to developed or agricultural uses, with resulting changes in water flow, increased pollution and habitat fragmentation (Stedman and Dahl 2008). As human habitation in coastal areas has increased, population density in the coastal counties has risen to be far greater than that of non-coastal counties (Crossett *et al.* 2004). For example, in coastal North Carolina, the lands situated between the ocean and the interior have exhibited consistently higher growth of residential development than lands far from the coast (Crawford 2007), and that same trend can be seen elsewhere in many coastal states. However, census data understate the impacts of development in many coastal areas because they do not account for seasonal influxes of residents and the related infrastructure needed to support coastal oriented tourism and growth (Beach 2002). Coastal development often contributes to land use changes that increase impervious surface area, affect water quality or disturb natural habitats through loss or fragmentation (Crawford 2007). The effects of development on wetlands are important as some estimates indicate that development will cover one quarter of the land area of the Nation's coastal watersheds by 2015 (Beach 2002). Figure 7 shows the increase in population in coastal counties in the conterminous U.S. These increases in population density are frequently associated with greater demands for resources (USEPA 2013a) and wetlands in coastal watersheds are more likely to be lost or degraded when wetlands come into conflict with land development interests or other stressors associated with urbanization, infrastructure development, or land-use changes that alter hydrology (Dahl 2011).

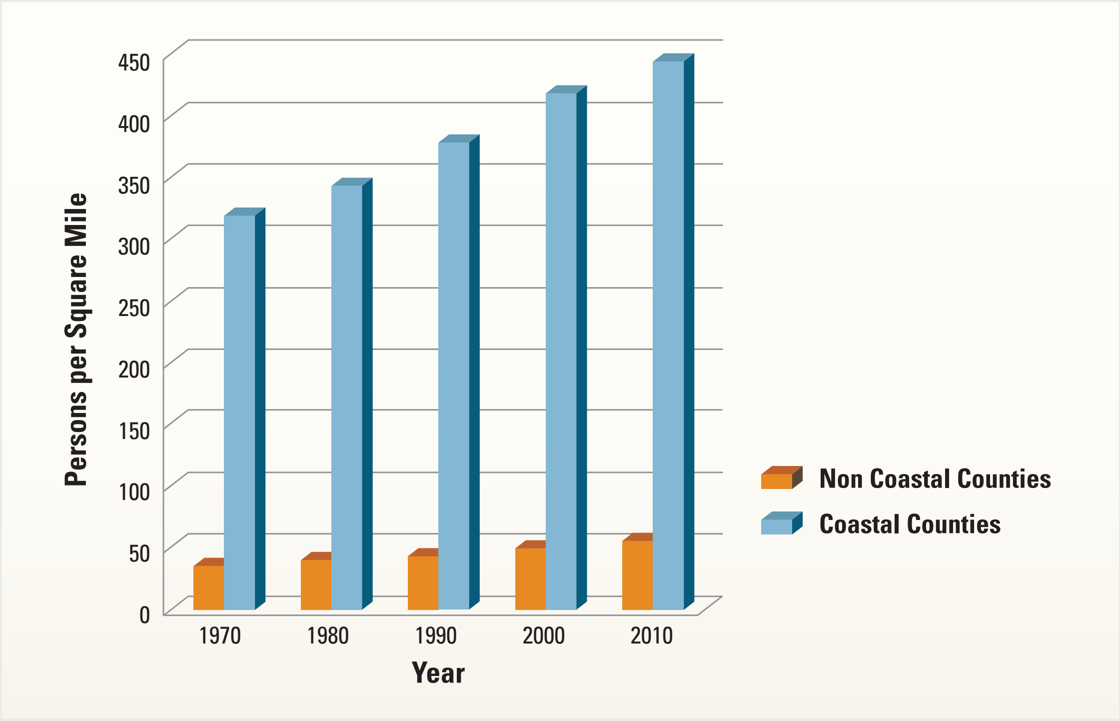


Figure 7. Changes in population density in the conterminous United States from 1970 to 2010. Data adapted from NOAA (2012).

Study Area

The study area was the coastal watersheds of the Atlantic, Great Lakes, Gulf of Mexico and Pacific coasts (Figure 8). NOAA uses a specific methodology (NOAA 1999) to identify coastal watersheds by combining information on the extent of ocean-derived tidal influence and the mapping of watershed (drainage) boundaries. The 8-digit hydrologic unit watersheds that contained tidal water bodies were used to denote coastal watersheds for this study. A similar method was used in the Great Lakes region to identify the extent of non-tidal coastal watersheds of the Great Lakes.

The outer coastal boundary was determined by the extent of the coastal sampling frame used by the FWS' National Wetlands Status and Trends Study for the Atlantic, Gulf of Mexico, Pacific and Great Lakes coastal areas. The total area sampled in these four coastal areas was 246.9 million acres[9] (Table 1). The inland study boundary coincided with the corresponding coastal watershed boundaries as provided by NOAA however, along the Pacific coast, this inland boundary was truncated by the Coast Range Physiographic Region boundary. The San Francisco Bay was also modified to include Sourin Bay.

The Atlantic coastline extends approximately 2,070 miles from Maine to south Florida. Coastal regions vary considerably from the steep rocky shorelines of New England to broad, flat coastal marshes in the Carolinas and the limestone landscapes of south Florida. Much of the Atlantic coast is typified by large coastal bays and sounds including Delaware Bay, Chesapeake Bay, Albemarle Sound, Pamlico Sound and the Indian River Lagoon. Barrier islands such as North Carolina's Outer Banks provide physical barriers between waves and tidal energy of the ocean and mainland features. Tidal stages range between a few inches in the Carolinas to 7 to 13 feet in parts of New England (USEPA 2012). The negative effects of human habitation on coastal wetlands and other natural resources can be readily seen in the urban corridor that stretches from New York City to Washington D.C. (National Fish Habitat Board, 2010). The coastal counties along the Southeast Atlantic had the largest rate of population increase (79%) of any coastal region in the conterminous United States between 1980 and 2006.

The Gulf of Mexico has about 1,630 miles of shoreline extending from the subtropical reefs of the Dry Tortugas in Florida to the extensive coastal flats and marshes of the Texas coast. The Mississippi delta (including Barataria and Terrebonne Bays) and its associated habitats are a major feature of this coastal area, as are Tampa Bay, Mississippi Sound and Galveston Bay. Engle (2011) has summarized some of the ecosystem services provided by wetlands along the Gulf coast. The economic importance of the resources in the Gulf were recently underscored by the Deepwater Horizon oil spill in 2010,[10] which affected hundreds of species of resident and migratory wildlife, commercial and recreational fishing, tourism and regional businesses of many types. A majority of the wetland loss (61,800 acres) found in coastal watersheds between 1998 and 2004 occurred along the Gulf of Mexico. Some of that loss was associated with the long-term continuing erosion and subsidence of the Mississippi delta, but more was related to development and other human activities along the entire coastline (Stedman and Dahl, 2008).

[9] This study incorporated some estuarine embayments not included in the total land area figure.

[10] This study did not include any wetland losses due to the Deepwater Horizon oil spill in 2010 since the effective dates of data collection for this study were between 2004 and 2009.

Table 1. Area (in acres) of coastal watersheds and shoreline (in miles) included in this study (shoreline information courtesy of NOAA, National Ocean Service).

Coastal Watershed	Area of Coastal Watersheds (acres)	Coastline (miles)	Tidal Shoreline (miles)
Atlantic Coast	89,096,000	2,070	28,670
Gulf Coast	67,562,000	1,630	17,140
Great Lakes (United States only)	55,869,000	5,180 (including connecting rivers)	NA
Pacific Coast	34,372,000	1,290	7,860
Total	**246,899,000**	**10,170**	**53,670**

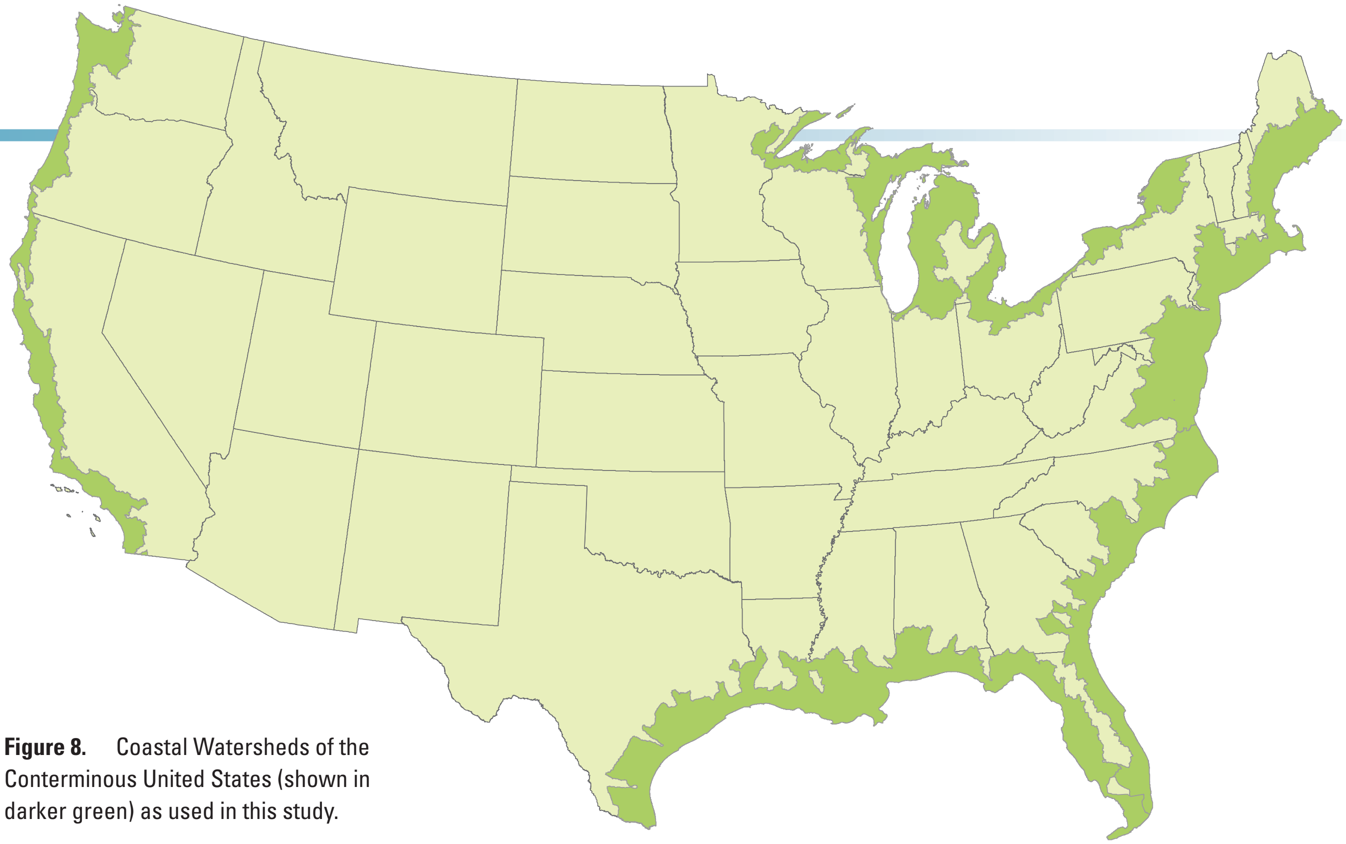


Figure 8. Coastal Watersheds of the Conterminous United States (shown in darker green) as used in this study.

Recognized collectively in federal law as the Nation's "fourth seacoast", the Great Lakes and their connecting channels and rivers comprise the world's largest body of freshwater (U.S. Commission on Ocean Policy 2004). The watersheds of the Great Lakes encompass a diversity of habitats including glacial scours, coniferous forests, rocky shorelines and sand dunes. The coastal wetland ecosystems of the Great Lakes include about 30,000 islands, bogs, fens, coastal marshes, coastal ridges and swales, shrub swamps, wet prairies, forested wetlands and alvars. Only a small percentage of the original extent of wetlands remains around the Great Lakes after over 200 years of intensive development and urbanization (Mitsch and Wang 2000).

