

# TABLE of CONTENTS



*Green-backed herons live near fresh and salt water lakes, streams, shores, swamps, marshes, rivers and ponds. Curiously, they are known to use bait (feathers, insects, twigs, moss, etc.) to lure fish.*

<i>Introduction .....</i>	<i>2</i>
<i>Southeast.....</i>	<i>4</i>
<i>Northeast/Mid-Atlantic .....</i>	<i>6</i>
<i>Great Lakes/Upper Mississippi.....</i>	<i>8</i>
<i>The Great Plains .....</i>	<i>10</i>
<i>Southwest .....</i>	<i>12</i>
<i>West/Great Basin.....</i>	<i>14</i>
<i>Alaska .....</i>	<i>16</i>
<i>Hawaii .....</i>	<i>18</i>
<i>Conclusion.....</i>	<i>19</i>
<i>Endnotes .....</i>	<i>20</i>
<i>Other Sources .....</i>	<i>20</i>
<i>Photo Credits .....</i>	<i>20</i>

# INTRODUCTION

AMERICA'S WETLANDS ARE IN DANGER. THIRTY YEARS AFTER PASSAGE OF THE CLEAN WATER ACT, WETLANDS CONTINUE TO BE DRAINED, FILLED AND POLLUTED AT AN ALARMING RATE. SO-CALLED "ISOLATED WETLANDS" ARE IN PARTICULAR PERIL, DUE IN GREAT MEASURE TO A RECENT SUPREME COURT DECISION POTENTIALLY JEOPARDIZING FEDERAL CLEAN WATER ACT PROTECTIONS FOR MILLIONS OF ACRES OF WATERS AND WETLANDS.



Smartweed

Wetlands perform several vital functions in the environment. Among other things, they filter pollutants from water, provide critical habitat for a variety of species and mitigate flood damage. Recognizing these important functions, Congress included protections for wetlands in the 1972 Clean Water Act. But in January 2001, the U.S. Supreme Court issued a ruling, *Solid Waste Agency of Northern Cook County (SWANCC) v. U.S. Army Corps of Engineers*, that could significantly narrow the scope of the Act's protection of wetlands. Although the scope of the Court's ruling is not completely clear, it has been read by some to

exclude waters determined to be "isolated" from protection under the Clean Water Act.

In application, the ruling has created both confusion and environmental peril because it leaves open to interpretation the question of which wetlands are in fact "isolated."

The issue is a matter of considerable debate, in part because the term "isolated" has no real grounding in science. Researchers and scientists recognize the complex web of connections between seemingly separate or "isolated" wetlands and other waters: they are often connected by water overflow or by groundwater; and they frequently support the same species but during different stages of their life cycles. In addition, so-called "isolated" wetlands, such as prairie potholes, absorb floodwaters and filter pesticides and other pollutants, protecting downstream tributaries, rivers, and wetlands. In short, seemingly "isolated" wetlands are critically necessary to the healthy functioning of the overall ecosystem.

In the public policy arena, however, as much as 20 to 30 percent of America's wetlands might eventually be deemed "isolated" by the executive branch or by the courts because they will apply an unscientific standard: the absence of a direct surface connection to other bodies of water.

Unless Congress takes action to reassert federal protection, or until individual states take action, decisions about which wetlands are to be protected will be made by the Environmental Protection Agency, the Army Corps of Engineers and the courts, attempting to interpret the Supreme Court's decision. The predictable result is that vast wetland areas will be destroyed, potentially devastating plant and animal life, including a range of migratory birds, increasing the risk of flood damage for populated communities, diminishing wetland-filtration of polluted waters and more. Indeed, in the short time since the SWANCC decision, this wetland loss has already begun to occur.



## THE SWANCC DECISION

As the pages that follow illustrate, “isolated” wetlands encompass a rich variety of marshland and small pools. They may be permanent or temporary, reappearing from season to season or year to year, depending on precipitation. Because many are small or exist only for a short period each year, their importance is often not appreciated by policymakers and the public. Indeed, developers frequently target isolated wetlands for commercial projects, despite their environmental importance. The truth is that isolated wetlands play the same vital roles in the environment as other wetlands:

- **CURBING DAMAGE FROM FLOODS.** Every year in the United States, floods cause approximately 200 deaths and some \$3 billion in property damage.<sup>1</sup> Wetlands help curb this loss by absorbing flood waters and impeding the rush of storm runoff, allowing for a slower discharge of water flow.
- **REPLENISHING WATER SUPPLIES.** Wetlands help replenish the drinking water supplies on which communities depend. For example, in west Texas, the Ogallala aquifer is recharged by thousands of scattered wetlands called “playa lakes.”
- **IMPROVING WATER QUALITY.** Dubbed the “kidneys” of the landscape, wetlands remove excess nutrients, toxic materials and sediments from the water that flows through them. “Restoring just one percent of a watershed’s area to appropriately located wetlands has the potential to reduce polluted runoff of nitrates and herbicides by up to 50 percent....[S]mall wetlands are at least as effective as the same acreage in a larger wetland,” according to one expert.<sup>2</sup>
- **PROVIDING WILDLIFE HABITAT AND ENSURING BIODIVERSITY.** Wetlands are crucial stopovers for millions of migrating waterfowl and shorebirds and provide food and cover for

In the past, under the Clean Water Act, property owners had to apply for a permit from the Army Corps of Engineers before destroying isolated wetlands. This federal jurisdiction was based in part on the Migratory Bird Rule, which protects habitat used by migrating birds. But on January 9, 2001, in *Solid Waste Agency of Northern Cook County (SWANCC) v. U.S. Army Corps of Engineers*, the Supreme Court ruled that the Migratory Bird Rule could not be used as the sole basis for federal regulation of “isolated” waters.

breeding and nesting. Without prairie potholes, the majority of ducks in the mid-continental United States would be at risk. According to the U.S. Environmental Protection Agency, 43 percent of federally threatened and endangered species, such as the whooping crane, rely on wetlands for their survival.

Temporary or seasonal isolated wetlands are critical to the survival of vulnerable amphibian populations. Juvenile frogs, toads and salamanders depend on small wetlands as a haven from fish predation. The loss of small wetlands can wipe out whole populations of amphibians.

Small wetlands also host diverse and unusual plant communities that could prove important to efforts to develop new medicines and other botanical products. But the plants are disappearing before even being studied.

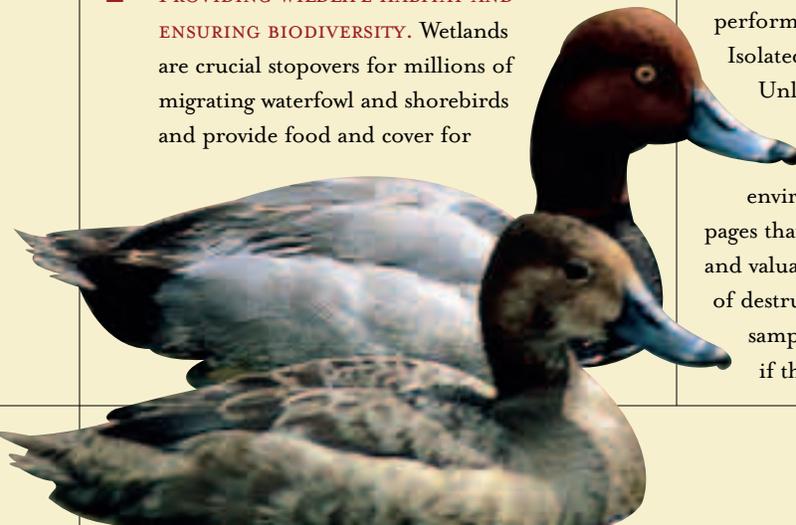
- **RECREATION, FOOD AND AESTHETIC ENJOYMENT.** Each year, millions of Americans visit wetland areas to hunt, canoe and birdwatch. Moreover, wetlands are living laboratories for students of all ages.

