Shelter from the Storm

How Wetlands Protect Our Communities from Flooding

April 2015

Acknowledgments

Report written by: Lindsey Hallock, Tom Van Heeke and Judee Burr, Frontier Group; and John Rumpler, Environment America Research and Policy Center.

The authors thank Richard Queen, Senior Environmental Manager at the Ohio Environmental Protection Agency's Division of Surface Water, for providing feedback on the methodology used in this report. Sincere thanks to Tony Dutzik at Frontier Group for providing editorial support.

Environment Colorado Research & Policy Center thanks the William Penn Foundation and an anonymous donor for making this report possible.

The authors bear responsibility for any factual errors. The views expressed in this report are those of the authors and do not necessarily reflect the views of our funders or those who provided review.

The Environment Colorado Research & Policy Center is a 501(c)(3) organization. We are dedicated to protecting Colorado's air, water and open spaces. We investigate problems, craft solutions, educate the public and decision-makers, and help Coloradans make their voices heard in local, state and national debates over the quality of our environment and our lives. For more information about Environment Colorado Research & Policy Center or for additional copies of this report, please visit www.environmentcoloradocenter.org.

Frontier Group provides information and ideas to help citizens build a cleaner, healthier, fairer and more democratic America. We address issues that will define our nation's course in the 21st century – from fracking to solar energy, global warming to transportation, clean water to clean elections. Our experts and writers deliver timely research and analysis that is accessible to the public, applying insights gleaned from a variety of disciplines to arrive at new ideas for solving pressing problems. For more information about Frontier Group, please visit www.frontiergroup.org.

America's Wetlands: Nature's Flood Control

In the summer of 1993, residents of the American Midwest experienced the most costly flood in the history of the United States.[1] By the end of that summer, the Mississippi River in St. Louis was 20 feet above flood stage, and levee breaks in Illinois led to the inundation of thousands of acres of land.[2] The flood claimed 48 lives and caused nearly $20 billion in damage.[3]

In the aftermath of the flood, numerous studies were conducted to examine what had gone wrong and what could be done to prevent another flood of this scale. The conclusion: the decades spent building levees and dams to control Mississippi river flooding had actually debilitated our first line of defense against flooding – wetlands.[4]

Scientists now know that wetlands are critical to the global water cycle.[5] They are the kidneys of our national water system, cleaning out sediment and water pollution. They are home to numerous plant and animal species, supporting our nation's biodiversity. They are also able to store vast amounts of water and are thus an important tool to protect America's cities and towns from flooding.

Wetlands Reduce the Risk of Flooding and Mitigate Its Worst Impacts

Wetlands can be found throughout the United States.[6] While there are many types of wetlands, and they differ by geographic location, by soil permeability and by the amount of water they contain at any given point in time, most share one common characteristic: they occur in low-lying areas near higher ground. The ability of wetlands to hold large amounts of water enables them to serve as a key protection against flooding.[7] During times of heavy precipitation, wetlands act as a sponge – slowing the velocity of runoff and retaining excess water, thereby reducing the danger of flooding.[8] Once captured by a wetland, excess water evaporates, settles into the soil to replenish groundwater, or is slowly released over time.[9]

During the 1993 Mississippi River Flood, the volume of water that brought the river above its normal levels at St. Louis could have been held by 13 million acres of wetlands – half of the wetlands acreage that has been destroyed in the Upper Mississippi Basin since 1780.[10]

The flood protection that wetlands provide is valuable. According to one study, inland wetlands in the United States provide over $237 billion in water flow regulation services annually.[11]

Flooding Is a Massive Problem that May Get Worse with Global Warming

Floods are the most common natural disaster in the United States, according to the Federal Emergency Management Agency (FEMA).[12] Over the past 30 years, floods have caused an average of $8.2 billion of damage and 89 fatalities per year.[13] Scientists predict that the damage caused by floods will only increase in the years to come, to over $1 trillion per year by 2050.[14]

As global warming continues to progress, the extreme rain events that often trigger flooding are likely to become more common. Warmer air is able to hold more water

vapor, leading to higher levels of precipitation during rain and snow storms.[15] Indeed, extreme rain and snow events have already become more than 30 percent more common since the first part of the 20th century, with the greatest changes in the Northeast and the Midwest.[16] Greater changes are in store for the decades ahead.

