Assessment of urban tree canopy damage in incorporated communities resulting from the August 2020 Midwest Derecho

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Summary of urban forest damage in incorporated communities resulting from a single derecho wind event.

INTRODUCTION

Derechos are commonplace in the eastern half of the contiguous United States with some locations experiencing up to two per year (Figure 1). In order to be classified as a derecho a storm must have consistent straight-line winds at speeds of 58 mph or greater, and wind damage which extends for at least 250 miles. Downbursts, or stronger winds within the storm path, can be clocked at upwards of 90 mph. The destructive potential of derechos is also due to the high speeds of the parent system. Often these storm systems move at speeds upwards of 50 mph, offering little to no warning for those in its path (Corfidi et. al. 2018).

Figure 1. Odds of the occurrence of derechos in the U.S. Data source: National Weather Service

"On August 10th and 11th, 2020 a derecho - a widespread, long-lived, straight-line windstorm - struck the State of Iowa and surrounding states delivering catastrophic damage to structures, crops, and trees" (Goff et. al. 2021). Sustained winds of 70 miles per hour (mph) lasted nearly an hour over a large swath of central and eastern Iowa, and wind gusts of 110 to 140 mph impacted portions of five Iowa counties (Figure 2).

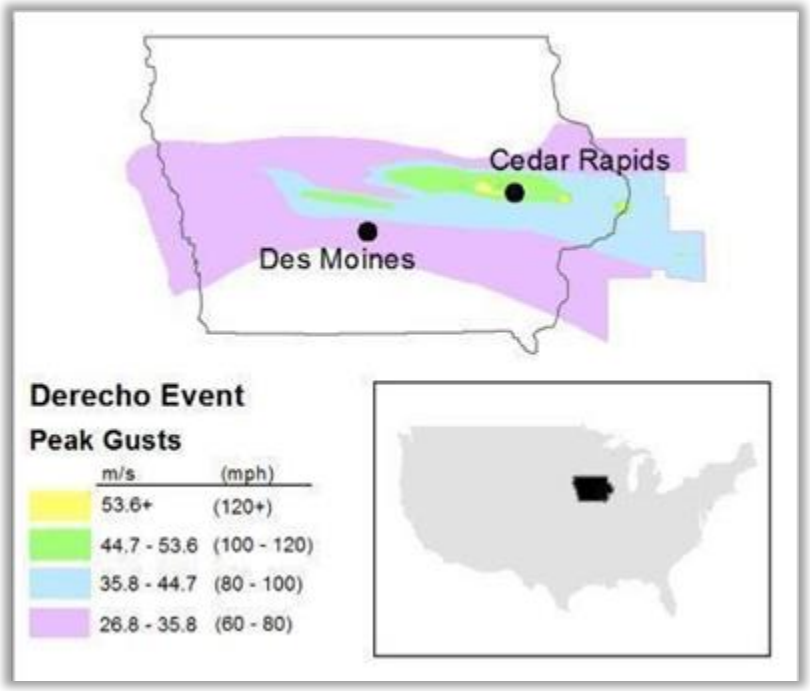

Figure 2. Estimated peak wind gusts of the Midwest Derecho, August 10-11, 2020. Iowa, USA. Data source: NOAA Storm Prediction Center (Goff et al.2021).

The swath of damage resulting from this line of storms extended over 770 miles over several state lines. This system also spawned twenty five tornados across Iowa, Illinois and Indiana (Figure 3).