For the first time this study included wetlands in the coastal watersheds of Washington, Oregon and California. These three states have 1,290 miles of shoreline extending from Puget Sound to the California – Mexico border, with more than 410 estuaries and bays (USEPA 2012). The Pacific coast lacks the extensive coastal plain found elsewhere in the U.S. and instead is characterized by steep topographic relief between land and sea. As a result, saltwater marshes and estuarine flats are found only in discontinuous segments. Intertidal wetlands are located principally in coastal embayments such as Grays Harbor, Willapa Bay and Puget Sound in Washington; the Columbia River Estuary, Coos Bay, Tillamook Bay and Yaquina Bay in Oregon; and Humboldt Bay, San Francisco Bay, Bolsa Chica Bay and the Tijuana Estuary in California. Since the 1850's 90 percent of California's original coastal wetland acreage has disappeared, and many of the remaining wetlands are in danger of being further degraded or destroyed due to filling, diking, dredging, pollution and other human disturbances (CA Natural Resources Agency 2013). The coastal areas of Oregon and Washington are somewhat less degraded than those of California, but dams and other water diversions affect the timing, quantity and quality of freshwater flows down rivers and into estuaries (Gleason *et al.* 2011).

Freshwater wetland on Madeline Island, Wisconsin.

Study Methods

In the previous study by Stedman and Dahl (2008), and in the present study analysis of the USFWS National Wetlands Status and Trends dataset was conducted to provide updated information specifically on the status and extent of wetland resources in the coastal watersheds and the recent changes that had occurred. Randomly selected plots were assessed using digital high-resolution imagery to identify change in wetlands, deepwater habitats and uplands. Imagery used to detect changes included digital high resolution (<1 meter) multispectral or infrared satellite imagery as well as true color photography (1 meter resolution).[11] Each sample plot was 4.0 square miles total area (2,560 acres). A total of 2,614 plots were used to sample the coastal watersheds. Wetland, deepwater and upland habitat changes were determined by intensive analysis of the aerial imagery, determination of wetland types and identification of the changes that occurred between the respective target dates. The mean dates of the aerial imagery used to determine wetland trends were 2004 and 2009, with the difference being an average of 4.5 years. For this study, wetlands 1.0 acres and larger composed the target population.[12] However, actual results indicated that for each wetland category included in the study, the minimum size represented was less than 1.0 acre. Additional information on the study design, data collection and analysis procedures has been discussed by Dahl (2011). Changes were recorded in areal extent or type of wetland observed on the sample plots between 2004 and 2009.

Ground verification of features on the aerial imagery was done for at least portions of 380 sample plots (14.5 percent) during 2009 and 2010. Field verification addressed questions regarding image interpretation, land use coding and attribution of wetland gains or losses. Field work was also performed as one of the quality control measures to verify that plot information was accurate. Verification involved field visits to a variety of wetland types and geographical settings.

To reflect reliability, each statistical estimate generated is accompanied by a coefficient of variation expressed as a percent. The wetland area estimates produced for this study include all wetlands regardless of land ownership. The results represent the latest wetland monitoring information specific to the coastal watersheds areas of the Atlantic, Gulf or Mexico, Great Lakes and Pacific.

[11] About 40 percent of the sample sites used satellite imagery and 60 percent aerial photography.

[12] Smaller wetlands were detected and included in the study, but it cannot be determined that all wetlands less than 1.0 acre were detected.

Cape Romain, South Carolina.

Habitat Definitions

During the mid-1970s USFWS began work on a biological definition of wetland and standardized nomenclature for the classification of wetland types. This system described by Cowardin *et al.* (1979), was adopted as a standard by USFWS and subsequently became a Federal Geographic Data Committee (FGDC) Standard for mapping, monitoring and reporting on wetlands (FGDC 1996). This institutionalization of a biological definition and classification system has facilitated its use in numerous Federal applications and has provided consistency and continuity by defining the biological extent of wetlands and common descriptors for wetland types. It is a two-part definition as indicated below:

> *Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water.*
>
> *For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes, (2) the substrate is predominantly undrained hydric soil, and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.*

Cowardin *et al.* (1979) and other researchers (Gosselink and Turner 1978; Mitsch and Gosselink 1993) recognized that hydrology was universally regarded as the most basic feature of wetlands and that hydrology, not the presence of vegetation, determines the existence of wetland (Cowardin and Golet 1995). For this reason, in areas that lack vegetation or soils (e.g. coastal mud flats, sand beaches, rocky bars and shorelines) hydrology determines that these areas are wetlands. In practice, three indicators - hydrophytic vegetation, undrained hydric soil, and wetland hydrology; two indicators - hydrophytic vegetation and wetland hydrology or undrained hydric soil and wetland hydrology; or a single indicator - wetland hydrology, may be used to identify wetland based on the conditions at any particular site (FGDC 2013).

Cowardin *et al.* (1979) defined "estuarine" and "marine" wetlands as saltwater systems; consequently no estuarine or marine wetlands were identified in the coastal watersheds of the Great Lakes portion of this study. Shoreline wetlands of the Great Lakes were included with other freshwater wetlands in the Great Lakes coastal watersheds.

Ephemeral waters, which are not recognized as a wetland type, and certain types of "farmed wetlands" as defined by the Food Security Act were not included in this study because they do not meet the Cowardin *et al.* definition. Habitat category definitions used in this study are given in synoptic form in Table 2. Complete definitions of wetland types and land use categories used in this study are provided in Appendix A.

Wetlands and deepwater habitats are defined separately by Cowardin *et al.* (1979) because the term wetland does not include deep, permanent water bodies. Deepwater habitats are permanently flooded land lying below the deepwater boundary of wetlands. Deepwater habitats include environments where surface water is permanent and often deep, so that water, rather than air, is the principal medium in which the dominant organisms live, whether or not they are attached to the substrate. For the purposes of conducting status and trends work, all lacustrine (lake) and riverine (river) waters as well as deep, open water estuaries and marine waters were considered deepwater habitats.

Upland included lands not meeting the definition of either wetland or deepwater habitats. An abbreviated upland classification system patterned after the U. S. Geological Survey land classification scheme described by Anderson *et al.* (1976), with five generalized categories, was used to describe uplands in this study.


Blue Crab (Callinectes sapidus), Monroe County, Florida

Study Limitations

The identification and delineation of wetland habitats through image analysis formed the foundation for deriving the wetland status and trends data results reported here. Because of the limitations of aerial imagery as the primary data source to detect some wetlands, certain wetland types were excluded from study. These limitations included the inability to detect small wetland areas; inability to accurately detect or monitor certain types of wetlands such as seagrasses that may require hyperspectral or other specialized imagery or analysis techniques (Dierssen *et al.* 2003; Peneva *et al.* 2008), submerged aquatic vegetation, or submerged reefs (Dahl 2005); and inability to consistently identify certain forested wetlands either because of their small size, canopy closure, or lack of visible hydrology.

Freshwater wetland, Weeks Bay, Alabama

Table 2. Wetland, deepwater, and upland categories used to conduct this study. The definitions for each category appear in the Appendix.

Saltwater Habitats	Common Description
Marine Subtidal*	Open ocean
Marine Intertidal	Near shore
Estuarine Subtidal*	Open-water/bay bottoms
Estuarine Intertidal Emergents	Salt marsh
Estuarine Intertidal Forested/Shrub	Mangroves or other estuarine shrubs
Estuarine Intertidal Unconsolidated Shore	Beaches/bars/shoals
Riverine* (may be tidal or non-tidal)	River systems
Freshwater Habitats	
Palustrine Forested	Forested swamps
Palustrine Shrub	Shrub wetlands
Palustrine Emergents	Inland marshes/wet meadows
Palustrine Unconsolidated Bottom (ponds)	Open-water ponds/aquatic bed
Lacustrine*	Lakes and reservoirs
Uplands	
Agriculture	Cropland, pasture, managed rangeland
Urban	Cities and incorporated developments
Silviculture	Planted or intensively managed forests; silviculture
Rural Development	Non-urban developed areas and infrastructure
Other Uplands	Rural uplands not in any other category barren lands

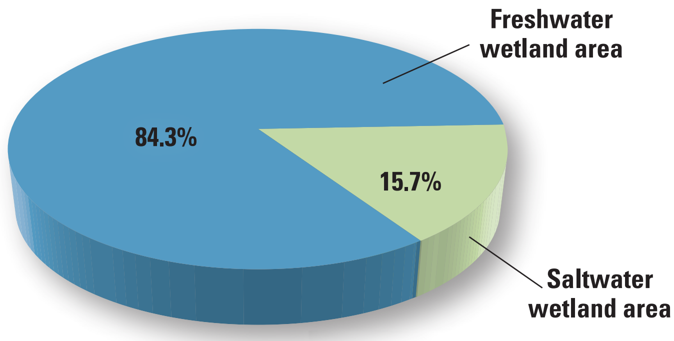
*Constitutes deepwater habitat

Coastal marsh, Pettaquamscutt Cove, Rhode Island

Freshwater wetlands, Big Pine Key, Florida

RESULTS: STATUS OF WETLANDS IN COASTAL WATERSHEDS, 2009

In 2009, there were an estimated 41.1 million acres of wetlands in the coastal watersheds of the United States.[13] This area represented 37.3 percent of total wetland area in the conterminous U.S. Of the wetland area in the coastal watersheds, an estimated 34.6 million acres (84.3 percent) were freshwater wetland types and 6.4 million acres (15.7 percent) were saltwater as shown in Figure 9.

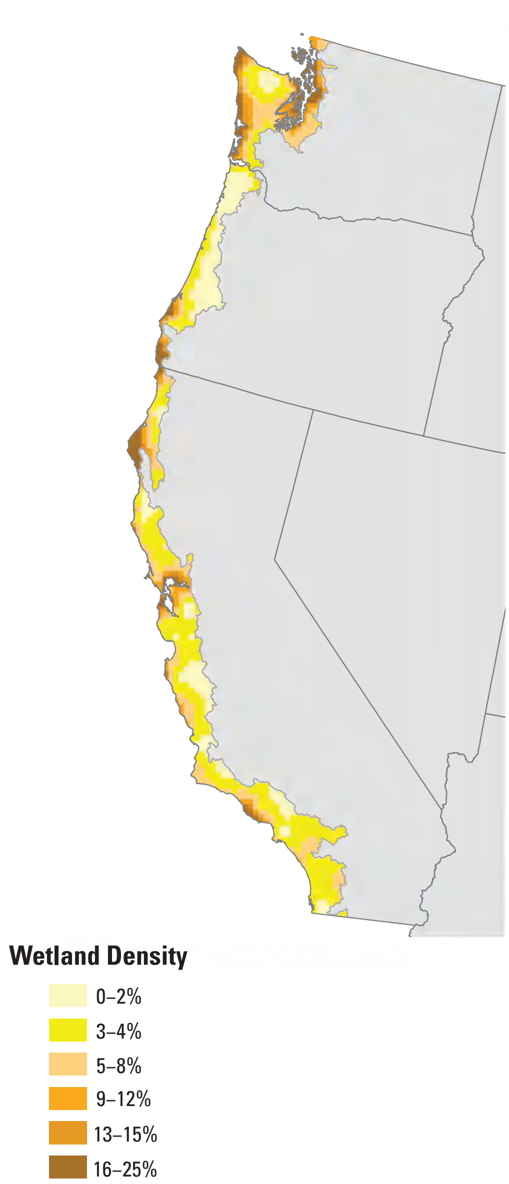


Saltwater wetlands were composed of estuarine emergent marshes, estuarine shrub wetlands and estuarine or marine non-vegetated wetland areas such as beaches, shoals, mud flats, coastal spits and sand bars. Estuarine emergent marshes were found to be the most prevalent saltwater wetland type making up an estimated 66.2 percent of all saltwater wetlands. Estuarine shrub wetlands and non-vegetated saltwater wetlands comprised an estimated 12.4 percent and 21.3 percent by area, respectively, in 2009.

Freshwater wetlands were found in each of the coastal watershed regions and made up an estimated 84 percent of the total wetland area of these watersheds in 2009. Freshwater wetlands were least prevalent in the Pacific watersheds and most abundant in the watersheds of the Atlantic. There were an estimated 20.8 million acres of forested wetland (this represented 60.2 percent of the area of all freshwater wetlands in the coastal watersheds). Freshwater shrub wetland area was estimated to have been 6.7 million acres (19.4 percent) with an estimated 5.9 million acres (17.1 percent) of freshwater emergent marshes and 1.2 million acres (3.3 percent) of freshwater ponds in 2009.

