Windstorm Damage to Trees
Anchorage, Alaska
September 2012

Observations and Recommendations

Alaska Division of Forestry Community Forestry Program

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Alaska Department of Natural Resources
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Community Forestry Program
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A large number of young cottonwoods blew down on the eastern side of the lake in Cheney Lake Park.

Introduction

On the evening of September 4, 2012 a massive low-pressure system pushed into the Anchorage area from southwestern Alaska carrying warm moist air from the Pacific Ocean. As the storm moved onshore, winds and precipitation intensified and peaked around midnight and into the early morning hours of September 5. According to the National Weather Service winds blowing from the east ranged from 40 to 90 mph across the Anchorage Bowl and may have exceeded 100 mph on the hillside. The Port of Anchorage reported a gust of 63 mph, McHugh Creek experienced an 88 mph gust, and 75 mph winds were recorded at Potter Marsh. Near the Glen Alps parking lot, amateur meteorologist Joe Connolly recorded a 131 mph gust. (Alaska Dispatch, 2012). Rainfall was also heavy; a weather station at Turpin Street and East 10th Avenue measured 4.72 on September 4 and 6.92 inches of rain on the following day. (Weather Underground).

As day broke on September 5, emergency responders, municipal agencies, and residents began assessing damage to trees on private and public property and found it to be considerable. Whole trees were uprooted, trunks snapped at different heights, and tree crowns were damaged. Woody debris blocking traffic was removed temporarily and piled along roadsides to allow vehicles to pass. Tree services and utility companies were quickly overwhelmed by the number of calls for assistance. Woodlots reopened with extended hours but were not equipped to handle the unprecedented volume of debris that arrived.

South central Alaska experiences winds of similar magnitude most years in winter or early spring. What set this storm apart from others is that it occurred in late summer when the trees were in full leaf and the ground was not frozen. No record or memory of such high winds at this time of year was reported. Soils saturated from heavy rainfall may also have contributed to the many soil failures.

Observations

On the morning of September 5 and in the days following the storm, Alaska Division of Forestry Community Forestry Program staff Patricia Joyner[1] and Stephen Nickel[2] visited public and private sites that appeared to have sustained the heaviest damage. They took photographs, inspected trees at each site to ascertain what most likely contributed to the failure, and recorded observations of trees that had fallen or been damaged.

Figure 1. Despite the heavy rainfall, gravelly soil just beneath turf grass was quite dry the morning following the storm. (Julie Riley)

Stephen Nickel investigated 13 additional sites at Russian Jack Springs Park (north and south of Debarr Road), Cheney Lake Park, Campbell Creek Greenbelt, Chester Creek Greenbelt, Johns Park, and Ruth Arcand Park. He recorded species, size, type of damage or failure, presence or absence of decay, defects present before the storm, site conditions, direction of fall, and cultural damage.

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[2] Community Assistance Forester, ISA Certified Arborist PN-2707A and PNW ISA certified Tree Risk Assessor #588

Types of Damage

Whole Tree Failures in Forested Areas

The forested sites investigated were characteristic of the temperate boreal forest. The trees that uprooted were primarily balsam poplar (*Populus balsamifera*), black cottonwood (*Populus tricocharpa*), paper birch (*Betula papyrifera*) and white spruce (*Picea glauca*). Most of the whole tree failures observed were attributed to soil failure; the force of the wind was too great for the root systems. Few had conditions such as root decay that would have predisposed them to failure. The failures were likely caused by a combination of high velocity winds and shallow, unfrozen soils. The high number of native deciduous tree failures relative to the number of spruce failures; may be because deciduous trees, unlike spruce, had not previously experienced such high winds when in full leaf.

Figures 2 - 3. Many large birches were uprooted in John's Park (l) and Russian Jack Springs Park (r).

Terrain may have played a role in some areas, especially along the base of the Chugach Mountains in east Anchorage where the damage was most severe. The heavy rainfall may have contributed to failures; however most trees observed were in gravelly or rocky soil that was dry below the organic layer on the surface.

In Cheney Lake Park and Russian Jack Spring Park there were sites in the interior of the forest where nearly all the trees were uprooted, surrounded by trees still standing. This type of damage was likely caused by microbursts - localized columns of sinking air that cause extensive damage similar to that caused by a tornado. However, microbursts create straight-line winds in contrast to the rotational winds of tornados.

Whole Tree Failures in Developed Landscapes

Forestry staff noted a clear pattern to tree failures in developed landscapes. Nearly all whole tree failures were caused by poor planting practices. The most common being trees planted too deeply, which caused the roots to either die due to lack of oxygen and moisture or grow up toward the surface where growing conditions were better. These roots tend to circle the trunk. As the trunk and circling root increase in diameter the root constricts the trunk and impedes the flow of photosynthate (carbohydrates) and water between the crown and roots. The roots begin to die and the tree's anchoring system weakens. The stress also predisposes trees to insect and disease damage and early decline. In severe cases, girdling roots can create inverse taper in the trunk resulting in a tree balancing on a narrow point of trunk wood. The tree will fall over eventually, often with no help from the wind.