The 1993 Mississippi River Flood devastated numerous communities along the river's route, including St. Charles, MO, pictured here. (Credit: USGS)

America's Wetlands Are in Danger

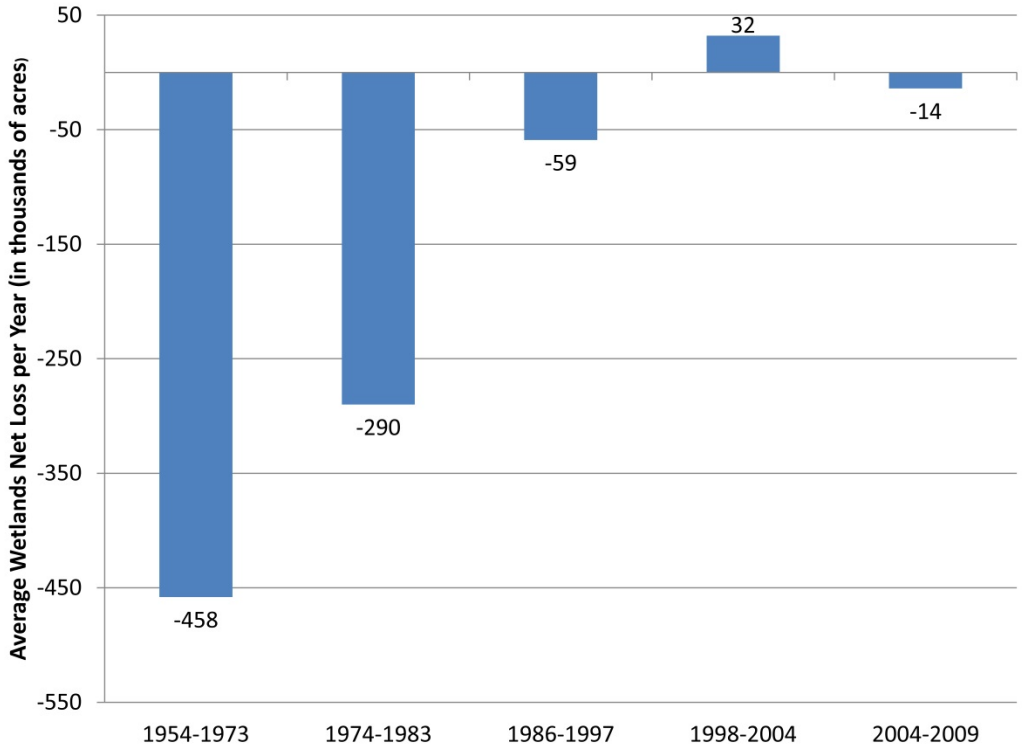
The U.S. is left with only 53 percent of the more than 221 million acres of wetlands that dotted colonial America.[17] For many years, wetlands were seen as obstacles to development, leading to decades of policies encouraging the building of wetlands-destroying levees, the filling of wetlands in order to build cities and shopping malls, and the draining of wetlands for agricultural purposes.[18]

Passage of the federal Clean Water Act in 1972 was an important step in stemming the loss of wetlands. The law established the goal of making all of the country's waterways safe for fishing, swimming and supplying drinking water, with wetlands protection a key strategy in achieving that goal.[19]

The Clean Water Act reduces wetland loss by requiring permits for the filling or draining of wetlands.[20] Those proposing to fill wetlands must show that they have taken steps to avoid wetlands impact and that they will provide compensation for unavoidable impacts.[21]

As a result of the act, the loss of wetlands slowed dramatically. According to the U.S. Fish and Wildlife Service, in the 20 years prior to enactment of the Clean Water Act, wetlands were decreasing at an average rate of 458,000 acres per year.[22] After the Clean Water Act was enacted, the rate of wetlands loss slowed, and there was even an increase in wetlands acreage from 1998 to 2004.[23]

Figure 1: The Rate of Wetlands Loss Before and After the Clean Water Act (1954-2009)



Clean Water Act Loophole Threatens Wetlands

The Clean Water Act's ability to safeguard wetlands is threatened, however, by a loophole in the law that could leave many wetlands outside of the law's protection.[24]

In 2006, the Supreme Court, in a case brought by a Michigan developer who filled wetlands without a permit, issued a decision that left in doubt Clean Water Act protection for 20 million acres our nation's wetlands – leaving them vulnerable to being damaged or destroyed.[25] Indeed, the 2004-2009 timeframe saw a return to annual national wetland loss after the improvements of the prior six years. (See Figure 1.)