The watersheds of the Atlantic and Gulf of Mexico have very similar amounts of wetland area (15.9 million and 15.4 million acres, respectively) with the Atlantic coastline having an estimated 460,000 acres more than the Gulf of Mexico. Watersheds of the Great Lakes had an estimated 8.5 million acres of wetland. The Pacific coastal watersheds had the least amount of wetland with an estimated 1.3 million acres. The percent of wetland area for each of the coastal regions in shown in Figure 10.

The distribution and relative wetland density of wetlands within the coastal watersheds in this study are shown in Figure 11.



[13] Stedman and Dahl (2008) found 39.8 million acres of wetlands in the coastal watersheds. This study includes the additional coastal watershed area of the Pacific coast in Washington, Oregon and California.

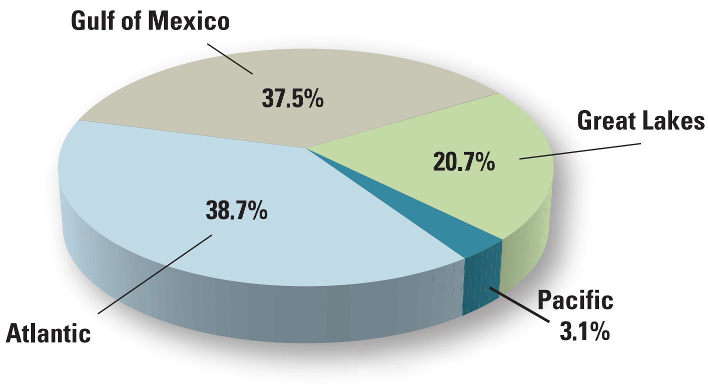
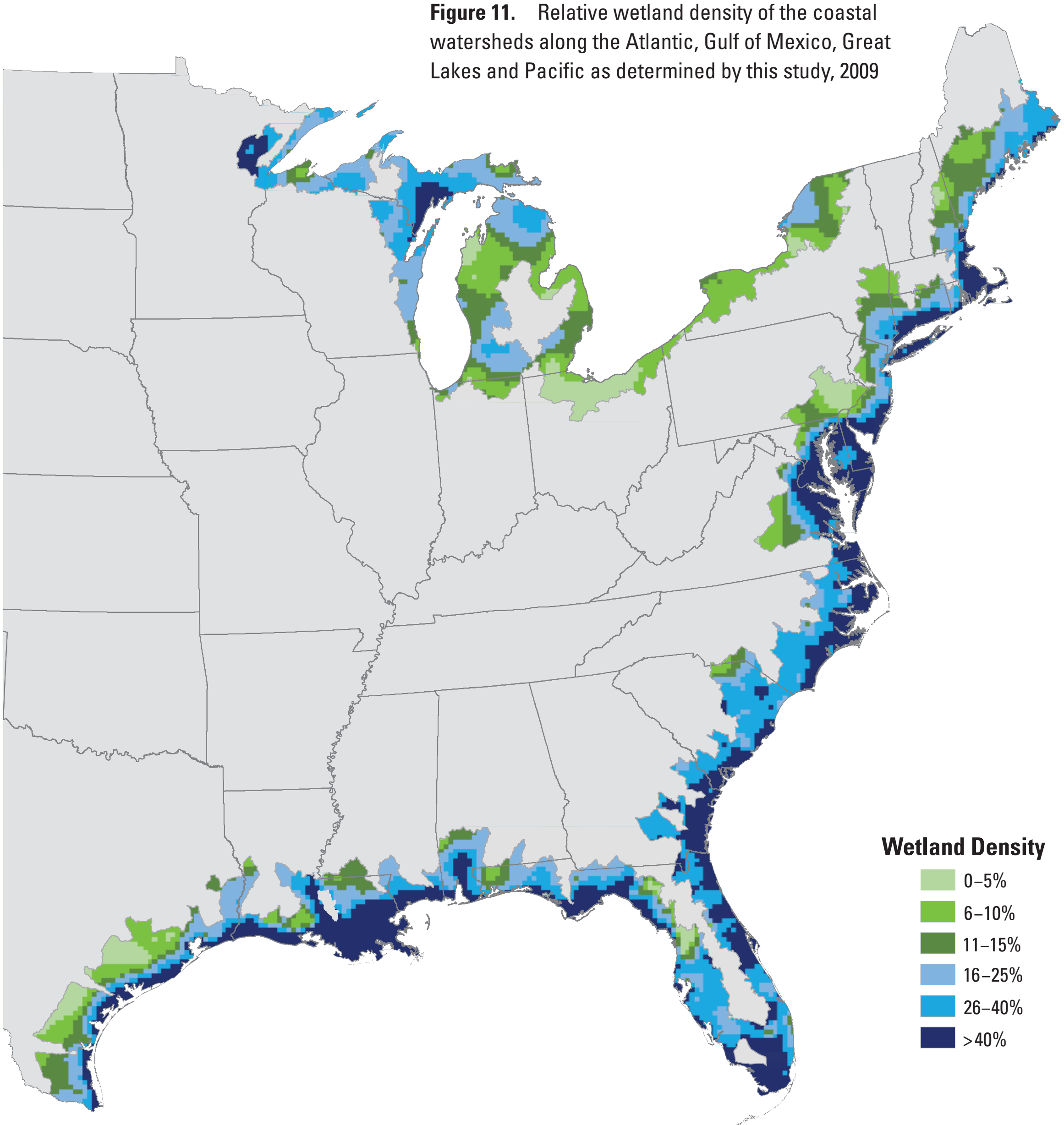


Figure 9. (Far left) Freshwater and saltwater wetland by area in the coastal watersheds (Atlantic, Gulf of Mexico, Great Lakes and Pacific), 2009.

Figure 10. (Left) Percent of all coastal wetland area by coastal region, 2009.

Figure 11. Relative wetland density of the coastal watersheds along the Atlantic, Gulf of Mexico, Great Lakes and Pacific as determined by this study, 2009



All saltwater (intertidal) wetlands in the conterminous U.S. (6.4 million acres) are located in the coastal watersheds. The distribution of saltwater wetland area in the coastal watersheds of the Atlantic, Gulf of Mexico and Pacific[14] is shown in Figure 12. The coastal watersheds along the Gulf of Mexico had the largest saltwater wetland area in 2009 with 3.4 million acres. The Atlantic had an estimated 2.4 million acres and the Pacific slightly over 700,000 acres. There were fewer wetlands along the Pacific coast of Washington, Oregon and California as these coastlines are characterized by rock outcrops, and less extensive areas of coastal plain (Figure 13).

Coastal watersheds of each coastal region also support considerable freshwater wetland types. An estimated 33.2 percent of all freshwater wetland area in the conterminous U.S. (Table 3) is located in these coastal watersheds. The Atlantic watersheds had the highest percentage with about 13.5 million acres of freshwater wetland. The Gulf of Mexico had slightly over 12 million acres and the Great Lakes had 8.5 million acres. The Pacific coastal watersheds had the least amount of freshwater wetland area with an estimated 556,000 acres (Figure 14).

[14] Because Cowardin *et al.* (1979) defines "marine" and "estuarine" wetlands as saltwater systems, no estuarine or marine wetlands were identified in the coastal watersheds of the Great Lakes portion of this study. All wetlands of the Great Lakes watersheds were freshwater wetlands.

Table 3. Estimated freshwater wetland area in the coastal watersheds of the Atlantic, Gulf of Mexico, Great Lakes and Pacific as compared to the conterminous United States, 2009. The coefficient of variation (CV) for each entry (expressed as a percentage) is given in parentheses.

Wetland Category	Area in Acres: Wetland in Coastal Watersheds, 2009	Area in Acres: Wetland in Conterminous U.S., 2009	Percent Wetland Area in Coastal Watersheds, 2009
Freshwater Non-vegetated (ponds)[1]	1,145,503 (4.5)	6,709,300 (4.5)	17.1%
Freshwater Forested	20,838,893 (3.2)	51,623,300 (2.7)	40.4%
Freshwater Shrub	6,713,742 (5.7)	18,511,500 (4.2)	36.3%
Freshwater Emergent	5,922,215 (5.9)	27,430,500 (7.6)	21.6%
Freshwater Vegetated[2]	33,474,851 (2.8)	97,565,300 (2.9)	34.3%
All Freshwater Wetlands	**34,620,353 (2.7)**	**104,274,600 (2.8)**	**33.2%**

[1] Includes the category: Palustrine Unconsolidated Bottom.

[2] Includes the categories: Palustrine Forested, Palustrine Shrub and Palustrine Emergent.

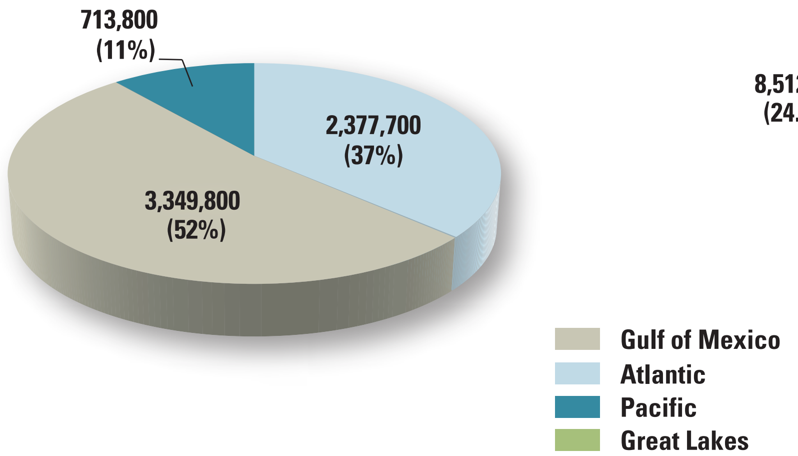


Figure 12. Saltwater (intertidal) wetland distribution (area in acres) by coastal regions, 2009.

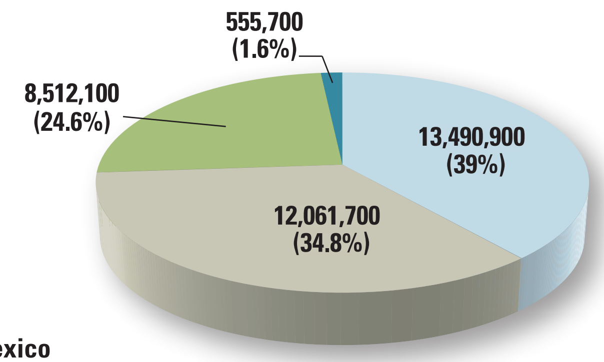


Figure 14. Freshwater wetland distribution (area in acres) by coastal regions, 2009.

Figure 13. Rocky shoreline along the coast of California.

CHANGES IN WETLANDS OF THE COASTAL WATERSHEDS, 2004 TO 2009

The estimated wetland area and changes for the coastal watersheds of the Atlantic, Gulf of Mexico, Great Lakes and Pacific from 2004 to 2009 are presented in Table 4. Differences between the 2004 estimates of all wetlands in coastal watersheds in this study as compared to estimates for the same time period reported by Stedman and Dahl (2008) were due to the addition of the Pacific coast wetland area that was not included previously.[15] Collectively, saltwater and freshwater wetland area declined by an estimated 360,720 acres between 2004 and 2009. The average annual rate of change for all wetlands in the coastal watersheds was a loss of 80,160 acres over the period of this study. This was a 25 percent increase in the rate of coastal wetland loss reported for the period between 1998 and 2004.

The Atlantic, Gulf of Mexico and Pacific coastal regions experienced net wetland losses of 111,960 acres, 257,150 acres and 5,220 acres, respectively. The watersheds of the Great Lakes region experienced a net gain in wetland area of an estimated 13,610 acres. Seventy one percent of the estimated wetland losses between 2004 and 2009 were in the coastal watersheds of the Gulf of Mexico.

There was an estimated net loss of 95,000 acres of saltwater wetlands. Modest gains in marine and estuarine non-vegetated wetland (flats, shoals and bars) were overshadowed by losses of estuarine vegetated wetlands which declined by 2.4 percent (Table 5). Most of the vegetated estuarine losses were to open saltwater (deepwater habitats) and virtually all of these losses occurred in the Gulf of Mexico.

