NDSU-North Dakota Forest Service

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General Sibley Park Assessment
Bismarck Parks and Recreation District

Executive Summary

Flood waters from the Missouri River inundated General Sibley Park from May 23, 2011, to August 31, 2011. The flood reached its peak river elevation of 19.24 feet on July 1, 2011. The Bismarck Parks and Recreation District requested assistance from the State Forester's office to conduct an assessment of the trees that failed during the summer flood, and a wind storm that occurred on July 31, 2011. This report contains the results of the assessment; options for wood utilization; recommendations for monitoring and reforestation; and estimating the cost of removal and replacement of the plant material at this vital recreational facility in the Bismarck-Mandan area.

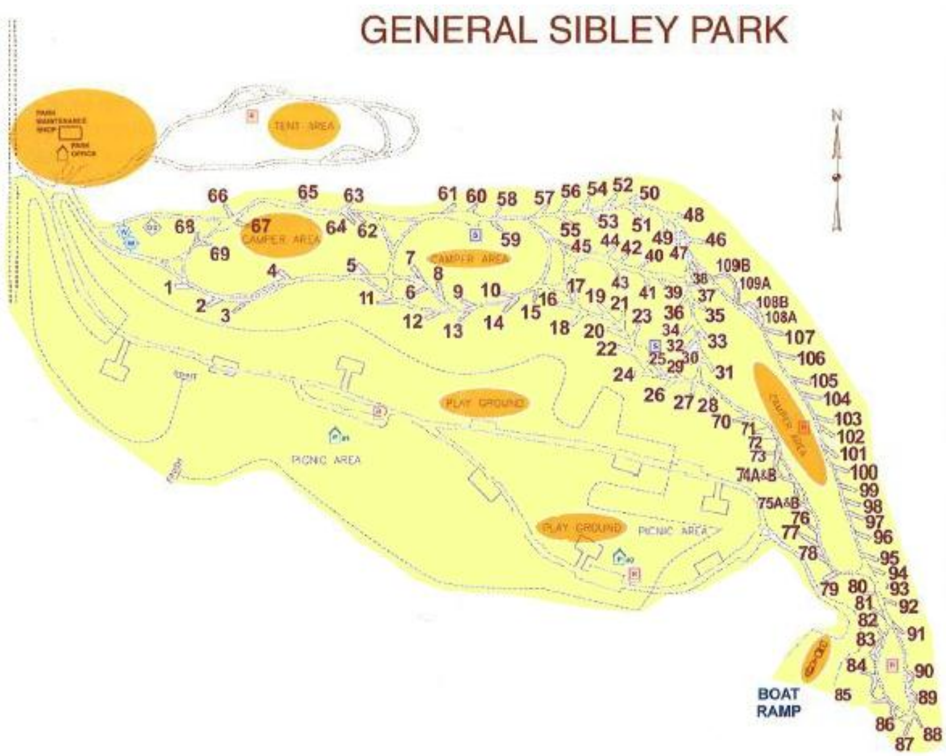
General Sibley Park, a property owned by the U.S. Army Corps of Engineers, is one of several recreation areas managed by Bismarck Parks and Recreation District. The 138- acre park is located four miles south of Bismarck. This park has an annual visitation rate of nearly 100,000, with 60 percent of the annual traffic from local residents within 20 miles of the park. A visual inspection conducted documented a total of 1,283 trees of all sizes that were toppled or partially up-rooted due to the saturated soil conditions caused by the flooding and the wind storm event. The extent of the root damage to the trees that remain standing is difficult to determine and depends on the species, soil type, and flood duration, as well as the age and prior health of the tree. Trees with the majority of their roots undamaged have a good chance of fully recovering over the next few years. Trees where the roots have been severely damaged may not survive, declining over the next several years.

The majority of the 1,283 trees destroyed were green ash, followed by cottonwood and boxelder. The total estimated removal and replacement cost for the 1,283 trees is $719,515. This includes $167,825 for tree removals and $551,690 for replacements with 2-inch caliper balled and burlapped (B&B) trees.