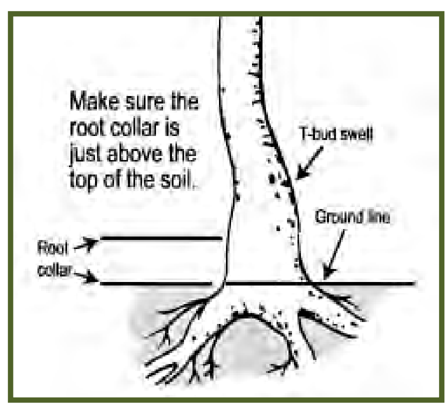


Figure 3. Trees planted at the correct depth develop stronger root systems that are more likely to anchor the tree during high winds.

Selecting trees without root defects or treating root defects before planting can prevent girdling roots. It is easier to inspect correct defects in bare root trees than in containerized or balled-in-burlap trees. Trees planted at the correct depth with no soil over the trunk flare are less likely to develop root defects and are more likely to thrive and remain anchored during a storm.

Figure 4. A common scene after the storm – multiple trees failed because of poor planting practices. It appeared that the greatest numbers of failures due to deep planting were cherries – *Prunus padus, P. maackii,* and *P. virginiana*.

Figure 5. A major cause of landscape tree failure was trunks with girdling roots. Note how the trunk of this Amur chokecherry (*Prunus maackii*) becomes narrower at the base – the opposite of what is normal. When trees are planted too deeply, the roots die or grow up toward the surface and then circle the trunk. As the trunk and root grow the root constricts the trunk.

Figure 6. This spruce was planted in the plastic bag. Roots that cannot spread cannot anchor the tree. All wrapping material and wire should be removed before a tree is planted. (Julie Riley)

Another cause of failure was asymmetrical or confined root systems due to construction damage or compacted soils. Compacted soils have limited pore space and low available oxygen, an environment not suitable for root growth. If roots cannot spread into an area, they cannot anchor the tree in that direction and are therefore more likely to fail. Physical barriers such as sidewalks, driveways, and landscape edging can create confined root systems if roots are not able to grow under these obstacles.

Figure 7. Notice the lack of roots on the right side of these cottonwoods. Vehicles compacted the soil and prevented the roots from spreading into the area. This lack of support on the windward side contributed to the tree blowing over.

Figure 8. Tree roots spread to twice the height of the tree in every direction when given enough space. Damaging the roots of large trees or planting them where soil is limited makes them more likely to fail in storms. (Photo on right by Peter Briggs)

Stem and Branch Failures

Trees fail at their weakest point but even sound trees and branches will fail in extreme winds. Trunks often break where they have decay or have been damaged, such as girdling by ties that are left around the trunk too long. Most of the branch and crown damage observed was caused by weak branch structure, codominant stems, included bark and/or improper pruning practices. All of these defects make trees more likely to fail and can be prevented by selecting high quality nursery stock and maintaining it properly.

Codominant stems are forked stems nearly the same size in diameter, arising from a common junction. They are prone to split apart unless corrected by pruning while the branches are still small. Included bark is bark that becomes imbedded in a crotch (union) between branch and trunk or between codominant stems. Purchase trees without these defects and prune early in the life of the tree to help develop strong structure.

Figure 9. When two stems of similar size grow from the same point, they push against each other, causing a crack that is prone to splitting. These trees should have been pruned to have one trunk (leader) when the trees were small.

Figure 10. A birch and spruce that had two stems of similar size pressing against each other. See the dark decayed areas. This weakness caused the trees to split during high winds.

Figure 11. This European bird cherry (Prunus padus) failed at the point of a large, improper pruning cut that caused trunk decay.

After the storm

After a storm experienced professionals should inspect trees for evidence that they pose a hazard to people or property. Danger signs are not apparent to the untrained eye and landowners and managers can put themselves in dangerous situations in an effort to clean up debris quickly. Trees that could be saved may be removed due to unfounded concern. Limited resources may be wasted removing trees that do not pose a threat and lives and property may be put at risk by not identifying those that do. Professionals will indicate which trees should be removed immediately to ensure public safety, which ones should be monitored, and which need maintenance to keep them safe and healthy.

Felling and disposing of damaged trees also requires a high level of skill and awareness. The forces of tension and compression are dynamic and can catch the most experienced person off guard. Salvage operations should be completed by licensed, bonded and insured professionals to ensure the task is completed in a safe and efficient manner.

