U.S. Fish & Wildlife Service

# Geographically Isolated Wetlands

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## *A Preliminary Assessment of Their Characteristics and Status in Selected Areas of the United States*

**U.S. Fish and Wildlife Service**

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# Preface

The mission of the Fish and Wildlife Service is to conserve, protect, and enhance fish, wildlife, plants and their habitats for the continuing benefit of the American people. Wetlands are among the Nation's most valuable natural resources, providing crucial habitat for a wide variety of fish and wildlife. Their landscape position, hydrology, and vegetation also make wetlands especially important for water quality renovation, flood water storage, shoreline stabilization, and production of food and fiber. Because of these and other values, wetlands and their associated waters receive much attention for resource protection, restoration, and management.

The Service's National Wetlands Inventory Program is responsible for mapping the Nation's wetlands, and reporting to the Congress at ten-year intervals on the national status and trends of these important habitats. This information aids planners, resource managers, decision-makers, and others in better understanding these valuable habitats, and in improving the status of wetlands.

Wetlands surrounded by upland - "geographically isolated wetlands" - are vital habitats for numerous wildlife species (including endangered and threatened plants). In many areas, these wetlands serve as oases for wildlife, especially in arid and semi-arid regions. Being surrounded by upland and often small in size also have made them perhaps the most vulnerable wetlands in the country. Development of adjacent uplands has posed significant threats both direct and indirect to these wetlands and their associated wildlife.

Given the wildlife significance of these wetlands, the Service prepared this report to provide an ecological and geographic overview of isolated wetland resources of the United States. For the purposes of this report, isolated wetlands have no apparent surface water connection to perennial rivers and streams, estuaries, or oceans. Ecological profiles were developed to provide the public with a better understanding of 19 types of wetlands that are often considered geographically isolated wetland habitats. The report also included the results of a study that estimated the extent of potentially isolated wetlands at 72 selected sites in 44 States. Available National Wetlands Inventory map data were combined with U.S. Geological Survey hydrology data through geographic information system analysis to develop these estimates. The report should increase public awareness of these significant and vulnerable wetlands.

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# Section 2. Overview of Isolated Wetlands

This section provides an introduction to isolated wetlands. It begins with a general discussion that explains different definitions of isolated wetlands and reviews major functions of isolated wetlands. The section concludes with brief profiles of individual wetland types that have been traditionally viewed as hydrologic connection to other wetlands or waters considering both surface and subsurface flows. Examples of hydrologically isolated wetlands are Southwest playas and Nebraska's Rainwater Basin wetlands. Many wetlands considered isolated from the landscape or geographic perspective are connected hydrologically via groundwater to other wetlands and to rivers and streams. For example, *Figure 2-3* shows subsurface flows from South Dakota prairie pothole wetlands to a regional groundwater system that eventually empties into a stream. Similar groundwater connections take place in other areas (see numerous illustrations in Fretwell et al. 1996; some of which are presented elsewhere in this section). In karst regions, many geographically isolated wetlands are hydrologically connected to underground waterways. Other geographically isolated wetlands may become hydrologically linked to other wetlands during extremely wet years as surface water overflows from one depressional wetland to another. So time may also be a factor when considering whether or not a given wetland is hydrologically isolated.

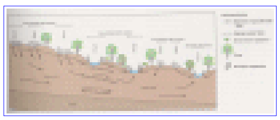

*Figure 2-3. General subsurface flows between different South Dakota potholes and riverine wetlands. (Source: Sando 1996)*

Isolation from an ecological perspective is even more difficult to define since one would have to identify physical, chemical, or other barriers to the exchange of genetic material, for example. Barriers that affect seed dispersal, animal movements, and reproductive success would have to be evaluated. Isolation in this context may be best defined relative to a particular organism, since some features that pose barriers to some organisms do not restrict others. From a wetland-dependent animal's standpoint, isolation is a function of the number of neighboring wetlands, the distance between them, the nature of the matrix land cover, and the mobility of the particular species (Gilberto Cintron, pers. comm.). Determining ecological isolation might also require identification of discontinuities in biological characteristics like genotypes or phenotypes of certain species. In the view of some landscape ecologists, an isolated system is one that has no exchange of energy or matter with its surrounding environment (Forman and Godron 1986). From this perspective, it may not be possible for any wetland to be truly isolated.

## Overview of Isolated Wetland Functions

Wetlands provide a host of functions that benefit ecosystems as well as society (see Mitsch and Gosselink 2000). Many of the functions are synergistic in producing services or materials that are valued by people (*Table 2-1*). Wetlands largely operate as a holistic or integrated system within a watershed, waterfowl flyway, or ecoregion (Tiner 1998). Individual wetlands working together provide valued functions and the value of a network of wetlands (e.g., within a watershed or flyway) is greater than the sum of its individual parts. A collection of wetlands on the landscape may be the vital ecological unit for some animals, while others require a combination of wetlands and uplands for survival and reproduction.

The following discussion is a brief overview of some of the functions of isolated wetlands. It is not intended to be exhaustive, but is designed to acquaint readers with the potential roles isolated wetlands play. For additional information about functions of specific types of isolated wetlands, readers are referred to the next subsection and to publications listed in the References Cited section.

*Table 2-1. Major wetland functions and some of their values. (Source: Tiner 1998)*

| Function | Some Values |
| --- | --- |

**Water storage**

Flood- and storm-damage protection, water source during dry seasons, groundwater recharge, fish and shellfish habitat, water source for fish and wildlife, recreational boating, fishing, shellfishing, waterfowl hunting, livestock watering, ice skating, nature photography, and aesthetic appreciation

**Slow water release**

Flood-damage protection, maintenance of stream flows, maintenance of fresh and saltwater balance in estuaries, linkages with watersheds for wildlife and water-based processes, nutrient transport, and recreational boating

**Nutrient retention and cycling**

Water-quality renovation, peat deposits, increases in plant productivity and aquatic productivity, decreases in eutrophication, pollutant abatement, global cycling of nitrogen, sulfur, methane, and carbon dioxide, reduction of harmful sulfates, production of methane to maintain Earth's protective ozone layer, and mining (peat and limestone)

**Sediment retention**

Water-quality renovation, reduction of sedimentation of waterways, and pollution abatement (retention of contaminants)

**Substrate for plants and animals**

Shoreline stabilization, reduction of flood crests and water's erosive potential, plant-biomass productivity, peat deposits, organic export, fish and wildlife habitats (specialized animals, including rare and endangered species), aquatic productivity, trapping, hunting, fishing, nature observation, production of timber and other natural commodities, livestock grazing, scientific study, environmental education, nature photography, and aesthetic appreciation

Water Storage

Depressional wetlands, whether isolated or not, store precipitation that could otherwise rapidly flow downstream, creating potential flooding of low-lying areas. Since isolated basins have no natural outlets, all water entering them is retained (including groundwater recharge). This is valuable for flood reduction, since such water does not contribute to local or regional flooding (Carter 1996). When an area contains thousands of isolated depressional wetlands, the surface water storage capacity can be enormous. For example, pothole wetlands in North Dakota's Devils Lake Basin can store as much as 72 percent of the total runoff from a 2-year frequency storm and about 41 percent from a 100-year storm (Ludden et al. 1983). In many cases, this water storage function facilitates an isolated wetland's potential role in groundwater recharge and streamflow maintenance (through contribution to regional groundwater supplies) and at the same time, provides valuable waterfowl and waterbird habitat. The multiple benefits of temporary water storage are considerable.

By holding water for long periods, isolated wetlands serve as water sources that benefit fish and wildlife, domestic livestock, and people. An abundance of water creates wetland habitats for native fish and wildlife that provide recreational opportunities for many people (e.g., hunting and fishing) and help support local economies. Isolated wetlands within rangeland are often used as watering holes for livestock, while similar wetlands in agricultural settings may serve as sources of irrigation water. These two uses can have adverse effects on wildlife and the habitat quality of these wetlands. The wettest of isolated wetlands may provide fish habitat that may be a valuable resource for local landowners. Recreational fishing and commercial harvest of fish may take place in some isolated wetlands. For example, fathead minnows are caught in Minnesota potholes and sold as baitfish (Hubbard 1988).

Slow Water Release

Many wetlands that appear isolated from surface waters are actually vital components of regional water systems, since they contribute to local and regional aquifers (Stone and Lindley Stone 1994). Examples of isolated wetlands contributing water to regional aquifers that ultimately support stream flow are shown in *Figures 2-4* and *2-5*. Isolated wetlands hold water until it is removed by evapotranspiration, seepage (percolation contributing to groundwater supplies), irrigation devices, or drainage structures. During extreme high water events, for example, water-filled isolated basins often contribute to groundwater supplies (including regional aquifers) as water enters more permeable adjacent soils and moves downward to underlying aquifers. Such groundwater may flow laterally to contribute to streamflow critical for supporting aquatic life and their respective ecosystems. Playa lakes are major recharge sites in the Southern High Plains (Wood and Osterkamp 1984 as reported in Carter 1996).

Figure 2-4. Generalized subsurface flows between isolated wetlands and rivers and estuaries. (Source: McPherson 1996)

and Gosselink 2000).

Sediment Retention

Isolated depressional wetlands are sediment traps. Given their landform and landscape position, they should retain all sediments and other particulates entering them. In fact, the volume of many such wetlands is reduced over time due to this process, especially in agricultural areas. Luo and others (1999) reported on sediment deposition in playa wetlands. Most of these sediments are water-borne materials originating from local watersheds. Coarser materials settle out first, so sand content is higher at the margins of playas, while finer particles are carried further and settle out near the center of the basins where clay content is greater.

Substrate for Plants and Animals

Wetlands provide substrates that support plant growth and colonization by thousands of animals ranging from microscopic invertebrates to large vertebrates. By doing this, wetlands provide habitat for plants and animals. The variety of wetland types is a major contributor to the Nation's biodiversity (see Tiner 1999 for examples of wetland plant communities).

From an ecological standpoint, isolated wetlands are among the country’s most significant biological resources. In some areas, isolation has led to the evolution of endemic species vital for the conservation of biodiversity. In other cases, their isolation and sheer numbers in a given locality have made these wetlands crucial habitats for amphibian breeding and survival (e.g., woodland vernal pools and cypress domes) or for waterfowl and waterbird breeding (e.g., potholes). In arid and semi-arid regions, many isolated wetlands are veritable oases – watering places and habitats vital to many wildlife that use them for breeding, feeding, and resting, or for their primary residence. Many of these wetlands may be small in size, but their value to wildlife is far greater than their size alone would suggest.

The high density of isolated marshes and wet meadows has made the Prairie Pothole Region, North America’s leading waterfowl production area. This region produces half of the continent’s waterfowl in an average year (Smith et al. 1964). Forty-one percent of the continent’s breeding dabbling ducks use this area (Bellrose 1979). Macroinvertebrates produced by the pothole marshes are a protein-rich food source required by nesting hens (Hubbard 1988).

Regions with a high density of isolated wetlands may provide a series of "stepping stones" for migrating waterfowl and waterbirds. For example, isolated wetlands east of the Rocky Mountains provide feeding and resting areas for millions of birds that overwinter along the Gulf Coast and migrate to northern breeding grounds. These wetlands produce an abundance of macroinvertebrates and plant life – nourishment required by these species to successfully make the migratory journey essential for maintaining their populations. Playas may be important intermediate stopover sites for migrating shorebirds (Davis and Smith 1998), while Rainwater Basin wetlands are stopover areas for millions of birds. Nearly all of the midcontinental population of greater white-fronted goose (*Anser albifrons*) stage in the Rainwater Basin every year (U.S. Fish and Wildlife Service 1985).

several factors including natural events (e.g., prolonged droughts and changing vegetation), disease, inbreeding, and habitat destruction. A study of wetlands in central Maine by Gibbs (1993) suggests that a high number of small wetlands increases the number of sources of potential colonists for wetlands that have lost populations due to chance extinction. The presence of a high number of small wetlands therefore increases the chances of survival of local populations over time.

Reducing the number of small wetlands in a given area increases overland migration distances and exposure of migrants (e.g., salamanders) to predators. This may place local populations at the risk of extinction. For example, Semlitsch and Bodie (1998) found that eliminating all natural wetlands less than 10 acres in size (in a South Carolina study area) would increase the nearest-wetland distance from 1,570 feet to 5,443 feet – a distance that would take most amphibian species several generations or more to travel. This type of loss would increase the probability of local population extinction for some amphibians.

Isolated wetlands with fluctuating water levels provide unique habitats for certain species, especially those that are vulnerable to fish predation. Much of the value of woodland vernal pools to amphibians is due to the absence of fish, which cannot survive periodic drawdowns. The presence of fish would eliminate or severely reduce the reproductive success of amphibians that breed in these pools.

Isolation and periodic drawdowns also promote endemism - the development of unique species. Increased number of species adds to the country's biological richness. Some examples of wetlands that are particularly important in this regard are West Coast vernal pools, desert spring wetlands, and Coastal Plain ponds (see discussion in following subsection).

**Profiles of Selected Isolated Wetland Types**

Regional differences in climate, physiography, hydrology, and other factors have led to the formation of a diverse assemblage of wetlands across the country. A number of distinct wetland types are typically isolated (e.g., playas, potholes, vernal pools, and interdunal swales), while others (e.g., Carolina bays and kettle-hole wetlands) may be either isolated or connected to streams and other surface waters. Isolated wetlands on former floodplains (e.g., oxbow lakes) were at one time periodically inundated by seasonal river flows but due to changes in river courses are now left isolated beyond the active floodplain. In other cases, the isolation of former floodplain wetlands has been caused by construction of levees to prevent overbank flooding to provide flood protection or by upstream dams that reduce flow regimes. Many other isolated wetlands were also created by human actions. Most of them are ponds built for a variety of reasons including aesthetic appreciation, livestock watering, irrigation, aquaculture, and stormwater management. Other isolated wetlands have been created by fragmentation from development; they represent remnants of once larger wetland complexes.

The following review describes the range and types of wetlands that have been considered isolated. For to consult the cited references for additional information.

Prairie Potholes

The Prairie Pothole Region extends from Iowa and South Dakota northward into south-central Canada (*Figure 2-6*). Glacial activity in this area created millions of shallow depressions now called "prairie pothole wetlands" (*Figure 2-7*). Most of these depressions have been commonly viewed as isolated wetlands, since they occur as separate basins on the land surface. Despite this, many of these wetlands are hydrologically connected (*Figure 2-8*). Prairie wetlands serve as both recharge and discharge areas, contributing to both local groundwater flow and regional flow (Lissey 1971). Water is recharged at topographic highs (wetlands at higher elevations) and discharged to regional lows (e.g., lakes and other wetlands) and eventually to local rivers and streams (Winter 1989). Seasonal changes in functions may occur as some wetlands contribute to groundwater during high water periods (recharge), yet receive groundwater inputs during the dry season due to evapotranspiration.

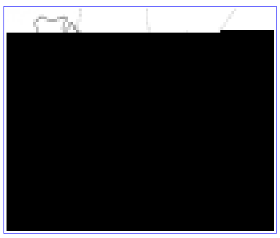

*Figure 2-6. Location of the Prairie Pothole Region. (Source: Hubbard 1988)*

*Figure 2-7. Aerial view showing high density of prairie pothole wetlands. (U.S. Fish and Wildlife Service photo)*

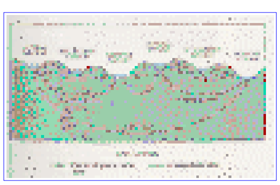

*Figure 2-8. Generalized subsurface flows between different pothole wetlands. (Source: Berkas 1996)*

The existence of millions of isolated basins in this region provides considerable surface water storage capacity. For example, the approximately 50,000 pothole wetlands in the Devils Lake Basin (North Dakota) that cover only 15 percent of the local landscape can store up to 72 percent of the total runoff of a 2-year storm event and 41 percent of a 100-year storm (Ludden et al. 1983). Water trapped within these basins is lost mainly through evapotranspiration and groundwater seepage. In their undrained state, these wetlands do not contribute to runoff (Wiche et al. 1990). Yet drainage of these basins and connection to the surface water network emptying into streams makes them contributing sources of stream flow, thereby exacerbating flooding problems. Artificial drainage increases the watershed runoff area and decreases the water storage capacity of potholes (Moore and Larson 1979).

individual potholes. Potholes are often described by the hydrology of the deepest part of their basins (i.e., permanent, semipermanent, seasonal, temporary, and ephemeral) (Stewart and Kantrud 1971). Concentric rings of vegetation zones are typical with aquatic bed species such as widgeon-grass (*Ruppia maritima*), pondweeds (*Potamogeton* spp.), and duckweeds (*Lemna* spp. and *Spirodela polyrhiza*) in the permanently flooded zone; robust emergents like cattails (*Typha* spp.) and bulrushes (*Scirpus* spp.) in the semipermanently flooded zone; other emergents including spikerush (*Eleocharis palustris*), giant

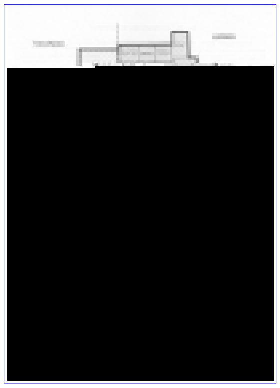

*Figure 2-11. Location of playa region in the Southern Great Plains, with playa density indicated. (Source: Nelson et al. 1983)*

Most playas derive water from rainfall and local runoff; very few (e.g., playa lakes) are linked to groundwater (Haukos and Smith 1994). Playas are usually dry in late winter, early spring, and late summer. Multiple wet-dry cycles during a single growing season are common (*Figure 2-12*). These fluctuating water levels promote nutrient cycling and biological productivity (Bolen et al. 1989).

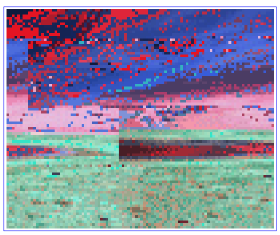

*Figure 2-12. A playa wetland during a wet phase. (U.S. Fish and Wildlife Service photo)*

According to Haukos and Smith (1994), playas are the only remaining native habitat in the Southern High Plains. From a wildlife standpoint, playas are perhaps most important as wintering grounds for waterfowl. More than 90 percent of the region's overwintering waterfowl depends on the playas: 600,000 to over 3 million ducks and geese (Nelson et al. 1983; U.S Fish and Wildlife Service 1988). More than 90 percent of the midcontinental population of sandhill cranes (*Grus canadensis*) overwinters here and many cranes frequent larger playas as well as salt lakes (Iverson et al. 1985). Migrating shorebirds feed heavily on aquatic invertebrates produced in the playas.

