WINDSTORMS CHAPTER

Hazard Analysis/Characterization

This chapter covers most kinds of windstorm events in Oregon, including the wind aspects of Pacific storm events. The precipitation aspects of Pacific storm events are covered in the Flood Chapter of this plan. Winds specifically associated with blizzards and ice storms are covered in the Winter Storms Chapter.1

History and Frequency of Windstorms

High winds occur frequently in Oregon; they are especially common in coastal regions and in the mountains of the Coast Range. Most official wind observations in Oregon have been at valley locations where both the surface friction and the blocking action of the mountain ranges substantially decrease the speed of surface winds. Even the more exposed areas of the coast are lacking in any long-term set of wind records. From unofficial, but reliable observations, it is reasonable to assume that gusts well above 100 mph occur several times each year across the higher ridges of the Coast and Cascades Ranges. At the most exposed Coast Range ridges, it is estimated, that wind gusts of up to 150 mph and sustained speeds of 110 mph will occur every five to ten years.

Severe Pacific storms produce high winds, and often, significant precipitation as well. These storms usually produce the highest winds in Western Oregon, especially in the coastal zone. Some of these events originate in the Gulf of Alaska and others in the Central Pacific Ocean. These storms are most common from October through March. The impacts of these storms on the state are influenced by storm location, intensity, and local terrain.

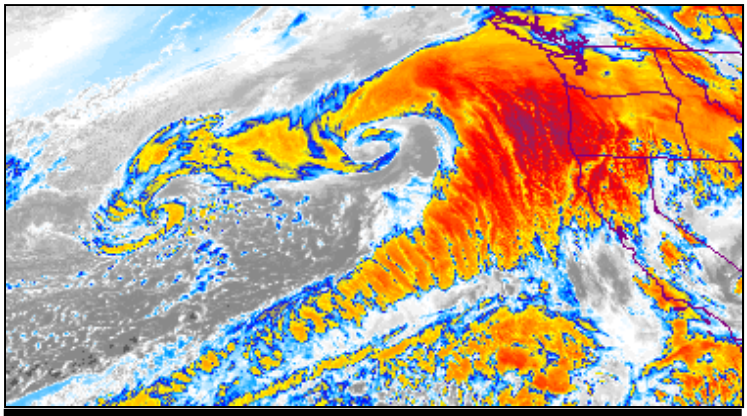

Figure W-1: Severe Pacific Storms like this one not only bring heavy precipitation, but also often bring high winds to Western Oregon (satellite image courtesy of NOAA).

The historian Lancaster Pollard documented exceptional storms that occurred in 1880, 1888, 1920, 1931, and 1962. (on) January 29, 1920 a hurricane (sic) off the mouth of the Columbia River had winds estimated at 160 miles per hour.[2]

One easterly windstorm that affected much of Oregon, particularly northern Oregon, was the northeasterly gale of April 21-22, 1931. This storm proved to be very destructive. Dust was reported by ships 600 miles out to sea. "While officially

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1 A full list of acronyms used in this chapter is provided in Appendix 8-B.

[2] *Pacific Northwest Quarterly,* "The Pacific Northwest Dust Storm of 1931," Paul C. Pitzer, April 1988, p. 50

recorded wind speeds were not extreme, sustained wind speeds observed were 36 mph at Medford, 32 mph at Portland, 28 mph at Baker, and 27 mph at Roseburg. Unofficial wind measuring equip-ment reported winds of up to 78 mph. Damage was heavy to standing timber and fruit orchards." [3]

Table W-1: Selected Significant Windstorms in Oregon

Month - Year	Location	Comments
October 1962	Western Oregon and some locations east of Cascades	Oregon's most famous and most destructive windstorm, the Columbus Day Storm, produced a barometric pressure low of 960 mb (*)
March 1963	Western Oregon	Second strongest windstorm in the Willamette Valley since 1950
October 1967	Most of Western and Central Oregon	An intense 977 mb low produced a sudden, destructive blow (*)
November 1981	Oregon Coast and N. Willamette Valley	Back-to-back storms on the 13th and 15th of November
January 1993	North Coast Range	Inauguration Day Storm; resulted in a major disaster declaration in Washington State
December 1995	Northwest Oregon	Strongest windstorm since Nov. 1981; barometric pressure of 966.1 mb at Astoria, and an *Oregon record low 953 mb* off the coast; major disaster declaration FEMA-1107-DR-OR (*)
February 2002	South and Central Coast, Southern Willamette Valley	Major disaster declaration FEMA-1405-DR-OR, a surprise windstorm
February 2007	Northwest & Central Coast and North Central Oregon	FEMA-1683-DR-OR: Severe Winter Storm with a Wind Component
December 2007	South, Central, North Coast and Willamette Valley	FEMA-1733-DR-OR: Severe Winter Storm, including Flood and Landslide Events

(*) For the sake of comparison, surface barometric pressures associated with Atlantic hurricanes are often in the range of 910 to 960 mb. The all-time record low sea level barometric pressure recorded was associated with Typhoon Tip in the Northwest Pacific Ocean on October 12, 1979 at 870 mb.