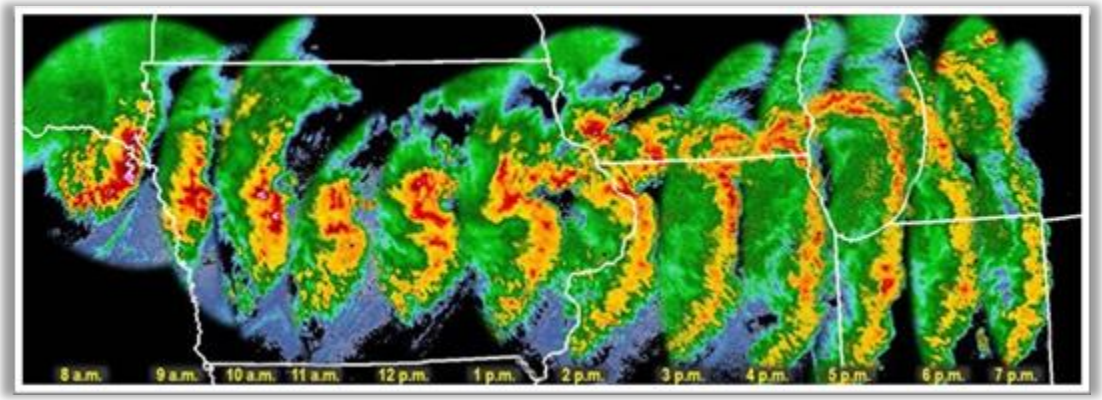

Figure 3. August 10, 2020 Derecho: Lowest Angle NWS Radar Reflectivity at One Hour Time Steps. Data Source: National Weather Service Chicago.

"The strongest estimated wind speeds in the vicinity of Cedar Rapids, Iowa, were among the highest wind speeds ever recorded during a derecho event, peaking at about 140 mph. Estimates indicate that this is the costliest thunderstorm event in recorded history in the United States" (NOAA). The severity and scope of damage crippled the Iowa communities within the storm path and necessitated a significant response from government at all levels.

DEFINITIONS

"Urban tree canopy, defined as the layer of tree leaves, branches and stems in a community that cover the ground when viewed from above, is a simple way for a community to get an overall picture of both private and public trees" (Iowa DNR). This definition does not include grassland. All estimates reported here are for canopy of any type within incorporated communities.

For the purposes of this report "damaged" is defined as injured but able to survive either on its own or with pruning. "Destroyed" is defined as having sustained extensive canopy and/or stem damage necessitating removal or already on

the ground.

METHODS

Acquiring the data in this report was made possible by a request to the USFS who assisted with an aerial flight of the impacted area. Iowa Derecho Damage Survey (IDDS) data, collected by Iowa DNR with the assistance of the Maryland Department of Agriculture, was collected September 21-24 with assistance from the USFS (Figure 4 through Figure 6). The percentage of acres damaged was assessed with Iowa Derecho Damage Survey (IDDS) data based on visible damage and destruction from the air along the designated flight path. In instances where multiple severity categories of damage were recorded, an averaged midpoint was applied when estimating damage and loss totals for that community. The damage estimates for communities evaluated through aerial inspection were compiled for each county to establish a baseline county average damage percentage.

The aerial flight of the Iowa Derecho Damage Survey was able to directly assess damage in 74 incorporated communities. Due to restrictions in the aerial flight of the Iowa Derecho Damage Survey it was not possible to survey all communities impacted by the derecho wind event. When possible, a baseline average damage percentage was established for each county using data collected from surveyed communities. That average, respectively, was applied to all communities within the county which were not directly surveyed. In counties where no communities were directly surveyed no baseline county average was established and no damage estimates were suggested.

The Iowa Derecho Damage Survey damage was applied to canopy cover data for total acres of damage. Urban canopy cover for Iowa communities was assessed using a high-resolution land cover dataset, target year 2009, (2009 High Resolution Land Cover Web Service) in conjunction with the incorporated boundaries from the 2010 census data (U.S. Census Bureau). An average of 135 trees per acre was assumed, using the nearest studied Midwest City, Chicago (Nowak & Greenfield 2018, US Urban Forest Statistics, Values, and Projections; Journal of Forestry, 171-172).

RESULTS

It is estimated that the derecho wind event damaged 32,773 acres of urban canopy across Iowa based on the methods listed above. The number of individual trees damaged or destroyed is estimated to be 4,424,426. This estimate was obtained using Chicago averages of i-Tree data of 135 trees per acre and tree cover averaging 35.8% (Nowak & Greenfield, 2018).

An estimate of some benefits lost due to the August 10, 2020 derecho wind event was calculated based on statewide data regarding urban forest structural characteristics (Nowak & Greenfield, 2018. 173-176). Assuming an urban canopy of 34,300,000 trees statewide, a total damaged estimate of 4,424,426 trees equates to 12.9% of the total canopy. This percentage was applied to all known structural characteristics and values to determine the annual loss of benefits as well as the immediate loss of long-term carbon storage. It is estimated the total impact for both sequestration and storage is $20,238,846.62 per year (Table 1). The standard error of these calculations is unknown.