Freshwater wetlands overall, experienced a net loss of more than 265,000 acres. Freshwater pond area increased by almost six percent and freshwater emergent marshes and shrub wetlands also increased in area. However, freshwater forested wetlands declined by 405,700 acres resulting in a net loss of freshwater vegetated wetland area of 328,800 acres (1.0 percent) between 2004 and 2009.

Changes to wetland area between 2004 and 2009 by coastal region are graphically displayed in Figure 15.

[15] When normalized the difference in the estimated total wetland area for 2004 between the two studies is <1.0 percent or within the statistical margin of error.

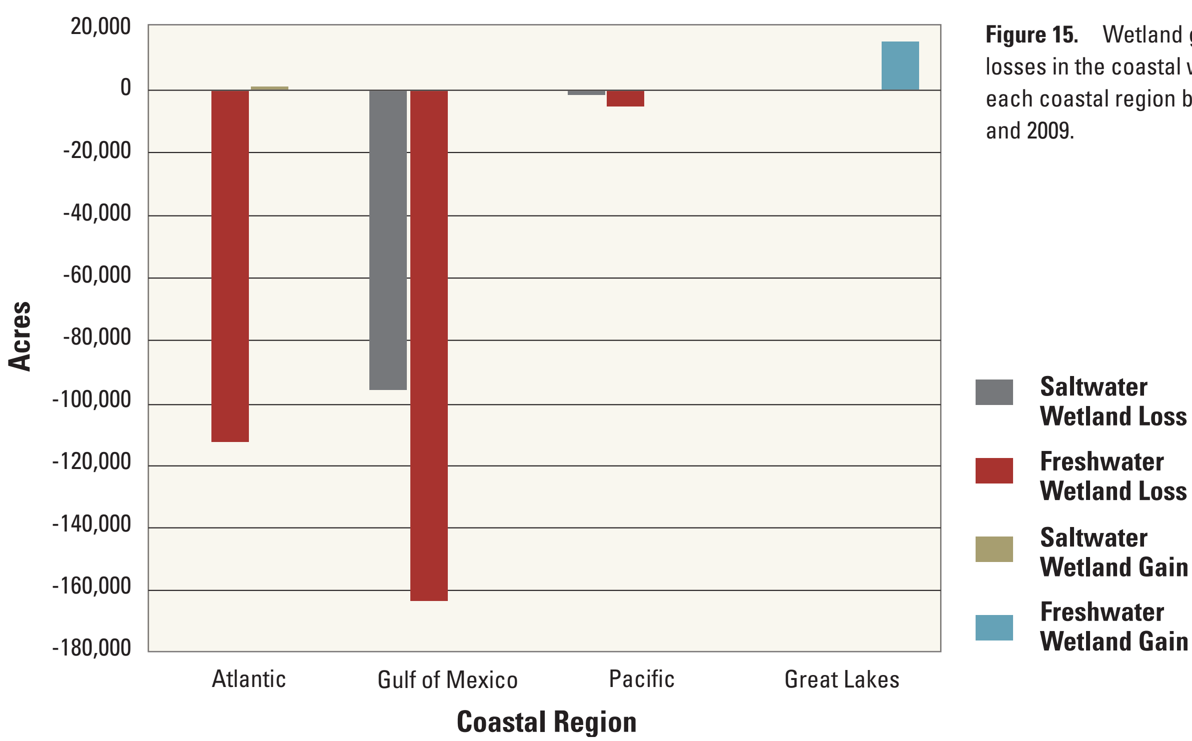


Figure 15. Wetland gains and losses in the coastal watersheds of each coastal region between 2004 and 2009.

Table 4. Changes in wetland area for the coastal watersheds of the Atlantic, Gulf of Mexico, Great Lakes and Pacific, 2004 to 2009.

Coastal Region	Wetland Area 2004 (acres)	Wetland Area 2009 (acres)	Net Change (acres)	Percent Change
Atlantic	15,980,550	15,868,594	-111,957	-0.7 %
Gulf of Mexico	15,668,626	15,411,472	-257,153	-1.6 %
Great Lakes	8,498,448	8,512,056	13,608	+0.2 %
Pacific	1,274,725	1,269,504	-5,221	-0.4 %
Total	**41,422,348**	**41,061,625**	**-360,723**	**-0.9 %**

Table 5. Estimated status and change in wetland area for selected categories in the coastal watersheds of the Atlantic, Gulf of Mexico, Great Lakes and Pacific, 2004 to 2009. The coefficient of variation (CV) for each entry (expressed as a percentage) is given in parentheses.

Wetland Category	Area in Acres			
	Estimated Area, 2004	Estimated Area, 2009	Change, 2004 to 2009	Change (percent)
Marine Intertidal	231,221 (15.2)	239,658 (14.8)	8,437 (50.1)	3.6%
Estuarine Intertidal Non-vegetated[1]	1,114,614 (12.9)	1,135,468 (12.7)	20,854 (44.3)	1.9%
Estuarine Intertidal Vegetated[2]	5,190,437 (4.5)	5,066,146 (4.5)	-124,290 (17.2)	-2.4%
All Intertidal (Saltwater) Wetlands	6,536,271 (4.5)	6,441,272 (4.5)	-94,999 (21.1)	-1.5%
Freshwater Non-vegetated[3]	1,082,424 (4.6)	1,145,503 (4.5)	63,079 (23.3)	5.8%
Freshwater Forested	21,244,634 (3.2)	20,838,893 (3.2)	-405,741 (19.6)	-1.9%
Freshwater Shrub	6,657,614 (5.7)	6,713,742 (5.7)	56,128 (*)	0.8%
Freshwater Emergent	5,901,405 (5.9)	5,922,215 (5.9)	20,811 (*)	0.4%
Freshwater Vegetated Wetlands[4]	33,803,653 (2.7)	33,474,851 (2.8)	-328,802 (19.6)	-1.0%
All Freshwater Wetlands	34,886,077 (2.6)	34,620,353 (2.7)	-265,723 (23.8)	-0.8%
All Wetlands	**41,422,349** **(2.3)**	**41,061,625** **(2.3)**	**-360,723** **(19.0)**	**-0.9%**

* Statistically unreliable

[1] Includes the category: Estuarine Intertidal Unconsolidated Shore

[2] Includes the categories: Estuarine Intertidal Emergent and Estuarine Intertidal Shrub

[3] Includes the categories: Palustrine Unconsolidated Bottom

[4] Includes the categories: Palustrine Emergent, Palustrine Forested and Palustrine Shrub.

Trends in Saltwater Wetlands, 2004 to 2009

The majority of saltwater (estuarine and marine) wetlands fall into three types: estuarine intertidal emergent wetlands (salt and brackish water marshes), estuarine shrub wetlands (mangrove swamps and other salt-tolerant woody species), and marine or estuarine intertidal non-vegetated wetlands. The latter category included exposed coastal beaches subject to tidal flooding, as well as sand bars, tidal mud flats, shoals and sand spits.

There were an estimated 6,441,300 acres of saltwater wetlands in the conterminous U.S. in 2009. Non-vegetated wetland types experienced considerable amount of change related to the constantly changing shape of the coastline. Estuarine vegetated wetlands experienced a decline of 124,300 acres between 2004 and 2009. As was seen in the earlier study covering 1998 to 2004, loss to open saltwater was responsible for the majority of these losses (Figure 16).

Saltwater wetland (vegetated and non-vegetated) area declined by an estimated 1.5 percent. This represented a 35 percent increase over the rate of saltwater wetland loss reported by Stedman and Dahl (2008) for the period between 1998 and 2004. The increased loss rate was attributed to accelerated losses in the Gulf of Mexico where the estimated rate of saltwater wetland loss more than doubled from 44,800 acres between 1998 and 2004 to 95,300 acres between 2004 and 2009 (Figure 17). These losses accounted for 99 percent of all saltwater wetland losses to open deepwater between 2004 and 2009. Saltwater wetland losses in the Gulf of Mexico have been attributed to the effects of severe coastal storms[16] such as Hurricanes Katrina and Rita in 2005 and Hurricane Ike in 2008, which inundated wetlands with storm surge, abnormally high tides, increased rainfall, runoff, increased sediment and debris deposition and

[16] Coastal storms include tropical storms, hurricanes and winter storms.

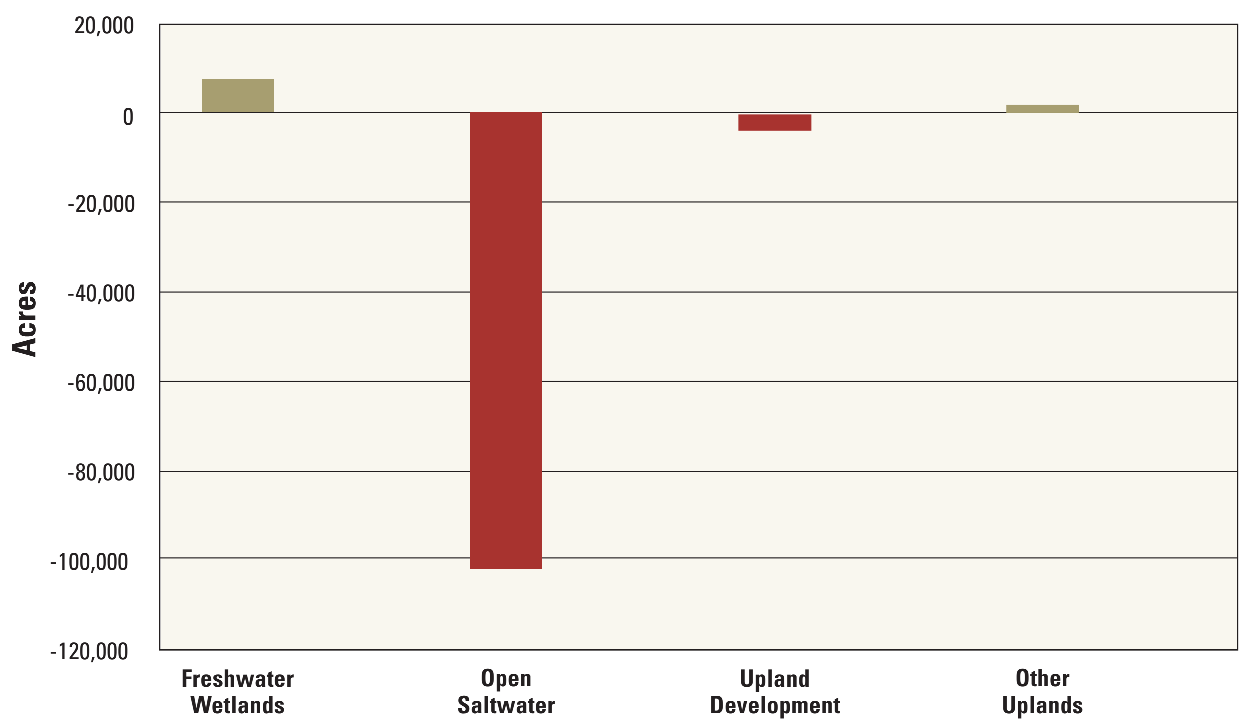


Figure 16. Attribution of loss or conversion of saltwater wetlands in the coastal watersheds of the Atlantic, Gulf of Mexico and Pacific, 2004 to 2009