Source: Oregon Climate Service (OCS) and the sources cited in footnotes #1 and #2.)

[3] http://www.wrh.noaa.gov/Portland/windstorm.html - For more information on this 1931 storm, see the Dust Storms Chapter of this plan, especially Appendix DS-1.

Table W-1 summarizes selected significant windstorms in Oregon. It does not include all significant windstorms. A more complete source of Oregon windstorm reports, technical data including barometric pressures, and information on other historical weather events in the Pacific Northwest can be found at:

http://oregonstate.edu/~readw/

Courtesy of OCS at OSU, some of the events described at the website above and on Table W-1 have also been included in Appendix W-1 to this chapter.

EFFECTS

The damaging effects of windstorms may extend for distances of 100 to 300 miles from the center of storm activity. Isolated wind phenomena in the mountainous regions have more localized effects. Near-surface winds and associated pressure effects exert loads on walls, doors, windows, and roofs, sometimes causing structural components to fail.

Positive wind pressure is a direct and frontal assault on a structure, pushing walls, doors, and windows inward. Negative pressure also affects the sides and roof: passing currents create lift and suction forces that act to pull building components and surfaces outward. The effects of high velocity winds are magnified in the upper levels of multi-story structures. As positive and negative forces impact and remove the building protective envelope (doors, windows, and walls), internal pressures rise and result in roof or leeward building component failures and considerable structural damage.

Debris carried along by extreme winds can directly contribute to loss of life and indirectly to the failure of protective building envelope components. Upon impact, wind-driven debris can rupture a building, allowing more significant positive and internal pressures. When severe windstorms strike a community, downed trees, powerlines, and damaged property are major hindrances to response and recovery.

TERRITORY AT RISK

Extreme weather events are experienced in all regions of Oregon. Areas experiencing the highest wind speeds are the Central and North Coast under the influence of winter low-pressure systems in the Gulf of Alaska and North Pacific Ocean; and the Columbia River Gorge, when cold air masses funnel down through the canyon. For example, at Crown Point, located about 20 miles east of Portland, easterly winds with a 24-hour average of more than 53 mph and gusts in excess of 120 mph were recorded.

Table W.2: Probability of Severe Wind Events by NHMP Region

one-minute average, 30 feet above the ground Location (Regions are from the Regional Natural Hazards Risk Assessment.)[3]	25-Year Event (4% annual probability)	50-Year Event (2% annual probability)	100-Year Event (1% annual probability)
Region 1 - Oregon Coast	75 mph	80 mph	90 mph
Region 2 - Northern Willamette Valley	65 mph	72 mph	80 mph
Region 3 - Mid/Southern Willamette Valley	60 mph	68 mph	75 mph
Region 4 - Southwest Oregon	60 mph	70 mph	80 mph
Region 5 - Mid-Columbia	75 mph	80 mph	90 mph
Region 6 - Central Oregon	60 mph	65 mph	75 mph
Region 7 - Northeast Oregon	70 mph	80 mph	90 mph
Region 8 - Southeast Oregon	55 mph	65 mph	75 mph

Source:PUC

Additional wind hazards occur on a very localized level, due to several down-slope windstorms along mountainous terrain. These regional phenomena known as foehn-type winds, result in winds exceeding 100 mph, but they are of short duration and affect relatively small geographic areas. A majority of the destructive surface winds in Oregon are from the southwest. Under certain conditions, very strong east winds may occur, but these are usually limited to small areas in the vicinity of the Columbia River Gorge or in mountain passes.

The much more frequent and widespread strong winds from the southwest are associated with storms moving onto the coast from the Pacific Ocean. If the winds are from the west, they are often stronger on the coast than in the interior valleys due to the north-south orientations of the Coast Range and Cascades. These mountain ranges obstruct and slow down the westerly surface winds.