Table 1. Estimated structural value and benefit loss in Iowa due to the derecho wind event on August 10, 2020. Data source: Nowack & Greenfield, 2018.

Structural Loss

Trees		Leaf Area	Leaf Biomass	Carbon Storage	
# of trees	Trees Per Capita	Acres	Tons	Tons	$
4,424,426	17.60	103,193	35,343.81	735,254.47	90,294,408.12

Annual Benefit Loss

Carbon Sequestration		Avoided Emissions		Air Pollution Removal	Avoided Energy Use	Total
Tons/Year	$/Year	Tons/Year	$/Year	$/Year	$/Year	$/Year
22,870.28	2,966,816.12	335.38	2,708,832.24	7,713,722.29	6,849,475.82	20,238,846.62

DISCUSSION

Although it would be feasible to rely on city data (e.g. inventories, FEMA reporting, etc.) to produce a smaller scale damage report on public trees, this report presents a statewide assessment of the swath of damage that occurred within Iowa urban areas as a result of the August 10, 2020, derecho wind event. Midpoints and averages were used for the best estimates.

The lowest estimated percentage of urban canopy damage in a community was 7%. No communities were assessed greater than 50% due to limitations in data collection. The flight path was structured to document the most severely damaged locations therefore county averages may not be a reflective sample (Figure 3).

With the understanding that not all incorporated communities within a given county were affected to the same degree and that unincorporated communities were not surveyed, the damage in estimated tree losses is grouped by county (Table 2). This report is a snapshot of trees exhibiting signs of damage or mortality at the time of the aerial survey. It does not account for future mortality due to tree injury, increases in pests and disease, or dieback exhibited after the Spring of 2021. Those factors were not included in the interest of producing this report as expediently as possible.

CITATIONS

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Nowak & Greenfield (2018). US Urban Forest Statistics, Values, and Projections; *Journal of Forestry,* 171-176.

U.S. Census Bureau. "Iowa: 2010, Population and Housing Unit Counts". Issued August 2012. https://www2.census.gov/library/publications/decennial/2010/cph-2/cph-2-17.pdf