Playas also serve as vital habitats for amphibians. Spotted chorus frog (*Pseudacris clarkii*), Blanchard's cricket frog (*Acris crepitans blanchardi*), Plains leopard frog (*Rana blairi*), Great Plains narrow-mouth toad (*Gastrophyrne olivacea*), Great Plains toad, Texas toad (*Bufo speciosus*), Woodhouse's toad (*B. woodhousei woodhousei*), Plains spadefoot (*Scaphiopus bombifrons*), New Mexico spadefoot (*S. multiplicatus*), Couch's spadefoot (*S. couchii*), and tiger salamander depend on playas (Anderson and Haukos 1997). Given the variability in playa wetness, amphibian community composition and populations fluctuate from year to year (Anderson et al. 1999). Haukos and Smith (1994) provide a summary of wildlife use of playas and stress the significance of playas to local landscape heterogeneity and regional and continental biodiversity. Additional information on playas can be found in "Playa Lakes - Symposium Proceedings" (U.S. Fish and Wildlife Service 1981) and "Playa Wetlands and Wildlife on the Southern Great Plains: A Characterization of Habitat" (Nelson et al. 1983).

Negative impacts to playas appear to be related most to water pollution. Playas receive poor quality water from a number of sources: 1) runoff from adjacent cropland (e.g., pesticides and herbicides), 2) discharge of contaminated water from oil fields, and 3) effluents from livestock operations such as cattle feedlots (Haukos and Smith 1994). The second source has led to widespread bird mortality. Playas adjacent to feedlots are often used as wastewater retention ponds (Bohlen et al. 1989). Other impacts to playas include sedimentation from farmland, pit construction (for irrigation), and overgrazing of playa vegetation.

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Rainwater Basin Wetlands

10 percent of this acreage remained (Farrar 1982). Agricultural activities such as drainage, clearing, and ground water pumping have exacted a tremendous toll on these wetlands. Losses of Basin wetlands have forced ducks and geese to concentrate in remaining wetlands. In dry years with late winter storms, migrating waterfowl crowd into Basin wetlands. Such concentrations increase the likelihood for spread of diseases like avian cholera. In 1980, avian cholera killed about 80,000 waterfowl in the Basin – this was the second largest reported cholera die-off in the country.

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## Nebraska Sandhills Wetlands

The Sandhills region of north-central and northwestern Nebraska is the largest sand dune area in the Western Hemisphere, covering about 20,000 square miles (*Figure 2-16*; Bleed and Flowerday 1990). This expansive grassland overlies the Ogallala Aquifer, to which most wetlands in the region owe their existence. Groundwater is a major water source for Sandhills wetlands in the eastern portion of the region and for subirrigated meadows (Chuck Elliott, pers. comm.).

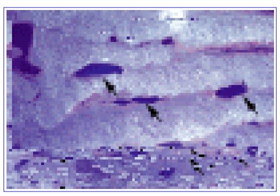

*Figure 2-16. Aerial photo showing isolated basins in the Sandhills.*

According to Ginsberg (1985), wet meadows characteristic of this region commonly have surface outlets. Yet many wet meadows in the western Sandhills have little or no surface outflow (*Figure 2-17*) (Frankforter 1996). Despite this apparent lack of surface outflow, most of these wetlands are interconnected with a regional groundwater system (*Figure 2-17*) (LeBaugh 1986; Winter 1986).

*Figure 2-17. Generalized flow of water between Sandhills wetlands. Note subsurface flow in north to south direction. (Source: Frankforter 1996)*

The Sandhills are among three major wetland resource areas in Nebraska that provide spring staging areas, breeding areas, migration and wintering habitat for endangered and threatened species, including whooping crane (*Grus americana*) and bald eagle (*Haliaeetus leucocephalus*) and for millions of migratory waterfowl (Elliott 1991; Gersib 1991). Two percent of the mallard duck breeding population of the north-central flyway depends on these wetlands (Novacek 1989).

Losses of these wetlands are due mostly to agriculture. The grassland economy of the Sandhills is based primarily on cattle grazing. Ditching of wet meadows has created large acreages of subirrigated meadows with water tables near the surface for cattle grazing and hay production. Wetland loss has resulted mainly from center-pivot irrigation operations, with associated drainage, land-leveling, filling, and lowered groundwater levels from deep well irrigation. These activities are largely responsible for about 30 percent of the loss of original Sandhills wetlands (Erickson and Leslie 1987).

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Salt Flat and Salt Lake Wetlands

Salt lakes and associated salt flat wetlands are found in arid and semi-arid regions and are characteristic of the Great Basin region. The Great Basin is a vast area of mountains and desert basins that includes most of Nevada and western Utah (*Figure 2-18*). It lies between Utah's Wasatch Mountains in the east, southward. Other birds using salt flat wetlands include red-necked phalarope (*Phalaropus lobatus*), western sandpiper (*Calidris mauri*), least sandpiper (*C. minutilla*), snowy plover (*Charadrius alexandrinus*), cinnamon teal (*Anas cyanoptera*), northern pintail, redhead, tundra swan (*Cygnus columbianus*), northern harrier, short-eared owl (*Asio flammeus*), and savannah sparrow (*Ammodramus savannarum*).

The abundance of food sources available in salt lakes is also vital to the success of breeding birds. From 44,000 to 65,000 California gulls (*Larus californicus*) breed on an island in Mono Lake.[1] The nation's largest colony of American white pelicans (*Pelecanus erythrorhynchos*) nests on an island in Pyramid Lake, Nevada. Other breeding birds of salt lake and salt flat wetlands include American avocet, black-necked stilt (*Himatopus mexicanus*), white-faced ibis (*Plegadis chihi*), spotted sandpiper (*Actitis macularia*), common snipe (*Gallinago gallinago*), and willet (Jehl 1994). Wetlands along California's Salton Sea are habitat for the federally endangered Yuma clapper rail (*Rallus longirostris obsoletus = R. longirostris yumanensis*).

Most inland salt marshes occur in the interior of the Great Basin and are not subjected to extensive development. Major threats to Great Basin wetlands are from road and utility construction. Salt flats in urbanizing areas are at greater risk due to impacts from encroaching urban development and associated disruption of drainage patterns (Dennis Peters, pers. comm.).

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Wetlands of Washington's Channeled Scablands

The Channeled Scablands area is on the east side of the Cascade Mountains in eastern Washington. This "rain-shadow" location creates a semi-desert environment that receives 7 to 10 inches of rain annually (U.S. Fish and Wildlife Service 1998a). The post-glacial Spokane Floods created channeled scablands and outwash lakes about 12,000 to 15,000 years ago. Today, only three creeks drain this area: Rock, Cow, and Crab Creeks. The rest of the area is pock-marked with isolated ponds, lakes, and cyclical wetlands (i.e., present during wet years and absent during drought years) forming a mosaic of wetlands across the landscape (see Lincoln County, Washington study area map in Section 4).

Although many of the wetlands occur in isolated depressions, they are often interconnected during high precipitation years, creating large wetland complexes of varied types (U.S. Fish and Wildlife Service 1998a). Common plants in these wetlands (from wettest to driest zones) include fennel-leaved pondweed (*Potamogeton pectinatus*), hornwort (*Ceratophyllum demersum*), common water milfoil (*Myriophyllum exalbescens*), broad-leaved cattail (*Typha latifolia*), hard-stemmed bulrush (*Scirpus acutus*), spikerush (*Eleocharis macrostachya*), common three-square (*Scirpus pungens = S. americanus*), Douglas' sedge (*Carex douglasi*), baltic rush, salt grass, Nevada bulrush (*Scirpus nevadensis*), and alkali cordgrass (*Spartina gracilis*). Some ponds contain the federally-threatened water howellia (*Howellia aquatilis*).

These wetlands are particularly valuable for waterfowl and other migratory birds, serving as staging areas during migration (early spring and fall) and breeding and brood-rearing habitat in summer. Migrants using these wetlands include tundra swan, trumpeter swan (*Cygnus buccinator*), Canada goose (*Branta canadensis*; several subspecies), Pacific white-fronted goose (*Anser albifrons frontalis*), lesser snow goose (*A. caerulescens caerulescens*), bufflehead (*Bucephala albeola*), common goldeneye (*B. clangula*), greater scaup (*Aythya marila*), hooded merganser (*Mergus cucullatus*), red-breasted merganser (*M. serrator*), and other waterfowl. Resident waterfowl include mallard, gadwall, northern pintail, green-winged teal, American wigeon, northern shoveler, wood duck (*Aix sponsa*), redhead, ruddy duck (*Oxyura jamaicensis*), western Canada goose (*Branta canadensis moffitti*), common merganser (*Mergus merganser*), coot (*Fulica americana*), and others. Nearly 100,000 individual birds may breed in these wetlands. The main breeding ducks are mallard, blue-winged teal, redhead, and ruddy duck. Other birds dependent on these wetlands are American white pelican, great blue heron (*Ardea herodius*), black-crowned night heron, common snipe, various shorebirds, avocet, sandhill crane, and bald eagle.

Scabland wetlands occur in rangeland and impacts from livestock may be significant. For example, cattle use ponds as wallows, which often interferes with waterfowl brood-rearing. Overgrazing of palustrine emergent wetlands also occurs. Some large ponds have been drained and converted to hayfields and pasture. The activity of carp has muddied many ponds, reducing their value to waterfowl. Carp removal has been initiated in some areas (U.S. Fish and Wildlife Service 1998a).

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Desert Springs and Their Wetlands

In the desert, springs arise where groundwater from large underground reserves discharges to the land surface via fractures in underlying rock strata (e.g., fault lines) or through porous materials (e.g., permeable carbonate rocks). Water discharging from springs may be quite old (8,000-12,000 years for Ash Meadow Springs in Nevada; Soltz and Naiman 1978). Isolated springs may harbor unique populations of endemic desert fishes (e.g., pupfish, *Cyprinodon* spp.), invertebrates, and plants. These springs may support wetlands of variable sizes from small fringes of vegetated wetlands to extensive bulrush and cattail marshes (*Figure 2-20*) (Minckley 1991). Some springs may be hot; often they are called "thermal springs."

*Figure 2-20. A spring-fed desert wetland. (Source: Minckley 1991; photo by J.N. Rinne)*

Isolated springs and seepage areas support small marshes (cienagas), oases (in California and Arizona), and other wetlands (*Figure 2-21*) (Bakker 1984; Bertoldi and Swain 1996). Saline wetlands form where water supply is persistent and drainage is limited. While some springs are isolated, others are headwaters of rivers like the Muddy River in Nevada.

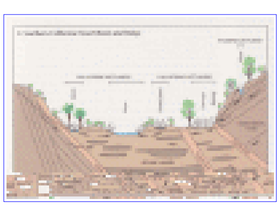

*Figure 2-21. Generalized flow of water between different wetland types in Southern California. (Source: Bertoldi and Swain 1996)*

Isolation has led to the development of unique populations of certain organisms. In the Death Valley region, there were more than 20 isolated pupfish populations in the late 1970s (Soltz and Naiman 1978).

*Figure 2-23. Alaskan kettle-hole bog.*

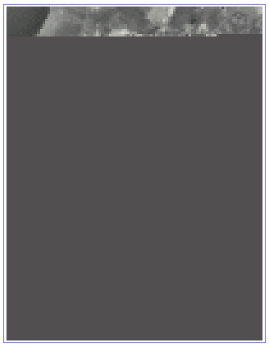

*Figure 2-24. Aerial photo showing a series of kettle-hole ponds and associated wetlands in South Kingstown, Rhode Island.*

Damman and French (1987) list three hydrological conditions under which bogs form in the northeastern United States.  One of these conditions is an undrained basin, while the other two are drained basins.

Along the Atlantic-Gulf Coastal Plain, isolated ponds have formed in depressions where groundwater flows to the land surface and rainwater collects. In glacial areas (e.g., New England and Long Island, New York), these ponds developed in kettle-holes or in shallow depressions in outwash plains. These isolated ponds may be hydrologically linked by groundwater, while others may be connected to small streams (Reschke 1990). In non-glaciated areas of the Coastal Plain (from New Jersey south), Coastal Plain ponds formed on broad flats. Some examples of Coastal Plain ponds are Calverton Ponds and Tarkill Pond on Long Island (New York), Clermont Bog and Bennett Bogs on Cape May (New Jersey) (U.S. Fish and Wildlife Service 1997), and ponds on barrier islands of the Florida Panhandle, such as St. Vincent, St. George, and Dog Islands (Wolfe et al. 1988).

Water levels fluctuate seasonally and annually, inducing significant changes in vegetation (U.S. Fish and Wildlife Service 1997). Periodic high water levels eliminate woody seedlings that may have colonized these ponds during drawdowns. Vegetation patterns are similar to prairie pothole wetlands, with concentric bands of vegetation following different water regimes (permanently flooded/intermittently exposed to semipermanently flooded to seasonally flooded zones – from wettest to driest).

The fluctuating water levels and isolated nature of coastal ponds have resulted in each pond hosting some unique species as well as possessing many common species. These ponds may be characterized by aquatic bed species such as water-shield (*Brasenia schreberi*), white water lily (*Nymphaea odorata*), water milfoil (*Myriophyllum humile*), naiad (*Najas flexilis*), waterweed (*Elodea* spp.), and pondweeds, and by shallow-water emergent species like bayonet rush (*Juncus militaris*) and spikerush (*Eleocharis robbinsii*) (Reschke 1990). Rare species may be associated with some ponds. For example, in the New York Bight region, four globally rare species - quill-leaf arrowhead (*Sagittaria teres*), pine barren bellwort (*Uvularia puberula* var. *nitida*), rose tickseed (*Coreopsis rosea*), and creeping St. John's-wort (*Hypericum adpressum*) - may occur in these ponds (Zaremba and Lamont 1993; U.S. Fish and Wildlife Service 1997). Rare dragonflies, damselflies, butterflies, and moths may also be found in these wetlands: lateral bluet (*Enallagma laterale*), painted bluet (*E. pictum*), Barrens blue damselfly (*E. recurvatum*), pink sallow (*Psectraglaea carnosa*), violet dart (*Euxoa violaris*), and chain fern borer moth (*Papaipema stenocelis*). Vertebrates of special concern living in these ponds include the Pine Barrens treefrog (*Hyla andersonii*), Cope's gray treefrog (*H. chrysoscelis*), eastern spadefoot (*Scaphiopus holbrookii holbrookii*), spotted salamander (*Ambystoma maculatum*), tiger salamander, and spotted turtle (*Clemmys guttata*). Plant species of concern found in Coastal Plain ponds include red-rooted flatsedge (*Cyperus erythrorhizos*), several spikerushes (*Eleocharis brittonii*, *E. equisetoides*, *E. melanocarpa*, *E. tricostata*, and *E. tuberculosa*), slender blue flag (*Iris prismatica*), stargrass (*Aletris farinosa*), Pine Barrens boneset (*Eupatorium resinosum*), several bladderworts (*Utricularia biflora*, *U. fibrosa*, *U. juncea*, *U. olivacea*, and *U. radiata*), awned meadowbeauty (*Rhexia aristosa*), and Pine Barrens gerardia (*Agalinis virgata*). Barrier island coastal ponds on the Florida Panhandle may be fringed with persimmon (*Diospyros virginiana*), while similar ponds on the mainland are ringed with titi (*Cyrilla racemiflora*) (Wolfe et al. 1988). The former ponds are especially important because they often provide the only source of freshwater on barrier islands for local wildlife and migratory birds.

Periodic drying out of coastal ponds eliminates fish from many ponds, thereby making them excellent breeding areas for amphibians. The regionally rare tiger salamander is one of several species (which include many vernal pool-breeding amphibians) using coastal ponds in the Northeast for reproduction (U.S. Fish and Wildlife Service 1997). Coastal ponds in Florida may contain fish, but still serve as breeding grounds for the southern toad (*Bufo terrestris*), southern leopard frog (*Rana utricularia*), and pig frog (*R. grylio*) (Wolfe et al. 1988).

Coastal development poses significant threats to these ponds. Disturbances that may be adversely impacting the remaining ponds include waste dumping, all-terrain vehicle driving on pond shores, water withdrawals, and water pollution from adjacent development, such as lawn, agricultural field, and road runoff (U.S. Fish and Wildlife Service 1997).

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Carolina Bay Wetlands

Somewhat egg-shaped (elliptical) basins called Carolina bays have formed on the Atlantic Coastal Plain from southeastern Virginia to Florida (*Figure 2-29*). They are most abundant in mid-coastal South Carolina and southeastern North Carolina. Carolina bays vary greatly in size, ranging from less than 150 feet long to more than 5 miles in length (Sharitz and Gibbons 1982). These bays commonly have a northwest to southeast orientation, with a conspicuous sandy rim (*Figure 2-30*). Most of the Carolina bays are hydrologically isolated nutrient-poor (oligotrophic) ponds or "naturally isolated habitats" that derive water mainly from rainfall (Sharitz and Gresham 1998). They are depressional wetlands often surrounded by flatwood wetlands and upland forests in undisturbed areas, or by farmland and urban land in developed areas.

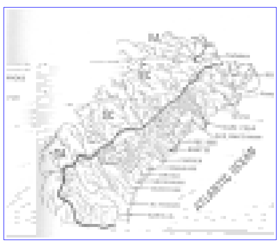

*Figure 2-29. Distribution of Carolina bay wetlands (larger than 800 feet long). The greatest concentration of bays are located within the dashed area. (Source: Sharitz and Gibbons 1982)*

*Figure 2-30. Aerial photo showing several Carolina bay wetlands in Bladen County, North Carolina. (Note: Arrows mark some bays for reference, but many others can be seen.)*

Carolina bays are forested or shrub-dominated palustrine wetlands. Predominant trees are pond pine (*Pinus serotina*), loblolly bay (*Gordonia lasianthus*), sweet bay (*Magnolia virginiana*), red bay (*Persea borbonia*), swamp bay (*P. palustris*), pond cypress (*Taxodium distichum* var. *nutans*), and swamp black gum (*Nyssa sylvatica* var. *biflora*). Dominant shrubs include ericaeous species such as fetterbush (*Lyonia lucida*), leucothoe (*Leucothoe* spp.), zenobia (*Zenobia pulverulenta*), and highbush blueberry, plus titi, sweet pepperbush (*Clethra alnifolia*), and hollies or gallberries (*Ilex* spp.) (Sharitz and Gibbons 1982). Their vegetation is quite similar to that of neighboring pocosins.