[3] http://csc.uoregon.edu/PDR_website/projects/state/snhra/snhra.htm

The most destructive winds are those which blow from the south, parallel to the major mountain ranges. The Columbus Day Storm of 1962 was a classic example of a south windstorm. The storm developed off the coast of California and moved from the southwest, then turned, coming into Oregon directly from the south. This was the most damaging windstorm in Oregon of the last century. Winds in the Willamette Valley topped 100 mph, while in the Coast Range they exceeded 140 mph. The Columbus Day Storm was the equivalent of a Category IV hurricane in terms of central pressure and wind speeds.

In terms of damage, "throughout the Willamette Valley, undamaged homes were the exception, not the rule. In 1962 dollars, the Columbus Day Storm caused an estimated $230-280 million in damage to property in California, Oregon, Washington and British Columbia combined, with $170-200 million happening in Oregon alone. This damage figure is comparable to eastern hurricanes that made landfall in the 1957-1961 time period...The (Columbus Day Storm) was declared the worst natural disaster of 1962 by the Metropolitan Life Insurance Company. In terms of timber loss, about 11.2 billion board feet was felled... in Oregon and Washington combined."[4] "The storm claimed 46 lives, injured hundreds more, and knocked power out for several million people.[5]

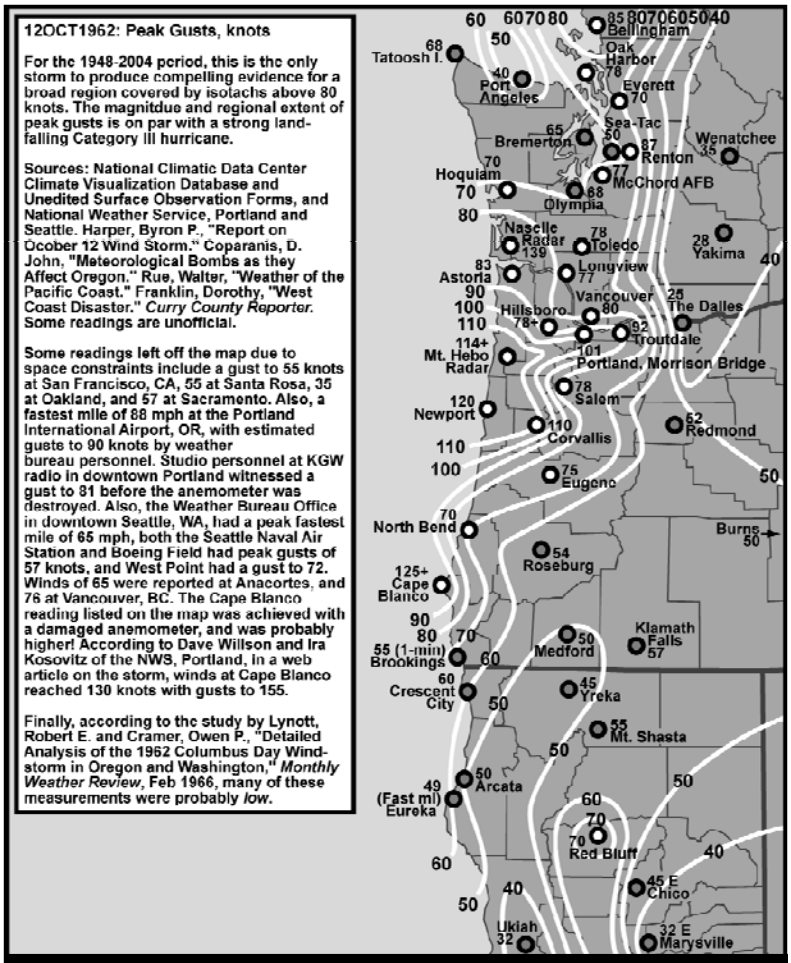

Figure W-3: This map and storm description, as well as similar graphics on pages W-4, W-5, and W-10 are courtesy of Wolf Read, Climatologist, Oregon Climate Center at Oregon State University. See also Appendix W-1.

See Appendix W-2 to this chapter, Comparison of Southeast United States Hurricane to Severe Pacific Storm.

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[4] http://oregonstate.edu/~readw/October1962.html

[5] http://www.wrh.noaa.gov/pqr/info/pdf/pacwindstorms.pdf

Other Issues

In the *HMST Report* developed in response to the February 7, 2002 windstormthe recommended observation issued that "differences in definitions of easements and allowable practices within them ('easement language') for private versus public, and urban forests vs. rural forests should be resolved." The State IHMT agencies agree that this issue continues to exist, but neither the resources nor the political will exist at this time to attempt to fix this complicated issue with many vested stakeholders.