Protect Our Communities from Worsening Flood Risks: Restore the Clean Water Act

America's wetlands protect our homes and businesses from damaging flooding while helping to clean our water and provide habitat for wildlife. To safeguard our wetlands, we need to ensure that they enjoy the full protection of the federal Clean Water Act.

In April 2014, the U.S. Army Corps of Engineers and the Environmental Protection Agency (EPA) proposed a rule that would restore full Clean Water Act protections to thousands of wetlands (as well as streams) across the country. More than 800,000 Americans have indicated their support for this clean water rule – including hundreds of mayors and other local community officials.

To protect our communities from flooding, the Obama administration should finalize the proposed clean water rule as soon possible so that our remaining wetlands are once again protected.

This rule will also help protect our communities by protecting thousands of headwaters and intermittent streams that feed drinking water sources for one in every three Americans.

In a warming world, the risk of flooding, and its impact on communities, is likely to grow. Wetlands are our first line of defense against that threat, and federal, state and local officials should do everything in their power to protect them for the future. In addition, officials should enact policies to curb global warming pollution to reduce the risk of extreme flooding in the in the years ahead.

Figure 2: Freshwater Wetlands in 100-Year-Flood Zones in Boulder County, North of Denver

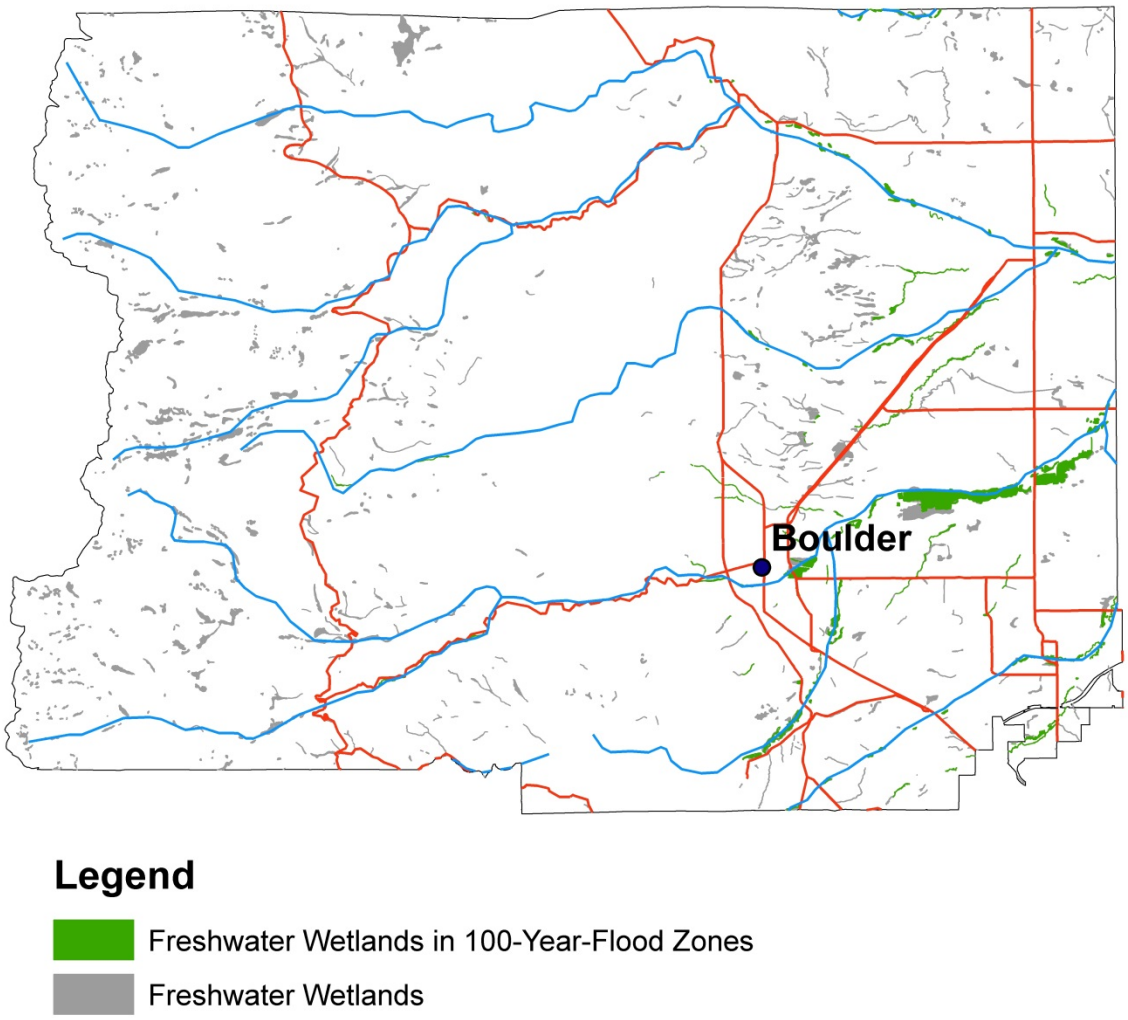


Table 1: Wetland Acreage in 100-Year-Flood Zones in Colorado and Boulder County

	Freshwater Wetlands (Acres)	Freshwater Wetlands in 100-Year-Flood Zones (24 of 64 Counties Included) (Acres)	Potential for Floodwater Absorption (All Freshwater Wetlands) (Millions of Gallons)
Statewide	1,028,306	74,627	339,341
Boulder County	10,241	2,550	3,379

Colorado's Wetlands: Critical Protection Against Flooding

Wetlands are more than just scenic parts of America's natural landscape. They are also home to wildlife and perform many vital functions that protect the health of our waterways and communities. By trapping sediment and filtering excess nutrients and pollutants out of the water that flows through them, wetlands support water quality.

Of crucial importance for our towns and cities, wetlands also offer flood protection by absorbing large amounts of water that may fall during a storm before releasing it slowly into the environment. An acre of wetland one foot deep can hold approximately 330,000 gallons of water.[26] This can reduce flood peaks and slow water flow.[27] Even isolated wetlands can help by reducing storm water runoff that might contribute to local flooding.[28] All told, the nation's inland wetlands provide over $237 billion worth of water flow regulation annually.[29]