Many Carolina bays include seasonal ponds (e.g., vernal pools). Like other vernal pools, their vegetation changes with the seasons. During dry periods, these ponds may be dominated by maidencane (*Panicum* *hemitomon*), little bluestem (*Schizachyrium scoparium* = *Andropogon scoparius*), and club-head cutgrass (*Leersia hexandra*), while aquatic plants (e.g., bladderworts, *Utricularia* spp.) are characteristic of the wet phase. Cypress savannas occur in Carolina bays with clay bottoms. Many rare species are associated with these savannas (Sharitz and Gresham 1998).

Amphibians are particularly abundant in Carolina bays. Thousands of amphibians were counted in a 2.5-acre Carolina Bay called "Sun Bay" at the Savannah River Plant (Georgia) in 1979: 500 ornate chorus frogs (*Pseudacris ornata*), 5,000 southern leopard frogs, and 500 mole salamanders (*Ambystoma talpoideum*) (Sharitz and Gibbons 1982). Over a two-year period, researchers captured more than 72,000 amphibians including nine species of salamanders and 16 species of frogs (Gibbons and Semlitsch 1981 as reported by Sharitz and Gresham 1998). Other species common in these wetlands included the southern toad, spadefoot toad, red-spotted newt (*Notophthalmus viridescens viridescens*), spring peeper (*Hyla crucifer crucifer*), and green frog (*Rana clamitans*).

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*Figure 2-32. Distribution of pocosin wetlands in North Carolina. Includes both isolated and non-isolated pocosins. (Source: Sharitz and Gibbons 1982)*

Specific definitions of pocosins may vary. For example, a forester's definition might include pine-dominated flatwoods of very wet sites, while a hydrologist's definition might restrict the term to shrub bogs on broad, undrained interstream areas (Sharitz and Gibbons 1982). In a textbook on pocosins, Richardson and others (1981) define the typical pocosin ecosystem, in part, as "… waterlogged, acid, nutrient poor, sandy or peaty soils located on broad, flat topographic plateaus, usually removed from large streams and subject to periodic burning." While many pocosins are contiguous with coastal and other non-isolated wetlands, many others may be located away from streams and drainageways. In their classification of pocosins, Weakley and Schafale (1991) identify at least one isolated type – the "small depression pocosin."[2] Other pocosins may also be isolated as they occur in swales (e.g., in the Sandhills) and in seasonally saturated interfluves.

One of the major functions of pocosins is to temporarily hold water that would otherwise run off the land more quickly into adjacent estuaries. This water is then slowly released to the estuaries. This pocosin function benefits the estuaries by giving them more time to assimilate the fresh water without rapid and drastic fluctuations in water quality (Daniel 1981). Yet when drained and connected to a coastal stream, the value of this buffering capacity is lost as ditched pocosins contribute more water (and possibly enriched water) to stream flow. Landscape-level ditching can, therefore, have significant detrimental effects on coastal waters.

Rare animals may live in pocosins. Examples include Hessel's hairstreak butterfly (*Mitoura hesseli*) and the Pine Barrens tree frog (Sharitz and Gresham 1998). The federally endangered red-cockaded woodpecker (*Picoides borealis*) inhabits mature pond pines of pocosins, but is more abundant in mature pine flatwoods. Wildlife of tall or forested pocosins is typical of Coastal Plain forests and include species such as white-tailed deer, gray fox (*Urocyon cineroargenteus*), raccoon, opossum (*Didelphis virginiana*), short-tailed shrew (*Blarina brevicauda*), cotton mouse (*Peromyscus gossypinus*), meadow vole (*Microtus pennsylvanicus*), pileated woodpecker (*Dryocopus pileatus*), Acadian flycatcher (*Empidonax virescens*), vireos (*Vireo flavifrons* and *V. olivaceus*), prothonotary warber (*Protonotaria citrea*), and worm-eating warbler (*Helmitheros vermivorus*). In low shrubby pocosins, birds like common yellowthroat (*Geothlypis trichas*), eastern wood-pewee (*Contopus virens*), and eastern towhee (*Piplio erythrophthalmus*) may be abundant.

Forestry and agriculture have had major impacts on pocosins. Of the 2.5 million acres of pocosins that once existed in North Carolina, roughly one million remained in natural condition by 1980 (Richardson et al. 1981). At least 33 percent of the original acreage has been converted to agriculture or managed forests (i.e., pine plantations), while 36 percent has been partially drained, cleared, or planned for development. Since the 1980s, more acreage has been converted to managed forests as nearly half of the pocosins are owned by forest companies.

Since drainage increases timber productivity, some pocosins that were naturally isolated from other wetlands and waters have been ditched and now are contributing sources for stream flow. Timber yields may also be increased by fertilization; so planted pines on former pocosins are fertilized (Sharitz and Gresham 1998). Former pocosins are cropped for soybeans and corn, but cultivation of remaining pocosins may have decreased recently due to removal of farm subsidies. Agricultural conversion of pocosins has some significant consequences: 1) lowered salinity in adjacent estuaries, particularly during heavy rainfall periods due to introduction of more fresh water (cropland drainage), 2) increased peak flow rates (up to 3 or 4 times that of undrained areas) and decreased flow durations, 3) increased turbidity (ditches had 4 to 40 times greater turbidity than that of natural streams in pocosin areas, depending on development phase – less at post-development), and 4) increased concentration of phosphate, nitrate, and ammonia in streams and adjacent estuaries (Sharitz and Gresham 1998). From this information, it is evident that human use of pocosins has adversely impacted water quality of adjacent streams and estuaries. Drainage of pocosins and its effects on estuarine salinity (decreased salinity) may be having a negative impact on North Carolina's brown shrimp (Street and McClees 1981).

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Cypress Domes[3]

Cypress swamps found in nearly circular isolated depressions are called cypress domes due to the appearance of the trees which are tallest in the center of the pond. Cypress domes are usually small in size, usually 2.5-25 acres and often form an ecological mosaic within the pine flatwoods (Mitsch and Gosselink 2000). They are abundant in Florida and southern Georgia.

Cypress domes receive water from precipitation, groundwater flow, and sometimes runoff. Most of the water arrives with summer rains in southern Florida or with winter and summer rains in northern Florida and southern Georgia (Ewel 1998).

Pond cypress and swamp black gum are the dominant trees of cypress domes (Mitsch and Gosselink 2000). Other trees include slash pine (*Pinus elliottii*), swamp bay, and sweet bay. The shrub layer may be comprised of fetterbush, wax myrtle, red maple (*Acer rubrum*), buttonbush (*Cephalanthus occidentalis*), and Virginia willow (*Itea*

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Sinkhole Wetlands

Isolated depressional wetlands are common features in karst landscapes.  Major karst regions are shown on the map in *Figure 2-33*.  Dissolution of underlying limestone causes a slumping of the land surface, thereby creating distinct basins which may or may not be connected to surface water or ground water.  Wetlands that form in depressions in karst topography are commonly referred to as sinkhole wetlands.  Lost streams (e.g., streams that disappear underground) and underground caverns may be common in karst areas.

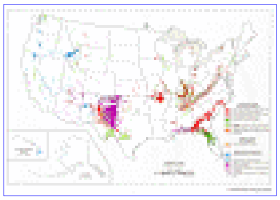

*Figure 2-33. Location of major karst regions in the United States. (Source: U.S. Geological Survey 1970)*

Some sinkhole wetlands receive groundwater discharge from underlying limestone deposits (e.g., in karst valleys).  Others simply occur in basins formed by the dissolution of underlying limestone (*Figure 2-34*).  Many cypress domes formed in such basins (see previous discussion).

*Figure 2-34. Generalized water flow patterns between wetlands in a karst region. (Source: Haag and Taylor 1996)*

Karst lakes and associated marginal wetlands may also be geographically isolated features on this type of landscape.  Many areas in Florida are pock-marked with isolated depressional wetlands and lakes due to the abundance of limestone on the peninsula (*Figure 2-35*).  Some lakes drain into streams connecting to larger ones flowing to the sea, while many do not.

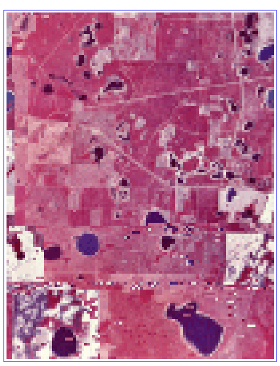

*Figure 2-35. Aerial photo showing karst lakes and wetlands in northern Florida.*

The vegetation of sinkhole wetlands varies geographically and in response to different hydrologies and other factors. The wetter ones may be ponds and marshes with cattail (*Typha* sp.), water plantain, water parsnip (*Sium suave*), St. John's-worts (*Hypericum* spp.), sedges (*Carex* spp.), bulrushes, beak-rushes (*Rhynchospora* spp.), spikerushes (*Eleocharis* spp.), manna-grasses (*Glyceria* spp.), rice cut-grass

(*Leersia oryzoides*), and bluejoint, and two hydrophytic shrubs - buttonbush and swamp rose (*Rosa palustris*). Other shrubs and trees may colonize drier sites: green ash (*Fraxinus pennsylvanica*) and willows (*Salix* spp.) in New York (Reschke 1990; Bartgis 1992 [illegible] eastern Maryland [illegible] (1992

Former floodplain wetlands are very common in Alaska. Rivers such as the Yukon and Kuskokwim have migrated back and forth in broad valleys over the course of thousands of years. As a result of these shifts, many oxbow channels and meander scars are now isolated - sometimes miles away from the active river channel. In some areas, the historic floodplain of the Yukon River is over 15 miles wide (Jon Hall, pers. comm.). An outstanding example illustrating these types of isolated former floodplain wetlands can be seen along Alaska's Porcupine River (*Figures 2-36 and 2-37*). These wetlands and waterbodies are havens for waterfowl. Isolated wetlands and lakes in the Yukon Flats are among Alaska's most important waterfowl nesting areas, with an average breeding population over one million ducks (Lensink and Derksen 1986).

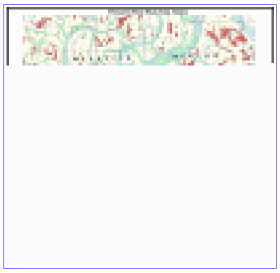

*Figure 2-36. Map showing isolated wetlands that were former floodplain wetlands along Alaska's Porcupine River. Red areas are isolated wetlands.*

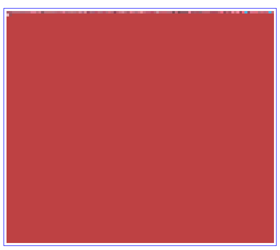

*Figure 2-37. Aerial photo showing mostly former floodplain wetlands (e.g., meander scars and oxbows) along Alaska's Porcupine River.*

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West Coast Vernal Pools[4]

West Coast vernal pools are cyclical wetlands that exhibit a marked seasonal shift in herbaceous vegetation from hydrophytic species to drier-site species (Tiner 1999). Their vegetation may change drastically within years and between years in response to changing environmental conditions (e.g., precipitation patterns).

West Coast vernal pools occur from southern Oregon to northern Baja Mexico. Many vernal pools and associated seasonally flooded wetlands form a complex of depressional wetland and swale features that are hydrologically linked during wet periods (*Figure 2-38*). They are typically filled with water by winter rains, characteristic of the region's Mediterranean climate. They may be flooded for weeks or months in some years (Baskin 1994). They achieve their greatest size in extremely wet years when individual depressions coalesce to form enormous complexes (Zedler 1987). When the pools form such complexes, they may drain into intermittent streams, ditches, or perennial streams.

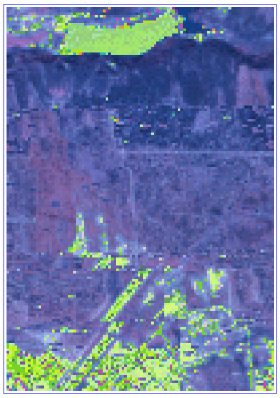

*Figure 2-38. Aerial photo showing Southern California vernal pool complex (Miramar Naval Air Station, San Diego). Note white areas are tops of mounds and darker areas between them are interconnected vernal pool swales.*

The isolated nature and unpredictable flooding promote endemism in vernal pool plants and animals thereby creating unique flora and fauna. This makes West Coast vernal pools vital sites for the conservation of biodiversity (Baskin 1994). Numerous federally-listed threatened and endangered species as well as state-endangered and rare species are among the characteristic flora of West Coast vernal pools. Some of the federally endangered species are San Diego mesa mint (*Pogogyne abramsii*), Otay mesa mint (*P. nudiuscula*), several species of Orcutt grasses (*Orcuttia* spp.), Solano grass (*Tuctoria* describing this variability. Although the following discussion focuses on these wetlands in the northeastern United States, the same principles apply to all woodland vernal pools (regarding their importance to amphibians), despite regional differences in species composition.

Vernal pools are temporary or ephemeral ponds that are inundated during the wet season, usually from late fall to mid- or late-summer in the Northeast (*Figure 2-40*). They range in size from a hundred square feet or less to several acres. Vernal pools may dry out every year or less often. The fluctuating water levels preclude the establishment of fish populations. The aquatic habitat and lack of predatory fish make these pools desirable and extremely productive sites for amphibian reproduction. Species dependent on vernal pool for breeding include marbled salamander (*Ambystoma opacum*), spotted salamander, Jefferson salamander (*A. jeffersonianum*), blue-spotted salamander (*A. laterale*), wood frog, and gray treefrog (*Hyla versicolor*). Other aquatic species that also reproduce in these ponds include spring peeper, American toad, green frog, and red-spotted newt. Spotted turtles frequent vernal pools after winter hibernation to obtain an easy source of food such as amphibian eggs and aquatic invertebrates (Kenney and Burne 2000).

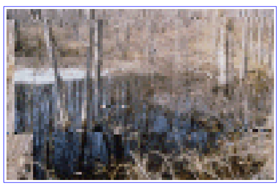

*Figure 2-40. Massachusetts woodland vernal pool. (R. Tiner photo)*

While many amphibians use vernal pools for reproduction and growth of larvae, the adults of most species spend the rest of their lives in the surrounding woodland either as burrowing vertebrates or arboreal species. This makes the vernal pools plus the surrounding forest vital habitats for their survival. In addition, each pool is often used by multiple species for breeding (e.g., marbled salamanders in fall, spotted salamanders and wood frogs in early spring, followed by spring peepers and gray treefrogs). Thousands of larvae may be produced from a single pool. For example, in a one-acre pond in eastern Massachusetts, nearly 14,000 adult amphibians were counted and a two-acre pond in western Massachusetts had 5,000 to 10,000 spotted salamanders and several times as many wood frogs and spring peepers (Tiner 1998). Vernal pools and their adjacent woodlands are vitally important for the of Mexico, Pacific Ocean, and the Great Lakes). Aeolian processes have created a rolling terrain of ridges and relatively narrow swales and in some cases, broader deflation plains. The ridge-and-swale complex forms dunefields of variable dimensions. The low depressions are often called dune swales and many are wetlands. They occur as a series of low valleys between dune ridges or may be more randomly dispersed on the land (*Figure 2-41*).[6] These wetlands intersect the local groundwater tables and support a variety of hydrophytic plants.

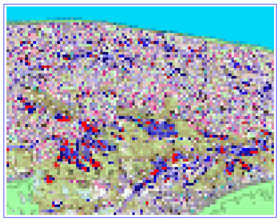

*Figure 2-41. Map showing dune swale wetlands near the tip of Cape Cod, Massachusetts (Provincetown). Red areas designate isolated wetlands among the sand dunes.*

Although most dune swales are isolated landforms surrounded by dry sand dunes, some are hydrologically connected to adjacent waters. The closer the swale is to the nearby waterbody, the higher the likelihood for a hydrologic linkage. For example, dune swales along the shores of the Great Lakes have water tables controlled by lake levels, while those further away are wet due to groundwater seepage (Albert 2000).

Vegetation in the swales and deflation plains is variable, depending on the hydrology and geography. The wettest swales are ponds and marshes.[7] They are rich aquatic habitats supporting numerous aquatic invertebrates and vertebrates alike. An abundance of aquatic insects in spring provides food for migratory birds. The drier swales are wet meadows, shrub swamps, and forested wetlands. Dune swale wetlands are colonized by many wide-ranging hydrophytic plants. Along the Atlantic Coast, wet dune swales may be colonized by common three-square, Canada rush (*Juncus canadensis*), marsh fern (*Thelypteris thelypteroides*), wool-grass (*Scirpus cyperinus*), cranberries (*Vaccinium macrocarpon* and *V. oxycoccos*), salt hay cordgrass (*Spartina patens*), northern bayberry (*Myrica pensylvanica*), red chokeberry (*Aronia arbutifolia*), and wax myrtle (Tiner and Burke 1995; Ralph Tiner, personal observations). Albert (2000) reported buttonbush, willows, alders (*Alnus* spp.), northern white cedar (*Thuja occidentalis*), and larch in similar habitats along the Great Lakes. Bogs, with bog laurel (*Kalmia polifolia*), cranberries, leatherleaf, and Labrador tea predominating, may form in the wet swales along Lake Superior (Albert 2000). For wet dune swales and broad deflation plains in the Pacific Northwest, several distinct communities have been reported (Wiedemann 1984). Dominant species in these communities included sickle-leaved rush (*Juncus falcatus*), springbank clover (*Trifolium wormskjoldii*), slough sedge (*Carex obnupta*), broad-leaved cattail, mountain Labrador-tea (*Ledum glandulosum*), Douglas' spiraea (*Spiraea douglasii*), hooker willow (*Salix hookeriana*), Pacific wax myrtle (*Myrica californica*), lodgepole pine (*Pinus contorta*), and western red cedar (*Thuja plicata*). Where deposition of wind-blown sand is heavy and dune migration is active, dune swale wetlands may become uplands when covered by thick sand deposits.

Dune marshes and ponds are vital habitats for many species (Wiedemann 1984). Dune marshes along the Oregon coast are vital habitat for 61 bird species, 17 mammals, 5 amphibians, and two reptiles (Akins 1973). They also provide winter habitat for 49 species of waterfowl, shorebirds, and wading birds. Fowler's toad (*Bufo woodhousei fowleri*) breeds in wet dune swales along the Northeast coast (Kenney and Burne 2000).

Some unique species are associated with wet dune swales. Plants found nowhere else in some States (e.g., Indiana) are found in these locations (Hiebert et al. 1986). Houghton's goldenrod (*Solidago houghtonii* *cathartica*), St. John's-wort (*Hypericum perforatum*), honeysuckles (*Lonicera tatarica* and *L. morrowii*), Canada bluegrass (*Poa compressa*), and rough-fruited cinquefoil (*Potentilla recta*) are among the more problematic invasive species (Reschke et al. 1999).