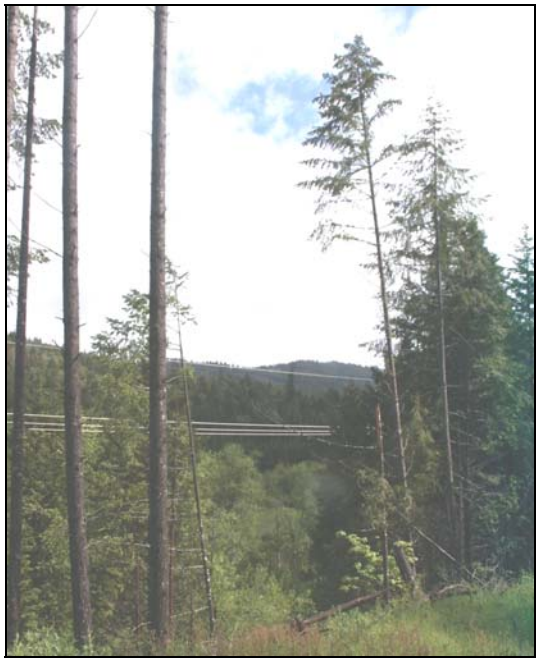


Figure W-4: Unstable trees left after a logging operation near electric lines pose a serious threat of personal injury, forest fire, and outages should high winds develop. Forest owners and workers need to coordinate their "leave trees" with electric utilities to prevent dangerous conditions as depicted here (photo courtesy of Randy Miller, PacifiCorp).

Two other issues identified in that report also continue to exist, but cannot be solved at this time: 1. "Land use actions being proposed by agencies with non-utility interests, which would affect land for which utilities have an interest, should be coordinated and should address vegetation management as it affects utility system operations" and 2. "Agencies and organizations should be identified to work with federal and state landowners to streamline processes by which electric utilities conduct hazard mitigation work on those lands..." Currently, ODOT issues permits for right-of-way work and ODF issues permits for the use of power equipment in forested areas.

Other areas of ongoing concern from this *HMST Report* are:

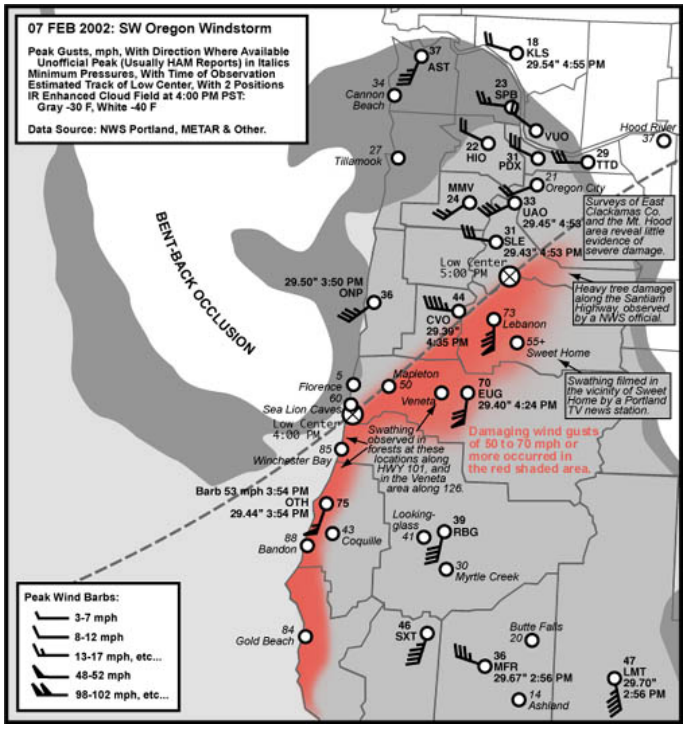
- Under Coordination - Utility providers should receive notification, from property owners, of planned tree-harvesting operations near utility lines.
- Under Vegetation Management - Diseased, damaged, and hazard trees near powerlines that could fall or hit utility lines should be removed. Some "leave trees" remaining after new building developments and tree harvesting operations pose a threat to utility line safety and reliability. See Appendix W-3 to this chapter, *How to Recognize and Prevent Tree Hazards*, for progress that has been made towards vegetation management issues.