Introduction

General Sibley Park is a 138-acre park, located four miles south of Bismarck on Washington Street. The park offers camping sites for tents and travel trailers with electrical hook-ups and full service restrooms. The park also has recreational opportunities for campers and day use patrons, including playgrounds, sand volleyball, horseshoes, a 24-hole disc golf course, picnic shelters and a boat ramp. The park hosts approximately 100,000 visitors each year, with representation from 40 states and several Canadian provinces. Up to 60 percent of the annual traffic is from local residents within 20 miles of the park. The purpose of the assessment is to assist the Bismarck Parks and Recreation District in determining how many trees failed due to the 2011 summer flooding, and a wind storm that occurred on July 31, 2011. The assessment documents the damage, and will aid the park and recreation district in estimating the cost of removal and replacement of the plant material. The Cities of Bismarck – Mandan and areas adjacent to the Missouri River experienced unprecedented flooding following a record release from Garrison Dam in 2011. The Missouri River "Action Stage" at Bismarck is 14 feet. Action Stage was exceeded on May 23 with a river level of 14.2 feet. Peak river elevation reached 19.24 feet on July 1. On August 31, the river fell below "Action Stage" with a river level of 13.96 feet.

A visual inspection was conducted by North Dakota Forest Service personnel to determine numbers and sizes of trees downed by the flood or by wind, and to mark for removal other trees determined to be high risk. The field inspection and data collection took place from September 3 to October 11, 2011.



The area that was covered by the assessment is highlighted in yellow on the map below. Areas that were not mowed or otherwise maintained were assessed only along the perimeter. There are two areas that were not assessed, the tent camping area and the area around the shop and host residence.

What was Found

Within the areas assessed, 1,283 trees were marked for removal. More than 100 of these trees are native cottonwood ranging in size from 8” to more than 40” diameter at breast height (DBH) and up to 100 feet tall. The remaining trees are mostly green ash, ranging in size from 6” to 28” DBH, with a majority of those trees about 20” DBH.

The next three to five years will determine the fate of the remaining trees. The root systems of many of the trees that were inundated with water for more than three months have been damaged. Roots need oxygen for growth and respiration, so the longer they are submerged the more difficult it is for the roots and tree to survive. Roots begin to decline within seven days of flooding. The longer the duration of the flooding, the more damage there will be to the root system. Trees that have suffered a substantial amount of root injury are prone to wind-throw, (being uprooted in heavy wind) and should be monitored closely or removed. Trees that begin to lean severely should be removed as soon as possible. The declining health of the root system and the wet soil decreases the ability of the roots to anchor the tree and hold it upright. Given the right conditions, a slight breeze or a strong wind can topple flooded trees.

The health of these root systems cannot be determined, some of the trees will recover, and others probably will decline and die. The trees in the park need to be monitored and trees removed if they die or fail due to the root damage that occurred during the flood.

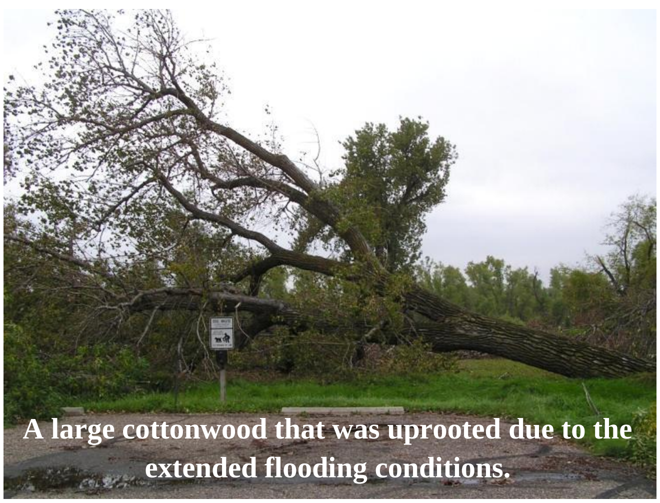
The following Extension Extra publication #6025 titled “Flood Damaged Trees” by Dr. John Ball, South Dakota State University Extension Forestry Specialist, states:

> *“Late spring and early summer flooding is the most harmful to trees, as they are the times when roots are actively growing. Standing in water, or even saturated soils, is harmful to all trees at this time of year. Flooding in late winter while the tree is dormant is the least harmful.*
>
> *Duration, depth, and water temperature and movement are all key factors in determining the impact of flooding on trees. The longer the water remains during the growing season, the greater the impact. If the flood-water recedes within a week, most trees will recover. If the waters remain for a month or two, many trees will begin to decline and may die. The depth is also an important factor. Water on the trunks is considerably more harmful than water just covering the roots, so a good rule of thumb is the higher the water the greater the injury. Lastly, the water temperature and movement have an influence on the amount of oxygen carried in the water. The warmer the water and the less movement, the lower the oxygen level and the more potential for injury.*
>
> *Simply put, if the floodwaters become stagnant and remain for several weeks or more, covering the lower 2 or 3 feet of the tree’s trunks, most likely the tree will decline and die, though this may take a year or more to occur.”*

The following July 1994 report by Dr. Kim Coder, University of Georgia, titled "Flood Damage to Trees," states:

> *"Tree root response to flooding is a reduction of root initiation and growth. Within seven days there is noticeable root growth loss. Flooding causes a loss of extent, reach and health of the roots. Over time, decline, death and decay are the results. In other words the longer an area is flooded the more damage you can expect to the root system.*
>
> *Trees stand erect against most wind and flood conditions on the basis of: tree weight, stiffness of the main trunk, width of the base, amount of fluid dynamics drag, fluid velocity, and fluid mass.*
>
> *In air, the tree tends to sway back and forth as it is loaded and unloaded. The period of the sway is set by the mechanical properties of the tree. The swaying can loosen tree roots from the soil and lead to toppling under light winds in saturated soils."*

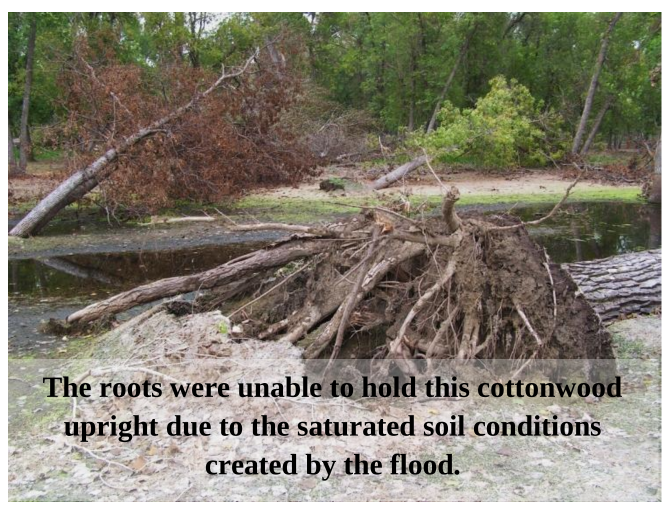
The following images were from the initial visit to General Sibley Park. Although they represent a small area of the park, the images illustrate the devastation that was found throughout the park.



A large cottonwood that was uprooted due to the extended flooding conditions.

Multiple trees have been uprooted and limbs broken due to the flooding and wind storm.

The green ash trees in this image were also unable to hold themselves upright due to the flooding conditions.



The roots were unable to hold this cottonwood upright due to the saturated soil conditions created by the flood.

The windstorm on July 31, 2011, played a role in toppling trees in the park, but flooding is the primary factor that caused so many trees to fall. The image above shows trees that toppled in different directions indicating it was the soil and roots that gave way; and the windstorm was a contributing factor in many cases.

The image to the left shows the trunk failed at ground level, while the image to the right indicates the failure occurred further up the tree trunk. The trunk breakage was caused by a wind storm, but mechanical damage in the past may have weakened the wood. Every effort should be made to prevent mechanical damage from string trimmers and lawnmowers during maintenance operations. Repeated injury decreases the overall health of the tree and allows access for wood-decaying pathogens to enter the tree. These trees might have survived the windstorm if there had not been previous mechanical damage.

The trunk failure on the green ash tree above shows damage from the wind storm. The image to the right is splitting damage to the trunk of a cottonwood. The injuries these trees suffered were not due to flooding.

The following images show trees that have failed due to flooded conditions.

The cottonwood above is still standing, but is leaning because of root damage caused by saturated soils; the image to the right shows that the roots are failing and the tree should be removed. Trees with similar or more excessive lean and bulging soil on one side should be removed. The tree is now off center, with the weight of the tree pulling on the roots that have already failed. It is only a matter of time before this tree finally topples over.