Storm damaged trees present many hazards and risks.

- Uprooted trees that are leaning on or have become entwined with other trees;
- Fallen trees under other trees may rapidly spring up or roll unexpectedly as weight is removed;
- A tree or branch under tension may suddenly snap and injure anyone standing nearby;
- Small broken branches are not a concern but large ones can fall and injure people or damage property;
- Cracks, bows, and bulges are signs that tree may fail;
- Root plates of fallen trees may fall back into place after being separated from the trunk;
- Leaning trees present many hazards and may split vertically along the trunk when cut;
- Damaged trees may fall in unexpected ways or directions during felling operations.
- Downed power lines are extremely dangerous. Always assume that electrical wires are live; never touch a wire, tree, or other object in contact with a wire.
- Untrained chainsaw operators present a danger to themselves and others; operate only after being trained and with proper gear.

Some damage may not become apparent until much later or until conditions or the weather changes. For example root, trunk, or branch damage that is not obvious may cause the tree to decline in health or fail in future high winds or precipitation.

A tree that begins to lean and create a mound of soil on one side of the trunk or has newly exposed roots may survive and stabilize over time or it may fail. If a tree is small, an experienced arborist can determine if steps can be taken to safely support and save it or if it should be removed.

Figure 12. Partially uprooted trees may stabilize with help but trees in high traffic areas should be evaluated by a Tree Risk Assessor soon after the storm to determine if they are a danger to people and property.

Figure 13. Large hanging branches pose a hazard to people and property and should be removed by someone with the skill to do so safely. Notice in the photo on the right, the buckling on the under (compression) side and the split bark on the upper (tension) side of the trunk. Trees under tension like this one are especially dangerous as they have stored energy that can release violently. Only experienced and skilled professionals should handle damaged, fallen, and tension loaded trees.

Figure 14. Caution is required when working around uprooted trees. Cutting through the trunk may cause the root plate to flip upright.

Other problems that may result from extensive loss of tree canopy include the following:

- Trees growing in a forest surrounded and protected by other trees are typically tall and spindly with weak trunks and most of the foliage is at the top. Some of these trees are now in the open due to windthrow. While open grown trees have adapted to the forces of the wind and developed stronger trunks interior trees have not and are more likely to fail when exposed to new site conditions.
- An increase in downed and damaged trees attracts the insects that feed on them. Local insect populations may expand to the point of attacking live trees as was seen in the spruce bark beetle epidemic. This is most likely in areas where large numbers of spruce were uprooted or stressed due to damage.
- Increased runoff, erosion, and changes to the local water table are possible in areas with significant changes to the forest canopy. Fewer trees mean more runoff and fewer roots to hold stream banks.
- Invasive trees species such as European bird cherry (*Prunus padus*) and common chokecherry (*Prunus virginiana*) and a variety of weeds may invade areas of blow down due to the increased light, exposed forest floor, and disturbed soil. Less competition for space, light, and water may allow aggressive species to spread. Grasses may grow more densely, hindering germination and growth of trees and shrubs. Tall, dead grass may also increase fire danger in the spring before green-up.

Follow-Up

On December 6, 2012 staff from the Alaska Division of Forestry and Municipality of Anchorage Fire Department, Project Management and Engineering, and Parks and Recreation departments met to discuss the response to the storm and how to handle large quantities of woody debris and mitigate hazards. The group identified the following points to consider in order to be prepared for future storms or other natural disasters:

1. A plan for dealing with fallen, damaged, and hazardous trees that is included in the general municipal wide response plan would make resources more readily available and the response more efficient.
2. A plan and resources are needed to handle the large volume of tree debris generated during a storm.
3. A process for professional arborists and tree risk assessors to identify trees at high risk of failure on sites with targets will improve the safety of the public and reduce cost of the response.
4. More effective community education could lead to an urban forest that is better able to weather a severe storm. Storm damage to landscape trees would not have been as severe if trees had better structure and were planted and maintained properly.
5. More effective community education can make the public aware of the possible hazards of storm-damaged trees and the need for trained professionals to remove them safely.
6. A document that records observations of storm damage by professionals in a variety of locations would be useful in responding to this storm and planning for future storms.