- Under Engineering, Construction, and Compliance - "During initial planning and design of utility lines, identify types of geographic areas already known to pose hazards during windstorms. Inventory and analyze areas of repetitive failures to determine alternate designs and construction methods that will mitigate future damages... Consider selective undergrounding of lines where repetitive tree damage occurs, keeping in mind excavations can undermine tree root zones and create new hazards."

Existing Strategies and Programs

Existing strategies and programs at the state level are principally the responsibility of the Public Utility Commission (OPUC), DCBS - Building Codes Division (BCD), Oregon Department of Forestry (ODF), Oregon Emergency Management (OEM), Oregon Department of Transportation (ODOT) and the Oregon Emergency Response System (OERS), have key roles in providing windstorm warnings statewide.

The Public Utility Commission endeavors to ensure that Operators manage, construct and maintain their utility lines and equipment in a safe and reliable manner[6]. These standards and related information are available at http://www.puc.state.or.us/PUC/safety/index.shtml. The OPUC promotes public education, and requires utilities to maintain adequate tree and vegetation clearances from high voltage utility lines and equipment. The Agency audits the vegetation management programs of electric utilities on a periodic basis. Further, the PUC has adopted ANSI A-300, Part 1, *Tree Care Operations*, so that utility vegetation management programs support the maintenance of healthy trees and vegetation next to utility lines. Vegetation should be managed in areas both within and adjacent to utility easements and public rights-of-way to ensure safety both for members of the public and workers, reduce fire hazards, insure unimpaired transportation and utility corridors - especially in forests, to maintain system reliability (i.e., reduce the number and duration of utility outages) and minimize the isolation of remote and rural communities during windstorm events.



6 Oregon Revised Statute: 757.020

The state's building codes include wind load design requirements for particular geographic areas.

See Appendix W-4 to this chapter, Building Codes Division Wind Speed Map for Oregon.

Much of the property damage that occurs during windstorms results from tree limbs breaking or entire trees uprooting. The Oregon Department of Forestry's Urban and Community Forestry Program provides assistance to communities to help them deal with hazard tree issues. The program provides technical, financial, and educational assistance on a wide range of urban forestry topics, including tree inventories, hazard tree evaluation, tree risk assessment, tree species selection, and tree care standards.[7]

ODF's program also promotes the adoption of the ANSI A-300 *Tree Care Standards* by local governments, other public agencies, and private landowners. Local governments are encouraged to adopt these standards in order to improve the quality of tree care that takes place on trees in the public right-of-way and on other public lands.

Figure W-5: Falling vegetation is the primary source of wind-related damage (photo courtesy of *The Courier*, Reedsport, Oregon).

Oregon Emergency Management strives to reduce damage and other impacts caused by windstorms, especially by working in partnership with the PUC, ODOT and ODF to promote strategies and programs that reduce tree-caused damage to utility systems and highway corridors. OEM does this by participating in training opportunities where the intermix of trees and utility equipment is a topic, and by providing pass-through federal funding for the best proposed cost-effective windstorm hazard mitigation projects when these funds are available.

[7] www.odf.state.or.us/UF

Danger Tree on the ROW Committee – 2008-2011

EXECUTIVE SUMMARY

General

From the Willamette Valley to the coast, severe wind, rain, and sometimes ice storms pummel western Oregon almost every winter. When the storms hit, trees fall over roadways, often pulling power lines down with them.

The aftermath of these winter storms come is measured in human misery: people trapped in their homes without power, unable to leave because fallen trees shut the roads. Sometimes, fallen trees lead to tragedy, like the recent incident involving an 81-year-old Lebanon man who died December 26, 2009, when his car struck a downed tree on Highway 211 south of Estacada. A portion of the tree came through the windshield of the man's car, hitting him in the head and neck.

(Photo courtesy of Oregon State Police)

Cleaning up after winter storms is a costly burden for the State, Utilities and affected communities. During the past three winters, storm damage in western Oregon has been especially severe.

After the 2007 winter storm, a state of emergency was declared (and subsequent federal major disaster declaration DR-1733) for Columbia, Clatsop and Tillamook counties, in the northwestern part of the State. The Legislature asked each of the state agencies involved in emergency response to brief the Veterans & Emergency Services legislative committee on the impact the storm had on the three counties, and the efforts made to restore services across all of the state's northwestern counties. At the legislative committee briefing the Oregon Department of Transportation (ODOT) presented information on the way fallen

trees had blocked traffic on major highways in Oregon, and the amount of resources required to remove the trees from the roads. ODOT also detailed how its agency coordinated its emergency response activities with power companies to open the highways for traffic.