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APPENDIX

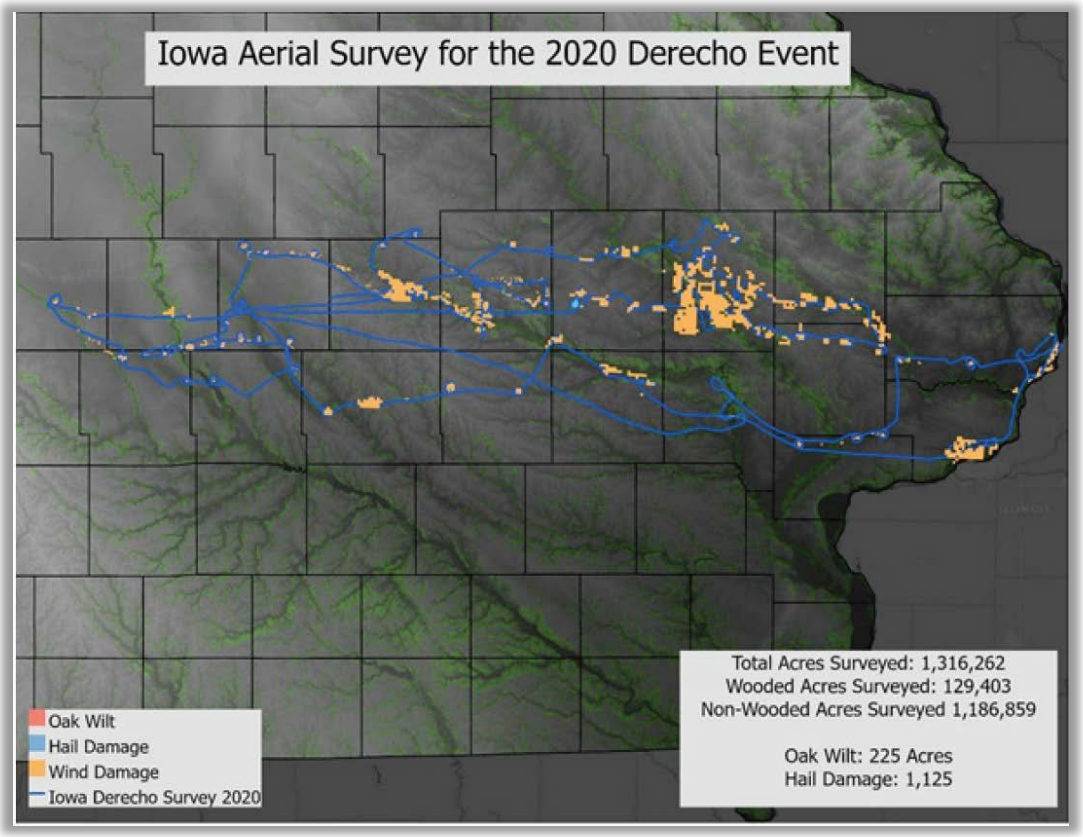

Figure 4. Iowa DNR Aerial Survey Map, 2020 Derecho Forest Health Monitoring.

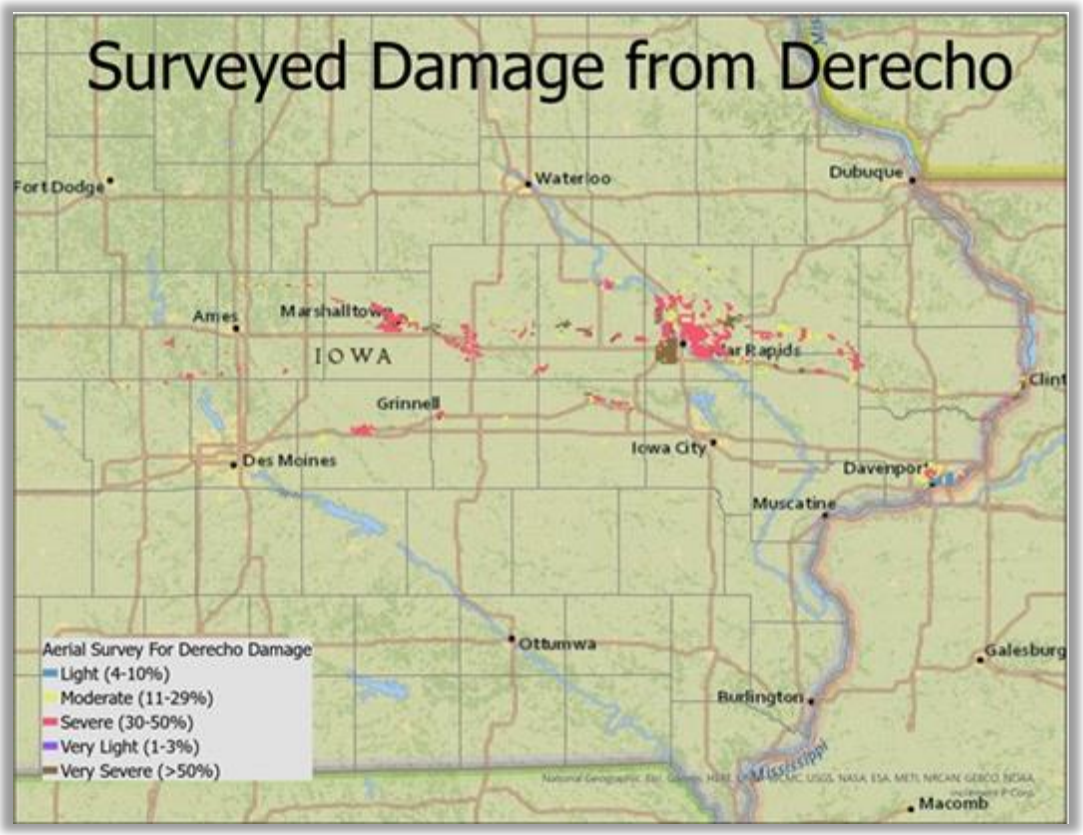

Figure 5. Damage assessment along the USFS flight path of derecho impacted areas of Iowa, collected September 21-24, 2020.