The Clean Water Act is the nation's most important tool for safeguarding wetlands – protecting our communities from flooding and preserving the quality of our water. Since its enactment, the Clean Water Act has succeeded in reducing the rate of wetlands loss nationwide. In fact, the rate of wetlands loss slowed after the law was passed and wetland acreage increased modestly between 1998 and 2004.[30] However, a recently exposed loophole in the law has cast doubt over the Clean Water Act's reach and puts millions of acres of wetlands at risk of destruction. The Environmental Protection Agency (EPA) has proposed a rule that would close this loophole – a step that would be the biggest victory for clean water in more than a decade.

To protect wetlands in Colorado and across the country, the EPA must finalize its proposed Clean Water Act rule this year.

Many of Colorado's Wetlands Are in Flood Zones

According to data from the National Wetlands Inventory, Colorado boasts approximately 1 million acres of freshwater wetlands statewide.[31] Approximately 75,000 acres of the state's freshwater wetlands lie in the 100-year-flood zones for which flood hazard data are available from the Federal Emergency Management Agency.[32] (See Table 1.)

In Boulder County, the scene of a once-in-a-thousand-years storm and associated major flooding in September 2013, there are approximately 10,200 acres of freshwater wetlands, of which approximately 2,600 acres are located in 100-year-flood zones. (See Figure 2.) Together, these wetlands are capable of holding approximately 3.4 billion gallons of water.[33]

Boulder County's Dramatic September 2013 Floods

In September 2013, a rainfall event with the statistical likelihood of occurring once every 1,000 years based on historical trends struck Boulder. It caused flooding that killed four people and caused 7,600 county residents to apply for federal assistance.[34]

This extreme rainstorm struck Colorado after an unusually dry month, and Boulder was hit exceptionally hard by the storm. The Boulder area received 12 inches of rain over a two-day period, causing Boulder Creek to

reach the highest water level observed in downtown Boulder since 1894.[35] Flood water damaged 150 miles of roadways in the county, including washing away the main highway connecting Boulder to Lyons, a nearby mountain community.[36] The estimated damage to county road infrastructure was between $100 and $150 million. More than 1,100 people were evacuated by air and 707 others were evacuated by road due to the flooding event.[37] This event set new one-day, two-day and seven-day records for total rainfall in Boulder.[38]

Paving over or otherwise destroying wetlands reduces the ability of a landscape to absorb rainfall from extreme precipitation events such as this one, which could exacerbate flooding and its impacts on nearby communities.