Researchers have found that ecological well-being depends not only on preserving the total acreage of wetlands, but on maintaining a mosaic of different types and sizes of wetlands that together perform these complex and critical functions.

Isolated wetlands are crucial pieces of this mosaic. Unless political leaders act quickly to protect them, however, they may be lost forever.

Wetlands play a vital role in the environment in all regions of the nation. The pages that follow offer a survey of many of the unique and valuable types of wetlands that are at greater risk of destruction due to the SWANCC decision and a sampling of the plant and animal life put at risk if these wetlands are lost.

above: Yellow-headed blackbird  
below: Red eared turtles  
left: Red head ducks





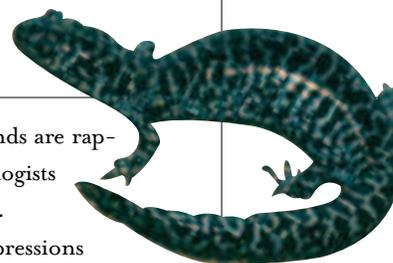
THE SOUTHEASTERN UNITED STATES OFFERS THE RICHEST VARIETY OF ISOLATED WETLANDS IN THE NATION INCLUDING *Carolina bays* AND *pocosins*, *gum ponds*, *Citronelle ponds*, *mountain bogs*, *cypress domes*, *oxbows*, *limesinks* AND *dunal swales*.

**m**any isolated wetlands in the southeast are critical to the health and survival of frogs, toads, newts and salamanders—amphibians whose populations are in precipitous decline around the globe. The causes of this decline are not fully understood, but habitat destruction is a prime culprit. Seventy-four native species of amphibians live in the coastal plain of the Southeast, including many that are threatened or endangered, such as the flatwoods salamander and gopher frog.

**CAROLINA BAYS** are home to dozens of amphibian species. Oval-shaped depressions of unknown

origin, Carolina bays are often too small or temporary to sustain fish, making them a safe haven for breeding amphibians and development of tadpoles. Indeed, some Carolina bays fill only in heavy rains and are sometimes mistaken for puddles. But these small wetlands are crucial for maintaining regional biodiversity. In a 16-year monitoring study of one-acre Rainbow Bay in South Carolina, for example, researchers identified 27 species of frogs, toads and salamanders and recorded breeding activity of nearly 42,000 female amphibians and the production of more than 200,000 metamorphosing juveniles.<sup>3</sup>

*Flatwoods salamander, a federally-endangered species, has suffered serious declines due to destruction of its pine flatwoods and seasonally-flooded wetland habitats.*



A small wetland's value as breeding habitat is partly a function of its proximity to other wetlands. "There used to be a whole suite of ponds that amphibians could go to—if some were flooded, others were dry," says Fish and Wildlife biologist Linda LaClaire who has studied "perched" isolated wetlands in upland areas of Mississippi. "Recent court cases have pretty much removed [Clean Water Act] protection, so they're continuing to be lost. There is no federal or state protection here in Mississippi for this type of wetland."

**POCOSINS**—bogs formed in clay or peat soil—are another vanishing resource. Pocosins, which take their name from the Algonquin word for "swamp on a hill," once covered more than half-a-million acres from Virginia to Alabama. Today less than one-third of this acreage remains. Remaining pocosins are home to a wealth of threatened and endangered plants, including the venus flytrap, sweet pitcher and spring-flowering goldenrod. If this habitat is lost, many plants may face extinction.

Pocosins also support a rich array of rare fauna, including Hessel's hairstreak butterfly, the endangered red-cockaded woodpecker, the American alligator, black bears, bobcats, marsh rabbits, and 65 species of migratory birds.

Pocosins also help control the movement of fresh water to nursery beds for shellfish by holding rainfall and diluting runoff across wide regions of the coastal plain. The loss of pocosins and other wetlands on the coastal plain threatens these nursery beds, which require the proper salinity in estuaries to thrive.

Pocosins, like all peat-accumulating wetlands, play an especially valuable role in the global environment, storing large amounts of organic matter that would otherwise decay and release carbon dioxide into the atmosphere, contributing to global warming.

Wetlands such as **CYPRESS DOMES** and **CITRONELLE PONDS** (also called **GRADY PONDS**) help protect coastal areas from flooding. Found along the Gulf Coast from Mississippi to the

Florida panhandle, Citronelle ponds are rapidly disappearing, even before biologists learn their full value and function.

Researchers believe these small depressions help prevent flooding, recharge groundwater and maintain water quality. "Action to preserve Citronelle ponds is urgently needed," according to Auburn University wetlands specialist George Folkerts. The vast tapestry of wetlands in the Southeast is in jeopardy. Three-quarters of the Carolina bays in South Carolina, for example, have already been disturbed or destroyed by agriculture and timber harvest, according to the U.S. Fish and Wildlife Service. Other wetlands are polluted by lawn, golf course and agricultural runoff, or are being filled for development.

In Barnwell, South Carolina, 76 acres of wetlands on a parcel of land had been federally protected. But the Army Corps of Engineers recently decided that the SWANCC ruling left it with jurisdiction over just 1.7 of those acres. The site has been proposed as a technology park, and the wetlands will likely be destroyed. Similar decisions have been made by the Corps for at least three dozen other sites in the Charleston district alone.

### SPECIES SPOTLIGHT | *Pine Barrens Treefrog (Hyla andersoni)*

**T**he tiny and elusive Pine Barrens treefrogs are one of nature's most colorful amphibians, with a bright green back accented by purple stripes and yellow-orange legs underneath. The frogs' toes have sticky pads suitable for clinging to bark. Hiding under cover and measuring in at just one and a half inches, the frogs can be difficult to find, but they are part of the "hidden biodiversity of the natural world," say biologists at the Savannah River Ecology Lab.

Pine Barrens treefrogs are found in only a few places: the pocosins and sandhills of the Carolinas, shrub habitat in the Florida panhandle and a small area of bogs in Alabama and New Jersey.

They use even the smallest of ponds for breeding, because they are safe there from predation by fish.

Scientists are studying Pine Barrens treefrogs to learn more about the important role amphibians play in wetland ecosystems. To learn where the treefrogs breed, researchers use special tape recorders called "frogloggers."



southeast

# NORTHEAST/ MID-ATLANTIC



THE NORTHEASTERN REGION OF THE UNITED STATES IS HOME TO A MIX OF *northern bogs, woodland vernal pools AND forested wetlands.*

**a** 1990 study of American black ducks demonstrated the importance of preserving a variety of wetland types. University of Maine researchers found that the ducks thrived in large **MARSHES** of dense vegetation near a complex of diverse wetlands.<sup>4</sup> Together, this diversity offers young ducks the diet they need, including bulrush, burreed and sedge, as well as seeds from water lilies and pond weeds. During the breeding season, American black ducks depend on **FORESTED WETLANDS**—swamps of red

maple, ash, cedar, spruce and larch; as well as **SCRUB-SHRUB HABITATS**—bogs and swamps dominated by shrubs and stunted trees. These wetlands offer seclusion and an abundant source of insects and other food critical for hens to produce large clutches of eggs.

**WOODLAND VERNAL POOLS** and other small, temporary wetlands are scattered throughout the region. Because of their temporary nature—reappearing and disappearing from year to year or season to season—it is important to have many such wetlands in close proximity so that wildlife will consistently have available habitat. “If you really were to lose most of the isolated wetlands, you’re talking about major implications for our amphibians,” says conservation biologist James Gibbs of the State University of New York in Syracuse.

"Small wetlands actually serve a whole different segment of the biota."