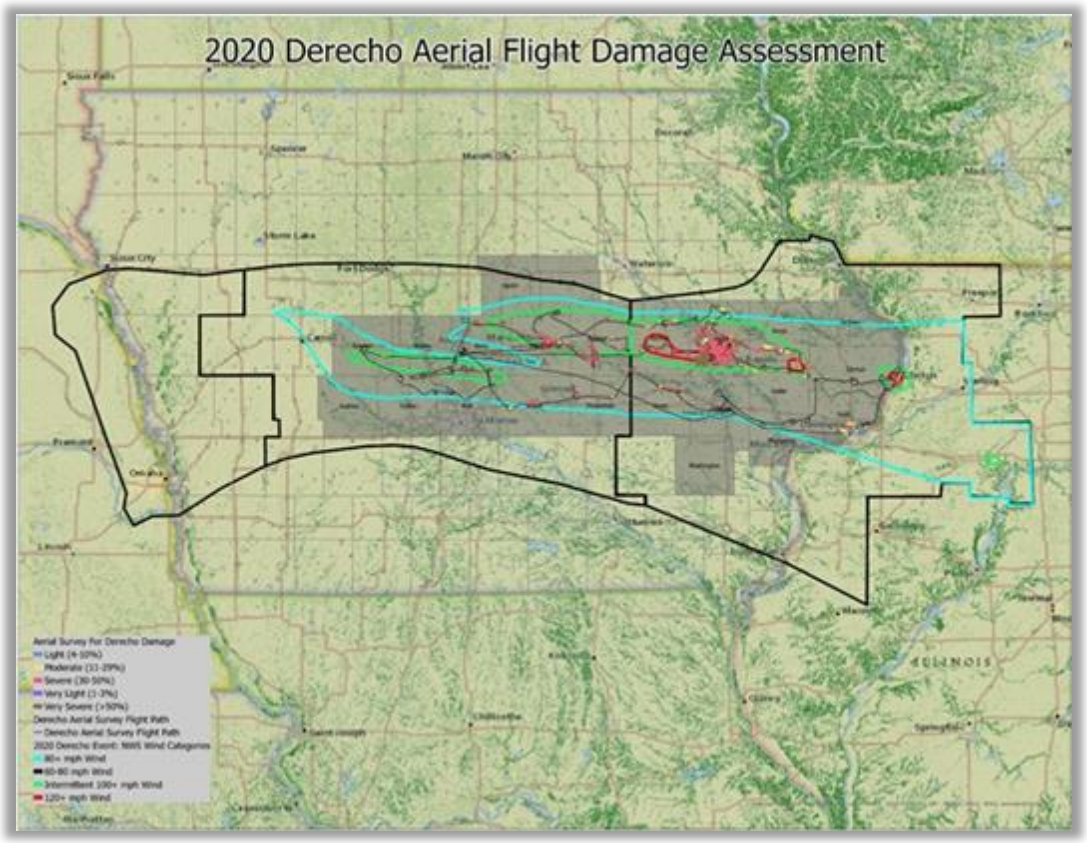

Figure 6. Summary of the USFS flight path over the derecho impacted areas of Iowa, collected September 21-24, 2020.

Table 2. Summary of damage for derecho affected counties in Iowa derived from USFS aerial flight assessment.

County	Estimated acres of canopy damaged	Estimated number of trees damaged
Total	32,773	4,424,426
Benton	548	74,125
Boone	805	108,702
Cedar	272	36,664
Clinton	2,580	348,344
Dallas	3,204	432,488
Greene	271	36,649
Grundy	185	24,973
Guthrie	247	33,369
Hardin	656	88,573
Iowa	113	15,255
Jackson	82	11,045
Japser	1,004	135,519
Johnson	1,738	234,567
Jones	640	86,432
Linn	7,061	953,224
Marshall	1,037	140,039
Muscatine	550	74,192
Polk	4,758	642,348
Poweshiek	413	55,752
Scott	3,809	514,163
Story	1,869	252,292
Tama	675	91,173
Washington	256	34,538