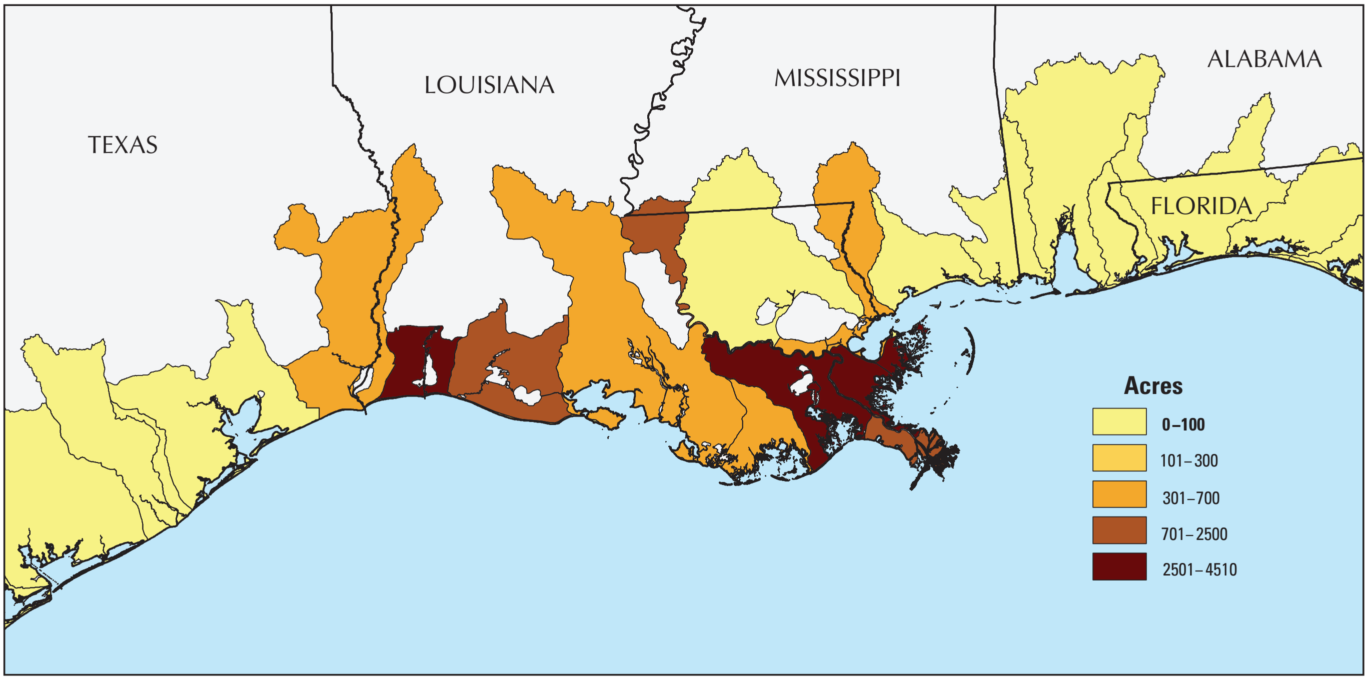


Figure 17. Coastal watersheds of the upper Gulf of Mexico showing the magnitude of saltwater (intertidal) wetland loss to open water, 2004 to 2009.

erosion. Considerable losses of wetland area resulted from Hurricane Katrina alone (Costanza *et al.* 2006). By comparison, a small percentage of saltwater wetland losses have been traced to discrete anthropogenic actions[17] in the Gulf of Mexico.

In contrast, the coastal watersheds of the Atlantic experienced a small net gain of about 330 acres (<1.0 percent) of saltwater wetlands (Table 6)[18]. Intertidal non-vegetated wetlands increased by approximately 2,200 acres and estuarine shrub wetlands increased by approximately 4,400 acres between 2004 and 2009. Saltwater inundation of freshwater wetlands and some uplands, primarily along the Atlantic coastline near Delaware Bay, coastal South Carolina and Georgia and in the Gulf of Mexico along the coast of central Florida, coastal Louisiana and Texas, resulted in the conversion of an estimated 7,800 acres of freshwater wetland and 1,940 acres of upland to become saltwater wetlands. However, there was also an estimated loss of 7,360 acres of estuarine saltmarsh in the coastal watersheds of the Atlantic. The majority of the losses in estuarine marsh area were attributed to erosion and/or inundation related to increases in sea level predominately along shorelines near Delaware Bay.

The density and distribution of saltwater wetlands in the Pacific coastal watersheds was very different compared to other coastlines. The watersheds of the Pacific contained the least amount of coastal wetland area and the Pacific was the only coastline where saltwater wetland area exceeded freshwater wetland. The tidal range in some of the northwestern tidal wetlands can exceed 9-10 feet (Seliskar and Gallagher 1983), which contributes to the formation of extensive coastal sand and mud flats. An estimated 70 percent (497,500 acres) of all intertidal wetlands[19] in the watersheds of the Pacific coast were non-vegetated. The remaining 30 percent were emergent saltmarsh wetlands that were found fringing the borders of rivers that flowed to the coast (Figure 18). There was very little change in any of the saltwater wetland types in the Pacific coastal watersheds between 2004 and 2009. The overall net change was an estimated loss of about 40 acres.

[17] Land subsidence and sea level rise may be attributed to human actions but could not be traced to a specific event or spatial change such as wetland fill, drainage or otherwise mechanically altering wetland area.

[18] These estimates pre-date any coastal wetland changes resulting from Hurricane Sandy that struck the Atlantic seaboard in 2012

[19] Includes marine intertidal and estuarine intertidal non-vegetated wetlands.

Table 6. Estimated changes to saltwater (intertidal) wetlands of the Atlantic (A), Gulf of Mexico (B) and Pacific (C) coastal watersheds, 2004 to 2009. (The Coefficient of Variation [CV] for each entry is given in the parentheses.)

A. Estimated Changes to Saltwater Wetlands of the Atlantic Coast

Wetland Category	Area in Acres			
	Estimated Area, 2004	Estimated Area, 2009	Change, 2004 to 2009	Change (percent)
Marine Intertidal	106,526 (23.4)	107,609 (23.2)	1,084 (*)	1.0%
Estuarine Intertidal Non-vegetated[1]	302,473 (17.5)	304,684 (17.4)	2,211 (98.5)	0.7%
Estuarine Emergent	1,846,327 (6.8)	1,838,965 (6.8)	-7,362 (61.9)	-0.4%
Estuarine Shrub	122,037 (15.3)	126,433 (15.1)	4,397 (73.9)	3.6%
Estuarine Intertidal Vegetated[2]	1,968,363 (6.5)	1,965,398 (6.5)	-2,965 (*)	-0.2%
All Intertidal (Saltwater) Wetlands	**2,377,362** **(6.5)**	**2,377,691** **(6.4)**	**329** **(*)**	**0.0%**

B. Estimated Changes to Saltwater Wetlands of the Gulf of Mexico Coast

Wetland Category	Area in Acres			
	Estimated Area, 2004	Estimated Area, 2009	Change, 2004 to 2009	Change (percent)
Marine Intertidal	33,146 (35.5)	40,499 (30.7)	7,353 (52.3)	22.2%
Estuarine Intertidal Non-vegetated[1]	406,222 (13.9)	424,865 (13.3)	18,643 (48.1)	4.6%
Estuarine Emergent	2,332,470 (6)	2,211,674 (6.1)	-120,796 (17.4)	-5.2%
Estuarine Shrub	673,236 (14.8)	672,750 (14.6)	-486 (*)	-0.1%
Estuarine Intertidal Vegetated[2]	3,005,706 (5.7)	2,884,424 (5.8)	-121,282 (17.3)	-4.0%
All Intertidal (Saltwater) Wetlands	**3,445,073** **(5.3)**	**3,349,788** **(5.4)**	**-95,285** **(20.4)**	**-2.8%**

* Statistically unreliable

[1] Includes the category: Estuarine Intertidal Unconsolidated Shore

[2] Includes the categories: Estuarine Intertidal Emergent and Estuarine Intertidal Shrub

Table 6. Estimated changes to saltwater (intertidal) wetlands of the Atlantic (A), Gulf of Mexico (B) and Pacific (C) coastal watersheds, 2004 to 2009. (The Coefficient of Variation [CV] for each entry is given in the parentheses.)—Continued

C. Estimated Changes to Saltwater Wetlands of the Pacific Coast

Wetland Category	Area in Acres			
	Estimated Area, 2004	Estimated Area, 2009	Change, 2004 to 2009	Change (percent)
Marine Intertidal	91,549 (23.9)	91,549 (23.9)	0 (0)	0.0%
Estuarine Intertidal Non-vegetated[1]	405,919 (29.9)	405,919 (29.9)	0 (0)	0.0%
Estuarine Emergent	216,313 (39.4)	216,269 (39.4)	-43 (99)	0.0%
Estuarine Shrub	55 (98.7)	55 (98.7)	0 (0)	0.0%
Estuarine Intertidal Vegetated[2]	216,367 (39.4)	216,324 (39.4)	-43 (99)	0.0%
All Intertidal (Saltwater) Wetlands	**713,836** **(24)**	**713,793** **(24)**	**-43** **(99)**	**0.0%**

* Statistically unreliable

[1] Includes the category: Estuarine Intertidal Unconsolidated Shore

[2] Includes the categories: Estuarine Intertidal Emergent and Estuarine Intertidal Shrub

Figure 18. Tidal saltmarsh in coastal Washington. This study found 30 percent of saltwater wetlands along in the Pacific coastal watersheds were emergent saltmarsh.

Trends in Coastal Freshwater Wetlands, 2004 to 2009

Overall, freshwater wetlands declined by an estimated 265,720 acres (0.8 percent) between 2004 and 2009. Regionally, there was a small net loss (5,180 acres) along the Pacific, net losses of 112,290 acres along the Atlantic, large net losses (161,870 acres) along the Gulf of Mexico and a modest net gain of 13,610 acres in the watersheds of the Great Lakes. The estimated changes to freshwater wetland types by coastal region are shown on pages 28–29 in Table 7. There were gains in area of freshwater shrub wetlands, emergent wetlands, and ponds; however these gains were offset by large losses of freshwater forested wetlands (Figure 19).

Forested wetland area declined by an estimated 405,740 acres between 2004 and 2009, a decrease of 1.9 percent. Forested wetlands declined in each of the coastal watershed areas with the exception of the Great Lakes. The greatest amount of change occurred in coastal watersheds from North Carolina to Florida on the Atlantic, and Florida to Texas on the Gulf of Mexico, where forested wetland area declined by an estimated 443,780 acres between 2004 and 2009. Of this total change in forested wetland area, 63 percent of the acreage was cleared and converted to other wetland types, such as freshwater shrubs. An estimated 36 percent (158,340 acres) was lost to upland land uses. A comparatively small increase of an estimated 47,940 acres of forested wetlands in the Great Lakes region offset some of the large losses of forested wetlands in the southeastern U.S. The estimated losses of freshwater forested wetland in the coastal watersheds made up over 64 percent of all forested losses in the conterminous U.S. between 2004 and 2009; thus the causes for those losses have far reaching implications for wetland management, protection and regulation strategies. The activities that converted forested wetland to upland in the southeastern U.S. and the amount of loss attributed to those activities are shown in Figure 20.

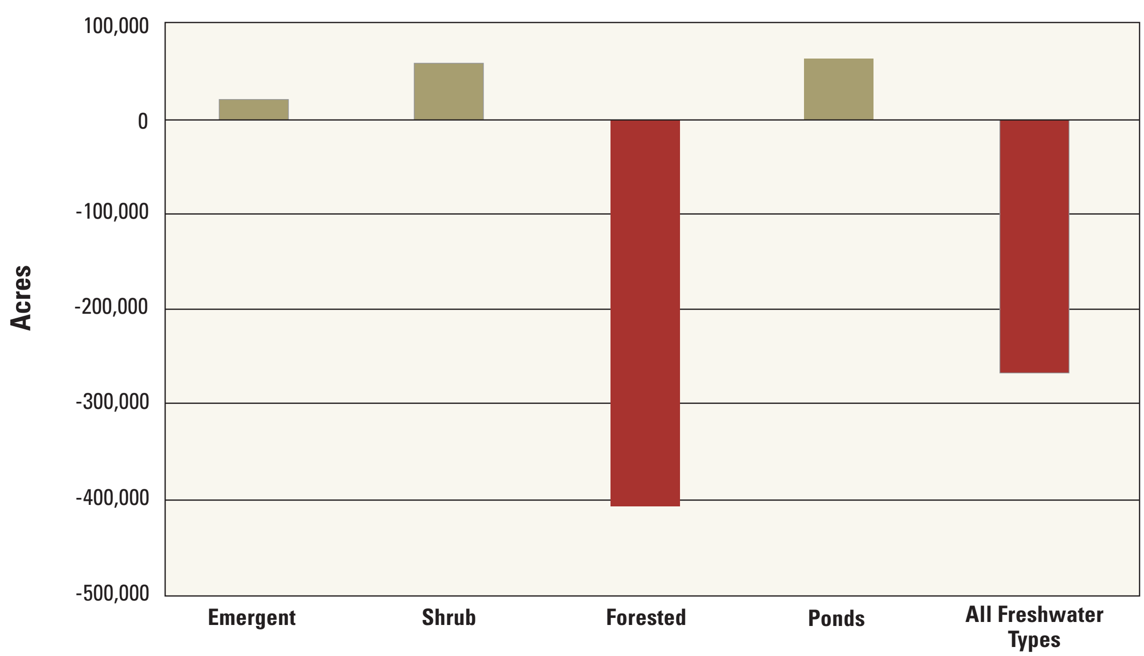


Figure 19. Estimated losses and gains in area for the freshwater wetland types in the coastal watersheds of the Atlantic, Gulf of Mexico, Great Lakes and Pacific, 2004 to 2009

Freshwater forested wetland near Weeks Bay, Alabama.