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## Footnotes

[1] Data source: www.monolake.org/naturalhistory/birds.

[2] Meador (1996) cites Sharitz and Gibbons (1982) as characterizing pocosins and Carolina bays "as examples of isolated wetlands…."

[3] The Dade City study area had 7,754 acres of wetlands dominated by cypress. Of these, about 57 percent (4,403 acres) were classified as isolated.

[4] Examples of West Coast vernal pool complexes can be seen on the maps for three study areas: Sacramento, Bird Landing, and La Mesa (Region 1).

[5] See also the California Wetlands Information System: ceres.ca.gov/wetlands.

[6] An example of these wetlands can be seen on the map of the Coquille River study area (Region 1).

[7] These ponds may be included in the categ33 fornia WeuonoolPlahe P may - d

Region 1 (totaling 1,934 square miles), nine in Region 2 (2,012 square miles), 10 in Region 3 (2,181 square miles), 12 in Region 4 (3,903 square miles), 19 in Region 5 (4,267 square miles), 11 in Region 6 (3,716 square miles), and three in Region 7 (742 square miles) (*Figure 3-1*). In total, the analysis covered nearly 19,000 square miles. From an ecoregion standpoint, the study areas fell into more than 20 ecoregions (see *Figures 3-2* and *3-3*). Study sites were located in all major U.S. watersheds (*Figure 3-4*), with at least one site per watershed.

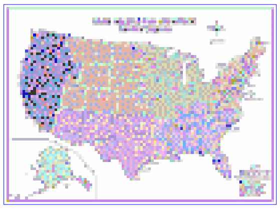

Figure 3-1. Location of study areas by U.S. Fish and Wildlife Service Region and State. Study area names are given.

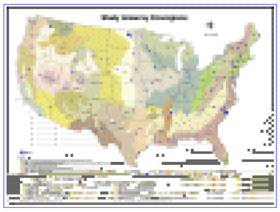

Figure 3-2. Location of study areas in the conterminous U.S. by Bailey ecoregions. (Source: Bailey 1995)

Figure 3-3. Location of study areas in Alaska by Bailey ecoregions. (Source: Bailey 1995)

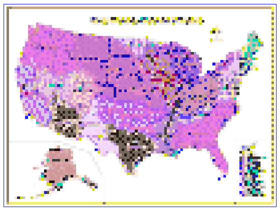

Figure 3-4. Location of study areas in major watersheds.

### Definition of Isolated and Non-isolated Wetlands for the Study

We used a landscape-based or geographic definition of isolated wetlands for this study that allowed us to readily and consistently extract information from existing digital data sources for tabulation and reporting purposes. Isolated wetlands were defined as wetlands with no apparent surface water connection to perennial rivers and streams[9], estuaries, or the ocean. Streamside wetlands where the stream disappeared underground or entered an isolated (no surface water outflow) lake or pond, as in karst topography, were classified as isolated. Wetlands associated with most isolated waterbodies were also identified as isolated.[10] Geographically isolated wetlands may be linked hydrologically to other wetlands or streams via subsurface flows (e.g., prairie potholes and Nebraska Sandhills wet meadows) or infrequent overflows (e.g., West Coast vernal pools), but this was impossible to determine using existing digital data. For this study, these wetlands were considered geographically isolated because: 1) they lack an apparent surface water connection, or 2) hydrologic linkages to streams or other waterbodies could not be determined using the available digital datasets. Readers should note that "isolated wetlands" referenced in this report are best described as "potentially isolated," since an accurate determination of isolation (as defined in this report or elsewhere) requires field verification in many, if not most, cases.

For this study, non-isolated wetlands included wetlands located: 1) along perennial rivers and streams and their intermittent tributaries (with some exception for karst regions – see remarks above) (*Figure 3-5*), 2) along the shores of lakes with outlets to rivers and streams, 3) along the margins of very large isolated lake systems (e.g., Great Salt Lake; see footnote 10), 4) along estuaries (*Figure 3-6*), and 5) along the shores of oceans and seas. Due to these landscape positions, many non-isolated wetlands are subjected to periodic flooding during high water stages. Others are groundwater-fed wetlands with surface drainage. Headwater wetlands serving as sources of streams were considered non-isolated since their connection to streams is apparent.

*Figure 3-5. Non-isolated freshwater wetlands along a meandering river. (R. Tiner photo)*

*Figure 3-6. Non-isolated brackish coastal marsh. (R. Tiner photo)*

### Data Compilation and Analysis

This study involved compiling existing data, creating new digital data, and geoprocessing digital data. Existing digital data sources included: 1) NWI polygon data, 2) digital line graph (DLG) hydrology coverages for study area quads, and 3) digital raster graphics (DRGs) for study quads. The NWI polygon data served as the prime source of wetland and deepwater habitat data, while the DLG hydrology layer was the major source of stream data. DRGs were used as collateral data to evaluate wetlands that were not readily identified as isolated or non-isolated. Note that the wetland digital data used for this analysis did not include NWI linear or point coverages. The analysis was strictly a GIS operation as no field work was performed.

The DLG hydrology data represented a consistent dataset for the analysis of wetland-stream connectivity and isolation. Preference was given to NWI polygon data for wetlands and to the DLG hydrology data for streams. In some cases, when reviewing the draft map products from the data compilation, gaps between the two sources were detected (e.g., wetland smaller on NWI than swamp symbols on the DLG and so stream did not intersect NWI wetland). These areas were reviewed to insure proper wetland classification. In hilly or mountainous terrain with prominent dendritic drainage patterns, most of the gaps were artifacts, so the upstream wetlands were classified as non-isolated.[11] In karst regions where perennial streams "disappear" as they go underground (e.g., "lost streams") and appear spatially isolated, wetlands along these stream segments were considered as isolated, since they lack a surface water connection to other streams (as per our definition).[12] In the few areas where DLG hydrology data were not available, we created a hydro-line coverage from the DRG by culling out the blue line features (representing streams) from the digital data.[13] The result was a crude hydro-line that was used for the analysis.

Stream data were buffered (e.g., stream width expanded) because linear (line-width) streams from the DLG may not intersect NWI wetlands that are actually streamside wetlands, due to differences in spatial accuracy (i.e., linking the two digital datasets). Buffering the streams helped remedy this situation. For the analysis, stream buffers of two-widths were used: 1) 20 meters and 2) 40 meters. The 20m buffer was initially considered sufficient to intersect the two data layers. However, in reviewing some of the preliminary draft maps, some headwater wetlands (sources of streams) were not selected as being associated with streams because of a data gap. A second buffer width - 40m - was chosen to capture these wetlands. Wetlands in the 20-40m zone were highlighted on the maps and tabulated separately. In this way, two scenarios could be produced: one that included them as isolated (when a 20m buffer was used) and another that included them as non-isolated or connected to streams (when the 40m buffer was used). Readers could then see whether including these wetlands as isolated or not would significantly affect the totals for isolated wetlands in each study area.

In reviewing draft maps (combined NWI and DLG coverages), we also noticed that wetlands separated by roads had been designated as isolated even when the adjacent wetland was classified as non-isolated. Subsequently, we added another category to the maps to highlight these wetlands. Although they are called "road-fragmented wetlands," they also included wetlands fragmented by railroads.[14] We suspect that many of these wetlands are connected to the non-isolated wetlands by a culvert but could not be certain, hence the specific classification. In this analysis, "road-fragmented wetlands" were included as non-isolated in two scenarios and isolated in one scenario to give readers a range of the estimated extent of isolated wetlands (see discussion of scenarios below).

In the Southwest, only the Texas coastal zone had digital data required for the isolated wetland analyses using the methods described above. Since we wanted to have a few study sites in each part of the country (including the playa region), we had to take an alternative approach where NWI digital data were not available. In this case, we scanned and vectorized the NWI maps, separated wetlands from deepwater habitats, labeled the general type (wetland or deepwater habitat), then performed the typical analysis using the DLG hydro data. Since we did not label the polygons to the specific NWI classification, we only reported quantitative data for these study areas.

Certain wetlands occurred along the edges of maps, extending into maps outside the study area. In general, we evaluated the larger map-edge wetlands to determine their status as isolated or not. Smaller ones were typically not reviewed and were labeled as "map-edge" wetlands. These unclassified wetlands were not included in the analysis. They represented only a minute fraction of the study area wetlands. Their totals, however, are listed on a detailed statistical data sheet for each study area.

**Scenarios for Data Presentation**

Three scenarios were chosen to generate estimates of isolated wetlands due to possible interpretations of "isolated wetlands" through GIS analysis. Estimates of isolated wetlands were compiled for each study area following three basic scenarios, ranging from restrictive to broad interpretations of isolated wetlands.

> Scenario 1, the most restrictive scenario, designated only those wetlands that had the highest likelihood of not being connected to a river, stream, or estuary as isolated (shown in red on the maps). This scenario produced the most limited extent of isolated wetlands (i.e., the red wetlands on the maps).
>
> Scenario 2 used a slightly broader interpretation of isolated wetlands, including wetlands in the 20-40m buffer (colored orange on the maps) as isolated. Under this scenario, both the red and orange-colored wetlands were considered isolated.
>
> Scenario 3, the broadest interpretation, added the road-fragmented wetlands (colored brown on the maps) to the isolated wetland category. The connection of these wetlands to neighboring non-isolated wetlands was not evident. This scenario generated the highest number and greatest extent of isolated wetlands for most study sites (i.e., the red, orange, and brown wetlands were considered isolated).

Thus a range of estimates for the number and acreage of isolated wetlands was generated for each study area. These data are most useful for describing isolated wetlands in relative, not absolute, terms.

**GIS-generated Products**

Thematic maps and accompanying estimates were produced for each study area. For most areas, a set of four 1:24,000 maps were tiled together to produce a study area map at 1:50,000. For other areas, the map scale varied to provide a satisfactory graphic representation of the information.

The maps were designed to highlight geographically isolated wetlands. The following aquatic features were depicted on the maps: 1) isolated wetlands (red polygons; wetlands with the highest probability of being geographically isolated), 2) wetlands 20-40 meters from streams (may be isolated or may be connected to stream; orange polygons), 3) road-fragmented wetlands (possibly connected but uncertain; brown polygons), 4) non-isolated wetlands (green polygons), 5) map-edge wetlands (not counted in the statistical analysis; salmon-colored polygons), 6) streams with a 20 meter buffer (light blue polygons), 7) deepwater habitats (blue polygons), and 8) isolated deepwater habitats (purple polygons). Source data for each map were listed in the map legend. For example, road data came from either the DLG or TIGER (Topologically Intergrated Geographic Encoding and Referencing from U.S. Census Bureau) data, with the former being the preferred source.

Analytical results generated for most study areas included tabulations of: 1) qualitative data on wetlands and deepwater habitats (frequency of polygons and acreage for each type as classified on the NWI maps), 2) three scenarios presenting a range of values for isolated wetlands (e.g., acreage and number of wetlands for each type, and corresponding percentages), and 3) qualitative data on isolated wetlands (Scenario 2) (see blank data sheet, *Figure 3-7*). For a few areas where NWI digital data do not exist, no qualitative data were reported.

*Figure 3-7. Blank Data Sheet*

## Study Limitations

Results presented here are estimates of the numbers or acreages of potentially isolated wetlands and corresponding percentages versus the rest of the wetlands in the study areas. This analysis was intended to provide improved information on the number and acreage of isolated wetlands for 72 study sites across the Nation. These results provide perspective on the potential extent of isolated vs. non-isolated wetlands. This geospatial analysis employed GIS technology and has inherent limitations associated with source data limitations. There are also constraints to developing protocols for identifying isolated wetlands from available data (either maps or digital data). Moreover, the data are not intended to be expanded to physiographic regions, states, or other areas to predict the extent of isolated or non-isolated wetlands for larger geographic regions.

### Source Data Limitations

not assumed to be hydrologically connected or isolated. Instead, they were designated as road-fragmented wetlands. Although many such fragments may be connected via a culvert, we could not verify this without field inspection (beyond scope of our analysis). These wetlands were considered non-isolated in two scenarios (Scenarios 1 and 2) and isolated in Scenario 3. In urban and suburban areas, underground connections via pipes could not be determined, so some wetlands designated as isolated may actually be connected to flowing waters upstream and downstream. Where urban wetlands were associated with a stream, they were designated as non-isolated since underground culverting is a common practice.

**Ditched Wetlands**

Ditched wetlands may be connected to rivers and streams or may simply move water from one isolated wetland to another isolated basin at a lower elevation. Where the digital data showed ditches connecting to rivers and streams, formerly isolated wetlands were designated as non-isolated, since they are now contributing sources of stream water (at least seasonally) and may also impact the quality of receiving waters. If ditches were not depicted as flowing into a river or stream, the affected wetlands were classified as isolated.

**Isolated Wetlands on Floodplains**

When analyzing the data, some areas with extensive floodplains possessed wetlands that were not

When stream data are merged with NWI data and NWI internal linework is dissolved (e.g., covertypes within a wetland complex), it is possible to readily identify isolated basins by their separation from streams.  Consequently, their number is more reliable than the number of non-isolated wetlands.  The number of non-isolated wetlands is more than it would be if a detailed HGM-type characterization was performed because road crossings that separate adjacent NWI polygons created additional "individual" wetlands.  Readers should, therefore, recognize that the ratio of the number of isolated wetlands vs. non-isolated wetlands presented in this study is somewhat conservative.  Study findings do not represent absolute numbers but are intended to show tendencies and provide relative estimates to put some perspective on the potential extent of isolated vs. non-isolated wetlands.

Also, the study did not use point or linear digital NWI data in its analysis since such data are not available or consistent for all areas.  In some areas, these dot-sized or linear wetlands make up a substantial number of wetlands (e.g., pothole region) that would increase the number of isolated wetlands.  Yet they often do not account for a significant acreage given the abundance of polygon-sized wetlands in these regions.

## Map Interpretation

Readers should note the following when reviewing the study area maps presented in this report:

- Red-colored polygons represent wetlands identified following study criteria as isolated under all scenarios.

Go to: [Results Region 1], [Results Region 2], [Results Region 3], [Results Region 4], [Results Region 5], [Results Region 6], [Results Region 7]

[Back to Table of Contents] [Home]

**Study Area:** State: FWS Region:

Ecoregion:

Watershed Region:

. . .

## STUDY AREA OVERVIEW:

| | Percent of Study Area |
|---|---|
| Total Acreage in Study Area...................... | |
| Upland Acreage......................................... | 6 |

**Study Area: La Mesa** State: CA FWS Region: 1

Ecoregion: California Coastal Chapparral Forest and Shrub

Watershed Region: California Region

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## STUDY AREA OVERVIEW:

11

**Study Area:** **Sacramento** State: CA FWS Region: 1

Ecoregion: California Dry Steppe

Watershed Region: California Region

. . .

## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area..................... | 149246.6 | | |
| Upland Acreage....................................... | 146138.2 | 97.9% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 1013.2 | 0.7% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage.................................... | 2095.2 | 1.4% | Wetlands |
| Number of Wetlands................................ | 646 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 190.3 | Lacustrine Wetlands: | 20.0 |
| PAB: | 3.4 | PFO: | 499.2 | PUB: | 477.5 | Marine Wetlands: | 0.0 |
| PEM: | 544.1 | Pf: | 0.0 | PUS: | 213.5 | Riverine Wetlands: | 118.7 |

. . .

## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 839.3 | 40.1% | 428 | 66.3% |
| Scenario 2: (Red and Orange) | 895.2 | 42.7% | 461 | 71.4% |
| Scenario 3: (Red, Orange and Brown) | 997.0 | 47.6% | 465 | 72.0% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 7.1 Number: 10

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 55.8 | Lacustrine Wetlands: | 20.0 |
| PAB: | 1.4 | Pf: | 0.0 | PUB: | 318.5 | Marine Wetlands: | 0.0 |
| PEM: | 259.8 | PFO: | 28.0 | PUS: | 211.4 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area:** **Wood River** State: ID FWS Region: 1

Ecoregion: Middle Rocky Mountain Steppe-Coniferous Forest Alpine Meadow

**Study Area: Four Mile Flat** State: NV FWS Region: 1

Ecoregion: Intermountain Semi-Desert and Desert

Watershed Region: Great Basin Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 147676.8 | | |
| Upland Acreage........................................ | 137273.4 | 93.0% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 0.0 | 0.0% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 10403.4 | 7.0% | Wetlands |
| Number of Wetlands................................. | 10 | | |

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## ACREAGE OF WETLAND TYPES:

Estuarine Wetlands: 0.0

**Study Area: Clackamas River** State: OR FWS Region: 1

Ecoregion: Pacific Lowland Mixed Forest / Cascade Mixed Forest-Coniferous Forest-Alpine Meadow

Watershed Region: Pacific Northwest Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 134350.7 | | |
| Upland Acreage........................................ | 131670.0 | 98.0% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 1021.6 | 0.8% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 1659.2 | 1.2% | Wetlands |
| Number of Wetlands................................. | 598 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 275.5 | Lacustrine Wetlands: | 6.3 |
| PAB: | 3.2 | PFO: | 755.7 | PUB: | 231.3 | Marine Wetlands: | 0.0 |
| PEM: | 130.3 | Pf: | 0.0 | PUS: | 0.0 | Riverine Wetlands: | 313.3 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 264.5 | 15.9% | 259 | 43.3% |
| Scenario 2: (Red and Orange) | 284.3 | 17.1% | 280 | 46.8% |
| Scenario 3: (Red, Orange and Brown) | 340.9 | 20.5% | 288 | 48.2% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 0.6 Number: 2

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 53.1 | Lacustrine Wetlands: | 0.0 |
| PAB: | 0.2 | Pf: | 0.0 | PUB: | 94.3 | Marine Wetlands: | 0.0 |
| PEM: | 43.8 | PFO: | 92.8 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area: Coquille River** State: OR FWS Region: 1

Ecoregion: Cascade Mixed Forest-Coniferous Forest-Alpine Meadow

Watershed Region: Pacific Northwest Region

. . .

