Wetlands are areas where the water table is at or near the surface, or the land is saturated or covered by shallow water for at least part of the growing season. These ecosystems support communities of plants and animals that are specialized to tolerate wet conditions. Although Illinois experienced significant losses in wetland area historically, the wetlands that remain are vitally important. Wetlands provide services like water purification, ground water improvement and flood abatement. They are also essential for maintaining biodiversity in Illinois; 40% of the state’s threatened and endangered species require wetlands for habitat (Figure 1).

The Critical Trends Assessment Program (CTAP) studies Illinois wetlands, monitoring their biological condition and tracking changes through time. This paper will:

- Provide information on Illinois wetland communities and their history
- Describe the condition of Illinois wetlands using the CTAP data
- Highlight three major issues facing Illinois wetlands and the role CTAP is playing in researching these issues
- Provide recommendations and resources for wetland conservation

**FIGURE 1.** (a) Wetlands like this one from Iroquois County are critical for wildlife. Some of Illinois’ threatened and endangered species that require wetlands for habitat include the (b) fringed white prairie orchid (*Platanthera leucophaea*) and (c) blanding’s turtle (*Emydoidea blandingii*).
Between about 1.6 million and 13 thousand years ago, Illinois was repeatedly scoured and scraped by advancing and retreating glaciers. This profoundly shaped most of the Illinois landscape, laying the foundation for how water would flow and where it would pool. The diversity and distribution of naturally occurring wetlands in Illinois are therefore largely a product of these glaciation events.

The naturally occurring wetlands of Illinois can be broadly classified into two types based on whether they accumulate peat—soil that is composed largely of organic material. Peat accumulating wetlands are typically found in Northeastern Illinois. Bogs, which derive all of their water from precipitation and have no significant outflows (Figure 2a). These wetlands support sphagnum mosses and acidic soils, allowing for deep layers of peat to accumulate. Fens are also peat-accumulating wetlands, but receive groundwater from mineral-rich soils (Figure 2b). This makes the soil in fens basic or pH neutral rather than acidic, and gives them their own characteristic vegetation.

While peat accumulating wetlands are relatively rare in Illinois, wetlands with mineral soils (i.e., soils with less organic matter) are more widespread. These wetlands can be distinguished by their hydrology. Wet meadows exist in saturated soils, but are usually not inundated for long periods of time (Figure 2c). This allows for the development of a diverse community of grasses, sedges and broad leafed herbaceous plants (called forbs). Marshes are frequently inundated with standing water for longer periods of time than wet meadows, restricting their plant communities to a few specialist species that can handle soil conditions that develop under continuous inundation (Figure 2d). The most common types of wetlands in Illinois are those associated with river and stream corridors. These include floodplain forests (Figure 2e), which accept discharge from flooding rivers and play an important role in flood abatement.

**FIGURE 2.** Wetlands in Illinois are diverse. Some of the wetland types found within the state include (a) bogs, (b) fens, (c) wet meadows, (d) marshes, and (e) floodplain forests.
In the 1780s Illinois had 3,323,000 hectares of wetland within its boundaries. Over the following two centuries, the vast majority of these wetlands would be drained for agriculture and development. By the 1980s, only 15% of the original wetland area remained in Illinois.

In the 1970s, the realization that wetlands provide many essential ecosystem services motivated political movements to protect wetlands. This resulted in the development of many wetland protection policies throughout the 1970s and 1980s. Broadly, these policies recognize that draining wetlands should be avoided, but when unavoidable, damages should be minimized and offset by restoring or creating wetlands elsewhere. The restoration and creation of wetlands to offset damages elsewhere is called wetland mitigation. Mitigation wetlands now dot the Illinois landscape, but questions linger about whether they function like and provide the same ecosystem services as the natural wetlands they are replacing. These questions remain a focus of scientific research.

In spite of the laws and policies put in place to protect wetlands, these valuable ecosystems continue to be threatened. Throughout Illinois, wetland ecosystems are changing in response to pressures from a wide variety of sources, such as industrial and agricultural pollution, sprawling development, invasive species, and climate change.