Methodology

To derive an estimate for the acreage of wetlands in 100-year-flood zones (i.e. an area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year, also known as a "Special Flood Hazard Area" (SFHA) in FEMA terminology), we began by establishing the specific types of wetlands we would focus on in our analysis.[39]

Relying on the categories of wetlands used by the U.S. Fish and Wildlife Service's National Wetlands Inventory, we eliminated wetland types that include bodies of water, estuaries and marine wetlands, leaving the following to be included in our analysis:

- Freshwater Forested and Shrub wetlands
- Freshwater Emergent wetlands
- Other Freshwater wetlands[40]

We conducted the bulk of our analysis using ArcGIS mapping software and downloaded the appropriate data files and map layers for analysis. Wetlands data are available state-by-state. We downloaded the geodatabase files for the states under consideration.[41] Flood hazard area data are produced at the county or municipal level but can be downloaded by state via the FEMA National Flood Hazard Layer (NFHL). We downloaded the single state file for the states under consideration.[42] Most states do not have flood hazard data available for all jurisdictions within a state. We considered as many jurisdictions as possible. The absence of flood hazard data for some jurisdictions in many of the states considered means that our wetlands estimates for each state are likely to be conservative.

Once a state's files were added to ArcGIS, we filtered the flood hazard data using a feature in the attribute table of the layer that indicates whether each flood hazard area examined is a SFHA. We created a new map layer from the filtered selection. This layer showed only the 100-year-flood zones.

To narrow down the statewide wetlands data, we first used the attribute table of the layer to select and highlight only the freshwater wetlands. We created a layer representing those data. We then used the "clip" geoprocessing tool in ArcGIS to clip the wetlands data to the extent of the newly created SFHA layer, creating yet another layer. At this point, we had two layers for analysis: one that showed all freshwater wetlands and one that showed all freshwater wetlands that also lie in SFHAs. We repeated this process at the county level to discern county-level data.

To calculate the acreage of the wetlands, we used ArcGIS' "Calculate Geometry" feature to add a field to the attribute table for each map layer under consideration containing the area of each polygon in the layer. We then exported the attribute table to a comma-delimited text file, which we subsequently copied into Microsoft Excel where we could use a sum function to total the acreage.

Notes

[1] Gary P. Johnson, Robert R. Holmes Jr. and Lloyd A. Waite, United States Geological Survey, *The Great Flood of 1993 on the Upper Mississippi River—10 Years Later,* May 2004.

[2] National Weather Service, *St. Louis, MO,* accessed at www.crh.noaa.gov, 18 March 2015.

[3] Gary P. Johnson, Robert R. Holmes Jr. and Lloyd A. Waite, United States Geological Survey, *The Great Flood of 1993 on the Upper Mississippi River—10 Years Later,* May 2004.

[4] Anne Jefferson, "Levees and the Illusion of Flood Control [explainer]" (blog), *Scientific American,* 20 May 2011.

[5] "Why are Wetlands So Important to Preserve?," *Scientific American,* 19 June 2013.

[6] Definition of wetland: United States Environment Protection Agency, *Wetlands Definitions,* accessed at water.epa.gov, 17 March 2015

[7] North Carolina State University Water Quality Group, *Types of Wetlands and Their Roles in the Watershed,* accessed at www.water.ncsu.edu, 17 March 2015.

[8] United States Environmental Protection Agency, *Wetlands: Protecting Life and Property from Flooding*, accessed at water.epa.gov, 17 March 2015.

[9] United States Geological Survey, *Technical Aspects of Wetlands: Wetland Hydrology, Water Quality, and Associated Functions*, accessed at water.usgs.gov, 17 March 2015.