**Study Area:** **Lincoln County** State: WA FWS Region: 1

Ecoregion: Intermountain Semi-Desert

Watershed Region: Pacific Northwest Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 257933.6 | | |
| Upland Acreage......................................... | 253578.3 | 98.3% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 58.5 | 0.1% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 136.7 | | |
| Wetlands Acreage..................................... | 4160.1 | 1.6% | Wetlands |
| Number of Wetlands................................. | 3124 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 31.8 | Lacustrine Wetlands: | 70.2 |
| PAB: | 34.0 | PFO: | 46.1 | PUB: | 694.4 | Marine Wetlands: | 0.0 |
| PEM: | 2989.3 | Pf: | 0.0 | | | | |

## Study Results

Study findings are reported for each study area below. Data for individual study areas are arranged by U.S. Fish and Wildlife Service Region. For each Region, there is a general discussion of the study results, a map showing the location of the study sites, a summary table of the findings, detailed data summary for each area, and a special wetland classification map for each study area. The latter two products are represented as "additional data links" within the regional summary table (first column). Simply click on the word "map" or "data" and the pertinent map and data will be displayed. *Please allow a minute or so for the map to appear. Note that printed maps may appear somewhat skewed since their projections reflect the curvature of the Earth.*

### Region 2 (Arizona, New Mexico, Texas, and Oklahoma)


Nine study areas were evaluated in the Southwest: one in Arizona, two in New Mexico, one in Oklahoma, and five in Texas. Two sites were coastal study areas (St. Charles Bay and Mustang Bayou, Texas), while the rest were interior regions. Two study sites were in the Texas playa region (Tokio and Tahoka). *Table 3-2* presents a summary of the data for Region 2 study areas.

<u>Percent of Study Areas Covered by Wetlands</u>

The extent of wetlands in the study sites ranged from less than 1 percent to 21 percent of the study areas. St. Charles Bay had the highest percentage of wetlands (21%; 34,921 acres). Second-ranked was the other coastal site – Mustang Bayou (8%; 12,631 acres). The playa sites and Oklahoma City, Oklahoma study area had 2 to 3 percent of their areas in wetlands.

<u>Percent of Wetland Area Identified as Isolated</u>

The two playa study areas (Tokio and Tahoka) have all (100%) of their wetland acreage (i.e., playa wetlands) designated as potentially isolated. Other areas had much lower percentages. Four areas had between 20 and 30 percent of their wetland acreage in this category (Mustang Bayou; Laguna Park, Texas; Carlsbad Caverns, New Mexico; St. Charles Bay). Isolated wetlands in Mustang Bayou were mostly palustrine emergent wetlands (1,882 acres; 51% under Scenario 2) and forested types (1,050 acres; 29%). For St. Charles Bay, most were palustrine emergent wetlands (7,398 acres 96%). Qualitative results for Tokio, Tahoka, Valle Grande (New Mexico), Laguna Park and Carlsbad Caverns were not collected because NWI digital data were not available.

<u>Percent of Wetlands (Number) Classified as Isolated</u>

All study areas had more than 20 percent of their wetlands identified as isolated. Again, the playa sites led the list, with all of their wetlands isolated. Study sites with more than 45 percent of their wetlands labeled as isolated were Mustang Bayou (77-86%), Oklahoma City (63-66%), Laguna Park (54-59%), St. Charles Bay (47-48%), and Valle Grande (44-48%).

Table 3-2. Summary data for study sites in Region 2. (<u>Note</u>: This table should be printed in landscape orientation.)

| | **Isolated Wetlands** |
|---|---|

| Additional Data Links | Study Area | State | Acreage in Study Area | Wetland Acreage | Wetlands % of Study Area | Number of Wetlands | Deepwater Habitats % of Study Area | Scenario 1 Area Percent of Total Wetlands | Scenario 2 Area Percent of Total Wetlands | Scenario 3 Area Percent of Total Wetlands | Scenario 1 Count Percent of Total Wetlands | Scenario 2 Count Percent of Total Wetlands | Scenario 3 Count Percent of Total Wetlands |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MAP DATA | Blackwater-Florence | AZ | 79916.4 | 383.6 | 0.5% | 41 | 0.0% | 3.3% | 4.2% | 4.2% | 31.7% | 36.6% | 36.6% |
| MAP DATA | Carlsbad Caverns | NM | 161486.4 | 252.8 | 0.2% | 154 | 0.0% | 24.4% | 25.4% | 25.4% | 21.4% | | |

**Study Area:** **Blackwater-Florence** State: AZ

**Study Area: Carlsbad Caverns** State: NM FWS Region: 2

Ecoregion: Chihuahuan Semi-Desert

Watershed Region: Rio Grande Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 161486.4 | | |
| Upland Acreage........................................ | 161233.6 | 99.8% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 0.0 | 0.0% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 252.8 | 0.2% | Wetlands |
| Number of Wetlands................................. | 154 | | |

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## ACREAGE OF WETLAND TYPES:

No qualitative wetland data collected, since NWI map data were scan-vectorized. Wetlands were separated from deepwater habitats, but individual wetland polygons were not labeled to specific type.

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 61.6 | 24.4% | 33 | 21.4% |
| Scenario 2: (Red and Orange) | 64.1 | 25.4% | 35 | 22.7% |
| Scenario 3: (Red, Orange and Brown) | 64.1 | 25.4% | 35 | 22.7% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 0.0 Number: 0

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## ACREAGE OF ISOLATED WETLAND TYPES:

No qualitative wetland data collected, since NWI map data were scan-vectorized. Wetlands were separated from deepwater habitats, but individual wetland polygons were not labeled to specific type.

**Study Area: Valle Grande** State: NM FWS Region: 2

Ecoregion: Southern Rocky Mountain Steppe-Coniferous Forest-Alpine Meadow

Watershed Region: Rio Grande Region

. . .

## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 154693.8 | | |
| Upland Acreage........................................ | 154156.1 | 99.7% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 0.0 | 0.0% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 537.7 | 0.3% | Wetlands |
| Number of Wetlands................................. | 218 | | |

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## ACREAGE OF WETLAND TYPES:

No qualitative wetland data collected, since NWI map data were scan-vectorized. Wetlands were separated from deepwater habitats, but individual wetland polygons were not labeled to specific type.

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 66.3 | 12.3% | 95 | 43.6% |
| Scenario 2: (Red and Orange) | 70.1 | 13.0% | 104 | 47.7% |
| Scenario 3: (Red, Orange and Brown) | 70.1 | 13.0% | 104 | 47.7% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 0.0 Number: 0

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## ACREAGE OF ISOLATED WETLAND TYPES:

No qualitative wetland data collected, since NWI map data were scan-vectorized. Wetlands were separated from deepwater habitats, but individual wetland polygons were not labeled to specific type.

**Study Area: Oklahoma City** State: OK FWS Region: 2

Ecoregion: Great Plains Steppe and Shrub

Watershed Region: Arkansas-White-Red Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 155635.1 | | |
| Upland Acreage........................................ | 149906.3 | 96.3% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 1340.0 | 0.9% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 41.7 | | |
| Wetlands Acreage..................................... | 4347.1 | 2.8% | Wetlands |
| Number of Wetlands................................. | 1180 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 831.6 | Lacustrine Wetlands: | 5.4 |
| PAB: | 11.1 | PFO: | 1093.7 | PUB: | 976.6 | Marine Wetlands: | 0.0 |
| PEM: | 631.2 | Pf: | 0.0 | PUS: | 72.7 | Riverine Wetlands: | 654.4 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 742.1 | 17.1% | 748 | 63.4% |
| Scenario 2: (Red and Orange) | 761.8 | 17.5% | 769 | 65.2% |
| Scenario 3: (Red, Orange and Brown) | 818.5 | 18.8% | 777 | 65.8% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 54.1 Number: 6

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 30.2 | Lacustrine Wetlands: | 0.0 |
| PAB: | 2.0 | Pf: | 0.0 | PUB: | 430.1 | Marine Wetlands: | 0.0 |
| PEM: | 161.1 | PFO: | 79.2 | PUS: | 55.0 | Riverine Wetlands: | 4.2 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area: Laguna Park** State: TX FWS Region: 2

Ecoregion: Southwest Plateau and Plains Dry Steppe and Shrub

Watershed Region: Texas Gulf Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 162261.3 | | |
| Upland Acreage........................................ | 160524.9 | 98.9% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 724.8 | 0.4% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 1011.6 | 0.6% | Wetlands |
| Number of Wetlands................................. | 1155 | | |

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## ACREAGE OF WETLAND TYPES:

No qualitative wetland data collected, since NWI map data were scan-vectorized. Wetlands were separated from deepwater habitats, but individual wetland polygons were not labeled to specific type.

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 250.4 | 24.8% | 623 | 53.9% |
| Scenario 2: (Red and Orange) | 276.8 | 27.4% | 676 | 58.5% |
| Scenario 3: (Red, Orange and Brown) | 276.8 | 27.4% | 676 | 58.5% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 0.0 Number: 0

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## ACREAGE OF ISOLATED WETLAND TYPES:

No qualitative wetland data collected, since NWI map data were scan-vectorized. Wetlands were separated from deepwater habitats, but individual wetland polygons were not labeled to specific type.

**Study Area: Saint Charles Bay** State: TX FWS Region: 2

Ecoregion: Prairie Parkland (Subtropical)

Watershed Region: Texas Gulf Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 168002.7 | | |
| Upland Acreage........................................ | 83396.3 | 49.6% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 49678.4 | 29.6% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 7.3 | | |
| Wetlands Acreage..................................... | 34920.7 | 20.8% | Wetlands |
| Number of Wetlands................................. | 2656 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 16362.2 |
| Palustrine Wetlands: | | | | PSS: | 618.1 | Lacustrine Wetlands: | 2.1 |
| PAB: | 5.7 | PFO: | 51.5 | PUB: | 95.7 | Marine Wetlands: | 65.9 |
| PEM: | 17644.5 | Pf: | 0.0 | PUS: | 74.9 | Riverine Wetlands: | 0.0 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 7680.6 | 22.0% | 1238 | 46.6% |
| Scenario 2: (Red and Orange) | 7699.7 | 22.0% | 1247 | 47.0% |
| Scenario 3: (Red, Orange and Brown) | 7900.1 | 22.6% | 1267 | 47.7% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 156.8 Number: 17

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 254.7 | Lacustrine Wetlands: | 0.0 |
| PAB: | 5.7 | Pf: | 0.0 | PUB: | 30.0 | Marine Wetlands: | 0.0 |
| PEM: | 7398.4 | PFO: | 11.8 | PUS: | 1.5 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area: Tokio** State: TX FWS Region: 2

Ecoregion: Southwest Plateau and Plains Dry Steppe and Shrub

Watershed Region: Texas Gulf Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 119809.1 | | |
| Upland Acreage........................................ | 117346.5 | 97.9% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 0.0 | 0.0% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 2462.7 | 2.1% | Wetlands |
| Number of Wetlands................................. | 392 | | |

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## ACREAGE OF WETLAND TYPES:

No qualitative wetland data collected, since NWI map data were scan-vectorized. Wetlands were separated from deepwater habitats, but individual wetland polygons were not labeled to specific type.

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 2462.7 | 100.0% | 392 | 100.0% |
| Scenario 2: (Red and Orange) | 2462.7 | 100.0% | 392 | 100.0% |
| Scenario 3: (Red, Orange and Brown) | 2462.7 | 100.0% | 392 | 100.0% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 0.0 Number: 0

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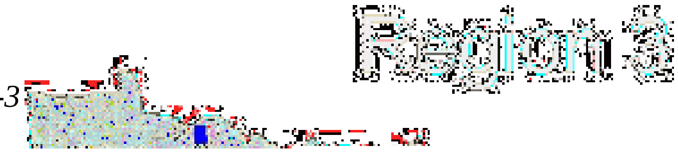
## ACREAGE OF ISOLATED WETLAND TYPES:

No qualitative wetland data collected, since NWI map data were scan-vectorized. Wetlands were separated from deepwater habitats, but individual wetland polygons were not labeled to specific type.

## Study Results

Study findings are reported for each study area below. Data for individual study areas are arranged by U.S. Fish and Wildlife Service Region. For each Region, there is a general discussion of the study results, a map showing the location of the study sites, a summary table of the findings, detailed data summary for each area, and a special wetland classification map for each study area. The latter two products are represented as "additional data links" within the regional summary table (first column). Simply click on the word "map" or "data" and the pertinent map and data will be displayed. *Please allow a minute or so for the map to appear. Note that printed maps may appear somewhat skewed since their projections reflect the curvature of the Earth.*

**Region 3 (Minnesota, Iowa, Missouri, Wisconsin, Illinois, Indiana, Michigan, and Ohio)**



Ten study sites were evaluated in the Midwest: two in Illinois, two in Indiana, one in Iowa, one in Michigan, three in Minnesota, and one in Missouri. One site (Grand Sable Lake) was along the shores of Lake Superior, while the other sites were inland. *Table 3-3* presents a summary of the data for Region 3 study areas.

Percent of Study Areas Covered by Wetlands

Two study sites had more than 20 percent of their areas covered by wetlands. Ericsburg, Minnesota was top-ranked with 44 percent (56,173 acres), followed by Lake Alexander, Minnesota with 21 percent (28,261 acres). Other areas with more than 10 percent coverage by wetlands included Big Lake, Minnesota (17%), Mongo, Indiana (13%), and Grand Sable Lake, Michigan (12%).

Percent of Wetland Area Identified as Isolated

Two sites had more than 30 percent of their wetland acreage designated as isolated: Bluffton, Indiana (50-54%) and Big Lake (30-35%), while Lake Alexander had 23-34 percent of its wetlands in this category, depending on the scenario evaluated (see *Table 4-3*). Most of Bluffton's isolated wetlands were forested (683 acres; 56% under Scenario 2), whereas Big Lake's were chiefly palustrine emergent wetlands (5,178 acres; 77% under Scenario 2). Isolated wetlands for Lake Alexander (under Scenario 2) were mainly distributed among three types: palustrine scrub-shrub wetlands (2,944 acres; 46%), emergent wetlands (1,888 acres; 29%), and ponds (20%). The Mongo site had 25 to 28 percent of its wetland acreage labeled as isolated, with emergent and forested types predominating.

Percent of Wetlands (Number) Classified as Isolated

All study sites had more than 40 percent of their wetlands defined as isolated. Most had percentages near or above 80 percent, giving evidence of the high density of small wetlands in the areas examined. The top-ranked study area in the percent of wetlands mapped as isolated was Lake Alexander (90-93%). The other sites with more than 80 percent were Grand Sable Lake (85-86%), Big Lake (84-86%), Ericsburg (81-84%), Bluffton (80-84%), and Mongo (79-81%).

Table 3-3. Summary data for study sites in Region 3. (Note: This table should be printed in landscape orientation.)

| | **Isolated Wetlands** |
|---|---|

| Additional Data Links | Study Area | State | Acreage in Study Area | Wetland Acreage | Wetlands % of Study Area | Number of Wetlands |
|---|---|---|---|---|---|---|

**Study Area:** **Goose Lake** State: IL FWS Region: 3

Ecoregion: Prairie Parkland (Temperate)

Watershed Region: Upper Mississippi Region

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**Study Area: Harrisburg** State: IL FWS Region: 3

Ecoregion: Eastern Broadleaf Forest (Continental)

Watershed Region: Ohio Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area..................... | 151272.5 | | |
| Upland Acreage....................................... | 141629.1 | 93.6% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 537.1 | 0.4% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 93.6 | | |
| Wetlands Acreage.................................... | 9012.7 | 6.0% | Wetlands |
| Number of Wetlands................................ | 1588 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 1147.0 | Lacustrine Wetlands: | 45.1 |
| PAB: | 52.0 | PFO: | 5711.2 | PUB: | 1286.8 | Marine Wetlands: | 0.0 |
| PEM: | 770.6 | Pf: | 0.0 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 982.8 | 10.9% | 1131 | 71.2% |
| Scenario 2: (Red and Orange) | 1108.3 | 12.3% | 1194 | 75.2% |
| Scenario 3: (Red, Orange and Brown) | 1119.4 | 12.4% | 1207 | 76.0% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 7.0 Number: 9

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 16.8 | Lacustrine Wetlands: | 0.0 |
| PAB: | 12.9 | Pf: | 0.0 | PUB: | 921.6 | Marine Wetlands: | 0.0 |
| PEM: | 60.7 | PFO: | 96.4 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area: Bluffton** State: IN FWS Region: 3

Ecoregion: Eastern Broadleaf Forest (Continental)

Watershed Region: Ohio Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 145068.7 | | |
| Upland Acreage........................................ | 142671.6 | 98.3% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 84.9 | 0.1% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 2312.2 | 1.6% | Wetlands |
| Number of Wetlands................................. | 906 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 29.9 | Lacustrine Wetlands: | 0.0 |
| PAB: | 0.0 | PFO: | 1576.1 | PUB: | 315.9 | Marine Wetlands: | 0.0 |
| PEM: | 390.3 | Pf: | 0.0 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| **SCENARIO*** | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 1159.3 | 50.1% | 723 | 79.8% |
| Scenario 2: (Red and Orange) | 1218.1 | 52.7% | 760 | 83.9% |
| Scenario 3: (Red, Orange and Brown) | 1244.8 | 53.8% | 763 | 84.2% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 32.8 Number: 17

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 22.9 | Lacustrine Wetlands: | 0.0 |
| PAB: | 0.0 | Pf: | 0.0 | PUB: | 221.0 | Marine Wetlands: | 0.0 |
| PEM: | 291.1 | PFO: | 682.6 | PUS: | 0.5 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area: Mongo** State: IN FWS Region: 3

Ecoregion: Eastern Broadleaf Forest (Continental)

Watershed Region: Great Lakes Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 142895.6 | | |
| Upland Acreage........................................ | 121081.4 | 84.7% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 3171.8 | 2.2% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 18642.4 | 13.1% | Wetlands |
| Number of Wetlands................................. | 3707 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 2251.0 | Lacustrine Wetlands: | 30.2 |
| PAB: | 62.2 | PFO: | 8539.5 | PUB: | 735.3 | Marine Wetlands: | 0.0 |
| PEM: | 7024.2 | Pf: | 0.0 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 4647.3 | 24.9% | 2915 | 78.6% |
| Scenario 2: (Red and Orange) | 4817.9 | 25.8% | 3014 | 81.3% |
| Scenario 3: (Red, Orange and Brown) | 5154.6 | 27.7% | 3063 | 81.3% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 120.0 Number: 30

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 333.5 | Lacustrine Wetlands: | 0.0 |
| PAB: | 37.9 | Pf: | 0.0 | PUB: | 304.3 | Marine Wetlands: | 0.0 |
| PEM: | 2297.9 | PFO: | 1844.3 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area: Allison** State: IA FWS Region: 3

Ecoregion: Prairie Parkland (Temperate)