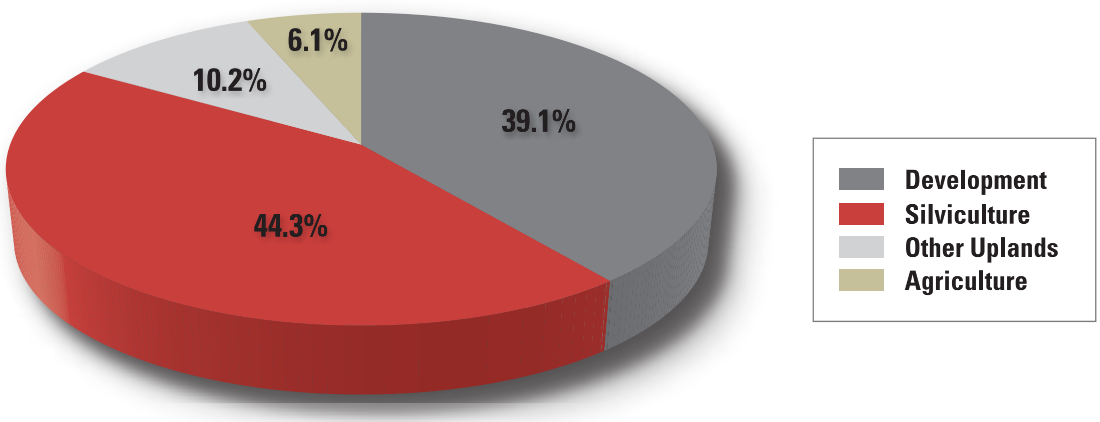


Figure 20. Forested wetland losses in the coastal watersheds of the Southeastern U.S. (North Carolina to Texas) as attributed to upland land use categories, 2004 to 2009. Total forested wetland losses to upland in this region were estimated to have been 158,340 acres over the years covered by this study.

Table 7. Estimated changes to freshwater wetlands of the Atlantic (A), Gulf of Mexico (B), Great Lakes (C), and Pacific (D) coastal watersheds, 2004 to 2009. (The Coefficient of Variation [CV] for each entry is given in the parentheses.)

A. Estimated Changes to Freshwater Wetlands of the Atlantic Coast

Wetland Category	Area in Acres			
	Estimated Area, 2004	Estimated Area, 2009	Change, 2004 to 2009	Change (percent)
Freshwater Non-vegetated (ponds)[1]	424,868 (8.8)	457,646 (8.4)	32,778 (29.3)	7.7%
Freshwater Forested	8,708,003 (3.9)	8,503,633 (3.9)	-204,370 (29.6)	-2.3%
Freshwater Shrub	2,607,902 (7.9)	2,623,595 (8)	15,692 (*)	0.6%
Freshwater Emergent	1,862,415 (10.3)	1,906,028 (9.9)	43,614 (83.9)	2.3%
Freshwater Vegetated[2]	13,178,320 (3.4)	13,033,256 (3.4)	-145,064 (29.4)	-1.1
All Freshwater Wetlands	**13,603,188 (3.3)**	**13,490,902 (3.3)**	**-112,286 (37.3)**	**-0.8%**
All Wetlands[3]	**15,980,550 (2.9)**	**15,868,594 (2.9)**	**-111,957 (37.3)**	**-0.7%**

B. Estimated Changes to Freshwater Wetlands of the Gulf of Mexico Coast

Wetland Category	Area in Acres			
	Estimated Area, 2004	Estimated Area, 2009	Change, 2004 to 2009	Change (percent)
Freshwater Non-vegetated (ponds)[1]	376,721 (6.5)	407,641 (6.3)	30,919 (30)	8.2%
Freshwater Forested	7,311,885 (5.1)	7,063,638 (5.1)	-248,247 (19.3)	-3.4%
Freshwater Shrub	1,744,905 (9.6)	1,802,400 (9.5)	57,495 (77.3)	3.3%
Freshwater Emergent	2,790,041 (9.5)	2,788,005 (9.4)	-2,035 (*)	-0.1%
Freshwater Vegetated[2]	11,846,831 (4.1)	11,654,043 (4.2)	-192,788 (24.3)	-1.6%
All Freshwater Wetlands	**12,223,552 (4)**	**12,061,684 (4)**	**-161,868 (28.6)**	**-1.3%**
All Wetlands[3]	**15,668,626 (3.3)**	**15,411,472 (3.3)**	**-257,153 (20.8)**	**-1.6%**

* Statistically unreliable

[1] Includes the category: Palustrine Unconsolidated Bottom

[2] Includes the categories: Palustrine Forested, Palustrine Shrub and Palustrine Emergent

[3] Includes all freshwater and saltwater wetlands

Table 7. Estimated changes to freshwater wetlands of the Atlantic (A), Gulf of Mexico (B), Great Lakes (C), and Pacific (D) coastal watersheds, 2004 to 2009. (The Coefficient of Variation [CV] for each entry is given in the parentheses.) —Continued

C. Estimated Changes to Freshwater Wetlands of the Great Lakes Coast

Wetland Category	Area in Acres			
	Estimated Area, 2004	Estimated Area, 2009	Change, 2004 to 2009	Change (percent)
Freshwater Non-vegetated (ponds)[1]	230,418 (9)	229,254 (9.6)	-1,163 (*)	-0.5%
Freshwater Forested	5,066,597 (9.2)	5,114,536 (9.1)	47,940 (41.3)	0.9%
Freshwater Shrub	2,191,113 (12.3)	2,174,479 (12.3)	-16,635 (*)	-0.8%
Freshwater Emergent	1,010,320 (11.7)	993,787 (11.9)	-16,534 (93.3)	-1.6%
Freshwater Vegetated[2]	8,268,030 (7.7)	8,282,802 (7.7)	14,771 (73)	0.2%
All Freshwater Wetlands	**8,498,448 (7.5)**	**8,512,056 (7.5)**	**13,608 (74.5)**	**0.2%**
All Wetlands[3]	**8,498,448 (7.5)**	**8,512,056 (7.5)**	**13,608 (74.5)**	**0.2%**

D. Estimated Changes to Freshwater Wetlands of the Pacific Coast

Wetland Category	Area in Acres			
	Estimated Area, 2004	Estimated Area,2009	Change, 2004 to 2009	Change(percent)
Freshwater Non-vegetated (ponds)[1]	50,417 (12)	50,961 (12.3)	544 (*)	1.1%
Freshwater Forested	158,150 (27.8)	157,085 (28)	-1,064 (46.9)	-0.7%
Freshwater Shrub	113,693 (23.1)	113,269 (23.2)	-424 (*)	-0.4%
Freshwater Emergent	238,629 (22.6)	234,395 (23)	-4,234 (65)	-1.8%
Freshwater Vegetated[2]	510,472 (15.9)	504,750 (16.1)	-5,722 (53.7)	-1.1%
All Freshwater Wetlands	**560,889 (14.7)**	**555,711 (14.8)**	**-5,178 (59)**	**-0.9%**
All Wetlands[3]	**1,274,725 (15.5)**	**1,269,504 (15.5)**	**-5,221 (58.5)**	**-0.4%**

* Statistically unreliable

[1] Includes the category: Palustrine Unconsolidated Bottom

[2] Includes the categories: Palustrine Forested, Palustrine Shrub and Palustrine Emergent

[3] Includes all freshwater and saltwater wetlands

Although there was an overall increase in freshwater emergent wetland area, emergent marshes declined along every coastline with the exception of the Atlantic where there was a net gain of an estimated 43,610 acres. The majority of this increase was attributed to the reestablishment of emergent wetlands in areas formerly classified as upland agriculture, other conservation practices or land retirement.

Freshwater shrubs exhibited an increase of 56,120 acres in the conterminous U.S. Freshwater shrub wetlands declined in the coastal watersheds of the Pacific and Great Lakes but increased in the coastal watersheds of the Atlantic and Gulf of Mexico. Freshwater shrub wetland area increased as freshwater forests in the southeastern U.S. were cleared and the areas were reclassified as shrub wetlands.

Freshwater ponds increased in area by an estimated 5.8 percent between 2004 and 2009. Urban ponds increased in area by 19 percent or 55,700 acres while natural ponds declined in area by 3.9 percent or 16,400 acres. The vast majority of these new ponds (99 percent) were constructed in the watersheds of the Atlantic and Gulf of Mexico and many were located in urban or suburban developments as likely water detention or ornamental ponds as opposed to targeted wetland reestablishment projects (Figure 21).

Figure 21. This aerial image shows the proliferation of freshwater ponds in a south Florida coastal watershed overtaken by development. Many vegetated wetlands have been replaced by artificially created, open water ponds (darker areas).

Overall, the largest land use associated with freshwater wetland loss in coastal watersheds was silviculture, followed by development (both urban and rural), which together account for 84 percent of the wetland loss. Freshwater wetland loss to deepwater habitats or saltwater wetlands is a smaller percentage of the total loss (16 percent), and a small amount of freshwater wetlands were gained from agricultural lands and other uplands. The loss or conversion of all freshwater wetlands from 2004 to 2009 is shown in Figure 22.

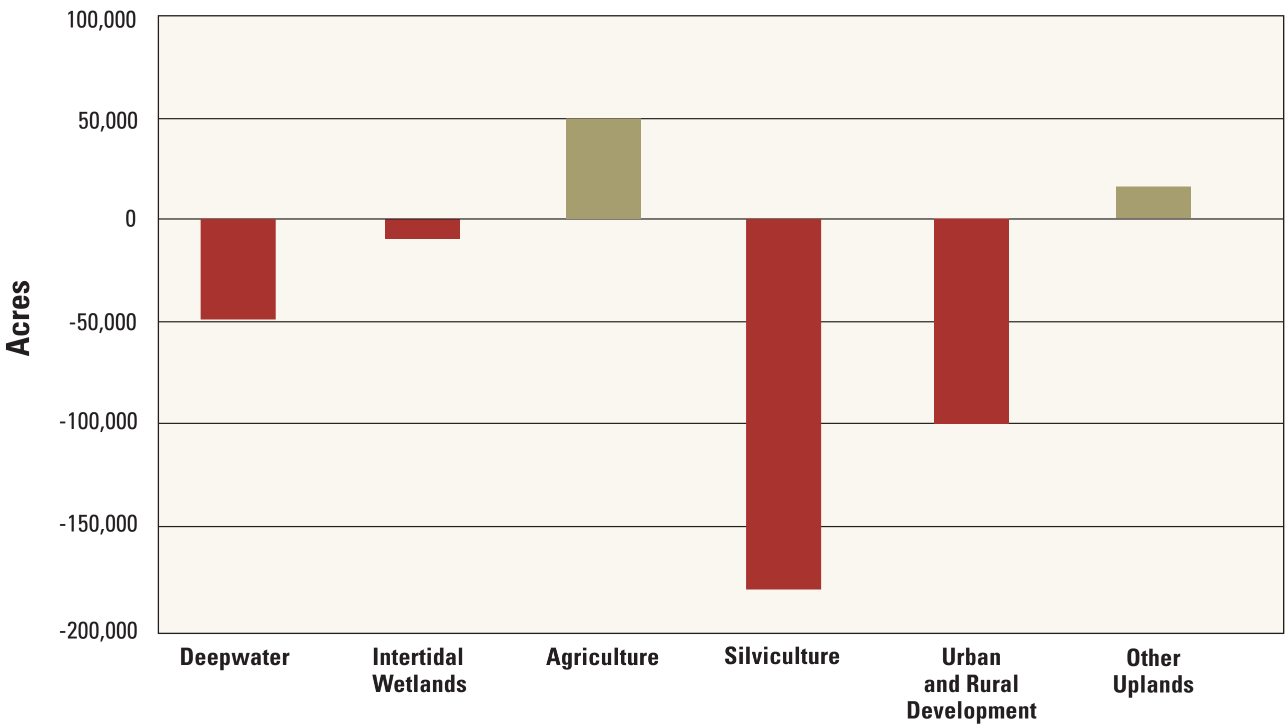


Figure 22. Attribution of loss or conversion of freshwater wetlands in the coastal watersheds, 2004 to 2009.