At about the same time, the Oregon Public Utility Commission requested a briefing by power companies to explain the impact of the 2007 storm and their respective restoration efforts. Commission members heard that the storm had damaged PacifiCorp's transmission lines from Astoria to Tillamook so severely; the lines were out of service for nearly a week, until extensive repairs could be completed.

Prior to the OPUC briefing on the impact of the 2007 storms, the State Interagency Hazard Mitigation Team (IHMT) met and recommended a committee be formed to review the problems caused by trees on main highways' right of ways (R/W) and transmission line corridors, and to come up with recommendations to eliminate, or at least reduce the impact future storms would

have from trees in the R/W. The State IHMT recommended that this newly formed committee include members from ODF, ODOT, OEM, OPUC, private timber owners & operators, power companies, local government or law enforcement agencies, private entity (ies), and Legal Counsel (Intern).

The Right of Way (R/W) Committee was formed and held its first meeting May 29, 2008 at the OPUC.

Committee Members

Tom Bergin – Clatsop County Sheriff

Dave Chaney – Accent Business Services

Erika Holsman – Legal Intern

Chris Jarmer – OFIC

Randy Miller – PacifiCorp

Luci Moore – ODOT

Bob Valdez – OPUC

J. R. Gonzalez – OPUC

Jerry Murray – OPUC

Lanny Quackenbush – ODF

Dennis Sigrist – OEM

Dave VanBossuyt – PGE

Patrick Cooney – ODOT

David Thompson – ODOT

Kevin Weeks – ODF

The Committee's Mission

The purpose of the committee was to investigate the feasibility of establishing proactive, collaborative vegetation management measures for roadways in the state of Oregon. The goal was to find ways to prevent the type of storm damage that occurred during the winter storm of 2007, when tens of thousands of trees

fell across Oregon roads and electrical transmission lines causing significant risk to public safety, millions of dollars of damage and disruption of state commerce.

The Project

The R/W Committee project focused on Senate District 16 in the northwestern corner of the state, where the 2007 winter storm caused considerable damage. The goal of the project was to refine the storm damage prevention processes and tools for a specific area of the State. A limited number of stakeholders were involved in the project's initial phase.

The project was demonstrate the feasibility and value of collaborative vegetation risk mitigation and apply lessons learned in northwestern Oregon statewide.

Committee Deliverables

- Review of codes and regulations at the local, state, and federal levels.
    - Look into ways to help mitigate the impact of severe storms on our highways and other services.
- Develop an informational video to educate interested persons.
    - Video is to be accessible on the web via standard streaming video.
    - Video is to demonstrate storm impact to residents of the affected counties, commerce, emergency response, power and traffic restoration efforts.
    - Video is to be made available for education and training programs statewide.
- Develop a Collaborative Mapping Tool systems to help identify the problem areas for trees in proximity to highways and power lines (website) – The purpose of this initiative is to provide an online "mash up" map that displays vegetation management and other pertinent data from various sources.
    - Easy to access and view through a standard web browser by all stakeholders.
    - Does not require downloading or installing special software to the desktop.
    - Able to import and display map data from various sources and technologies:
        - Shape files from ESRI sources (e.g., PacifiCorp, PGE, ODOT, ODF, etc.).
        - PDF map files.
        - Other sources, such as GEORSS8and KML9 (future enhancement).
- Develop recommendations to address the Danger Trees on the R/W.

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8 GeoRSS: A Spatial Data Mapping Application

9 KML: An XML Software-Based Language for Geographic Annotation

The Success Factors' Metrics Moving Forward

- Reduce the impact of tree damage from major winter storms.
- Mitigate or completely eliminate the significant risk to public safety.
- Facilitate collaboration between vegetation management stakeholders.
- Overall cost savings and improved safety for all Oregonians.
- Build trust, develop relationships, and improve coordination with all participating entities.
- Identify high-risk geographic areas.
- Establish high-risk geographic areas that have mitigated the hazard.

FEMA's Hazard Mitigation Grant

To accomplish the above, the R/W Committee filed a Hazard Mitigation Grant application with FEMA, via OEM, for $64,000.00. The grant required 25% matching fund. Portland General Electric and PacifiCorp graciously agreed to contribute $8,000.00 each, to meet the matching funds requirement of $16,000.00. The grant was awarded the Committee on September 23, 2008, for work to be completed no later than March 31, 2010.