Watershed Region: Upper Mississippi Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 140348.9 | | |
| Upland Acreage........................................ | 135033.8 | 96.2% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 425.9 | 0.3% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 4889.2 | 3.5% | Wetlands |
| Number of Wetlands................................. | 966 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 66.8 | Lacustrine Wetlands: | 0.0 |
| PAB: | 0.0 | PFO: | 1946.9 | PUB: | 338.4 | Marine Wetlands: | 0.0 |
| PEM: | 2517.8 | Pf: | 0.0 | PUS: | 0.0 | Riverine Wetlands: | 19.3 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 518.2 | 10.6% | 435 | 45.0% |
| Scenario 2: (Red and Orange) | 568.1 | 11.6% | 499 | 51.7% |
| Scenario 3: (Red, Orange and Brown) | 576.8 | 11.8% | 504 | 52.2% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 13.8 Number: 3

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 11.6 | Lacustrine Wetlands: | 0.0 |
| PAB: | 0.0 | Pf: | 0.0 | PUB: | 81.6 | Marine Wetlands: | 0.0 |
| PEM: | 439.4 | PFO: | 35.6 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area: Grand Sable Lake** State: MI FWS Region: 3

Ecoregion: Laurentian Mixed Forest

Watershed Region: Great Lakes Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 131400.6 | | |
| Upland Acreage........................................ | 64528.3 | 49.1% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 49959.5 | 38.7% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 901.7 | | |
| Wetlands Acreage..................................... | 16011.2 | 12.2% | Wetlands |
| Number of Wetlands................................. | 473 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 2426.9 | Lacustrine Wetlands: | 0.0 |
| PAB: | 6.0 | PFO: | 11924.5 | PUB: | 716.3 | Marine Wetlands: | 0.0 |
| PEM: | 937.4 | Pf: | 0.0 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 2452.5 | 15.3% | 402 | 85.0% |
| Scenario 2: (Red and Orange) | 2452.5 | 15.3% | 402 | 85.0% |
| Scenario 3: (Red, Orange and Brown) | 2557.5 | 16.0% | 405 | 85.6% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 169.9 Number: 21

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 432.6 | Lacustrine Wetlands: | 0.0 |
| PAB: | 6.0 | Pf: | 0.0 | PUB: | 361.6 | Marine Wetlands: | 0.0 |
| PEM: | 353.4 | PFO: | 1298.9 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area: Big Lake** State: MN FWS Region: 3

Ecoregion: Eastern Broadleaf Forest (Continental)

Watershed Region: Upper Mississippi Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 134354.0 | | |
| Upland Acreage........................................ | 107692.2 | 80.2% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 3153.8 | 3.1% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 1007.6 | | |
| Wetlands Acreage..................................... | 22500.4 | 16.8% | Wetlands |
| Number of Wetlands................................. | 2982 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 4551.1 | Lacustrine Wetlands: | 2.7 |
| PAB: | 0.0 | PFO: | 3261.1 | PUB: | 579.8 | Marine Wetlands: | 0.0 |
| PEM: | 14078.0 | Pf: | 0.0 | PUS: | 10.0 | Riverine Wetlands: | 17.7 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 6733.2 | 29.9% | 2508 | 84.1% |
| Scenario 2: (Red and Orange) | 6766.8 | 30.1% | 2532 | 84.9% |
| Scenario 3: (Red, Orange and Brown) | 7973.0 | 35.4% | 2567 | 86.1% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 179.8 Number: 61

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 786.3 | Lacustrine Wetlands: | 2.7 |
| PAB: | 0.0 | Pf: | 0.0 | PUB: | 360.8 | Marine Wetlands: | 0.0 |
| PEM: | 5178.4 | PFO: | 436.2 | PUS: | 2.3 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area:** **Lake Alexander** State: MN FWS Region: 3

Ecoregion: Eastern Broadleaf Forest (Continental)

Watershed Region: Upper Mississippi Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 132617.8 | | |
| Upland Acreage......................................... | 98677.0 | 74.4% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 4566.5 | 4.3% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 1113.2 | | |
| Wetlands Acreage...................................... | 28261.0 | 21.3% | Wetlands |
| Number of Wetlands.................................. | 3471 | | |

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## ACREAGE OF WETLAND TYPES:

Estuarine Wetlands: 0.0

Palustrine Wetlands:

## Study Results

Study findings are reported for each study area below. Data for individual study areas are arranged by U.S. Fish and Wildlife Service Region. For each Region, there is a general discussion of the study results, a map showing the location of the study sites, a summary table of the findings, detailed data summary for each area, and a special wetland classification map for each study area. The latter two products are represented as "additional data links" within the regional summary table (first column). Simply click on the word "map" or "data" and the pertinent map and data will be displayed. *Please allow a minute or so for the map to appear. Note that printed maps may appear somewhat skewed since their projections reflect the curvature of the Earth.*

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### Region 4 (North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Arkansas, Tennessee, and Kentucky)

Twelve areas were studied in the Southeast: one in Alabama, one in Arkansas, two in Florida, one in Georgia, one in Kentucky, two in Louisiana,one in Mississippi, two in North Carolina, and one in South Carolina. The latter area was the largest area evaluated: Horry County. *Table 3-4*

**Study Area: Trinity** State: AL FWS Region: 4

Ecoregion: Southeastern Mixed Forest (Eastern Broadleaf Forest (Continental))

Watershed Region: Tennessee Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 157213.3 | | |
| Upland Acreage........................................ | 130468.5 | 83.0% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 4288.2 | 2.7% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 22456.7 | 14.3% | Wetlands |
| Number of Wetlands................................. | 1393 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 895.0 | Lacustrine Wetlands: | 4076.7 |
| PAB: | 0.3 | PFO: | 13602.5 | PUB: | 809.7 | Marine Wetlands: | 0.0 |
| PEM: | 3032.5 | Pf: | 0.0 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| **SCENARIO*** | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 1657.4 | 7.4% | 868 | 62.3% |
| Scenario 2: (Red and Orange) | 1769.2 | 7.9% | 927 | 66.5% |
| Scenario 3: (Red, Orange and Brown) | 2026.4 | 9.0% | 941 | 67.6% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 107.6 Number: 14

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 53.2 | Lacustrine Wetlands: | 10.1 |
| PAB: | 0.3 | Pf: | 0.0 | PUB: | 432.9 | Marine Wetlands: | 0.0 |
| PEM: | 292.3 | PFO: | 980.3 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area:** **Hazen** State: AR FWS Region: 4

Ecoregion: Southeastern Mixed Forest

Watershed Region: Lower Mississippi Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area..................... | 156576.8 | | |
| Upland Acreage........................................ | 140659.5 | 89.8% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 433.3 | 0.3% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 15484.0 | 9.9% | Wetlands |
| Number of Wetlands................................. | 659 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 906.9 | Lacustrine Wetlands: | 4413.2 |
| PAB: | 16.8 | PFO: | 8628.8 | PUB: | 988.4 | Marine Wetlands: | 0.0 |
| PEM: | 529.9 | Pf: | 0.0 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | Number |
|---|---|---|
| | Percent of Total | Percent of Total |

**SCENARIO***PercencncncncncncncncncncncncncncncncncncncncncncncncncncncncncncncncncncncncncncncncncncncncncSm 0 0 8.789 94Red)531 -1.693

**Study Area:** **Crystal Lake** State: FL FWS Region: 4

Ecoregion: Outer Coastal Plain Mixed Forest

Watershed Region: South Atlantic Gulf Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 164297.3 | | |
| Upland Acreage........................................ | 130454.7 | 79.4% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 489.6 | 2.5% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 3632.6 | | |
| Wetlands Acreage..................................... | 29720.4 | 18.1% | Wetlands |
| Number of Wetlands................................. | 1175 | | |

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## ACREAGE OF WETLAND TYPES:

Estuarine Wetlands: 0.0

Palustrine Wetlands:

**Study Area:** **Dade City** State: FL FWS Region: 4

Ecoregion: Outer Coastal Plain Mixed Forest

Watershed Region: South Atlantic Gulf Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 167883.9 | | |
| Upland Acreage......................................... | 132323.1 | 78.8% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 730.9 | 0.8% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 680.5 | | |
| Wetlands Acreage..................................... | 34149.4 | 20.3% | Wetlands |
| Number of Wetlands................................. | 4136 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 560.6 | Lacustrine Wetlands: | 2.9 |
| PAB: | 713.1 | PFO: | 20585.8 | PUB: | 1298.8 | Marine Wetlands: | 0.0 |
| PEM: | 10900.2 | Pf: | 0.0 | PUS: | 35.0 | Riverine Wetlands: | 52.8 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| **SCENARIO*** | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |

Scenario 1: (Red)rAcreageler1868.7024 473.445 m 118.405 e0 reaLro6C 4a7104 00 Td 75 09:

**Study Area:** **Acworth** State: GA FWS Region: 4

Ecoregion: Southeastern Mixed Forest

Watershed Region: South Atlantic Gulf Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 158320.6 | | |
| Upland Acreage........................................ | 153004.3 | 96.6% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 2558.4 | 1.6% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 2757.9 | 1.7% | Wetlands |
| Number of Wetlands................................. | 764 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 316.3 | Lacustrine Wetlands: | 11.4 |
| PAB: | 0.0 | PFO: | 1096.0 | PUB: | 1187.0 | Marine Wetlands: | 0.0 |
| PEM: | 137.0 | Pf: | 0.0 | PUS: | 9.6 | Riverine Wetlands: | 0.4 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 706.6 | 25.6% | 483 | 63.2% |
| Scenario 2: (Red and Orange) | 786.0 | 28.5% | 513 | 67.1% |
| Scenario 3: (Red, Orange and Brown) | 805.0 | 29.2% | 521 | 68.2% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 1.5 Number: 3

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 43.8 | Lacustrine Wetlands: | 0.0 |
| PAB: | 0.0 | Pf: | 0.0 | PUB: | 620.8 | Marine Wetlands: | 0.0 |
| PEM: | 19.1 | PFO: | 100.4 | PUS: | 2.0 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area:** **Bee Spring** State: KY FWS Region: 4

Ecoregion: Eastern Broadleaf Forest (Continental)

Watershed Region: Ohio Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 151953.7 | | |
| Upland Acreage........................................ | 149641.1 | 98.5% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 1062.1 | 0.7% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 1250.4 | 0.8% | Wetlands |
| Number of Wetlands................................. | 1601 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 56.4 | Lacustrine Wetlands: | 14.2 |
| PAB: | 15.2 | PFO: | 509.6 | PUB: | 547.0 | Marine Wetlands: | 0.0 |
| PEM: | 106.0 | Pf: | 0.0 | PUS: | 0.4 | Riverine Wetlands: | 1.5 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 576.1 | 46.1% | 1411 | 88.1% |
| Scenario 2: (Red and Orange) | 591.3 | 47.3% | 1442 | 90.1% |
| Scenario 3: (Red, Orange and Brown) | 595.0 | 47.6% | 1444 | 90.2% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 2.7 Number: 8

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 15.8 | Lacustrine Wetlands: | 0.0 |
| PAB: | 6.6 | Pf: | 0.0 | PUB: | 478.8 | Marine Wetlands: | 0.0 |
| PEM: | 40.7 | PFO: | 49.4 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area: New Orleans** State: LA FWS Region: 4

Ecoregion: Outer Coastal Plain Mixed Forest

Watershed Region: Lower Mississippi Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 165154.3 | | |
| Upland Acreage........................................ | 17559.5 | 10.6% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 108814.2 | 65.9% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 84.9 | | |
| Wetlands Acreage..................................... | 38695.7 | 23.4% | Wetlands |
| Number of Wetlands................................. | 304 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 19341.0 |
| Palustrine Wetlands: | | | | PSS: | 2378.7 | Lacustrine Wetlands: | 218.1 |
| PAB: | 316.4 | PFO: | 7821.2 | PUB: | 769.1 | Marine Wetlands: | 0.0 |
| PEM: | 7851.1 | Pf: | 0.0 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 666.4 | 1.7% | 73 | 24.0% |
| Scenario 2: (Red and Orange) | 807.1 | 2.1% | 76 | 25.0% |
| Scenario 3: (Red, Orange and Brown) | 991.3 | 2.6% | 87 | 28.6% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 29.6 Number: 3

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 99.9 | Lacustrine Wetlands: | 180.3 |
| PAB: | 2.2 | Pf: | 0.0 | PUB: | 159.6 | Marine Wetlands: | 0.0 |
| PEM: | 59.6 | PFO: | 305.6 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area:** **Holly Springs** State: MS FWS Region: 4

Ecoregion: Southeastern Mixed Forest

Watershed Region: Lower Mississippi Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 156931.8 | | |
| Upland Acreage........................................ | 145917.6 | 93.0% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 799.4 | 0.5% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 10214.9 | 6.5% | Wetlands |
| Number of Wetlands................................. | 1575 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 1258.5 | Lacustrine Wetlands: | 31.6 |
| PAB: | 7.7 | PFO: | 7198.1 | PUB: | 1147.3 | Marine Wetlands: | 0.0 |
| PEM: | 548.0 | Pf: | 0.0 | PUS: | 18.0 | Riverine Wetlands: | 2.4 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| **SCENARIO*** | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 538.8 | 5.3% | 885 | 56.2% |
| Scenario 2: (Red and Orange) | 566.2 | 5.5% | 928 | 58.9% |
| Scenario 3: (Red, Orange and Brown) | 581.15.5% | | | |

**Study Area:** **Dublin** State: NC FWS Region: 4

Ecoregion: Outer Coastal Plain Mixed Forest

Watershed Region: South Atlantic Gulf Region

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## STUDY AREA OVERVIEW:

| | | **Percent of Study Area** | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 157165.2 | | |
| Upland Acreage........................................ | 119475.2 | 76.0% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 1607.3 | 1.0% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 36082.6 | 23.0% | Wetlands |
| Number of Wetlands................................. | 1292 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 3785.1 | Lacustrine Wetlands: | 0.0 |
| PAB: | 12.5 | PFO: | 31134.4 | PUB: | 323.1 | Marine Wetlands: | 0.0 |
| PEM: | 827.6 | Pf: | 0.0 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

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## ESTIMATES FOR ISOLATED WETLANDS:

**Area**

**Study Area: Horry County** State: SC FWS Region: 4

Ecoregion: Outer Coastal Plain Mixed Forest

Watershed Region: South Atlantic Gulf Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 742107.8 | | |
| Upland Acreage........................................ | 400307.6 | 53.9% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 14898.2 | 2.0% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 326902.0 | 44.1% | Wetlands |
| Number of Wetlands................................. | 7639 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 2583.5 |
| Palustrine Wetlands: | | | | PSS: | 44391.5 | Lacustrine Wetlands: | 108.9 |
| PAB: | 132.1 | PFO: | 269570.8 | PUB: | 5392.6 | Marine Wetlands: | 754.5 |
| PEM: | 3942.3 | Pf: | 0.0 | PUS: | 23.1 | Riverine Wetlands: | 2.6 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 16742.9 | 5.1% | 4832 | 63.3% |
| Scenario 2: (Red and Orange) | 16928.2 | 5.2% | 4923 | 64.4% |
| Scenario 3: (Red, Orange and Brown) | 29700.8 | 9.1% | 5394 | 70.6% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description. Note that Carolina bay wetlands are common in this area and that although some have been identified as isolated, others have not been so designated since the NWI data showed that they were contiguous with other wetlands. These results may underestimate the extent of isolated wetlands if these Carolina bay wetlands are separated from other wetlands by a narrow band of upland.

** Map-edge isolated wetlands not included: Acreage: 357.6 Number: 31

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 2675.7 | Lacustrine Wetlands: | 0.0 |
| PAB: | 15.1 | Pf: | 0.0 | PUB: | 1797.1 | Marine Wetlands: | 0.0 |
| PEM: | 375.6 | PFO: | 12052.0 | PUS: | 6.2 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

## Study Results

Study findings are reported for each study area below. Data for individual study areas are arranged by U.S. Fish and Wildlife Service Region. For each Region, there is a general discussion of the study results, a map showing the location of the study sites, a summary table of the findings, detailed data summary for each area, and a special wetland classification map for each study area. The latter two products are represented as "additional data links" within the regional summary table (first column). Simply click on the word "map" or "data" and the pertinent map and data will be displayed. *Please allow a minute or so for the map to appear. Note that printed maps may appear somewhat skewed since their projections reflect the curvature of the Earth.*

**Region 5 (Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, and West Virginia)**

Nineteen study sites were evaluated in the Northeast: one in Delaware, one in Massachusetts, two in Maryland, one in Maine, two in New Hampshire, four in New Jersey, two in New York, three in Pennsylvania, one in Virginia, one in Vermont, and one in West Virginia. *Table 3-5* presents a summary of the data for the Region's study areas.

<u>Percent of Study Areas Covered by Wetlands</u>

Wetlands were most extensive in the southern New Jersey study areas: Atsion (41% of study area) and Cape May (31%). Several other sites had more than 10 percent of their areas covered by wetlands: Boonton, New Jersey (16%), Upper Delmarva Potholes, Maryland/Delaware (15%), Epping, New Hampshire (13%), Porcupine Mountain, Maine (13%), Newton, New Jersey (10%), and Edgemere, Pennsylvania (10%). These are either coastal plain or glaciated locations. Mountainous areas had much less wetland area (e.g., Rainelle, West Virginia and Distant, Pennsylvania).

<u>Percent of Wetland Area Identified as Isolated</u>

Most study areas had more than 15 percent of their wetland acreage designated as isolated. Top-ranked were Rainelle (35-41%) and Upper Delmarva Potholes (35-39%). Most of the former area's isolated wetlands were ponds (149 acres; 62% under Scenario 2), whereas the latter's isolated types were chiefly forested wetlands (7,562 acres; 91%). The Millbrook, New York study area had more than 25 percent of its wetland acreage mapped as isolated. About half (48%) of them were forested wetlands, while 27 percent were ponds (under Scenario 2).

<u>Percent of Wetlands (Number) Classified as Isolated</u>

All areas had high percentages of isolated wetlands by number. The lowest percentage was 34-38 percent for the Earlysville, Virginia study area, whereas the highest numbers were attributed to the Upper Delmarva Potholes (77-81%). Sites with more than 60 percent of their wetlands in the isolated category included: Cape May, Porcupine Mountain, Eastern Lake Ontario (New York), Newton, Millbrook, Epping, and Rainelle.