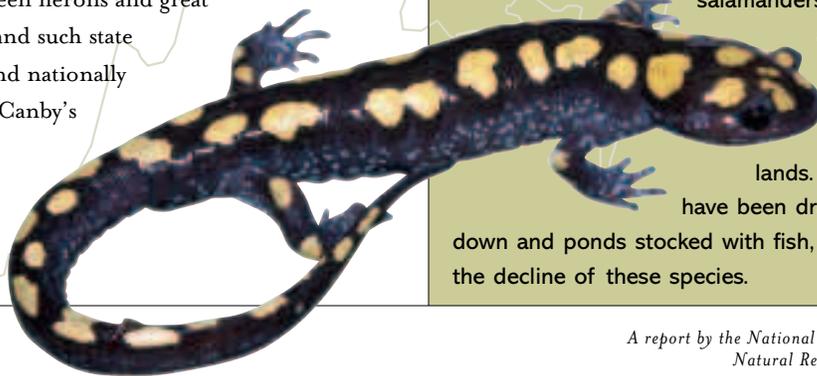
In a study of a single, one-acre pond in eastern Massachusetts, 14,000 adult amphibians were counted. In addition to amphibians, various species of dragonflies, damselflies and many rare turtles inhabit these temporary, isolated pools. Another unusual species, intricate fairy shrimp, exist only in ten small pools in Massachusetts, according to the U.S. Fish and Wildlife Service.

**KETTLE HOLES** and **BOGS**, found from New Jersey's pine barrens through New England, are another feature typical of this region. Fed by groundwater and rain, these small bowls house many rare species of plants, including a wide variety of orchids.

To the south, some 40 percent of the Delmarva Peninsula is covered by forested wetlands, many of them isolated. The sandy soil of the region is heavily farmed, and the leaching of agricultural chemicals, notably nitrates, poses a serious threat to groundwater. Forested wetlands help alleviate this problem by trapping and removing nitrates. According to a study of three regions on the Delmarva Peninsula by the U.S. Geological Survey, forested wetlands are among the most important factors affecting water quality there.<sup>5</sup>

Also in Delaware and Maryland are unusual wetlands known as **DELMARVA BAYS** (sometimes called potholes, kettles, sinkholes, round ponds, black bottoms, loblollies and whale wallows). Like their southern cousin, the Carolina bay, Delmarva bays are elliptical depressions with distinct sandy rims that are flooded in late winter and spring. Over the years, many Delmarva bays have been destroyed for farming; however, Maryland law now affords them special protection. Among the biological treasures dependent upon these small wetlands are nesting colonies of green herons and great blue herons, and such state endangered and nationally rare plants as Canby's dropwort and Harper's sedge.

Amphibian



residents include spring peepers and rare Eastern tiger salamanders.

While the New England states and Maryland have some of the strongest wetland protections in the nation, gaps in those legal protections leave small, isolated wetlands at risk. In other states in the region, many wetlands are in jeopardy.

New York, for example, regulates only those wetlands 12.4 acres or larger or of "unusual local importance." As of January 2002, the Buffalo District of the Corps, citing the SWANCC decision, had renounced its authority over more than 80 acres of wetlands.

In Delaware, such isolated wetlands as vernal pools, **SEA LEVEL FENS** and Delmarva bays currently have no protection.

### SPECIES SPOTLIGHT | *Spotted Salamander (Ambystoma maculatum)*

**A**s the snow melts in spring, spotted salamanders emerge from their underground burrows and migrate to vernal pools or larger ponds. There, for a few nights each year, the salamanders breed, the males rubbing the females with their nose as part of the courtship. The females lay a mass of eggs that hatch in just a few days. As the larvae metamorphose into juvenile salamanders, small pools, free of fish, offer them a safe environment. For the next few years, the young salamanders live on land before reaching sexual maturity and migrating to their natal pond, if possible, for breeding. Some live as long as 30 years, spending most of their lives in the forest, except for their annual breeding migration.

Scientists stress that the spotted salamanders and other amphibians depend on forested areas and small wetlands. Yet, wetlands have been drained, forests cut down and ponds stocked with fish, contributing to the decline of these species.



above: Great blue heron and Calico pennant dragonfly

opposite page: New England bog

n o r t h e a s t / m i d - a t l a n t i c

# GREAT LAKES/ UPPER MISSISSIPPI



MILLIONS OF ACRES OF WETLANDS ARE AT RISK IN THE GREAT LAKES REGION OF THE MIDWEST, INCLUDING *glacial kettle holes, coastal swales, northern peat bogs, prairie potholes,* AND *ephemeral wetlands*. THE REGION PROVIDES IMPORTANT HABITAT FOR WATERFOWL, PARTICULARLY FOR MALLARD DUCKS. BECAUSE OF THIS, DUCKS UNLIMITED FINDS THE POTENTIAL LOSS OF ISOLATED WETLANDS IN THE REGION TO BE ESPECIALLY TROUBLING.<sup>7</sup>

**a**long the Missouri River, researchers found that a mix of wetlands was essential as habitat for map and slider turtles. In warmer months, turtles seek out **SCOURED WETLANDS** (formed as isolated ponds when river levees fail) and **TEMPORARY WETLANDS** in forests and agricultural lands. "Seasonal floodplain wetlands

are some of the most productive freshwater habitats; hence it is likely that turtles move en masse to these habitats from March through August to take advantage of the seasonal flush of productivity," note University of Missouri biologists.<sup>8</sup>

**NORTHERN PEATLANDS**, such as the Lake Agassiz peatlands of northern Minnesota, are an

*Ephemeral wetland*



SPECIES SPOTLIGHT | *Pitcher Plant (Sarracenia purpurea)*

inhospitable environment for many plants and animals, with few nutrients, acidic waters and extreme temperatures. But highly specialized plants, such as sphagnum moss and wild cranberry, have adapted to these conditions. Peatlands are thus a key ecosystem for conservation of biodiversity. They are also habitat for migrating birds and for mammals, from the masked shrew, to beavers, lynx and moose.

**EPHEMERAL WETLANDS** are another valuable feature of the Midwestern landscape. Rainwater in these shallow depressions warms quickly in early spring, producing an abundance of food for wood ducks and other wildlife before other wetlands begin to thaw.

More than 40 percent of Ohio's wetlands might be classified as isolated. One species at risk is the mole salamander, whose prime breeding habitat is **VERNAL POOLS**. Also at risk are the wood frog and chorus frog, and plants such as the Cypress knee sedge.

In Indiana, the Department of Environmental Management estimates that more than one-third of the state's 800,000 acres of wetlands may be classified as isolated. Wetlands at risk include globally rare **DUNE AND SWALE WETLAND COMPLEXES**. These low depressions along beaches and sand dunes are rich aquatic habitats, home to such unique plant species as Houghton's goldenrod, Lapland buttercup and round-leaved orchid.

The Wisconsin Wetlands Association called the SWANCC decision "the worst threat to our state's precious wetland resources for more than 20 years." Before the state legislature had time to pass a new law to protect isolated wetlands, 23 acres had

**T**he pitcher plant, an intriguing carnivorous plant, dines on insects and spiders, and even the occasional small frog. To lure their prey, the plants have a beautiful, seductive exterior. Unsuspecting organisms land on the pitcher's red lip and are drawn downward by nectar-laced veins and fine hairs into a deadly brew of dew, rainwater and digestive enzymes. Despite their propensity for devouring bugs, pitcher-plants actually have a benign relationship with ants, bees and butterflies who savor the nectar without succumbing to the plant's fatal charms.