Discussion

Similar to the previous coastal wetland study conducted by Stedman and Dahl (2008), the majority of the estimated wetland losses in coastal watersheds between 2004 and 2009 occurred in the freshwater system and were attributed to different types of human activity that converted wetlands to uplands. Understanding the underlying cause(s) of these losses is important, particularly as they relate to efforts to adjust policy or management strategies to reverse this trend. Based on this study, the following issues appear to be central to understanding the ongoing loss of wetlands in coastal watersheds.

Lack of Reestablishment of Wetlands in Coastal Watersheds

Past studies of wetlands in the conterminous United States have documented losses that total about half of the wetland acreage that existed pre-European colonization (Dahl 1990). The Clean Water Act of 1977 (CWA)[20] and other federal and state laws protecting wetlands have decreased losses, and reestablishment programs have reversed some losses. For the Nation as a whole, there has been a marked decrease in the overall rate of wetland loss since 1998. One of the federal strategies to help reduce wetland losses has been to promote and enable wetland reestablishment and creation projects. This strategy has enjoyed some success and some wetland losses have been offset by wetland reestablishment, especially in agricultural areas (Dahl 2011).

Results from this study indicated that some wetland losses in coastal watersheds were being offset by wetland reestablishment and creation projects. For example, there were net gains in freshwater wetland area from agricultural lands (50,230 acres) and lands classified as "other uplands" (15,290 acres) (Figure 23). Coastal wetland gains occurred through reestablishment projects, changes in coastal geomorphology and in response to changing hydrology. Wetland reestablishment as measured by the conversion from upland to wetland[21] was most prevalent on agricultural lands primarily in the coastal watersheds of South Carolina, Georgia and the upper reaches of the watersheds in central Florida and in the watersheds of the Great Lakes. In the Great Lakes watersheds historical conversion of wetlands to agricultural land uses through ditching and draining (Miller *et al.* 2012) has provided ample possibilities for wetland reestablishment.

However, the strategy of offsetting wetland losses with wetland reestablishment and creation does not appear to be as effective in coastal watersheds as it has been nationally. Wetland losses in coastal watersheds have continued to outdistance wetland gains, by an estimated 360,720 acres between 2004 and 2009. This rate of loss increased by 25 percent since the previous reporting period of 1998 to 2004,[22] and these continued losses of wetlands have direct costs for people and longer-term resource implications for fish, wildlife and other natural resources.

Several factors are likely responsible for wetland reestablishment in coastal watersheds lagging behind reestablishment rates nationally, including the logistical difficulties of working in coastal ecosystems, competing land use interests and higher costs to reestablish coastal wetlands (Stedman and Dahl 2008). The reestablishment of intertidal wetlands poses unique challenges related to their complex linkages to terrestrial and marine habitats (Atkinson 2003). Sustainable wetland reestablishment opportunities in coastal watersheds are further limited by geography, human encroachment, land-use resulting in fewer suitable sites, geophysical processes from the sea that hamper reestablishment efforts (i.e. coastal storms, sea level rise, erosion and subsidence) and the amount of historic wetland area available for reestablishment. Some coastal watersheds have been developed to a point where wetland reestablishment or mitigation opportunities may be very limited given the changes in regional hydrology or the current land use. These changes reduce the chances for successful implementation of a watershed-based approach for compensatory mitigation of wetland losses.

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[20] The Clean Water Act of 1977 [P.L. 95217] (U.S. Army Corps of Engineers 1987)

[21] Emergent wetlands typify wetland reestablishment projects.

[22] Some of these increased losses were due to the addition of the Pacific coastal watersheds which contributed about 1,160 acres per year to the overall wetland loss rate.

Wetland Gains and Loss Examples on "Other" Lands (Undetermined Land Use)

This study found an estimated 15,290 acre net increase in freshwater wetland came from uplands classified as "other" lands or lands with undetermined land use.

Other lands have included areas such as prairie, unmanaged or non-patterned upland forests, scrub lands, barren and abandoned land, lands enrolled in set-aside programs, conservation easement or other lands designated as wildlife management areas. Lands in transition may also fit into this category when land has been cleared but not yet developed to the point of a distinguishable land use (Figure 23).

Figure 23. The term "Other" lands has been used to describe land in transition when it was not possible to categorize a distinguishable land use (e.g. urban or agriculture). In this photograph, a coastal freshwater wetland has been filled (loss in area) but the land use could not be determined (Louisiana, 2009).

Tidal salt marsh, Washington

Losses to Development

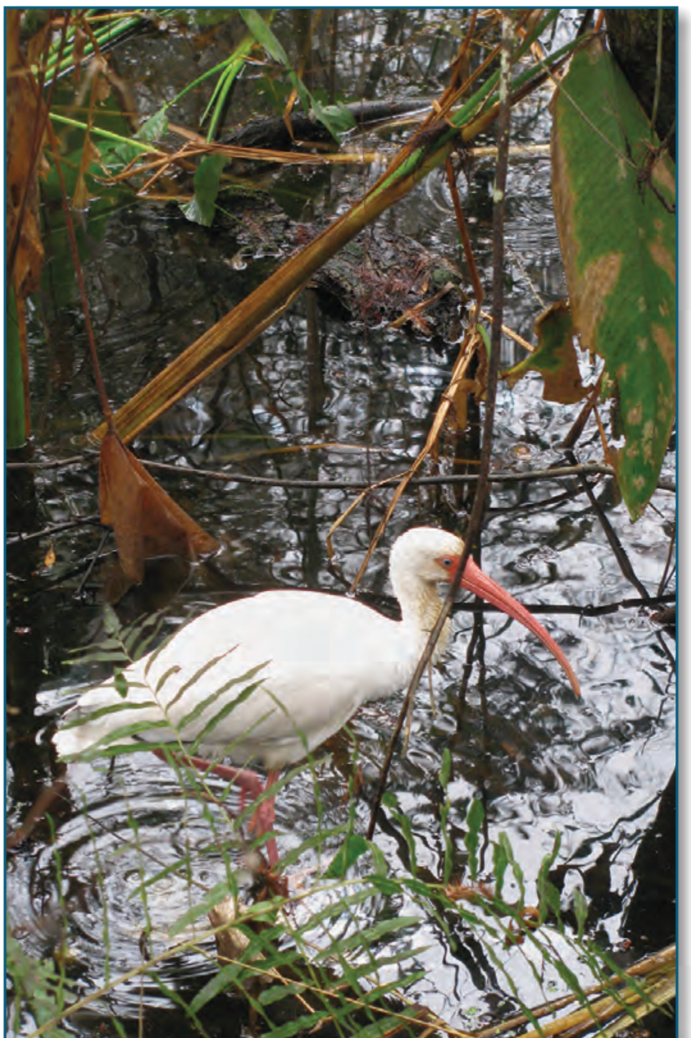
Of the estimated freshwater wetland losses to upland, urban and rural development accounted for an estimated 97,800 acres or 37 percent (Figure 24). Urban and rural development was an important factor in wetland loss in coastal watersheds during the previous time period (1998-2004) as well (Stedman and Dahl, 2008). Coastal development has been identified by local stakeholders as a serious threat to coastal wetlands due to the direct and indirect effects of residential and commercial development, associated recreational development and expansion of supporting infrastructure including roads, bridges and utilities (USEPA 2013a). There is general recognition that once wetlands are lost through development, the loss of their functions and values is often irreversible (Mitsch and Gosselink 2000). Recognizing the potential for degradation of the Nation's waters, the U.S. Congress enacted the CWA to maintain and restore the chemical, physical and biological integrity of the waters of the United States. Section 404 of the Act requires avoidance and minimization of impacts to aquatic resources, including wetlands, and requires compensatory mitigation to offset losses that result from authorized development. Development can and does occur without authorization or in wetlands not under CWA jurisdiction. An area considered to be a wetland under the Cowardin classification system may or may not be a wetland under jurisdiction or it may be exempt from protection under the CWA for a number of reasons including how wetlands are delineated per the Army Corps of Engineers Wetland Delineation Manual (U.S. Army Corps of Engineers 1987) or recent Supreme Court rulings that have limited the CWA's jurisdiction. The CWA has undoubtedly reduced the loss of coastal wetlands to development, but not eliminated it.

Some states have implemented wetland regulatory programs governed by rules and/or state statutes that may extend protection beyond the jurisdiction of the CWA.

Figure 24. A residential housing development built on filled wetland in the upper portion of a coastal watershed in Louisiana.

Forested Wetlands and Silviculture

This study found that forested wetland area declined by an estimated 443,780 acres in the coastal watersheds of the southeastern U.S. between 2004 and 2009. Of this total change in forested wetland area, 63 percent of the acreage was cleared and converted to other wetland types, but was not considered a wetland loss, and an estimated 36 percent (158,340 acres) was lost to upland land uses. Of the forested wetland area lost to upland, an estimated 44 percent or 69,700 acres were attributed to silvicultural practices in the southeastern coastal watersheds. Other studies have also reported substantial changes to wetlands due to silviculture practices (USEPA 2013a; Swords 2012; Dahl 2011; 1999; NCSU 2008).



White ibis (Eudocimus albus), Corkscrew Swamp Sanctuary, Florida

Harvesting or the removal of trees from forested wetlands does not, in itself, constitute a wetland loss.[23] However, some activities associated with forested plantations involve drainage ditching, intensive site preparations, timber stand management and harvest practices that can alter or eliminate site hydrology, thereby causing a loss of wetland. Under Section 404 of the CWA a permit is not required for the discharge of dredged or fill material associated with normal silviculture activities or the construction of and maintenance of forest roads. However, the CWA and implementing regulations also state that activities that convert "waters of the United States" to upland always require authorization under Section 404. These two concepts, that certain actions are exempt from the federal wetland regulatory process and that any action that converts wetlands as waters of the United States always requires authorization seem to be at odds and in practice, it is unclear whether silvicultural practices that cause the loss of wetlands are fully understood or addressed in a consistent manner under the existing regulatory provisions.

A Memorandum to the Field issued by EPA and the Army Corps of Engineers in 1995 provided specific guidance for pine plantations in the southeast U.S. on the circumstances where mechanical silvicultural site preparation activities will or will not require a permit. Mechanical silvicultural site preparation activities in seasonally flooded and other wetter wetland types require a permit (USEPA 2010). Other forested wetlands including temporarily flooded or saturated forested areas do not require a permit for silvicultural activities, although a number of Best Management Practices are recommended to minimize impacts. When applied to the southeastern coastal watersheds, this guidance means that no CWA permit is required for silvicultural activities in approximately 6.5 million acres of forested wetlands including pine flatwood wetlands, seepage forests, saturated hammocks, pond pine woodland and forested wet flats. It was in these forested habitats that wetland losses were the greatest.

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[23] A wetland was not considered lost unless there was sufficient artificial drainage, ditching or filling to substantially alter hydrology. Removal of tree canopy without hydrologic alteration resulted in change in wetland classification (i.e. forest to shrub wetland or forest to emergent wetland).

Losses of Saltwater Wetlands

Saltwater wetland losses were observed most notably in the Gulf of Mexico where erosion and/or inundation were the primary causes of these losses. Throughout the northern coastal region of the Gulf of Mexico, saltwater wetlands have been adversely affected by the cumulative effects of oil and gas development (Dahl 2011)[24] which has increased the vulnerability of these wetlands to climate related changes (Twilley 2007) such as increased frequency and intensity of hurricanes and other coastal storm events. Costanza *et al.* (2008) cited the experience of Hurricane Katrina as an example of the enormous costs incurred by allowing coastal wetlands to degrade. Although Louisiana has developed a comprehensive plan[25] to protect and restore the remainder of the states coastal wetlands, other Gulf of Mexico states are only beginning this process prompted by the need to plan for restoration of the damage caused by the Deepwater Horizon oil spill of 2010.

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[24] This study did not address impacts from the Deepwater Horizon oil spill in 2010.

[25] Coast 2050: Toward a Sustainable Coastal Louisiana. *http://www.coast2050.gov/*

Mud flats, Picnkney Island NWR, South Carolina.