Table 3-5. Summary data for study sites in Region 5. (<u>Note</u>: This table should be printed in landscape orientation.)

| | | | | | | | | **Isolated Wetlands** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Additional Data Links | Study Area | State | Acreage in Study Area | Wetland Acreage | Wetlands % of Study Area | Number of Wetlands | Deepwater Habitats % of Study Area | Scenario 1 Area Percent of Total Wetlands | Scenario 2 Area Percent of Total Wetlands | Scenario 3 Area Percent of Total Wetlands | Scenario 1 Count Percent of Total Wetlands |

**Study Area: Upper Delmarva Potholes** State: DE-MD FWS Region: 5

Ecoregion: Outer Coastal Plain Mixed Forest

Watershed Region: Mid Atlantic Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 147900.7 | | |
| Upland Acreage........................................ | 124991.1 | 84.5% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 744.2 | 0.5% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 22165.4 | 15.0% | Wetlands |
| Number of Wetlands................................. | 3670 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 134.1 |
| Palustrine Wetlands: | | | | PSS: | 605.7 | Lacustrine Wetlands: | 8.2 |
| PAB: | 4.8 | PFO: | 20301.6 | PUB: | 469.9 | Marine Wetlands: | 0.0 |
| PEM: | 630.9 | Pf: | 0.0 | PUS: | 0.8 | Riverine Wetlands: | 9.6 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 7855.8 | 35.4% | 2816 | 76.7% |
| Scenario 2: (Red and Orange) | 8302.9 | 37.5% | 2931 | 79.9% |
| Scenario 3: (Red, Orange and Brown) | 8600.9 | 38.8% | 2962 | 80.7% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 112.8 Number: 39

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 282.8 | Lacustrine Wetlands: | 0.0 |
| PAB: | 4.8 | Pf: | 0.0 | PUB: | 199.9 | Marine Wetlands: | 0.0 |
| PEM: | 253.4 | PFO: | 7562.0 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area:** **Northampton** State: MA FWS Region: 5

Ecoregion: Adirondack-New England Mixed Forest-Conifreous Forest-Alpine Meadow

Watershed Region: New England Region

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## STUDY AREA OVERVIEW:

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**Study Area:** **Porcupine Mountain** State: ME FWS Region: 5

Ecoregion: Laurentian Mixed Forest

Watershed Region: New England Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 135273.3 | | |
| Upland Acreage........................................ | 105177.5 | 77.8% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 12550.6 | 9.4% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 137.8 | | |
| Wetlands Acreage..................................... | 17407.4 | 12.9% | Wetlands |
| Number of Wetlands................................. | 1691 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 7253.1 | Lacustrine Wetlands: | 0.0 |
| PAB: | 0.0 | PFO: | 7887.4 | PUB: | 340.2 | Marine Wetlands: | 0.0 |
| PEM: | 1926.7 | Pf: | 0.0 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 2905.7 | 16.7% | 1111 | 65.7% |
| Scenario 2: (Red and Orange) | 2910.2 | 16.7% | 1116 | 66.0% |
| Scenario 3: (Red, Orange and Brown) | 3082.7 | 17.7% | 1140 | 67.4% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 93.8 Number: 30

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 707.6 | Lacustrine Wetlands: | 0.0 |
| PAB: | 0.0 | Pf: | 0.0 | PUB: | 94.3 | Marine Wetlands: | 0.0 |
| PEM: | 132.8 | PFO: | 1975.4 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area:** **Conway** State: NH FWS Region: 5

Ecoregion: Adirondack-New England Mixed Forest-Conifreous Forest-Alpine Meadow

Watershed Region: New England Region

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## STUDY AREA OVERVIEW:

**Study Area: Epping** State: NH FWS Region: 5

Ecoregion: Eastern Broadleaf Forest (Oceanic)

Watershed Region: New England

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## STUDY AREA OVERVIEW:

**Percent**

**Study Area: Atsion** State: NJ FWS Region: 5

Ecoregion: Eastern Broadleaf Forest (Oceanic)

Watershed Region: Mid Atlantic Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 146846.2 | | |
| Upland Acreage........................................ | 85365.6 | 58.1% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 554.5 | 0.4% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 60926.1 | 41.5% | Wetlands |
| Number of Wetlands................................. | 236 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 12440.8 | Lacustrine Wetlands: | 492.8 |
| PAB: | 0.0 | PFO: | 43008.4 | PUB: | 338.7 | Marine Wetlands: | 0.0 |
| PEM: | 2082.8 | Pf: | 2562.6 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 580.9 | 1.0% | 115 | 48.7% |
| Scenario 2: (Red and Orange) | 611.2 | 1.0% | 118 | 50.0% |
| Scenario 3: (Red, Orange and Brown) | 689.6 | 1.1% | 121 | 51.3% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 44.9 Number: 10

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 98.4 | Lacustrine Wetlands: | 0.0 |
| PAB: | 0.0 | Pf: | 0.0 | PUB: | 23.6 | Marine Wetlands: | 0.0 |
| PEM: | 8.7 | PFO: | 480.4 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area: Cape May** State: NJ FWS Region: 5

Ecoregion: Eastern Broadleaf Forest (Oceanic)

Watershed Region: Mid Atlantic Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 148144.8 | | |
| Upland Acreage......................................... | 52548.2 | 35.5% | Uplands |

**Study Area:** **Newton** State: NJ FWS Region: 5

Ecoregion: Eastern Broadleaf Forest (Oceanic)

Watershed Region: Mid Atlantic Region

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**Study Area:** **Eastern Lake Ontario** State: NY FWS Region: 5

Ecoregion:

**Study Area:** **Millbrook** State: NY FWS Region: 5

Ecoregion: Eastern Broadleaf Forest (Oceanic)

Watershed Region: Mid Atlantic Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area..................... | 142321.9 | | |
| Upland Acreage....................................... | 133950.2 | 94.1% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 907.3 | 0.6% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage.................................... | 7464.3 | 5.2% | Wetlands |
| Number of Wetlands................................ | 3445 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 1043.1 | Lacustrine Wetlands: | 91.4 |
| PAB: | 23.1 | PFO: | 3974.9 | PUB: | 1130.0 | Marine Wetlands: | 0.0 |
| PEM: | 1193.0 | Pf: | 0.0 | PUS: | 8.7 | Riverine Wetlands: | 0.0 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| **SCENARIO*** | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 1845.4 | 24.7% | 2138 | 62.1% |
| Scenario 2: (Red and Orange) | 2055.3 | 27.5% | 2286 | 66.4% |
| Scenario 3: (Red, Orange and Brown) | 2107.8 | 28.2% | 2299 | 66.7% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 17.3 Number: 16

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 231.8 | Lacustrine Wetlands: | 0.0 |
| PAB: | 7.8 | Pf: | 0.0 | PUB: | 545.5 | Marine Wetlands: | 0.0 |
| PEM: | 290.5 | PFO: | 976.5 | PUS: | 3.1 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area: Distant** State: PA FWS Region: 5

Ecoregion: Eastern Broadleaf Forest (Oceanic)

Watershed Region: Ohio Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 144521.0 | | |
| Upland Acreage........................................ | 141861.8 | 98.2% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 2349.3 | 1.6% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 309.9 | 0.2% | Wetlands |
| Number of Wetlands................................. | 163 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 18.2 | Lacustrine Wetlands: | 0.0 |
| PAB: | 0.0 | PFO: | 183.0 | PUB: | 103.9 | Marine Wetlands: | 0.0 |
| PEM: | 4.9 | Pf: | 0.0 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 53.7 | 17.3% | 65 | 39.9% |
| Scenario 2: (Red and Orange) | 56.6 | 18.3% | 72 | 44.2% |
| Scenario 3: (Red, Orange and Brown) | 56.6 | 18.3% | 72 | 44.2% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 0.4 Number: 2

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 0.9 | Lacustrine Wetlands: | 0.0 |
| PAB: | 0.0 | Pf: | 0.0 | PUB: | 54.9 | Marine Wetlands: | 0.0 |
| PEM: | 0.3 | PFO: | 0.5 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area:** **Lake Como** State: PA FWS Region: 5

Ecoregion: Laurentian Mixed Forest

Watershed Region: Mid Atlantic Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 142559.1 | | |
| Upland Acreage........................................ | 135171.3 | 94.8% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 2478.7 | 1.7% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 4909.2 | 3.4% | Wetlands |
| Number of Wetlands................................. | 1321 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 941.1 | Lacustrine Wetlands: | 14.4 |
| PAB: | 7.8 | PFO: | 1962.6 | PUB: | 904.9 | Marine Wetlands: | 0.0 |
| PEM: | 998.3 | Pf: | 0.0 | PUS: | 0.0 | Riverine Wetlands: | 80.2 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 761.7 | 15.5% | 553 | 41.9% |
| Scenario 2: (Red and Orange) | 874.4 | 17.8% | 601 | 45.5% |
| Scenario 3: (Red, Orange and Brown) | 886.3 | 18.1% | 603 | 45.6% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 21.4 Number: 10

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 112.5 | Lacustrine Wetlands: | 0.0 |
| PAB: | 7.8 | Pf: | 0.0 | PUB: | 210.1 | Marine Wetlands: | 0.0 |
| PEM: | 127.8 | PFO: | 416.2 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area:** **Earlysville** State: VA FWS Region: 5

Ecoregion: Central Appalachian Broadleaf Forest-Coniferous Forest-Meadow

Watershed Region: Mid Atlantic Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area..................... | 150367.9 | | |
| Upland Acreage........................................ | 148297.7 | 98.6% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 786.6 | 0.5% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 1283.7 | 0.9% | Wetlands |
| Number of Wetlands................................. | 733 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | |
|---|---|---|---|---|---|
| Palustrine Wetlands: | | | | PSS: | 73.8 |
| PAB: | 0.0 | PFO: | 295.0 | PUB: | 780.9 |
| PEM: | 100.1 | Pf: | 0.0 | PUS: | 0.0 |

| | |
|---|---|
| Estuarine Wetlands: | 0.0 |
| Lacustrine Wetlands: | 0.9 |
| Marine Wetlands: | 0.0 |

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**Study Area:** **Bread Loaf** State: VT FWS Region: 5

Ecoregion: Adirondack-New England Mixed Forest-Conifreous Forest-Alpine Meadow

Watershed Region: New England Region / Mid Atlantic Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area..................... | 137875.0 | | |
| Upland Acreage........................................ | 137171.3 | 99.5% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 5.5 | 0.0% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 698.2 | 0.5% | Wetlands |
| Number of Wetlands................................. | 245 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 335.5 | Lacustrine Wetlands: | 0.0 |
| PAB: | 0.0 | PFO: | 208.3 | PUB: | 80.6 | Marine Wetlands: | 0.0 |
| PEM: | 53.8 | Pf: | 0.0 | PUS: | 0.0 | Riverine Wetlands: | 20.0 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| **SCENARIO*** | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | | | | |

**Study Area: Rainelle** State: WV FWS Region: 5

Ecoregion: Central Appalachian Broadleaf Forest-Coniferous Forest-Meadow

Watershed Region: Ohio Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area..................... | 150694.1 | | |
| Upland Acreage....................................... | 149343.5 | 99.1% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 747.9 | 0.5% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage.................................... | 602.8 | 0.4% | Wetlands |
| Number of Wetlands................................ | 763 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 56.1 | Lacustrine Wetlands: | 0.0 |
| PAB: | 0.0 | PFO: | 67.3 | PUB: | 274.1 | Marine Wetlands: | 0.0 |
| PEM: | 188.3 | Pf: | 0.0 | PUS: | 16.4 | Riverine Wetlands: | 0.7 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 209.6 | 34.8% | 460 | 60.3% |
| Scenario 2: (Red and Orange) | 240.8 | 40.0% | 497 | 65.1% |
| Scenario 3: (Red, Orange and Brown) | 246.8 | 40.9% | 499 | 65.4% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 4.7 Number: 4

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 12.8 | Lacustrine Wetlands: | 0.0 |
| PAB: | 0.0 | Pf: | 0.0 | PUB: | 148.9 | Marine Wetlands: | 0.0 |
| PEM: | 54.6 | PFO: | 10.8 | PUS: | 13.7 | Riverine Wetlands: | 0.0 |

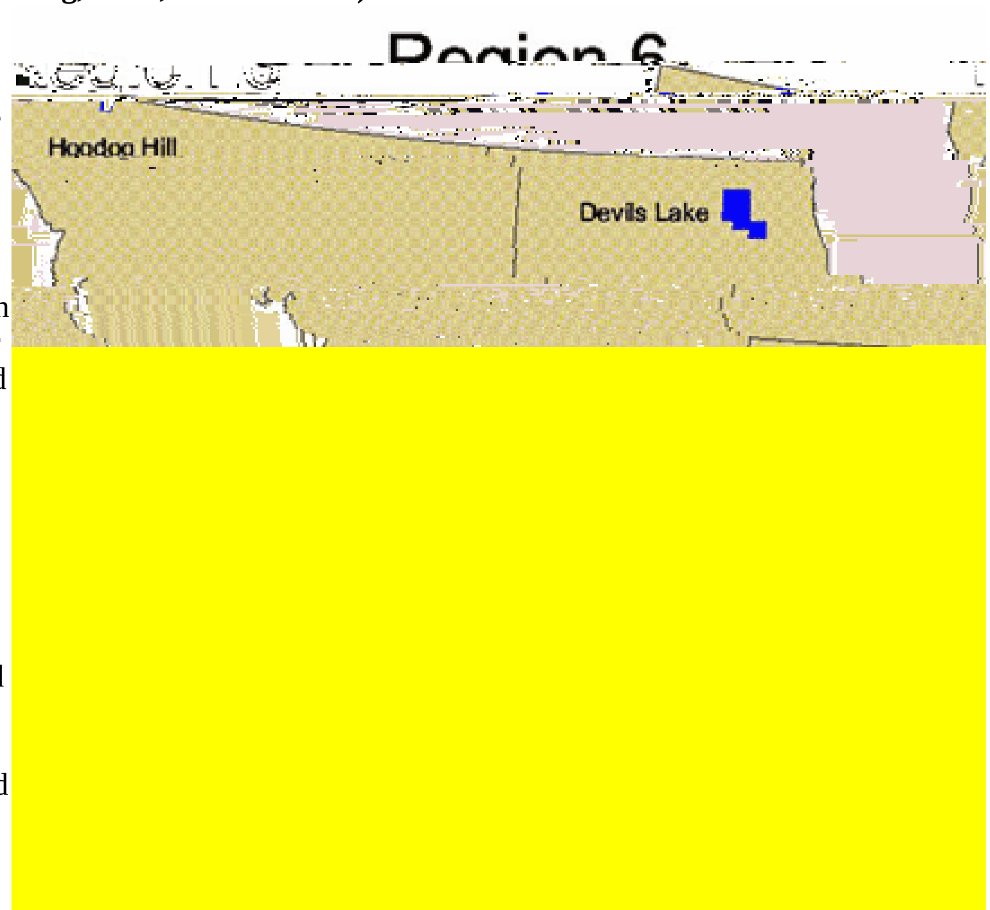
*** Acreage of Isolated Wetlands based on Scenario 2.

## Study Results

Study findings are reported for each study area below. Data for individual study areas are arranged by U.S. Fish and Wildlife Service Region. For each Region, there is a general discussion of the study results, a map showing the location of the study sites, a summary table of the findings, detailed data summary for each area, and a special wetland classification map for each study area. The latter two products are represented as "additional data links" within the regional summary table (first column). Simply click on the word "map" or "data" and the pertinent map and data will be displayed. *Please allow a minute or so for the map to appear. Note that printed maps may appear somewhat skewed since their projections reflect the curvature of the Earth.*

**Region 6 (North Dakota, South Dakota, Nebraska, Kansas, Colorado, Wyoming, Utah, and Montana)**

Eleven sites were studied in Region 6: one in Colorado, one in Kansas, one in Montana, one in North Dakota, three in Nebraska, one in South Dakota, two in Utah, and one in Wyoming. The North Dakota site was Devils Lake that alone covered 1,447 square miles. *Table 3-6* presents a summary of the data for the Region's study areas.




Percent of Study Areas Covered by Wetlands

Wetlands were most extensive in two prairie pothole areas: Devils Lake, North Dakota (15% of the area) and Clark, South Dakota (11%). Utah's Green River study area had 7 percent of its area covered by wetlands. Wetlands represented only 1 to 2 percent of most of the remaining areas.

Percent of Wetland Area Identified as Isolated

Isolated wetlands accounted for a large proportion of the wetlands in six areas. Ninety-eight percent of Clark's wetland acreage was classified as isolated. Two other areas had more than 80 percent of their wetland acreage dominated by isolated wetlands: Rainwater Basin, Nebraska (84-85%) and Black Thunder, Wyoming (80-81%). Devils Lake, Olathe-Kansas City (Kansas), and Hill Lake (Nebraska; Sandhills wetlands) had about half of their wetland acreage in this category. Palustrine emergent wetland was the predominant isolated wetland type in all areas, except Olathe-Kansas City where aquatic bed (pond) was the main type.

Percent of Wetlands (Number) Classified as Isolated

Two areas had more than 90 percent of their wetlands designated as isolated: Devils Lake (97-98%) and Clark (94-95%). Both these areas are located in the Prairie Pothole Region. The percentages would be even higher if point or dot-sized wetlands were counted. For Devils Lake, an additional 6,273 point wetlands could be added to the wetland total for this study area (increasing the total count from 42,327 to 48,600). Nearly all these point wetlands should meet the isolated wetland criterion (Chuck Elliott, pers. comm.). Three other areas had more than 50 percent of their wetlands mapped as isolated under all three scenarios: Hill Lake (66-74%), Olathe-Kansas City (70-71%), and Rainwater Basin (64-68%).

Table 3-6. Summary data for study sites in Region 6. (Note: This table should be printed in landscape orientation.)

| | **Isolated Wetlands** |
|---|---|

| Additional Data Links | Study Area | State | Acreage in Study Area | Wetland Acreage | Wetlands % of Study Area | Number of Wetlands | Habitats % of |
|---|---|---|---|---|---|---|---|

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**Study Area:** **Cherry Creek Lake** State: CO FWS Region: 6

Ecoregion: Great Plains-Palouse Dry Steppe

Watershed Region: Missouri Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 147106.3 | | |
| Upland Acreage........................................ | 144253.9 | 98.1% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 1050.2 | 0.7% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 1802.1 | 1.2% | Wetlands |
| Number of Wetlands................................. | 943 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 289.5 | Lacustrine Wetlands: | 108.1 |
| PAB: | 97.0 | PFO: | 69.9 | PUB: | 322.6 | Marine Wetlands: | 0.0 |
| PEM: | 415.7 | Pf: | 0.0 | PUS: | 25.5 | Riverine Wetlands: | 473.8 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| **SCENARIO*** | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 250.0 | 13.9% | 298 | 31.6% |
| Scenario 2: (Red and Orange) | 301.0 | | | |

**Study Area: Olathe-Kansas City** State: KS FWS Region: 6

Ecoregion: Prairie Parkland (Temperate)

Watershed Region: Missouri Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 223128.6 | | |
| Upland Acreage........................................ | 219437.0 | 98.3% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 1255.5 | 0.6% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 2436.1 | 1.1% | Wetlands |
| Number of Wetlands................................. | 2866 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 16.0 | Lacustrine Wetlands: | 0.0 |
| PAB: | 1884.7 | PFO: | 107.8 | PUB: | 116.8 | Marine Wetlands: | 0.0 |
| PEM: | 256.9 | Pf: | 0.0 | PUS: | 11.0 | Riverine Wetlands: | 42.2 |

. . .

## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 1118.1 | 45.9% | 2008 | 70.1% |
| Scenario 2: (Red and Orange) | 1137.8 | 46.7% | 2029 | 70.8% |
| Scenario 3: (Red, Orange and Brown) | 1194.5 | 49.0% | 2037 | 71.1% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 18.6 Number: 18

. . .

## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 2.0 | Lacustrine Wetlands: | 0.0 |
| PAB: | 900.4 | Pf: | 0.0 | PUB: | 86.4 | Marine Wetlands: | 0.0 |
| PEM: | 135.2 | PFO: | 4.7 | PUS: | 8.9 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area: Hoodoo Hill** State: MT FWS Region: 6

Ecoregion: Great Plains-Palouse Dry Steppe

Watershed Region: Missouri Region

. . .

## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 125966.8 | | |
| Upland Acreage........................................ | 124017.5 | 98.5% | Uplands |

**Study Area:** **Devils Lake** State: ND FWS Region: 6

Ecoregion: Great Plains Steppe

Watershed Region: Souris-Red-Rainy Region

. . .

## STUDY AREA OVERVIEW:

**Study Area:** **Altona** State: NE FWS Region: 6

Ecoregion: Prairie Parkland (Temperate)

**Study Area: Hill Lake** State: NE FWS Region: 6

Ecoregion: Great Plains Steppe

Watershed Region: Missouri Region

. . .

## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 141327.9 | | |
| Upland Acreage........................................ | 135426.1 | 95.8% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 0.0 | 0.0% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 5901.8 | 4.2% | Wetlands |
| Number of Wetlands................................. | 1006 | | |

. . .

## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 0.0 | Lacustrine Wetlands: | 1065.4 |
| PAB: | 244.6 | PFO: | 14.1 | PUB: | 0.0 | Marine Wetlands: | 0.0 |
| PEM: | 4571.9 | Pf: | 0.0 | PUS: | 5.5 | Riverine Wetlands: | 0.4 |

. . .

## ESTIMATES FOR ISOLATED WETLANDS:

| SCENARIO* | Area: Acreage | Area: Percent of Total Wetlands** | Number: Count | Number: Percent of Total Wetlands** |
|---|---|---|---|---|
| Scenario 1: (Red) | 2727.5 | 46.2% | 666 | 66.2% |
| Scenario 2: (Red and Orange) | 2784.1 | 47.2% | 741 | 73.7% |
| Scenario 3: (Red, Orange and Brown) | 2787.1 | 47.2% | 742 | 73.8% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 9.0 Number: 3

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 0.0 | Lacustrine Wetlands: | 723.4 |
| PAB: | 178.2 | Pf: | 0.0 | PUB: | 0.0 | Marine Wetlands: | 0.0 |
| PEM: | 1871.4 | PFO: | 5.7 | PUS: | 5.5 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area: Rainwater Basin** State: NE FWS Region: 6

Ecoregion: Prairie Parkland (Temperate)

Watershed Region: Missouri Region

. . .

## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 145276.3 | | |
| Upland Acreage........................................ | 140507.1 | 96.7% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 61.1 | 0.0% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 4708.1 | 3.2% | Wetlands |
| Number of Wetlands................................. | 1076 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 16.9 | Lacustrine Wetlands: | 0.0 |
| PAB: | 478.0 | PFO: | 208.7 | PUB: | 274.5 | Marine Wetlands: | 0.0 |
| PEM: | 3599.4 | Pf: | 0.0 | PUS: | 99.4 | Riverine Wetlands: | 31.1 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| **SCENARIO*** | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 3958.3 | 84.1% | 693 | 64.4% |
| Scenario 2: (Red and Orange) | 3982.4 | 84.6% | 728 | 67.7% |
| Scenario 3: (Red, Orange and Brown) | 3982.4 | 84.6% | 728 | 67.7% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 33.5 Number: 15

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 4.6 | Lacustrine Wetlands: | 0.0 |
| PAB: | 298.9 | Pf: | 0.0 | PUB: | 198.8 | Marine Wetlands: | 0.0 |
| PEM: | 3359.4 | PFO: | 41.5 | PUS: | 79.1 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area:** **Clark** State: SD FWS Region: 6

Ecoregion:

**Study Area:** **Green River** State: UT FWS Region: 6

Ecoregion: Intermountain Semi-Desert and Desert Province

Watershed Region: Upper Colorado Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 109610.8 | | |
| Upland Acreage........................................ | 99983.3 | 91.2% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 2342.1 | 2.1% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 7285.4 | 6.6% | Wetlands |
| Number of Wetlands................................. | 304 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 1733.6 | Lacustrine Wetlands: | 1218.9 |
| PAB: | 23.1 | PFO: | 652.6 | PUB: | 1.0 | Marine Wetlands: | 0.0 |
| PEM: | 2826.4 | Pf: | 0.0 | PUS: | 200.7 | Riverine Wetlands: | 629.0 |

. . .

## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| **SCENARIO*** | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 216.3 | 3.0% | 55 | 18.1% |
| Scenario 2: (Red and Orange) | 248.7 | 3.4% | 62 | 20.4% |
| Scenario 3: (Red, Orange and Brown) | 249.3 | 3.4% | 63 | 20.7% |

**Study Area:** **Rockport Lake** State: UT FWS Region: 6

Ecoregion: Southern Rocky Mountain Steppe-Open Woodland-Coniferous Forest-Alpine Meadow

Watershed Region: Great Basin Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 144460.6 | | |
| Upland Acreage........................................ | 139895.0 | 96.8% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 1107.6 | 0.8% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 3458.0 | 2.4% | Wetlands |
| Number of Wetlands................................. | 632 | | |

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## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 315.2 | Lacustrine Wetlands: | 2089.4 |
| PAB: | 168.6 | PFO: | 87.9 | PUB: | 0.0 | Marine Wetlands: | 0.0 |
| PEM: | 768.6 | Pf: | 0.0 | PUS: | 23.9 | Riverine Wetlands: | 3.5 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| **SCENARIO*** | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 122.3 | 3.5% | 151 | 23.9% |
| Scenario 2: (Red and Orange) | 166.0 | 4.8% | 217 | 34.3% |
| Scenario 3: (Red, Orange and Brown) | 257.9 | 7.5% | 232 | 36.7% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 0.0 Number: 0

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 1.9 | Lacustrine Wetlands: | 0.0 |
| PAB: | 28.6 | Pf: | 0.0 | PUB: | 0.0 | Marine Wetlands: | 0.0 |
| PEM: | 133.4 | PFO: | 0.0 | PUS: | 2.2 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area: Black Thunder** State: WY FWS Region: 6

Ecoregion: Great Plains-Palouse Dry Steppe

Watershed Region: Missouri Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 138098.4 | | |
| Upland Acreage......................................... | 135863.2 | 98.4% | Uplands |

## Study Results

Study findings are reported for each study area below. Data for individual study areas are arranged by U.S. Fish and Wildlife Service Region. For each Region, there is a general discussion of the study results, a map showing the location of the study sites, a summary table of the findings, detailed data summary for each area, and a special wetland classification map for each study area. The latter two products are represented as "additional data links" within the regional summary table (first column). Simply click on the word "map" or "data" and the pertinent map and data will be displayed. *Please*

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MAP DATA | Kenai | AK | 142311.7 | 28149.8 | 19.8% | 1254 | 10.5% | 23.4% | 23.5% | 24.9% | 96.3% | 96.6% | 96.7% |
| MAP DATA | Mount McKinley | AK | 170681.6 | 77442.0 | 45.4% | 323 | 0.0% | 4.7% | 5.1% | 5.1% | 82.7% | 83.9% | 83.9% |

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**Study Area: Charley River** State: AK FWS Region: 7

Ecoregion: Upper Yukon Tagya-Meadow

Watershed Region: Alaska Region

## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 161603.7 | | |
| Upland Acreage........................................ | 86089.4 | 53.3% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 630.6 | 0.4% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 74883.7 | 46.3% | Wetlands |
| Number of Wetlands................................. | 384 | | |

## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 72563.6 | Lacustrine Wetlands: | 0.0 |
| PAB: | 11.8 | PFO: | 358.1 | PUB: | 48.5 | Marine Wetlands: | 0.0 |
| PEM: | 1679.5 | Pf: | 0.0 | PUS: | 0.0 | Riverine Wetlands: | 222.2 |

## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 2772.8 | 3.7% | 243 | 63.3% |
| Scenario 2: (Red and Orange) | 2826.5 | 3.8% | 255 | 66.4% |
| Scenario 3: (Red, Orange and Brown) | 2826.5 | 3.8% | 255 | 66.4% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 282.4 Number: 21

## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 2653.4 | Lacustrine Wetlands: | 0.0 |
| PAB: | 0.0 | Pf: | 0.0 | PUB: | 6.6 | Marine Wetlands: | 0.0 |
| PEM: | 160.7 | PFO: | 5.7 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area: Kenai** State: AK FWS Region: 7

Ecoregion: Coastal Trough Humid Tayga

Watershed Region: Alaska Region

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## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 142311.7 | | |
| Upland Acreage......................................... | 99233.9 | 69.7% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 14524.5 | 10.5% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 403.4 | | |
| Wetlands Acreage..................................... | 28149.8 | 19.8% | Wetlands |
| Number of Wetlands................................. | 1254 | | |

. . .

## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 22112.6 | Lacustrine Wetlands: | 0.0 |
| PAB: | 3.2 | PFO: | 876.5 | PUB: | 376.5 | Marine Wetlands: | 0.0 |
| PEM: | 4780.9 | Pf: | 0.0 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| SCENARIO* | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 6597.9 | 23.4% | 1208 | 96.3% |
| Scenario 2: (Red and Orange) | 6620.6 | 23.5% | 1211 | 96.6% |
| Scenario 3: (Red, Orange and Brown) | 7011.6 | 24.9% | 1213 | 96.7% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 72.9 Number: 13

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 4318.7 | Lacustrine Wetlands: | 0.0 |
| PAB: | 3.2 | Pf: | 0.0 | PUB: | 202.0 | Marine Wetlands: | 0.0 |
| PEM: | 1945.1 | PFO: | 151.5 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

**Study Area: Mount McKinley** State: AK FWS Region: 7

Ecoregion: Alaska Range Humid Tayga-Tundra-Meadow

Watershed Region: Alaska Region

. . .

## STUDY AREA OVERVIEW:

| | | Percent of Study Area | |
|---|---|---|---|
| Total Acreage in Study Area...................... | 170681.6 | | |
| Upland Acreage........................................ | 93219.5 | 54.6% | Uplands |
| Non-Isolated Deepwater Habitats Acreage. | 20.1 | 0.0% | All Deepwater Habitats |
| Isolated Deepwater Habitats Acreage........ | 0.0 | | |
| Wetlands Acreage..................................... | 77442.0 | 45.4% | Wetlands |
| Number of Wetlands................................. | 323 | | |

. . .

## ACREAGE OF WETLAND TYPES:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 71522.8 | Lacustrine Wetlands: | 43.5 |
| PAB: | 28.6 | PFO: | 54.2 | PUB: | 121.4 | Marine Wetlands: | 0.0 |
| PEM: | 1217.8 | Pf: | 0.0 | PUS: | 0.0 | Riverine Wetlands: | 4453.6 |

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## ESTIMATES FOR ISOLATED WETLANDS:

| | Area | | Number | |
|---|---|---|---|---|
| **SCENARIO*** | Acreage | Percent of Total Wetlands** | Count | Percent of Total Wetlands** |
| Scenario 1: (Red) | 3664.9 | 4.7% | 267 | 82.7% |
| Scenario 2: (Red and Orange) | 3971.2 | 5.1% | 271 | 83.9% |
| Scenario 3: (Red, Orange and Brown) | 3971.2 | 5.1% | 271 | 83.9% |

* Scenarios range from restrictive to broad interpretation of isolated wetlands, see Methods for description.

** Map-edge isolated wetlands not included: Acreage: 43.1 Number: 8

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## ACREAGE OF ISOLATED WETLAND TYPES:***

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Estuarine Wetlands: | 0.0 |
| Palustrine Wetlands: | | | | PSS: | 3762.0 | Lacustrine Wetlands: | 0.0 |
| PAB: | 0.0 | Pf: | 0.0 | PUB: | 19.0 | Marine Wetlands: | 0.0 |
| PEM: | 190.3 | PFO: | 0.0 | PUS: | 0.0 | Riverine Wetlands: | 0.0 |

*** Acreage of Isolated Wetlands based on Scenario 2.

| | |
|---|---|
| 70-79% | Lincoln County (WA) |
| 60-69% | None |
| 50-59% | Bluffton (IN) |
| 40-49% | Devils Lake (ND), Hill Lake (NE), Bee Spring (KY), Olathe-Kansas City (KS), Crystal Lake (FL), Dade City (FL), and Sacramento (CA) |
| 30-39% | Upper Delmarva Potholes (DE/MD), Rainelle (WV), and Big Lake (MN) |
| 20-29% | Acworth (GA), Mongo (IN), Laguna Park (TX), Millbrook (NY), Carlsbad Caverns (NM), Kenai (AK), Lake Alexander (MN), St. Charles Bay (TX), Mustang Bayou (TX), Dublin (NC), Altona (NE), Eastern Lake Ontario (NY), Hoodoo Hill (MT), and Savage River (MD) |
| 10-19% | |

| | |
|---|---|
| 50-59% | Holly Springs (MS), Edgemere (PA), Savage River (MD), Laguna Park (TX), and Bird Landing (CA) |
| 40-49% | Hazen (AR), Atsion (NJ), Hoodoo Hill (MT), Coquille River (OR), St. Charles Bay (TX), Trenton (MO), Allison (IA), Northampton (MA), Valle Grande (NM), Clackamas River (OR), Frederick (MD), Altona (NE), Boonton (NJ), Lake Como (PA), Goose Lake (IL), Black Thunder (WY), Distant (PA), and Charlotte (NC/SC) |
| 30-39% | Conway (NH), Breadloaf (VT), Earlysville (VA), Blackwater-Florence (AZ), Cherry Creek Lake (CO), and Wood River (ID) |
| 20-29% | New Orleans (LA), Rockport Lake (UT), La Mesa (CA), and Carlsbad Caverns (NM) |
| 10-19% | Green River (UT) |

This report documented the importance and variety of wetlands that are isolated in numerous physiographic settings across America. Although the national extent and statistical estimates of the percentage of isolated wetlands remain unknown, the report highlighted many areas where isolated wetlands are abundant. The profiles of isolated wetlands presented in this report have shown that many of the functions and benefits ascribed to non-isolated wetlands are performed by isolated wetlands. Moreover, their geographic isolation and local and regional distribution place isolated wetlands in a rather unique position to provide habitats crucial for the survival of many plant and animal species (e.g., endemism and breeding grounds for numerous amphibian and bird species). Isolated wetlands are vital natural resources, important for maintaining the Nation's biodiversity and for providing a host of other functions.

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# Section 5.  Acknowledgments

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## General Printing Instructions

Using Microsoft **Internet Explorer** Web browser, first navigate to the section or page you would like to print. Then under the "File" (upper left corner of Web Browser) drop down menu, select "Page Setup", and change all margins to 0.5 inches, using the Portrait Orientation then click on "OK". Go to the "File" drop down menu again, and select "Print" from the list, then click on the "Print" button to print.

## Printing Results section for individual Regions

First navigate to the Regional Results Section you would like to print, then highlight the text and Region Map (not including the spreadsheet). Now, go the the "File" drop down menu, and select "Print" from the list. In the "Page Range" box (bottom left) and click on "Selection", then click on the "Print" button to print the selection.

## Printing Summary spreadsheets from Results section for individual Regions

When printing a spreadsheet from a Regional Results section, first highlight the spreadsheet. Go to the "File" drop down menu, and select "Page Setup" from the list and click on Landscape in the "Orientation" box. Then go to the "File" drop down menu, and select "Print". In the "Page Range" box click on "Selection", then click on the "Print" button to print the selected spreadsheet.

## Printing DATA sheet for a specific Study Area

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wetland acreage designated as isolated: 1) Four Mile Flat, Nevada (salt flat wetlands), 2) Lincoln County, Washington (Channeled Scablands wetlands), 3) Tahoka, Texas (playa wetlands), 4) Tokio, Texas (playa wetlands), 5) Bluffton, Indiana (mostly forested wetlands), 6) Black Thunder, Wyoming (emergent wetlands), 7) Clark, South Dakota (prairie pothole wetlands), and 8) Rainwater Basin, Nebraska (Rainwater Basin wetlands). All of these sites except Bluffton had nearly 80 percent or more of their wetland acreage classified as isolated. Fourteen other areas had from 25-50 percent of their acreage identified as isolated. Only 19 of the 72 sites (or 26%) had less than 10 percent of their wetland acreage isolated. From a numeric standpoint (i.e., number of wetlands), all study areas except Green River (Utah) had more than 20 percent of their wetlands designated as isolated. Over 50 sites had more than 50 percent of their wetlands isolated. For most areas, isolated wetlands tended to be smaller than the non-isolated wetlands; hence they represented a higher proportion of the total number of wetlands than they did in regard to the total wetland acreage. Nine study areas had more than 90 percent of their wetlands classified as isolated: 1) Tokio, Texas, 2) Tahoka, Texas, 3) Four Mile Flat, Nevada, 4) Devils Lake, North Dakota, 5) Kenai, Alaska, 6) Lincoln County, Washington, 7) Clark, South Dakota, 8) Lake Alexander, Minnesota, and 9) Dade City, Florida.

Although the national extent of isolated wetlands remains unknown, this report highlights many areas where isolated wetlands are abundant. The profiles of isolated wetlands presented in this report show that many of the functions and benefits (e.g., water storage, nutrient retention and cycling, sediment retention, and wildlife habitat) ascribed to non-isolated wetlands are performed by isolated wetlands. Moreover, their geographic isolation and local and regional distribution place isolated wetlands in a rather unique position to provide habitats crucial for the survival of many plant and animal species (e.g., endemism and breeding grounds for numerous amphibian and bird species). Isolated wetlands are vital natural resources, important for maintaining the Nation's biodiversity and wetland-dependent wildlife and for providing a host of other functions.

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