According to the International Carnivorous Plant Society, 95 percent of wetland habitat for pitcher-plants and other carnivorous plants in the United States has been irretrievably lost. Adding to the problem is the "mining" of peat moss from bogs by the nursery trade and overzealous collecting by plant lovers. Protecting the small portion of remaining habitat is critical to ensuring these unique plants will survive for future generations to enjoy.

already been filled for a new truck stop. But most other states have far less protection. In Illinois, where the SWANCC case originated, Don Hey, of the Wetlands Initiative, says, "We're in a major crisis. I see the effects of [SWANCC] all over the place. In Chicago they're draining and filling wetlands as fast as they can."

missi

**T**he Upper Mississippi Valley region offers a prime example of the role wetlands play in flood control. According to specialists with the Wetlands Initiative in Chicago, writing in the journal *Restoration Ecology*, "It was the rampant drainage of wetlands in the 19th century that gave rise to many of today's water resources management problems."<sup>6</sup> Rivers are now increasingly constrained between levees, and during storms, they become ever deeper, faster-moving torrents. The article notes that the extensive historical drainage of wetlands in the Upper Mississippi basin contributed greatly to the devastating floods of 1993 that caused \$16 billion in damage. Rather than continuing to drain wetlands and construct ever higher levees in the region, many scientists urge restoration of a vast network of wetlands. This strategy is far less expensive than paying the annual cost of flood damage.



# THE GREAT PLAINS



SCATTERED THROUGH THE ROLLING GRASSLANDS OF THE GREAT PLAINS IN THE UNITED STATES AND CANADA ARE MILLIONS OF SHALLOW BASINS KNOWN AS *prairie potholes*.



**t**he prairie pothole region provides essential habitat for North America's waterfowl. **PRAIRIE POTHOLE**s offer birds shelter for breeding, as well as a rich diet of insects and other invertebrates, a major source of protein for nesting hens. The region is the primary breeding ground for 40 percent of North America's dabbling ducks, including mallards, northern pintails, American widgeons, gadwall, northern shoveler and teals, as well as such diving ducks as the canvasback and ring-necked duck. In addition, prairie potholes are a major refueling station for 36 species of migrating shorebirds, including 13 species that breed there.

In addition to birds, prairie wetlands support such furbearers as mink and muskrat, as well as game animals and many species of non-game wildlife. The economic value of hunting, fur harvest and live bait production provided by these wetlands is substantial.

Historically, however, prairie potholes have been regarded as nuisance areas—obstacles to agricultural production. As a result, more than 95 percent of Iowa's wetlands have been drained, as have 53 percent of wetlands in Minnesota, 35 percent in South Dakota, and 60 percent in North Dakota. Now this precious resource faces a new threat from the SWANCC decision.

According to the U.S. Fish and Wildlife Service, temporary or small potholes, less than one acre in size, represent 87 percent of the 2.7 million potholes remaining in the Dakotas and north-eastern Montana. If these small wetlands were drained, the breeding duck population would decline by an alarming 72 percent, according to projections. Populations of shorebirds and marsh birds would also be severely affected if these isolated wetlands were destroyed.

Loss of wetland protection in the prairie pothole region is especially troublesome given the role of this area in the recent recovery of North American duck populations, according to a recent report by Ducks Unlimited.<sup>9</sup>

Prairie potholes are not the only isolated wetlands at risk in the Great Plains. So too are **GRASSED WATERWAYS, EPHEMERAL STREAMS, CUTOFF OXBOWS FROM RIVERS, SALINE SEEPS** and **MUDFLATS**.

Of particular concern in the southern Great Plains is the loss of **RAINWATER BASINS, SALINE WETLANDS** and **SANDHILLS WETLANDS** in Nebraska. Nebraska alone has nearly 829,000 acres of wetlands that might be considered isolated, according to the state Game and Parks Commission. These unusual wetlands are being replaced with car dealerships, condominiums, roads and houses.

Rainwater basins, clay-bottom depressions that catch and hold precipitation, attract 5 to 7 million ducks and geese annually, including 90 percent of the mid-continent population of greater white-fronted geese and 50 percent of mallards.<sup>10</sup> As with prairie potholes, hundreds of thousands of shorebirds pass through in the spring on their migrations between points as distant as Tierra del Fuego at the southern tip of South America and the



SPECIES SPOTLIGHT | Pintail Duck (*Anas Acuta*)

**P**intail ducks are frequent visitors to the Prairie Pothole region. The bird is named for the male's pointed tail, which can grow as long as ten inches. Described as "supreme table fare," pintails have long been prized by hunters. Their harvest is now strictly limited by most of the states over which they fly.

Birdwatchers are also long-time admirers of pintails, as this account from a May 1898 issue of *Birds & Nature* describes: "They move about with a graceful motion of the head, and with tail partially erect, and upon the land step off with a dignity of carriage as if impressed with the thought that they are no common Duck."<sup>15</sup>

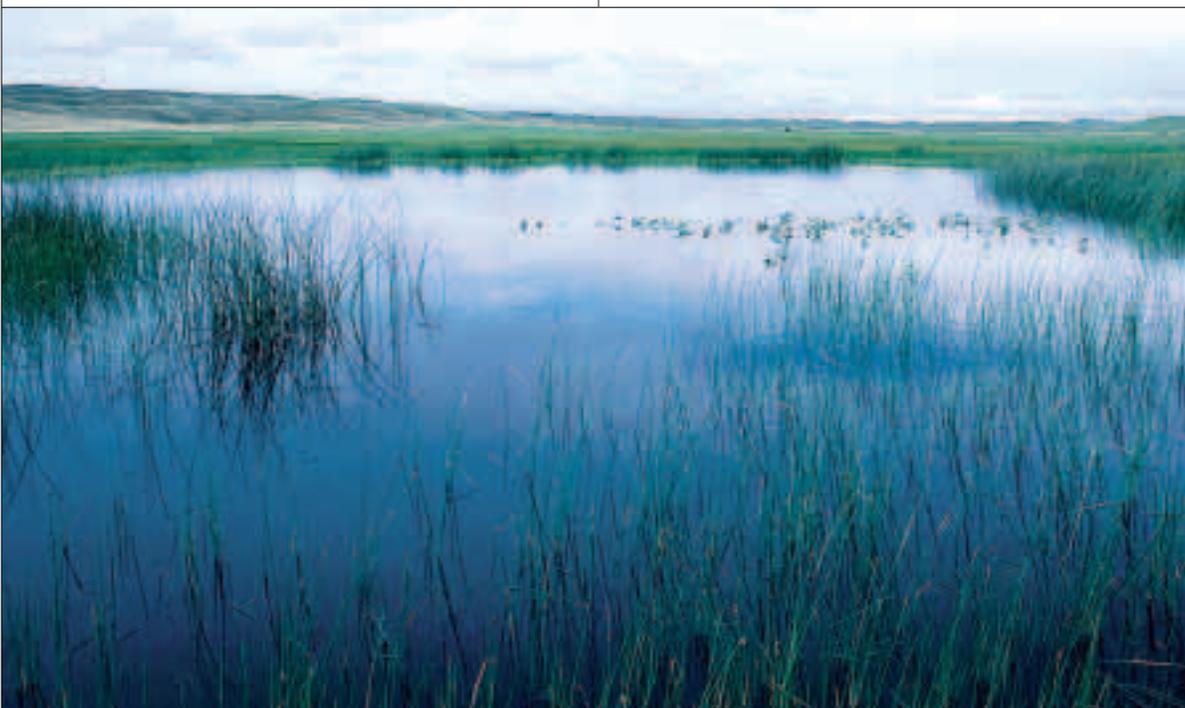


Canadian and Alaskan arctic. Rainwater basins are especially important habitat for the endangered whooping crane.