In 1997, CTAP began an ongoing, statewide survey of wetlands to document their condition and develop a deeper understanding of how these communities are changing. Researchers are using the CTAP dataset to draw inferences about the nature of these changes, and the conclusions they reach can guide land management decisions. In this way, CTAP is helping to ensure that the rich ecological communities of Illinois wetlands have a promising future.
Wetlands are randomly selected throughout Illinois for CTAP surveys (Figure 3). This gives researchers insight into the general conditions of the state’s wetlands. In addition to these randomly selected wetlands, high quality wetland communities (called reference wetlands) were identified and surveyed. These reference wetlands provide a basis of comparison between randomly selected CTAP wetlands and minimally disturbed natural areas that retain many of their historical characteristics.

**Wetland plant communities**

Across sampling years, randomly selected wetlands had an average of 17.6 vascular plant species whereas reference wetlands had nearly twice the amount, with an average of 30.3. Additionally, exotic species make up a larger share of the flora of randomly selected wetlands compared to reference wetlands. Twice as
many exotic species were identified in randomly selected wetlands (Figure 4). And, while only accounting for 16% of the flora, exotic species are a sizable component of wetland communities in terms of their abundance. In reference wetlands, exotic species account for only 5% coverage the total area sampled. In contrast, the abundance of exotic species in randomly selected wetlands has consistently increased from 39% to 45% coverage of the total area sampled since 1997 (Figure 5).

Compositional differences between randomly selected wetlands and reference wetlands are evident in the datasets (Box 1). Significantly, tussock sedge (Carex stricta), a dominant native species that builds important wetland structures known as tussocks, is common in reference wetlands. In randomly selected sites, reed canary grass (Phalaris arundinacea), an aggressive invasive species that can diminish wetland diversity (see section below), is the most commonly found plant.

Taking all of this information together, the comparison between typical Illinois wetlands and reference quality wetlands is stark: randomly selected wetlands support far less biodiversity while at the same time harbor increasingly abundant exotic species. This finding has relevance beyond concern for the species that inhabit wetlands, since biodiversity tends to be positively related to the provision of ecosystem services. Improving the ecological
Photographs courtesy of Lady Bird Johnson Wildflower Center: (a–c, g, i), R.W. Smith, (d) Alan Cressler, (h) Peggy Romfh, (j) Stephanie Brundage.
condition of Illinois wetlands may therefore have substantial positive outcomes for the general wellbeing of Illinoisans. In light of this, conservation actions are needed to address the challenges that threaten Illinois wetlands, some of which are highlighted in the sections that follow.

**Arthropods in Illinois wetlands**

Recent research has indicated that arthropod abundances have been declining at precipitous rates across the globe. Preliminary analysis of insect data taken by CTAP reveals that Illinois wetlands are also experiencing severe losses of insects (Figure 6).

Arthropods are fundamental to the health of ecosystems, with a total biomass that is far greater than that of any other animal phylum. It can be expected that the loss of these animals will affect populations of other animals, such as fish, amphibians, reptiles, birds, and mammals, which rely on arthropods for food and other necessities.

*FIGURE 6. ABUNDANCE OF TEN ARTHROPOD ORDERS IN ILLINOIS WETLANDS*

Since CTAP began sampling, numbers of recorded individuals from ten arthropod orders have declined in Illinois wetlands.
Challenge 1: Invasive species in wetlands

Wetlands are positioned in low-lying areas, acting as sinks on the landscape that accept water from upland and upstream areas. Wetlands therefore concentrate the debris, pollutants and plant propagules (seeds and plant fragments that can take root) that are carried by floodwaters. Many of the propagules carried into wetlands come from invasive wetland plants. These invasive plants may be introduced exotic species or aggressive native species, but in either case, these plants are among the most aggressive invasive species in the world. This combination of flood disturbance, propagule concentration, and aggressive invaders makes wetlands very susceptible to domination by harmful invasive species.

One invasive species that is threatening the integrity of wetland plant communities is the aforementioned reed canary grass. CTAP scientists have been monitoring how this especially aggressive grass has been spreading in Illinois and documenting the biological consequences associated with its dominance. Since 1997, the year CTAP scientists began collecting data, reed canary grass has increased its abundance and distribution throughout the state (Figure 7). It is now the most common and most abundant species in Illinois wetlands.