OEM and OPUC executed the Grantee – Sub-Grantee agreement on March 04, 2009.

Recommendations – The Outcome of the Committee's Work

The R/W Committee recommendations, embodies two parts. First, through the committee process it was agreed that existing authorities could provide better results with a more deliberate approach to communication. ODOT and ODF agreed to, and have already begun, to implement a communication strategy that will better predict and respond to potential danger trees and corridors prior to catastrophic failure. The commitment to better communication, not only with ODOT and ODF but landowners, utilities, counties, and others, will be enhanced significantly by the mapping tool generated from the Committee's work.

The second part involved recommendations for statutory changes, as follows;

- Provide exemption to ODOT from obtaining local permits before removing trees
- Permit ODOT to inspect and condemn trees that potentially pose immediate or substantial risk to State Highways
- Permit ODOT to remove the tree without prior notification to the tree owner
- Increase the minimum appraised value of forest product before requiring public auction
- Remove the mandate for reforestation in an area where it is reasonable to predict dangerous situations will arise as new trees reach maturity. ODOT is required to make the determination in coordination with ODF.

The above statutory recommendations were reviewed by Legislative Counsel and written as legislative concept, which through its review process was presented during the 2011 -2013 legislative session as Senate Bill (SB) 455.

Hazard Mitigation Success

Safe

WINDSTORMS

disaster avoided through hazard mitigation

Hazard Tree Mitigation through Education

BENTON, LANE, LINN, MARION, AND POLK COUNTIES, OREGON:

As part of mitigation activities, Oregon Emergency Management and the Oregon Department of Forestry cooperated to provide a grant program to help address hazard tree mitigation. Actions completed include: use of posters and news articles, demonstrations at an annual tree fair, printing and distribution of 40,000 copies of a new homeowner's guide to tree hazards, and mailing tree care brochures to utility customers along with their bills.

Towards State NHMP Goals: #1, 2, 3, and 4.

Pre-2012 Oregon NHMP Actions Met: W-ST-2 and W-ST-4

Lead Agency: Oregon Department of Forestry as a subgrantee for FEMA's Hazard Mitigation Grant Program (HMGP)

Support Agencies: local communities and nonprofit organizations

Project Type: education/outreach/public awareness/training

Project Start Date: September 2003

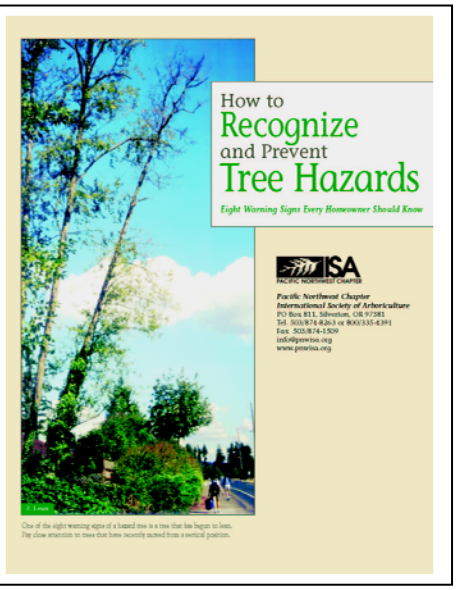
Project End Date: June 2004

Year Project Tested: January 2004

Funding Sources: FEMA's HMGP, local communities tax revenues and in-kind donations, nonprofit organization funds

Project Cost: $65,000

Project Benefits: Damaging windstorms have occurred in the past in Oregon and they will happen again. Although not all tree failures can be prevented, we must make every effort to learn from tree failures and help the public understand how their actions can help lower the risk.



Problem: A severe winter storm and ensuing strong winds produced significant property damage and power outages across Benton, Lane, Linn, Marion, and Polk counties in February of 2002. Many downed trees created safety hazards and power outages. Some damage could have been prevented had people learned more about what it takes to prevent hazard trees.
Solution: By providing grant dollars to Oregon communities, the agencies have been able to increase public education and awareness about the dangers of hazard trees, and helped the public understand both hazard tree prevention and how to properly care for trees.
(photo below courtesy of Oregon Dept. of Forestry)

Reducing Damage, Maintaining Electrical Service

By undergrounding the overhead electric line called the Emerald Circuit, the Springfield Utility Board (SUB) has strengthened their capability for future delivery of services and increased their capacity to respond to other emergency problems.