[10] Donald L. Hey and Nanci S. Philippi, "Flood Reduction through Wetland Restoration: The Upper Mississippi River Basin as a Case History," *Restoration Ecology,* 3(1)4-17, doi: 10.1111/j.1526-100X.1995.tb00070.x, 7 April 2006.

[11] This value of water flow regulation by inland wetlands is in international dollars (a hypothetical unit of currency widely used in economics with the same purchasing power parity of the U.S. dollar at a given point in time) as calculated by: Rudolf de Groot et al., "Global estimates of the value of ecosystems and their services in monetary units," *Ecosystem Services,* (1)50-61, 2012. The value of inland wetlands in the United States was calculated by multiplying the value of services from the source above, by the acreage of freshwater wetlands in the United States as sited by: T.E. Dahl, United States Fish and Wildlife Service, *Status and Trends of Wetlands in the Conterminous United States 2004 to 2009,* October 2011.

[12] Federal Emergency Management Agency, *Know Your Risk, Take Action & Be a Force of Nature during Flood Safety Awareness Week* (news release), 16 March 2015.

[13] National Weather Service, *Hydrologic Information Center – Flood Loss Data,* accessed at www.nws.noaa.gov, 17 March 2015.

[14] Stephane Hallegatte et al, "Future Flood Losses in Major Coastal Cities," *Nature Climate Change,* doi: 10/1038/NCLIMATE1979, 18 August 2013.

[15] Jerry M. Melillo, Terese Richmond, and Gary W. Yohe, U.S. Global Change Research Program, *Climate Change Impacts in the United States: The Third National Climate Assessment*, doi:10.7930/J0Z31WJ2, 2014.

[16] Jerry M. Melillo, Terese Richmond, and Gary W. Yohe, U.S. Global Change Research Program, *Climate Change Impacts in the United States: The Third National Climate Assessment*, doi:10.7930/J0Z31WJ2, 2014, 36.

[17] Ann Vileisis, *Discovering the Unknown Landscape: A History of America's Wetlands,* (Washington, D.C.: Island Press, 1999), 3.

[18] Thomas E. Dahl, U.S. Fish and Wildlife Service, Gregory J. Allord, U.S. Geological Survey, *History of Wetlands in the Conterminous United States,* accessed at water.usgs.gov/nwsum/WSP2425/history.html, 18 March 2015.

[19] U.S. Government Printing Office, *An Act to Amend the Federal Water Pollution Control Act, Public Law 92-500*, "Declaration of Goals and Policy, Section 101," 18 October 1972.

[20] United States Environmental Protection Agency, *Section 404 Permitting,* accessed at water.epa.gov, 19 March 2015.

[21] United States Environmental Protection Agency, *Section 404 Permitting,* accessed at water.epa.gov, 19 March 2015.

[22] The Emergency Wetlands Resources Act (1986) requires the U.S. Fish and Wildlife Service to report on the status and trends of wetlands in the lower 48 states every ten years, per United States Environmental Protection Agency, *Report on the Environment: Wetlands,* accessed at cfpub.epa.gov, 19 March 2015.

[23] United States Environmental Protection Agency, *Report on the Environment: Wetlands,* accessed at cfpub.epa.gov, 19 March 2015.

[24] United States Environmental Protection Agency, *Syllabus: Rapanos et ux. et al. vs. The United States,* accessed at www.epa.gov, 20 March 2015.

[25] "Government, Developer Settle Dispute Over Michigan Wetlands," Associated Press, 30 December 2008; Alexandra Fields, Environment America, *EPA Proposes Biggest Step for Clean Water in a Decade* (news release)*,* 25 March 2014.

[26] Brian K. Miller, Department of Forestry and Natural Resources, School of Agriculture, Purdue University, *Wetlands and Water Quality*, accessed at www.extension.purdue.edu, 17 March 2015. A separate estimate published by the U.S. EPA was consistent with this, reporting that an acre of wetland three feet deep can hold approximately one million gallons of water, per U.S. Environmental Protection Agency, *Economic Benefits of Wetlands*, May 2006. For the purposes of calculations in this factsheet, we assume all wetlands are one foot deep.