Because wetlands are complex, multifaceted communities, scientists measured the impact of reed canary grass invasion in multiple ways. One simple way is to compare species richness—a count of the number of species within a sampling unit—across wetlands that vary in reed canary grass abundance. A more nuanced way of understanding how reed canary grass affects the “quality” of an ecosystem is to use a measure known as the Floristic Quality Index (FQI). This measure is based on whether the native plants present in the wetland are more indicative of high quality natural areas (high FQI scores), or degraded natural areas (low FQI scores).

CTAP scientists have shown that both these measures of ecological health decline as reed canary grass becomes more abundant (Figure 8). This indicates that the biological integrity of wetlands has declined throughout the state, threatening ecological functions and the capacity for Illinois wetlands to support wildlife. Additionally, as the pattern of increasing reed canary grass abundance and declining local species has been repeated.
throughout the state, Illinois wetlands have become more similar to each other over time. This form of biodiversity loss is called biotic homogenization and can potentially simplify foodwebs and wetland functions (Figure 9).

Other invasive species, such as hybrid cattail (*Typha × glauca*), common reed (*Phragmites australis*), and purple loosestrife (*Lythrum salicaria*), are also common in Illinois wetlands (Figure 10). All of these species pose threats to wetland biodiversity and function. Wetland managers must be diligent to prevent invasions by these species and to manage the invasive species that are present (see Recommendations for Conservation for advice on the prevention and treatment of invasive species).

**FIGURE 9. ILLINOIS WETLANDS ARE UNDERGOING BIOTIC HOMOGENIZATION**

This figure represents a possible biotic homogenization scenario as four unique wetlands become more similar to each other following invasion by reed canary grass.

**FIGURE 10. Common wetland invasive species include: (a) hybrid cattail (*Typha × glauca*), (b) common reed (*Phragmites australis*), and (c) purple loosestrife (*Lythrum salicaria*).**
Twenty nine percent of the wetland area in Illinois is classified as herbaceous emergent. Forbs and grasses dominate these wetlands, and distinguish them from wetlands, such as floodplain forests, which are dominated by woody species. Herbaceous emergent wetlands include marshes and wet meadows, and provide critical habitat for wildlife.

Unfortunately, these important ecological communities are under threat across the globe from an unexpected source: woody plants. Historically, herbaceous emergent wetlands were kept free of woody species by several mechanisms, including periodic wildfires and hydrologic conditions that favored grasses and forbs. However, human activities have altered these controlling mechanisms to favor the establishment of woody vegetation. For instance, trees and shrubs that need prolonged dry periods to become established can thrive when landscape modifications due to roads, agriculture and development drain water away from wet areas. Likewise, wildfires that kill young woody plants, but leave fire adapted herbaceous emergent vegetation unharmed, have been suppressed. Additionally, human activities have created environmental conditions, such as increased atmospheric CO$_2$ and enriched soils, that favor woody species.

As invading trees and shrubs eventually close the canopy of a wetland, numerous species of plants and animals that are adapted to open canopy conditions are lost. Once this occurs, biological and environmental feedbacks reinforce the woody dominated state, making the restoration of open canopy conditions extremely difficult. Thus, woody encroachment represents a severe and potentially intractable threat to Illinois biodiversity.

**FIGURE 11.** A current threat to herbaceous emergent wetlands in Illinois is the encroachment of woody species. These pictures were taken from the same point and facing the same direction in a CTAP wetland in (a) 2005, (b) 2010, and (c) 2015.
The CTAP dataset reveals that woody encroachment is occurring in Illinois. Eighteen percent of the herbaceous emergent wetlands monitored by CTAP have become woodier since initial surveys were conducted (Figure 11). More than half of these wetlands could no longer be monitored because canopy cover exceeded thresholds in CTAP protocols. Currently, the number of sites lost to woody species encroachment exceed any other site loss explanation, including agriculture and development (Figure 12).

Although woody encroachment is transforming wetlands across the planet, it is largely manageable at the local level. Land managers should therefore take care to ensure that woody encroachment is managed before it becomes irreversible. The historical mechanisms that maintained herbaceous emergent vegetation can be reestablished, or protected where they still exist. Periodic burns of herbaceous emergent wetlands can keep woody species down. Maintaining site hydrology is also important for maintaining open conditions as drainage and reductions in flood disturbance tend to allow woody species to become established. Ultimately, such efforts will help preserve these important wetlands and the wildlife that are dependent on them.
The complex relationship between hydrology and wetland plants may make wetlands especially vulnerable to climate change. Climate models predict that Illinois will experience significantly wetter springs and drier summers by the middle of the 21st century. As hydrological conditions will change with shifts in annual precipitation patterns, wetland plant communities and the animals they support can be expected to change as well. Wetlands provide habitat for sizable portion of Illinois’ threatened and endangered species, so understanding how wetland communities will change as a result of climate change is a conservation priority (Figure 13).