Only one-quarter of Nebraska's original 100,000 rainwater basins remain. Many more may soon be lost, according to biologists with state and federal agencies. In the first year after the SWANCC ruling, property owners were permitted to destroy 40 wetlands in Nebraska, because the Army Corps of Engineers no longer claimed jurisdiction. In addition, an untold number are being drained or filled

without owners even bothering to seek permits. "Any that we lose are important because there are just a few left," says Corps biologist Mike Rabbe. Eastern saline wetlands, considered critically imperiled in Nebraska, are also being destroyed. These wetlands, containing salt deposits from an ancient sea, are home to many rare plants and invertebrates, including the endangered tiger beetle. "A lot of our work is pretty much down the tubes," says Rabbe. The SWANCC decision "was a major loss for wetlands."

the great plains



Sandhills wetlands, Nebraska



PERHAPS NOWHERE ARE WETLANDS MORE CRITICAL THAN IN THE ARID SOUTHWEST AND SOUTHERN PLAINS OF TEXAS. ALONG THE VAST SOUTHERN HIGH PLAINS OR *Llano Estacado* PLATEAU OF TEXAS AND NEW MEXICO ARE SOME 22,000 SHALLOW ROUND BASINS, KNOWN AS PLAYAS. "WHEN INUNDATED, THE [PLAYA] BASINS FORM SHALLOW LAKES AND WETLANDS THAT SIGNIFICANTLY INCREASE PLANT AND ANIMAL DIVERSITY IN AN INTENSIVELY CULTIVATED LANDSCAPE."<sup>11</sup>

**P**LAYAS serve a number of critical functions for people and for wildlife. Dry much of the year, they fill during rainstorms in May through September. This dynamic change between dry and wet enables playas to capture more rainwater, helping to control flooding.

Playas also replenish the Ogallala Aquifer, the only source of water on Llano Estacado.

The aquifer is critical to human settlement in the area, but its recharge rate is lower than the amount of water extracted for public use and agriculture. If playas are depleted, the water shortage will become critical.

The playa lake region also offers critical habitat for waterfowl, shorebirds, raptors and other migratory birds. Some 2 million ducks winter in the region. An estimated 400,000 to 500,000 sandhill

cranes and similar numbers of geese do the same. Between 12 and 15 million migrating birds are estimated to rest and refuel around playas.

According to one team of researchers, "Playas are clearly responsible for the abundance and presence of wildlife in an intensively cultivated region four times the area of Massachusetts."<sup>12</sup>

In the absence of playas, amphibians could not survive in the region. Playas are also one of the last refuges for native plants, which have been sharply reduced by agricultural applications of insecticides, herbicides and fertilizer.

The playas themselves are seriously threatened by pollution as well. According to John Horning of the nonprofit group Forest Guardians, "Industries, the military and even cities have been treating the playa lakes of southern New Mexico like private dumping grounds." The result is that many playa lakes have become so toxic that thousands of migratory birds have died on their shores. Forest Guardians initiated legal action in 2000 against four of the area's worst polluters, but the SWANCC decision has undercut the litigation, because the lakes are now considered isolated and thus exempt from the Clean Water Act.

Despite their importance, playas have not been protected by state statute either. Texas and New Mexico do little to regulate activities that have an impact on playas.

Other isolated wetlands in the region are important to the ecosystem as well. The Cimarron Terrace of North Central Oklahoma has **POTHOLE-TYPE WETLANDS** used by migratory birds, including waterfowl. And along the Texas coast, **DEPRESSIONS** have been formed between wind-swept dunes. As the depressions fill with water, a variety of sedges take hold, creating habitat for shorebirds, ducks and raptors.

These wetlands play a significant role in bringing hunters, ecotourists and birdwatchers to coastal Texas, generating hundreds of millions of dollars for the state's economy. According to statistics cited in a 1997 study by the U.S. Fish

and Wildlife Service regional office in New Mexico, "In 1991, the economic impact of waterfowl hunting and nonconsumptive waterfowl use in Texas was about \$96 million and \$240 million respectively... In the spring of 1992, about 6,000 birdwatchers poured into tiny High Island in eastern Galveston county," generating \$4 to \$6 million over a two-month period. These activities and revenue will suffer if isolated wetlands are lost.

Wetland losses are already occurring in the wake of SWANCC. In Bayport, Texas, all but 2.5 acres of a 100-acre wetland site were recently classified by the Corps as isolated—and thus not protected—even though the wetlands are connected by a series of ditches to a tidal creek. The site, along the shoreline of Galveston Bay, is now being developed as a port. Conservationists are challenging the classification.



Sandhill cranes on the Llano Estacado.

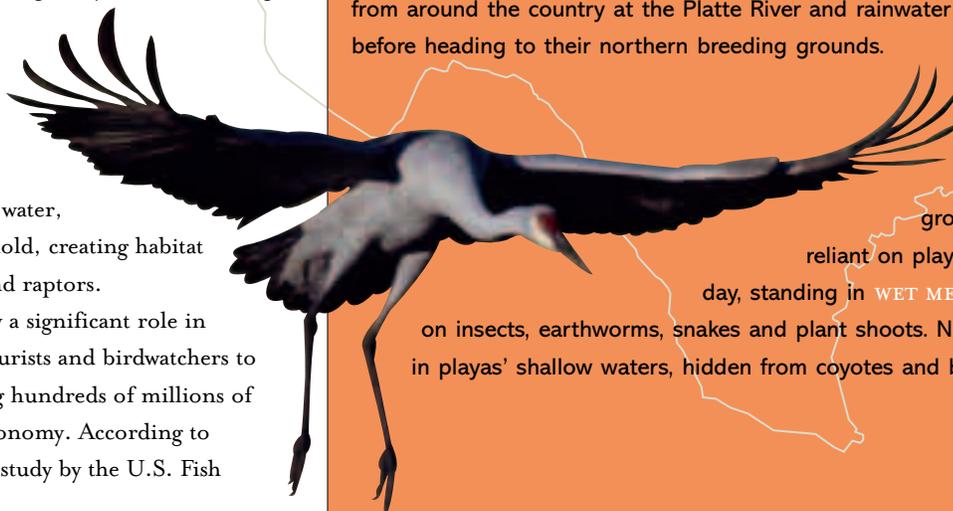
south  
we

## SPECIES SPOTLIGHT | Sandhill Crane (*Grus canadensis*)

An ancient species, the sandhill crane stands nearly four feet tall, with a six-foot wingspread. Its trumpeting call, heard for a mile, often announces its arrival. The cranes are a welcome sight in the Southwest, with many farmers leaving corn standing in the fields to encourage these gangly visitors. The cranes are best known for their bizarre dancing rituals. The birds choreograph a complex minuet, circling, bowing, hopping in the air, pirouetting and fluttering their wings. At times, a pair may both throw back their heads and "sing" a lusty duet. So strong is the dance instinct that a five-day-old chick will leap up and down and go through the motions.

In the spring, sandhill cranes fly hundreds of miles, converging with flocks from around the country at the Platte River and rainwater basins in Nebraska, before heading to their northern breeding grounds.

As marshland disappears, the cranes have grown increasingly reliant on playa lakes. During the day, standing in **WET MEADOWS**, they gorge on insects, earthworms, snakes and plant shoots. Nightfall finds them in playas' shallow waters, hidden from coyotes and bobcats.



# WEST/GREAT BASIN



A KEY WETLAND ECOSYSTEM THAT SUPPORTS GREAT BIODIVERSITY IS THE *California vernal pool*. THESE SEASONAL WETLANDS FILL WITH SPRING RAINS, REMAINING SOGGY FOR A SHORT PERIOD OF TIME, BEFORE DRYING OUT IN THE SUMMER.

DURING THE SPRING GROWING SEASON, THE POOLS BURST WITH CONCENTRIC RINGS OF WILDFLOWERS IN A VIRTUAL RAINBOW OF COLORS. BOTANISTS HAVE IDENTIFIED 200 SPECIES OF PLANTS IN CALIFORNIA VERNAL POOLS, INCLUDING 70 THAT CAN BE FOUND NOWHERE ELSE. VERNAL POOLS ALSO SUPPORT THE CALIFORNIA TIGER SALAMANDER AND SUCH TINY CRUSTACEANS AS THE RED-TAILED FAIRY SHRIMP.