[27] Joy P. Michaud, *At Home with Wetlands: A Landowner's Guide, 2nd ed.*, (Olympia, WA: State of Washington, Department of Ecology, 2001); State of Washington, Department of Ecology, *Functions and Values of Wetlands*, accessed at www.ecy.wa.gov, 17 March 2015.

[28] Washington State Department of Ecology, *Functions and Values of Wetlands*, accessed at www.ecy.wa.gov, 31 March 2015.

[29] This value of water flow regulation by inland wetlands is in international dollars as calculated by: Rudolf de Groot et al., "Global estimates of the value of ecosystems and their services in monetary units," *Ecosystem Services,* (1)50-61, 2012. The value of inland wetlands in the United States was calculated by multiplying the value of services from the source above, by the acreage of freshwater wetlands in the United States as sited by: T.E. Dahl, United States Fish and Wildlife Service, *Status and Trends of Wetlands in the Conterminous United States 2004 to 2009,* October 2011.

[30] United States Environmental Protection Agency, *Report on the Environment: Wetlands,* accessed at cfpub.epa.gov/eroe,, 19 March 2015.

[31] For the purposes of this analysis, we exclude bodies of water (rivers, streams, lakes, ponds and oceans) and any marine or estuarial wetlands. The term "freshwater wetlands" thus refers to the following categories of wetlands as delineated by the U.S. Fish and Wildlife Service: Freshwater Forested and Shrub wetland; Freshwater Emergent wetland; and Other Freshwater wetland. For more on wetland categories, see: U.S. Fish and Wildlife Service, National Wetlands Inventory, *Wetlands Mapper Legend Categories*, accessed at www.fws.gov/wetlands, 13 March 2015.

[32] We relied on the National Flood Hazard Layer produced by the Federal Emergency Management Agency (FEMA) for data on the presence and extent of flood hazard zones. These data are not available in ArcGIS format for all Connecticut counties, which limited our analysis.

[33] Based on an acre of wetland one foot deep holding 330,000 gallons of water.

[34] Charlie Brennan and John Aguilar, "Eight Days, 1,000-year Rain, 100-Year Flood," *Boulder Daily Camera*, 21 September 2013; Michon Scott, "Historic Rainfall and Floods in Colorado," *National Oceanic and Atmospheric Administration*, 17 September 2013.

[35] Michon Scott, "Historic Rainfall and Floods in Colorado," *National Oceanic and Atmospheric Administration*, 17 September 2013.

[36] 150 miles: Charlie Brennan and John Aguilar, "Eight Days, 1,000-year Rain, 100-Year Flood," *Boulder Daily Camera*, 21 September 2013, available at http://www.dailycamera.com/news/boulder-flood/ci_24148258/boulder-county-colorado-flood-2013-survival-100-rain-100-year-flood; Lyons: Michon Scott, "Historic Rainfall and Floods in Colorado," *National Oceanic and Atmospheric Administration*, 17 September 2013, available at www.climate.gov/news-features/event-tracker/historic-rainfall-and-floods-colorado.

[37] Charlie Brennan and John Aguilar, "Eight Days, 1,000-year Rain, 100-Year Flood," *Boulder Daily Camera*, 21 September 2013.

[38] Western Water Assessment, CIRES, NOAA and Colorado Climate Center, *Severe Flooding on the Colorado Front Range*, September 2013.

[39] A Special Flood Hazard Area (SFHA) is an area covered by the "base flood," which is defined as the flood "having a one percent chance of being equaled or exceeded in any given year. This is the regulatory standard also referred to as the '100-year flood,'" per Federal Emergency Management Agency, *Base Flood*, accessed at www.fema.gov/national-flood-insurance-program/base-flood, 13 March 2015; Federal Emergency Management Agency, Special Flood Hazard Area, accessed at www.fema.gov/floodplain-management/special-flood-hazard-area, 13 March 2015.

[40] U.S. Fish and Wildlife Service, National Wetlands Inventory, *Wetlands Mapper Legend Categories*, accessed at www.fws.gov/wetlands, 13 March 2015.

[41] U.S. Fish and Wildlife Service, National Wetlands Inventory, *Download Seamless Wetlands Data by State*, www.fws.gov/wetlands, 13 March 2015.

[42] Federal Emergency Management Agency, *Flood Map Service Center*, accessed at www.msc.fema.gov/portal, 13 March 2015.