**FIGURE 13.** Species that are at risk from climate change include threatened and endangered wetland plants such as (a) Cypripedium candidum, (b) Sarracenia purpurea, (c) Drosera intermedia, (d) Platanthera leucophaea.
In 2015, CTAP scientists participated in a study that quantified the climate change vulnerabilities of 73 important Illinois plant species. While not every plant in Illinois was included in this study, some general trends in the climate change vulnerability of the Illinois flora could be surmised. Native species tended to be more vulnerable to climate change than non-native species. In fact, scientists predicted that several non-native invasive species will thrive with changes in climate, potentially increasing their distribution and abundance. Also, the plants most vulnerable to climate change appeared to be those that are already of conservation concern (i.e. state or federally endangered species).

Although more research is needed to fully understand how plant distributions will change with climate, two important points can be made about climate change and the future of Illinois wetlands.

First, natural areas in Illinois are highly fragmented by agriculture and development, and are often separated by great distances. In scenarios where climate change alters local environmental conditions to the point that endemic species must disperse to find suitable habitat, this fragmented landscape represents a significant barrier to survival.

Second, it is important to note that most rare wetland communities in Illinois, like fens and bogs, are found almost exclusively in northern Illinois (Figure 14). In combination with other pressures, such as habitat loss and pollution, northerly shifts in suitable environmental conditions for wetland plants put the future of many of Illinois’ rarest plant and animal species into question. Increased monitoring of rare wetland plants in Illinois and an understanding of how to overcome dispersal limitations are critical for conserving important parts of the Illinois flora.

Climate change presents a future for Illinois that has no analog. The responses of plant species, especially those that are rare or invasive, to climate change must be understood if adaptive management efforts are to be effective. Monitoring trends in biological communities is therefore critically important. To this end CTAP, which has been continuously monitoring wetlands throughout Illinois since 1997, is an indispensable resource for preserving Illinois’ biological heritage.
Set aside more land for wetland conservation

Such significant losses of historic wetland area make it imperative to set aside as much land for wetland conservation as possible. With more than 90% of Illinois land in private ownership, the most effective efforts in wetland conservation and restoration will include private landowners. Many government programs offer incentives for setting aside areas for wetlands, including the Wetland Reserve Easement option in the Agricultural Conservation Easement Program and the Conservation Reserve Program (CRP). In addition to these incentives, wetlands provide many ecosystem services and benefits directly to property owners. Some of these services include erosion control, improvement of ground water quality, increased aesthetic values, and opportunities to hunt, fish and view wildlife.

Become familiar with high quality wetlands

While Illinois wetlands face many challenges, it is important to emphasize that high quality wetlands in Illinois do still exist. In fact, 5 of the 38 US wetland areas that have been designated as wetlands of international importance by the Ramsar Convention...
on Wetlands (an international treaty for wetland conservation) are found, at least partially, in Illinois. Other high quality wetland areas can be found at state and municipal parks, and conservation areas. These wetlands are invaluable resources for those concerned with wetland restoration and conservation. Developing a first-hand familiarity with the ecological, structural, and functional attributes of high quality wetlands will not only deepen a person’s appreciation of these spectacular communities, but can also help set conservation goals and guide restoration efforts.

Understand, preserve and restore hydrology

No factor in determining wetland health is more important than hydrology. Even in long established wetlands, small changes in hydrology can lead to large shifts in communities and degradation. Understanding site hydrology is the first step in determining the long-term viability of wetland communities.

Much of the current Illinois landscape has substantially altered hydrology, and pressures from agriculture, development and climate change will continue to threaten Illinois wetlands. Preserving intact wetland hydrology is therefore critically important for wetland posterity. Wetland conservation and restoration sites should be selected largely based on their potential to reflect natural wetland hydrology. Efforts to identify and inventory critical hydrological connections in Illinois are needed to ensure their preservation.