*opposite page, top: Desert pupfish in a Nevada desert spring swim alongside exotic fish that threaten their survival.*

*opposite page, bottom: Vernal pool goldfields is a member of the sunflower family that is native to the vernal pools of California.*

California's Great Central Valley was once filled with millions of such vernal pools. A scant ten percent remain. In San Diego County, just three percent are left. Their loss affects the ecology of the region in ways scientists are only beginning to understand.

Whether California vernal pools will be classified as isolated and lose federal protection remains in question. Conservationists argue that most vernal pools—like many other types of wetlands that are considered isolated—are connected hydrologically to other waters. Spring rains flow from the vernal pool complexes into swales, channels, streams and tributaries, eventually reaching interstate navigable waters.

But the future of these vernal pools is in doubt. After years of being drained for agriculture, they are now threatened by urban and industrial development. Concerns have been raised about how a new University of California campus to be built in Merced and a retired air base in Sacramento slated for development will harm vernal pools in the region.

At the close of the last Great Ice Age, catastrophic floods scoured out an area from what is now Montana to the Washington coastline. Among the remarkable land formations that were carved in the black basaltic rock were the Channeled Scablands of southeastern Washington. This unique ecosystem

contains myriad wetlands, supporting a host of species, many of which can be found nowhere else.

In the spring, the shallow waters of **SEASONAL WETLANDS** are prime feeding grounds for migrating waterfowl and shelter for bonding pairs of resident mallard and pintail ducks. Every August, hundreds of thousands of shorebirds including sandpipers, dunlins and avocets arrive. Because of the unusual topography and wildlife, the area draws tourists, hunters, birdwatchers and nature lovers.

The most important role of Channeled Scablands, though, is to support biodiversity,



**SPECIES SPOTLIGHT** *Howellia*  
(*Howellia aquatilis*)

**H**owellia is one of many lovely flowering plants that can survive only in small seasonal wetlands with fluctuating dry-wet conditions. In the fall, Howellia seeds, which must be exposed to air to germinate, lie on the dry pond bed before over-wintering as seedlings. In spring, as the pond fills up, the plant flowers appear as closed buds underwater. In late spring, when the plant reaches the water's surface, it produces a showy display of delicate white blossoms. Howellia, found only in small wetlands in California, Montana, Idaho and Washington, is listed by state and federal governments as a threatened species. Among the threats to its survival: loss of wetland habitat, invasion by noxious weeds, livestock grazing and timber harvest on adjacent uplands.

particularly in the many small vernal pools. Among the plants are rare species of monkey-flower, downingia and the threatened inch-high rush. The unique Great Basin spadefoot toad also depends on these wetlands. The only amphibian adapted to a desert environment, the toad lives in burrows, emerging during rainy periods to eat and breed in temporary pools.

Isolated wetlands in this region also serve as habitat for bats, which feed on swarms of mosquitoes, stoneflies and mayflies.

This important network of wetlands is threatened by development along the basalt hillsides. Development in isolated wetlands can have consequences in addition to loss of wildlife habitat: in Spokane, homes built on top of vernal wetland systems are now plagued with flooding problems.

Another unusual mix of Western wetlands can be found in the Great Basin region. The arid area gets fewer than ten inches of rain a year, but for short periods in the winter and spring, a network of small wetlands hold water. **LAKES, FLATS** (also called **PANS**), **BASINS AND MARSHES** are especially critical for a few key species of migrating birds. For example, Wilson's phalarope, a shorebird, doubles its body weight feeding along alkaline flats before making a three-day, 3,000 mile nonstop flight to South America.

**SALT FLATS** along California's Salton Sea provide habitat for the endangered Yuma clapper rail and for breeding white pelicans.

A rich mix of rare, threatened and endangered species also depend on **DESERT SPRINGS** and their associated wetlands. Underground water reserves percolate through rock fractures, creating habitat for unusual animals and plants, including the tiny pup fish and Ash Meadows milk vetch.

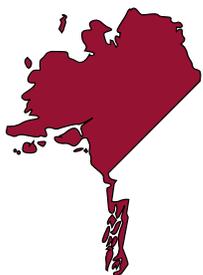
Development pressures may be more intense in the West than anywhere else in the nation. That, combined with the dry climate in many areas, make protection of these wetlands especially urgent.



west/great basin



# ALASKA



ALASKA HAS MORE WETLAND ACREAGE THAN THE OTHER 49 STATES COMBINED—SOME 175 MILLION ACRES. WETLANDS COVER MORE THAN 40 PERCENT OF ALASKA, COMPARED TO FIVE PERCENT OF LAND COVERED BY WETLANDS IN THE LOWER 48 STATES.

According to the U.S. Environmental Protection Agency, “Alaska’s diverse array of wetlands possess a variety of functions and values that contribute substantially to the nation’s economy and well being.” Of this rich mix of **BOGS**, **FENS**, **TUNDRA**, **FORESTS**, **FLATS** and **MARSHES**, more than 33 million acres, or 19 percent, are at risk of being classified as isolated.

One of the most important types are **BASINS** found on former floodplains in interior Alaska. Over the centuries, as the Yukon, Kuskokwim and other rivers have shifted their channels, the historic

floodplains left behind isolated lakes, ponds, marshes and bogs. Natural levees surround poorly drained sites dominated by low shrubs and scrub black spruce. Many of these wetlands are vitally important to wildlife. The Yukon Flats, for example, where the historic floodplain is more than 15 miles wide, supports some of the most valuable nesting habitat in the state. More than a million ducks come to breed each year.

Bogs are common in the southeast, south-central and interior regions of the state. The Anchorage area, where nearly half of Alaskans live,



*Patterned peatlands are formed by ridges of peat separated by long, shallow pools.*

is dotted with **KETTLE HOLE BOGS**. These wetlands are popular sites for outdoor education, wildlife viewing and photography. In addition, Native village populations depend on bogs as an essential food source. Villagers with a subsistence lifestyle hunt the bogs' waterfowl and harvest cranberries and blueberries from them.

Another type of isolated wetland unique to Alaska is tundra—shallow waters formed during the spring thaw in the treeless plains of the Arctic. These wetlands offer vital breeding habitat for swans, geese, shorebirds, raptors, songbirds and many migrating species. Proposals to allow oil drilling along the coastal plain of the Arctic National Wildlife Refuge have sparked outrage among conservationists because of the extreme biological value of this area, which is 90 percent wetland. The coastal plain of the refuge attracts millions of birds of 135 species. These birds originate from four continents and every state in the union, except Hawaii. The coastal plain also serves as the primary calving ground of the porcupine caribou herd, because it is nutrient rich and relatively free of predators.<sup>13</sup>

How these tens of millions of acres of wetlands and the wildlife they support will be affected by the



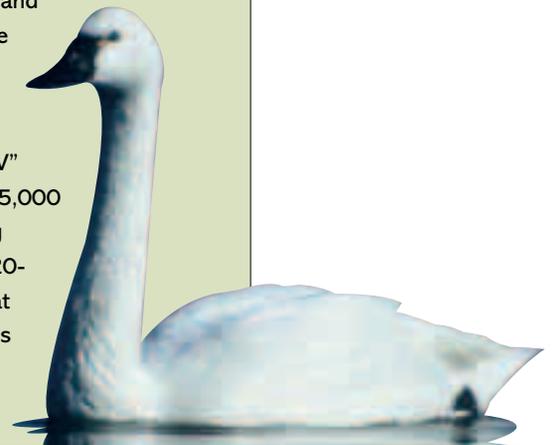
SWANCC decision remains to be seen. However, by May 2002, the Corps had already issued notices to developers of 14 wetland sites in the Anchorage area that no permit would be required to destroy these valuable systems.

alaska

### SPECIES SPOTLIGHT | *Tundra Swan (Cygnus columbianus)*

**W**ith a wing span of seven feet, the tundra swan is one of the most magnificent birds of North America. Tundra swans breed in the marshes and ponds of Alaska and the Canadian Arctic, building large nests of grasses, sedge, reeds, moss and feathers, and feeding on aquatic plants, often in isolated wetlands. Typically the birds, which mate for life, return each year to their old nests. The birds have only a few short months to find a nesting site, lay eggs, hatch their young, and nurture the babies until they are large enough to make the long migration flight. At the same time, the adults must fatten up and undergo their annual molt. All this must be completed by September, when many small wetlands begin icing up.