Appendix

References

Trees and Storms. This 5-page brochure clearly describes common types of storm damage to trees, prevention, and post-storm response. Purdue University Extension, FNR-FAQ-12-W by Lindsey Purcell, Urban Forestry Specialist, Department of Forestry and Natural Resources. June 2013. https://www.ces.**purdue**.edu/extmedia/FNR/FNR-FAQ-12-W.pdf

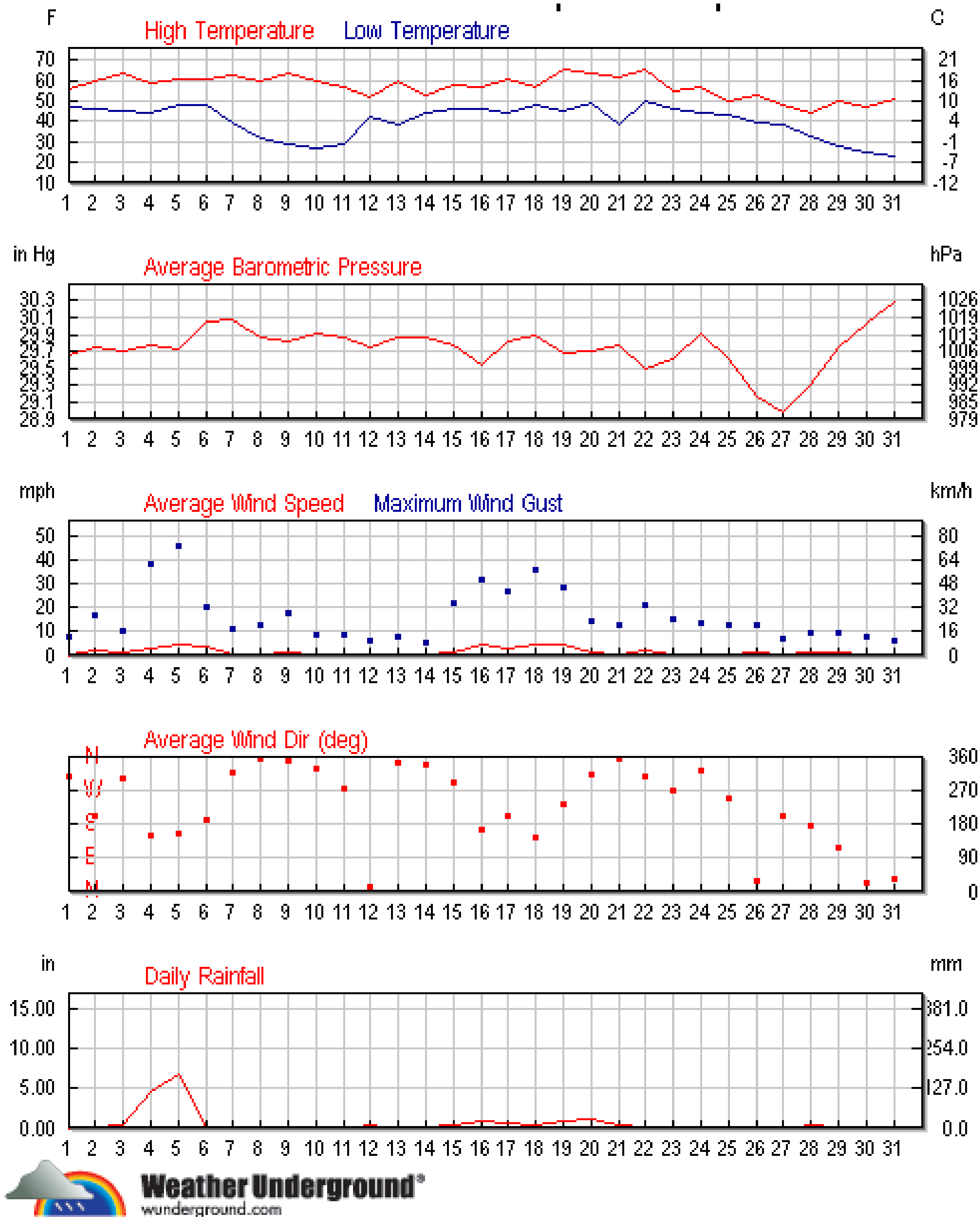
Hazard Tree Management in Alaska. US Forest Service website http://www.fs.usda.gov/detail/r10/forest-grasslandhealth/?cid=fsbdev2_038336

Plant a Tree: An Alaskan Guide to Tree Selection, Planting, & Care. Alaska Division of Forestry Community Forestry Program and UAF Cooperative Extension Service, August 2011.

Anchorage Municipal Forester. Maria D'Agostino (343-4716, d'agostinoma@muni.org) For information on salvaging downed trees or other concerns related to storm damage and recovery on municipal property.

Figure 15. Storm damaged trees are dangerous. Don't tackle clean up unless you have the training, experience, and gear needed to do the work safely.

Weather Graph for September 2012



Weather station history for Turpin and East 10th Ave., Anchorage, Alaska
Elevation: 315 ft, Longitude: 149.7° W Latitude: 61.2° N

Anchorage Storm Damage Map

Damage in municipal parks mapped by Anchorage Parks & Recreation employees.

Red: 100+ complete tree failures
Black: 20-100 complete tree failures