The roots of the green ash pictured above have completely failed due to the flooding. The tree poses an obstacle to maintenance equipment and a tripping hazard for park visitors. Trees that have completely failed like this should be removed.

This image shows the roots of a toppled cottonwood tree; only the largest roots have broken, the other roots are bent but intact. The saturated soil, due to the flooding, resulted in root failure.

In some locations, not only were trees lost, but the pavement was damaged when the trees fell. Utility lines, in several locations, were also downed as trees fell.

Hanging and Broken Branches

Hanging and broken branches were not documented in this assessment, but they do pose a serious threat to structures, vehicles and patrons of the park when they fall. Once the fallen and severely damaged trees have been removed from the park, hanging and broken branches should also be removed.

Heart Rot

Many of the green ash trees in the park are showing symptoms of heart rot, a fungal disease that deteriorates the strength of the wood slowly over time. The images below show the fruiting bodies of the fungus called conks.

Diversity

The assessed park tree population is dominated by three species: green ash - *Fraxinus pennsylvanica* – 83 percent; cottonwood – *Populus deltoides* -10 percent; and boxelder - *Acer negundo* – 5 percent. The other 2 percent is composed of American linden – *Tilia americana;* bur oak – *Quercus macrocarpa;* chokecherry - *Prunus virginiana;* Colorado spruce – *Picea pungens;* maple – *Acer;* Russian olive – *Elaeagnus angustifolia* and willow – *Salix*. There is a need to increase the number of species located in the park. Increasing species diversity in the park will help insure that if an invasive insect or disease were to be introduced into the park, not all the trees would be affected by the insect or disease. The assessment shows that the dominant tree species is green ash. If emerald ash borer were to enter the park, the vast majority of trees could be killed within a few years.

Recommended species that have varying degrees of tolerance to flooding are: boxelder - *Acer negundo;* Manchurian Alder Prairie Horizon - *Alnus hirsuta 'Harbin';* Northern Tribute™ River Birch - *Betula nigra 'Dickinson';* hackberry - *Celtis occidentalis;* thornless honeylocust - *Gleditisia triacanthos var. inermi;* American hophornbeam - *Ostrya virginiana;* bur oak - *Quercus macrocarpa;* laurel leaf willow - *Salix pentandra* and other willow species; and Prairie Expedition American elm - *Ulmus americana 'Lewis & Clark'*.

Reforestation

New tree regeneration is emerging since the end of the flood. This image shows new green ash and boxelder seedlings growing in the previously flooded area. These new seedlings could be protected to help reforest parts of the park. New tree regeneration should be managed and protected for at least five-years to avoid damaging the young trees. Care should be exercised to avoid mowing or spraying the seedlings with herbicides. This management approach may work best on the edges of the park that are not used as intensively as the camping or playground areas. In these high-use areas, replacement planting with commercial nursery stock may be warranted. Increasing the park's overall tree diversity could be accomplished by planting a variety of tree species in these areas.

Replanting Costs

Table # 1 estimates the cost to purchase and replant 2-inch caliper trees to replace the 1,283 trees will be $551,690.

Table #1 - Replanting Costs

Number of Trees Destroyed	Tree Stock $300 average cost per tree (2" caliper B&B)	Planting and Staking $130 average cost per tree	Total Replacement Costs
1,283	$384,900	$166,790	$551,690

Assessment Numbers

Table #2 indicates 1,283 trees were destroyed in General Sibley Park. Table #2 also lists the number of trees destroyed by species and size class.

Table #2 - Trees Destroyed in General Sibley Park

Tree Species	Number
American linden	12
boxelder	58
bur oak	4
chokecherry	2
Colorado spruce	4
cottonwood	123
green ash	1066
maple	9
Russian olive	2
willow	3
Totals	1,283

Tree Size Class	Number
Less than 6 inches	167
6-12 inches	756
12-18 inches	219
18-24 inches	35
24-30 inches	65
30-36 inches	26
36-42 inches	11
42-48 inches	4
Total	1,283

Wood Utilization

This natural disaster has created a large amount of wood that will have to be used or disposed of. The task of removing trees from the area will involve prioritizing the areas for clean-up, determining uses for the wood, establishing areas to store product and debris, and contracting the work. The following websites may aid the park and recreation district in answering some of these questions:

North Dakota Department of Health, Division of Waste Management, (www.ndhealth.gov/wm/Publications/) provides information on options for waste disposal, as well as a list of wood processing/recycling facilities and equipment vendors that offer services within the state of North Dakota. The Bismarck City Forestry Department (www.bismarck.org/index.aspx?NID=101) provides a list of licensed arborists (contractors).