Learn to recognize invasive species

Invasive species are diverse in their mechanisms of dominance, colonization pathways, and feedbacks. Likewise, invasive species are diverse in their responses to control treatments. For instance, while certain invasive species can be easily controlled with prescribed burning, others are invigorated by it. Proper invasive species management therefore begins with species identification and an understanding of a species’ biology. Only then can a proper treatment plan be implemented.

Treat invasive species and encroaching woody species before they become problematic

Abundant invasive and encroaching woody species diminish biodiversity, habitat quality, and ecosystem functions. Once these species become problematic, it is very hard to restore wetlands, even after the invasive and woody species are removed. It is

LEFT. Reed canary grass (Phalaris arundinacea).
therefore critical to monitor land for invasive species and woody encroachment and to treat them as soon as they are recognized. Identifying potential routes of invasion from adjacent highly invaded areas is worthwhile, especially if these invaded areas are upstream. Monitoring invasive species following flooding or other disturbances is also important, as many invasive species become established or spread through disturbance events.

**Periodic burning to reduce woody invasion**

Many herbaceous emergent wetlands are fire-adapted systems. The historical suppression of wildfires is one possible cause of woody encroachment in open wetland communities. Reestablishing a regiment of periodic burning may therefore help control populations of woody species in wetlands during early stages of woody species establishment. To address this issue at a state-wide scale, research is needed to identify and prioritize wetlands in need of this type of management. At the local scale, land managers are encouraged to consider prescribed burning in wetlands being invaded by woody species.

Prescribed burning can be dangerous and should be done with the utmost care. Burn permits may need to be acquired from local fire departments, and neighbors and law enforcement may also need to be notified. To gain experience with prescribed burns, consult local park districts and conservation groups for volunteer opportunities.

**Conduct control treatments with care**

Wetland plant and animal communities are very sensitive to changes in environmental conditions. These include disturbances associated with invasive species control. Soft, wet soils are easily stripped bare by tires and trampling, allowing opportunities for...
invaders to become established. Shoes and equipment must be kept clean and free of invasive propagules. Many restoration attempts have been thwarted by propagules hitching a ride on someone’s boots! Special care must also be taken when applying chemical herbicides in wetlands as many herbicides have ground water restrictions.

Increase habitat connectivity

Connectivity between patches of habitat increases the likelihood of maintaining healthy populations of plants and animals. Unfortunately, the nearly ubiquitous conversion of Illinois land has resulted in the fragmentation and isolation of wetlands and other natural areas. These isolated wetlands support fewer sensitive species, like amphibians, and are more susceptible to local extinctions. Loss of connectivity also poses severe barriers to species dispersal and migration. Increasing habitat connectivity may help species vulnerable to climate change find refuge in more habitable locales. Similarly, increasing habitat connectivity ensures that important migratory corridors, such as the Mississippi Flyway, continue to be functional. However, attempts to increase habitat connectivity must be done thoughtfully, as this may also allow undesirable invasive species to spread across newly connected habitats.
Support upland buffers

Wetlands do not exist in isolation from their surroundings. Rather, the quality of the landscape around wetlands strongly influences their condition and the amount of biodiversity they support. For instance, many animals that live in and utilize wetlands also require adjacent upland areas for habitat, resources, and protection from predators. Adjacent upland communities also slow the influx of water into wetlands and intercept some pollutants, providing additional protection for water resources. The conservation of high quality upland areas is therefore an important component of wetland conservation. Those interested in this aspect of wetland conservation should know that the impact an upland buffer has on a wetland is largely a function of the buffer’s size—the bigger, the better.

References


Text by Edward P. Price.
INHS photographs courtesy of CTAP, Dan Busemeyer, Connie Carroll Cunningham, Michael Dreslik, Michael Jeffords, Paul Marcum, Susan Post, Mary Kay Solecki, Greg Spyreas, and John Taft. Other photos courtesy of Lady Bird Johnson Wildflower Center: Stephanie Brundage (Boehmeria cylindrica), Alan Cressler (Campanula aparainoides), Peggy Romfh (Solidago canadensis), and R.W. Smith (Carex stricta, Calamagrostis canadensis, Leersia oryzoides, Scutellaria galericulata, and Symphyotrichum lanceolatum).
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