Summary

This study examined recent trends in coastal wetland extent and type throughout the coastal watersheds of the conterminous United States. Wetland trends were measured by the examination of remotely sensed imagery for 2,614 sample plots in the coastal watersheds of the Atlantic, Gulf of Mexico, Great Lakes and Pacific. Wetlands and deepwater habitats were described using the USFWS biological definition of wetland as defined by Cowardin *et al.* (1979). The information in this study provides a quantitative measure of the areal extent of all wetlands, regardless of ownership, but does not draw conclusions about trends in the quality or condition of wetlands in the coastal watersheds. The data provide baseline information to facilitate ongoing collaborative efforts to assess coastal wetland losses and conservation.

The study found that in 2009 there were an estimated 41.1 million acres of wetlands in the coastal watersheds of the Atlantic, Gulf of Mexico, Great Lakes and Pacific. This represented 37.3 percent of the total wetland area in the conterminous U.S.

Changes in wetland area between 2004 and 2009 indicated that the coastal watersheds of the Atlantic declined by an estimated 111,960 acres. The Gulf of Mexico sustained larger losses of an estimated 257,150 acres and the watersheds of the Pacific 5,220 acres. The watersheds of the Great Lakes had a net gain in wetland area of an estimated 13,610 acres.

Both saltwater and freshwater wetlands sustained net losses between 2004 and 2009. There were an estimated 95,000 acres of saltwater wetland losses and 265,720 acres of freshwater wetland losses.

Between 2004 and 2009, wetlands in the coastal watersheds declined by an estimated 360,720 acres or 80,160 acres per year. This rate of wetland loss was about six times greater the estimated rate of wetland loss for the entire Nation for the same time period.[26] The average annual rate of wetland loss in the coastal watersheds has increased by 25 percent over the previous reporting period. This increase in the rate of coastal wetland loss was statistically significant ($p = 0.007$) when results from this study were compared to the coastal wetland loss estimates from 1998 to 2004.

The increase in the rate of wetland loss was attributed to losses of saltwater wetlands in the Gulf of Mexico resulting from coastal storms in combination with freshwater wetland losses in both the Atlantic and Gulf of Mexico in the southeastern U.S. Large losses of freshwater forested wetland area were attributed to urban and rural development as well as silvicultural operations.

Wetlands in the coastal watersheds make up an increasingly fragile network of lands that continue to shrink in area. In coming years sea level rise threatens inundation or displacement of coastal lands, infrastructure and ecosystems (Day *et al.* 2008; Tebaldi *et al.* 2012). Dealing with the impacts of sea level rise will include a mix of engineering solutions and adaptive management strategies which, depending on their implementation, may have substantial impacts on coastal wetland systems.

In the upper portions of the coastal watersheds, stressors associated with residential and infrastructure development or land use changes that alter wetland distribution and extent continue to constrict wetland area. Of particular concern is the continued loss of vegetated wetlands to human related causes. In some regards, our understanding of coastal processes and interactions has not kept pace with the cumulative impacts resulting from wetland loss due to human-induced actions.

In some parts of coastal watersheds, wetlands are vulnerable to both development on the landward side and coastal ocean processes from the sea. This has imposed considerable challenges for coastal wetland resource management, including mitigation options. At the Federal level there is recognition that more needs to be done to curtail wetland losses and to effectively protect and restore wetlands in the coastal watersheds

[26] From 2004 to 2009 wetlands declined by an estimated 62,300 acres, nationally (13,800 acres per year).

as these efforts are important to coastal and marine habitat conservation (National Ocean Council 2013). To better address imminent threats to coastal wetlands, federal agencies have been working collaboratively to understand the underlying causes of coastal wetland loss and how wetland trends are affected by wetland regulatory processes, land utilization practices and trends, and other factors. Those efforts have factored into the development of the National Ocean Policy Implementation Plan (National Ocean Council 2013) that describes specific actions Federal agencies will take to address key challenges and promote stewardship of coastal resources. The data in this report provide new and more comprehensive information about coastal wetland trends and may be instrumental in further formulation of recommendations to improve the management of wetlands in coastal watersheds, reduce losses and ensure that coastal infrastructure and resources are protected.

Pee Dee River, South Carolina.

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APPENDIX: Definitions of Habitat Categories

Wetlands[27]

In general terms, wetlands are lands where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface. The single feature that most wetlands share is soil or substrate that is at least periodically saturated with or covered by water. The water creates severe physiological problems for all plants and animals except those that are adapted for life in water or in saturated soil.

> *Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes [28], (2) the substrate is predominantly undrained hydric soil [29], and (3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year.*

The term wetland includes a variety of areas that fall into one of five categories: (1) areas with hydrophytes and hydric soils, such as those commonly known as marshes, swamps, and bogs; (2) areas without hydrophytes but with hydric soils—for example, flats where drastic fluctuation in water level, wave action, turbidity, or high concentration of salts may prevent the growth of hydrophytes; (3) areas with hydrophytes but non-hydric soils, such as margins of impoundments or excavations where hydrophytes have become established but hydric soils have not yet developed; (4) areas without soils but with hydrophytes such as the seaweed covered portions of rocky shores; and (5) wetlands without soil and without hydrophytes, such as gravel beaches or rocky shores without vegetation.

Marine System

The marine system consists of the open ocean overlying the continental shelf and its associated high energy coastline. Marine habitats are exposed to the waves and currents of the open ocean. Salinity exceeds 30 parts per thousand, with little or no dilution except outside the mouths of estuaries. Shallow coastal indentations or bays without appreciable freshwater inflow and coasts with exposed rocky islands that provide the mainland with little or no shelter from wind and waves are also considered part of the Marine System because they generally support a typical marine biota.

Estuarine System

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 ocean water is at least occasionally diluted by freshwater runoff from the land. 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, such as red mangroves (Rhizophora mangle) and eastern oysters (Crassostrea virginica), are also included in the Estuarine System.

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[27] Adapted from Cowardin *et al.* 1979.

[28] The U.S. Army Corps of Engineers has published the list of plant species that occur in wetlands of the United States. See: *http://wetland_plants.usace.army.mil*.

[29] U.S. Department of Agriculture has developed the list of hydric soils for the United States. See: *http://soils.usda.gov/use/hydric/*.

Marine and Estuarine Subsystems

Subtidal The substrate is continuously submerged by marine or estuarine waters

Intertidal The substrate is exposed and flooded by tides. Intertidal includes the splash zone of coastal waters.

Palustrine

The palustrine (freshwater) system includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, farmed wetlands, and similar wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 parts per thousand. It also includes wetlands lacking such vegetation, but with all of the following four characteristics: (1) area less than 20 acres; (2) an active wave formed or bedrock shoreline features are lacking; (3) water depth in the deepest part of a basin less than 6.6 feet at low water; and (4) salinity due to ocean derived salts less than 0.5 parts per thousand.

Classes

Unconsolidated bottom Unconsolidated bottom includes all wetlands with at least 25 percent cover of particles smaller than stones, and a vegetative cover less than 30 percent. Examples of unconsolidated substrates are: sand, mud, organic material, cobble gravel.

Aquatic Bed Aquatic beds are dominated by plants that grow principally on or below the surface of the water for most of the growing season in most years. Examples include seagrass beds, pondweeds (*Potamogeton spp.*), wild celery (*Vallisneria americana*), waterweed (*Elodea spp.*), and duckweed (*Lemna spp.*).

Rocky Shore Rocky shore includes wetland environments characterized by bedrock, stones, or boulders which singly or in combination have an aerial cover of 75 percent or more and an aerial vegetative coverage of less than 30 percent.

Unconsolidated Shore Unconsolidated shore includes all wetland habitats having two characteristics: (1) unconsolidated substrates with less than 75 percent areal cover of stones, boulders or bedrock and; (2) less than 30 percent areal cover of vegetation other than pioneering plants.

Emergent Wetland Emergent wetlands are characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants.

Shrub Wetland Shrub Wetlands include areas dominated by woody vegetation less than 20 feet tall. The species include true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions.

Forested Wetland Forested Wetlands are characterized by woody vegetation that is 20 feet tall or more.

Farmed Wetland Farmed wetlands are wetlands that meet the Cowardin *et al.* definition where the soil surface has been mechanically or physically altered for production of crops, but where hydrophytes will become reestablished if farming is discontinued.

Deepwater Habitat

Wetlands and deepwater habitats were defined separately because the term wetland does not include deep, permanent water bodies. For conducting status and trends studies, Riverine and Lacustrine were considered deepwater habitats. Elements of Marine or Estuarine systems can be wetland or deepwater. Palustrine includes only wetland habitats.

Deepwater habitats were permanently flooded land lying below the deepwater of wetlands. Deepwater habitats include environments where surface water is permanent and often deep, so that water, rather than air, is the principal medium in which the dominant organisms live, whether or not they were attached to the substrate. As in wetlands, the dominant plants were hydrophytes; however, the substrates were considered nonsoil because the water is too deep to support emergent vegetation.

Riverine System

The riverine system includes deepwater habitats contained in a channel, with the exception of habitats with water containing ocean derived salts in excess of 0.5 parts per thousand. A channel is an open conduit either naturally or artificially created which periodically or continuously contains moving water, or which forms a connecting link between two bodies of standing water.

Lacustrine System

The lacustrine system includes deepwater habitats with all of the following characteristics: (1) situated in a topographic depression or a dammed river channel; (2) lacking trees, shrubs, persistent emergents, emergent mosses or lichens with greater than 30 percent coverage; (3) total area exceeds 20 acres.

Uplands

Agriculture[30]

Agricultural land may be defined broadly as land used primarily for production of food and fiber. Agricultural activity is evidenced by distinctive geometric field and road patterns on the landscape and the traces produced by livestock or mechanized equipment. Examples of agricultural land use include cropland and pasture; orchards, groves, vineyards, nurseries, cultivated lands, and ornamental horticultural areas including sod farms; confined feeding operations; and other agricultural land including livestock feed lots, farmsteads including houses, support structures (silos) and adjacent yards, barns, poultry sheds, etc.

Urban

Urban land is comprised of areas of intensive use in which much of the land is covered by structures (high building density). Urbanized areas are cities and towns that provide the goods and services needed to survive by modern day standards through a central business district. Services such as banking, medical and legal office buildings, supermarkets, and department stores make up the business center of a city. Commercial strip developments along main transportation routes, shopping centers, contiguous dense residential areas, industrial and commercial complexes, transportation, power and communication facilities, city parks, ball fields and golf courses can also be included in the urban category.

Silviculture

Silviculture includes forested plantations or areas of planted and managed forest stands. Planted pines, Christmas tree farms, clear cuts, and other managed forest stands, such as hardwood forestry are included in this category. Forested plantations can be identified by observing the following remote sensing indicators: 1) trees planted in rows or blocks; 2) forested blocks growing with uniform crown heights; and 3) logging activity and use patterns.

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[30]Adapted from Anderson *et al.* 1976.

Rural Development

Rural developments occur in sparse rural and suburban settings outside distinct urban cities and towns. They are characterized by non-intensive land use and sparse building density. Typically, a rural development is a cross-roads community that has a corner gas station and a convenience store which are surrounded by sparse residential housing and agriculture. Scattered suburban communities located outside of a major urban center can also be included in this category as well as some industrial and commercial complexes; isolated transportation, power, and communication facilities; strip mines; quarries; and recreational areas such as golf courses, etc. Major highways through rural development areas are included in the rural development category.

Other Land Use

Other land use is composed of uplands not characterized by the previous categories. Typically these lands would include native prairie; unmanaged or non-patterned upland forests and scrub lands; and barren land. Lands in transition may also fit into this category. Transitional lands are lands in transition from one land use to another. They generally occur in large acreage blocks of 40 acres or more and are characterized by the lack of any remote sensor information that would enable the interpreter to reliably predict future use. The transitional phase occurs when wetlands are drained, ditched, filled, leveled, or the vegetation has been removed and the area is temporarily bare.

Laughing gulls (Leucophaeus atricilla), Sandwich terns (Thalasseus sandvicensis), and Brown pelicans (Pelecanus occidentalis) on Indian Beach, Florida (Nicole Rankin/USFWS)

Front cover photo, top.
Freshwater wetlands of coastal Alabama.

Front cover photo, bottom.
Whalehead Beach , Oregon.

Inside cover photo.
Cave Point, Wisconsin . (Taylor Trimble)

Blue Crab photo, page 13, by *Phil's 1stPix , Flickr .*

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