The migration of tundra swans is one of the great epic stories of nature. Flying in a “V” formation, the swans cruise at an average speed of 30 miles per hour and as high as 5,000 feet before reaching the Chesapeake Bay region and the Carolinas by November. Young swans stay close to their parents, learning the route they will follow throughout their 20-year life span. Along the way, swans rely on isolated wetlands in the Midwest and Great Lakes as staging areas for refueling for the long journey south. In mid-March, the swans once again take to the sky to begin the trek back to their Alaskan breeding grounds.



# HAWAII



HAWAII HAS MORE ENDANGERED SPECIES THAN ANY STATE IN THE NATION, MOSTLY DUE TO HABITAT LOSS. THIS LOSS INCLUDES 30 PERCENT OF THE STATE'S WETLANDS. ACCORDING TO DUCKS UNLIMITED, THE NUMBER OF WINTERING WATERFOWL HAVE DROPPED FROM 40,000 PRIOR TO THE 1940S TO JUST 1,000 IN 1990.<sup>14</sup>

Anchialine Pond



on coastal lava fields and are connected to the ocean through underground cracks.

Among the endangered species living in anchialine ponds are red shrimp that feed off algae clinging to rocks. The tiny shrimp can colonize hundreds of acres, migrating from pond to pond through fissures in the rock.

Also dependent on the ponds are Hawaii's endangered waterbirds and waterfowl and many migratory birds.

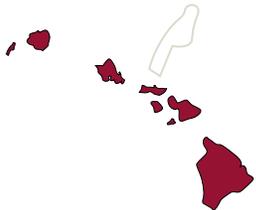
Anchialine ponds and other coastal wetlands are being filled and replaced with houses and shopping centers, as development pressures along the coast continue.

High in the island mountains lies a completely different kind of wetland—montane bogs. These bogs, found on perched flat areas at elevations of 3,000 to 5,000 feet, are home to many rare plants and forest birds, such as the kaloha duck.

Although montane bogs are too inaccessible to be affected by development, they face other threats, including feral pigs and goats that destroy the wetlands, and invasive plant species.

**h**awaii's wetlands include two unusual types that may be classified as isolated: **ANCHIALINE PONDS** and **MONTANE BOGS**.

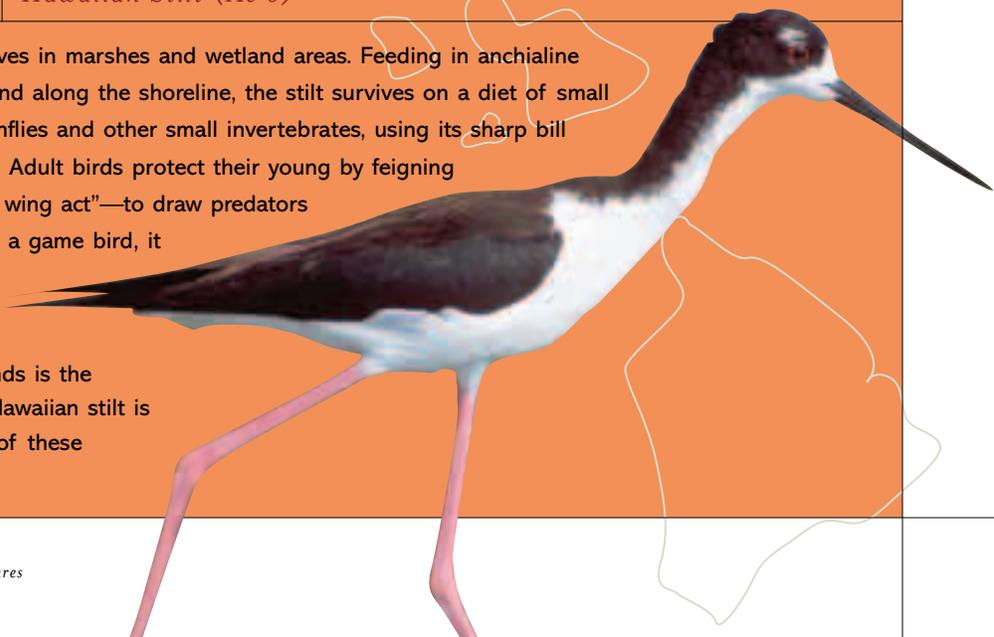
Anchialine ponds are brackish, mixing fresh water from the mountains with seawater. They occur



## SPECIES SPOTLIGHT | Hawaiian Stilt (Ae'o)

**T**he Hawaiian stilt lives in marshes and wetland areas. Feeding in anchialine ponds, mud flats and along the shoreline, the stilt survives on a diet of small fish, worms, dragonflies and other small invertebrates, using its sharp bill to crack open crab shells. Adult birds protect their young by feigning injury—using “the broken wing act”—to draw predators away from the nest. Once a game bird, it has been protected from hunting since 1941.

Today, drainage of wetlands is the primary reason why the Hawaiian stilt is endangered. Only 1,500 of these lovely birds remain.



top of page: Red Shrimp ('opae'ula), graze algae from anchialine pools, leaving a beautiful orange cyanobacterial crust. If the shrimp are eliminated by introduced fish, green filamentous algae overtakes the pools.



## CONCLUSION

AMERICA'S WIDELY DIVERSE WETLANDS ARE A RICH AND VITAL RESOURCE FOR PEOPLE AND WILDLIFE. THEIR VALUE TO WILDLIFE AND HUMANS IS UNRELATED TO WHETHER THEY ARE SMALL, OR LARGE; SEASONALLY OR PERMANENTLY FLOODED; "ISOLATED" OR NEXT TO A RIVER.

Each wetland has unique characteristics, functions and values that must be protected in order to preserve the wildlife and wild places in our world, and the water resources upon which humans depend. "Things that isolated wetlands do, we take for granted," says Ben Tuggle, Chief of the Habitat Conservation Division of the U.S. Fish and Wildlife Service. "It is so easy to overlook isolated wetlands—until we have a major flood."

Even those states or local jurisdictions with strong wetland protections in place are harmed by the SWANCC decision. When federal protection is eliminated, cash-strapped local governments are forced to foot the bill for maintaining environmental

standards. Yet wetlands are a national (and even international) resource. A patchwork of local and state protections cannot ensure the future survival of wetland-dependent migratory birds that fly thousands of miles, crossing entire continents. The damage caused by wetland destruction—increased water pollution and flooding and decreased groundwater recharge—is not restricted to one state. Local communities, states and the U.S. Congress must act quickly to ensure the future of the nation's imperiled wetland treasures, or they will be lost forever. The inevitable result will be increased flooding, more water pollution and greater loss of wildlife habitat and biodiversity. We will all be the poorer for it.