Possible Uses for Wood

Lumber

Trees that are solid, with little or no rot, could be milled into lumber and used for projects within the park and recreation district. North Dakota's primary wood-using industry is comprised mainly of small sawmills operating on a part-time basis. Products include rough lumber, pallet cants, chips, planking and other unfinished products of cottonwood, green ash, American elm, basswood and bur oak. A *North Dakota Sawmill Directory* is available at: http://www.ndsu.edu/fileadmin/ndfs/sawmill_directory_2010_FINAL.pdf)

Wood Mulch for Landscaping

All of the wood and woody debris could be chipped and used as wood mulch. It may not be practical to chip everything at once due to the quantity of wood. The wood is wet, which will increase the possibility of spontaneous combustion in the chip piles. Long-term storage of chips may also decrease their quality for intended uses. If possible, store the wood in log form. The logs may be chipped over an extended period of time to avoid storage and quality issues. Low quality trees that have rot present could be chipped and composted. The compost could be used in flower beds and other locations to improve soil health.

Firewood

Most of the trees marked for removal are green ash, ranging in size from 6" to 24" diameter at breast height (DBH). Although these trees may show evidence of decay, the material can be used for firewood. Table # 3 indicates an estimated 244 cords of firewood could be generated from the 1,177 green ash trees destroyed in General Sibley Park.

Table #3 Firewood (green ash)

Tree Size	Number of Trees	Volume of Firewood
6"	167	6 cords
6" - 12"	756	150 cords
12" - 18"	219	70 cords
18 - 24"	35	18 cords
Totals	**1,177**	**244 cords**

There is more wood than the park district will be able to use. The public could be allowed to enter the park and harvest the firewood following the removal of the severely damaged standing trees. Tree trunks and branches suitable for firewood could be left on the ground along trails and roads for easy access. The number of firewood cutters should be limited to provide a safe and orderly working environment.

Wood Biomass Boiler

Bismarck Parks and Recreation District utilizes a biomass boiler for heating the Aquatic Center at Bismarck State College. The destroyed cottonwood trees could be ground and used as fuel for energy. As soon as the wood is ground and piled it begins to lose BTUs. The logs should be stored and allowed to dry out before grinding is done.

Table # 4 indicates an estimated volume of 267 cords or 695 tons of biomass could be generated from the 106 large cottonwood trees marked for removal in the park.

One possible site for storage of wood is the Missouri River Correctional Center, located just west of the park. The feasibility of using the site should be considered by decision-makers and with concurrence by the correctional center management.

Table #4 Biomass (wood chips) – From Cottonwood Trees

Tree Size	Number of Trees	Volume
24" – 30"	65	130 cords
30" – 36"	26	75 cords
36" – 42"	11	44 cords
42" – 48"	4	18 cords
Totals	**106**	**267 cords or 695 tons**

Each cord provides 212 cu. ft. of wood chips One cord = 2.6 tons

Costs of Tree Removal

Table #5 estimates removal costs for the 1,283 trees destroyed will be $167,825. The costs are based on estimates from a number of local tree service contractors:

Table # 5 Tree Removal Costs

Tree Size	Number of Trees	Cost/Tree	Total Removal Cost
<6" – 12"	923	$75	$69,225
12" – 24"	254	$150	$38,100
24" – 36"	91	$500	$45,500
36" – 48"	15	$1000	$15,000
Totals	**1,283**		**$167,825**

These totals are conservative estimates. Variables such as distance to disposal site and landfill costs could bring total costs of removal and clean-up to $500,000.

References

Dr. John Ball of South Dakota State University, Extension Extra publication #6025-Revised June 2011, Flood-Damaged Trees

Dr. Kim D. Coder, Extension Forest Resource, University of Georgia July 1994, Flood Damage to Trees

List of Contacts

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Disclaimer

The assessment was limited to visual inspection of accessible subject trees within the defined areas as noted for the purpose of evaluating and estimating losses, costs of removal, and costs of replanting.