*top of page: Shorebirds complete incredible annual migrations of up to 20,000 miles roundtrip.*

## ENDNOTES

1. Robinson, Ann. 1995. Small and seasonal does not mean insignificant: why it's worth standing up for tiny and temporary wetlands. *Journal of Soil and Water Conservation* November/December: 588.
2. Robinson, p. 588.
3. Semlitsch, Raymond. 2000. Size does matter: the value of small isolated wetlands. *National Wetlands Newsletter* January/February: 6.
4. Frazer, Catherine, Longcore, Jerry R., McAuley, Daniel G. 1990. Habitat use by postfledging American black ducks in Maine and New Brunswick. *Journal of Wildlife Management* 3:451-459.
5. Phillips, Patrick J., Denver, Judith M., Shedlock, Robert J., Hamilton, Pixie A. 1993. Effect of forested wetlands on nitrate concentrations in ground water and surface water on the Delmarva Peninsula. *Wetlands, Special Issue*, 13(2):75-83.
6. Hey, Donald L., Philippi, Nancy S. 1995. Flood reduction through wetland restoration: the Upper Mississippi River Basin as a case history. *Restoration Ecology* 3(1):4-17.
7. Petrie, M., Rochon, J., et. al. 2001. The SWANCC decision: implications for wetlands and waterfowl. Ducks Unlimited, Inc. pp. 44-45.
8. Bodie, J. Russell, Semlitsch, Raymond D. 2000. Spatial and temporal use of floodplain habitats by lentic and lotic species of aquatic turtles. *Oecologia* 122:138-146.
9. Petrie, p. 47.
10. Robinson, p. 589.
11. Bolen, Eric G., Smith, Loren M., Schramm, Harold L. Jr. 1989. Playa lakes: prairie wetlands of the Southern High Plains. *BioScience* (9):615-622.
12. Bolen, et al., p. 619.
13. Adams, Jim. 2002. Controversy on Alaska's Coastal Plain. *National Wetlands Newsletter* 24:1 p.1.
14. Ducks Unlimited Inc. website. <http://www.ducks.org/conservation/hawaii.asp>
15. The Pintail Duck, *Birds & Nature*, May 1898, Vol. III, No. 5, May, 1898, at [www.birdnature.com](http://www.birdnature.com).

## OTHER SOURCES

- Butcher, Gregory S., Zimpel, Brenda of Cornell Laboratory of Ornithology. 1991. Habitat value of isolated waters to migratory birds: an annotated bibliography," prepared for U.S. EPA Office of Wetlands Protection, April 9, 131 pp.
- Coleman, Dorcas. Delmarva bays—natural enigmas, Maryland Department of Natural Resources, [www.dnr.state.md.us/naturalresource/spring2001/delmarvabays.html](http://www.dnr.state.md.us/naturalresource/spring2001/delmarvabays.html).
- Dodd, C. Kenneth. Reptiles and amphibians in the endangered longleaf pine ecosystem, <http://biology.usgs.gov>.

- Folkerts, George W. 1997. Citronelle ponds: little-known wetlands of the Central Gulf coastal plain, USA. *Natural Areas Journal* 17(1):6-16.
- Gibbs, James P. 2000. Wetland loss and biodiversity conservation. *Conservation Biology* 11(1): 314-317.
- Gren, Ing-Marie, Folke, Carl, Turner, Kerry, Batemen, Ian. 1994. Primary and secondary values of wetland ecosystems. *Environmental and Resource Economics* 4:55-74.
- Groffman, Peter M. 1994. Denitrification in freshwater wetlands. *Current Topics in Wetland Biogeochemistry* 1:15-35.
- Gustafson, Sarah Steinberg. 1990. *Ephemeral Edens. Pacific Discovery*, Spring:23-32.
- Haukos, David A., Smith, Loren, M. 1992. *Ecology of playa lakes. Waterfowl Management Handbook*, U.S. Fish and Wildlife Service leaflet 13.3.7: 7 pp.
- Hubbard, Daniel E. 1988. Glaciated prairie wetland functions and values: a synthesis of the literature, US Fish and Wildlife Service, *Biological Report* 88 (43):50 pp.
- Kantrud, Harold, et al. 1989. Prairie basin wetlands of the Dakotas: a community profile. US Fish and Wildlife Service, *Biological Report* 85(7.28) 110 pp.
- LaClaire, Linda V. 1990. Importance of isolated wetlands in upland landscapes. *Florida Lake Management Society Proceedings of 2nd Annual Meeting*. 15 pp.
- LaGrange, Ted. 1997. Guide to Nebraska's wetlands and their conservation needs. Nebraska Game and Parks Commission.
- Lannoo, Michael J. 1998. The decline in amphibian populations. *National Wetlands Newsletter* 20(1):13-17.
- Mitsch, William J., Gosselink, James G. 2000. *Wetlands*, John Wiley & Sons, Inc. 920 pp.
- Moulton, D.W., Dahl, T.E., Dall, D.M. 1997. Texas coastal wetlands—status and trends, mid-1950s to early 1990s. Texas Parks & Wildlife and U.S. Fish and Wildlife Service. 32 pp.
- Richardson, Curtis J. 1983. Pocosins: vanishing wastelands or valuable wetlands? *BioScience* 33(10):626-633.
- Skagen, Susan K., Thompson, Genevieve. 2001. Northern Plains/Prairie Potholes Regional shore-bird conservation plan, version 1.0. prepared by US Geological Survey and National Audubon Society.
- Snodgrass, Joel W., Komoroski, Mark J., Bryan, A. Lawrence Jr., Burger, Joanna. 2000. Relationships among isolated wetland size, hydroperiod and amphibian species richness: implications for wetland regulations. *Conservation Biology* 14(2):414-419.
- Witham, C.W., Bauder, E.T., Beik, D., Ferren, W.R., Jr., Ornduff, R. (Editors). 1998. *Ecology, Conservation and Management of Vernal Pool Ecosystems—Proceedings from a 1996 Conference*. California Native Plant Society. pp 1-14.

## PHOTO CREDITS

- Page 1 Green-backed heron, NEBRASKAland Magazine/Nebraska Game and Parks Commission
- Page 2 Smartweed, NEBRASKAland Magazine/Nebraska Game and Parks Commission
- Page 3 Yellow-headed blackbird, Natural Resource Conservation Service  
Red eared turtles, Natural Resources Conservation Service  
Red head ducks, Thomas Dahl, U.S. Fish and Wildlife Service
- Page 4 Forested wetland, Thomas Dahl, U.S. Fish and Wildlife Service
- Page 5 Flatwoods salamander, John Jensen  
Pine barrens tree frog, John Jensen
- Page 6 New England bog, Thomas Dahl, U.S. Fish and Wildlife Service
- Page 7 Great blue heron, Julie Sibbing  
Calico pennant dragonfly, Blair Nikula  
Spotted salamander, John Jensen
- Page 8 Ephemeral wetland, Thomas Dahl, U.S. Fish and Wildlife Service
- Page 9 Pitcher plants, John Ritzenthaler  
Flooding in Minnesota, Federal Emergency Management Agency
- Page 10 Prairie pothole wetlands, M. Colby
- Page 11 Pintail duck, R. & S. Day/VIREO  
Sandhills wetlands, NEBRASKAland Magazine/Nebraska Game and Parks Commission
- Page 12 Playa lake, Tom Cloud
- Page 13 Sandhill cranes, Wyman Meinzer  
Sandhill crane, A. Morris/VIREO
- Page 14 California vernal pool, Carol Witham/vernalpools.org
- Page 15 Pupfish, Peter Unmack  
Howellia, Kristi DuBois  
Vernal pool goldfields, Carol Witham/vernalpools.org
- Page 16 Alaskan marsh, Allen Prier/Accent Alaska.com
- Page 17 Patterned peatlands, Allison Aldous  
Bull moose in wetland, Allen Prier/Accent Alaska.com  
Tundra swan, A. Morris/VIREO
- Page 18 Anchialine pond, R.A. Englund  
Red shrimp, R.A. Englund and D.J. Preston  
Hawaiian stilt, Peter LaTourrette
- Page 19 Shorebirds, Julie Sibbing  
Flooding, Federal Emergency Management Agency
- Inside MN Flooding, Federal Emergency  
back cover Management Agency  
Vernal pool goldfields, Carol Witham/vernalpools.org  
Boreal bluet damselfly, Blair Nikula
- Back cover Horses in playa lake, Wyman Meinzer  
Nevada desert spring, Tom Webster  
Pitcher plants, Ohio Department of Natural Resources