SPRINGFIELD (LANE COUNTY), OREGON: During the late December 2003, early January 2004 wind, snow, and ice storms in the Willamette Valley, what was once a sure bet for power outages is now a mitigation success. The Emerald Circuit is a main distribution line among three substations serving approximately 800 homes; assorted businesses, a fire station and two SUB water reservoirs. As a backup, this line provides power to another 400 homes, schools, a shopping center, and numerous traffic signals.

Towards State NHMP Goal: #2

Pre-2012 Oregon NHMP Actions Met: W-ST-1

Lead Agency: Oregon Emergency Management as grantee for FEMA's Hazard Mitigation Grant Program

Project Cost: $163,642

Project Benefits: $180,000 (infrastructure, only)

It is estimated that a major storm damaging all poles and lines would cost $180,000 for replacement, which does not include loss of electrical service to the homes, businesses, and essential facilities this circuit serves.

Photos above and to the left are OEM.
The photo below is courtesy of SUB.

Problem: Emerald Circuit right-of-way showing 25' easement within 50'-90' tall wooded corridor. Note leaning small tree hazard left of line.
Solution: Underground lines will minimize future emergency repairs on this steep terrain. Trench with conduit in place next to existing poles and line (left). Same project section (below) as above, with fallen tree. Underground line did not sustain damage from broken trees during 2003/04 winter storms.

disaster avoided through hazard mitigation

Clatsop County, Oregon

Rural Forested Communities along the Coast Range of U.S. Highway 26: FEMA approved funding from Public Assistance and Hazard Mitigation Grant Programs, allowing Western Oregon Electric Cooperative to construct 16.1 miles of underground (Three-Phase 34,500 Volt) conductors placed in conduit, from Timber to Elsie.

This particular route was severely impacted, during the December 2007 storm isolating the communities of Elsie and Hamlet and surrounding rural residents in the area. This underground conversion was constructed and placed into service in December 2009. The contract-work endeavor required the removal and clearing of all vegetation along the designated pathway as initial plans called for plowing the lines along the utility easement.

Once it was determined that this construction method was ineffective the contractor resorted to horizontal directional boring, which is less evasive than traditional plow or trench and backfill techniques.

LeadAgency: Oregon Emergency Management as grantee for FEMA's Hazard Mitigation Grant Program

Project Cost: $2,645,375.00

In recent years, technology and electrical based systems have flourished, the inter-dependency of individuals, communities and our economy upon energy resources has grown exponentially. Not long ago a power outage was a simple inconvenience. Now an outage is a matter of survivability until the restoration is accomplished

This deployment will insure service delivery and reliability to this heavily forested and remote region in Oregon's North Coastal range.

disaster avoided through hazard mitigation

Ensuring Critical Communication

Loss of electricity is an inconvenience, but when critical communications are inoperative, it can lead to disaster. Understanding the importance of ensuring service to their customers, Emerald People's Utility District breaks the cycle of emergency repairs by placing an overhead powerline underground.

LANE COUNTY, OREGON: The communications facility on the 3,350-foot summit of Harness Mountain provides an important service for the regional communities and is also a vital relay station for the Federal Aviation Administration and the Oregon State Police. Unfortunately the 12kV overhead line that served the summit was plagued with repetitive outages and required difficult emergency measures to restore power. Having the entire line underground virtually eliminates outages caused by snow and wind and enables Emerald PUD, for the first time since 1983, to be a dependable power source for the nine critical communication and broadcast sites on Harness Mountain.

Towards State NHMP Goal: #2

Pre-2012 Oregon NHMP Actions Met: W-ST-1

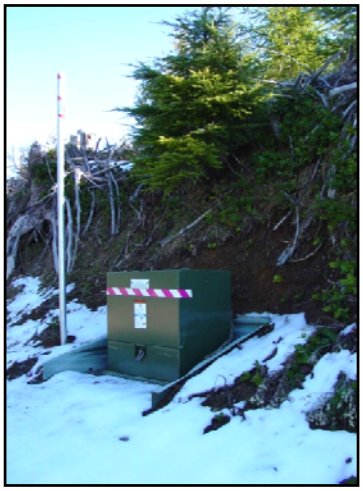
Problem: Emerald PUD's 5.5-mile easement through private forestland was prone to repetitive outages and difficult repair. With shoulder deep snow, impassable roads, and fallen trees, the task of restoring power could take many hours or even days.
Solution: The underground line is no longer vulnerable to wind, ice, and snow damage and acts doubly to avoid wildfire ignitions. Underground line did not sustain damage from broken trees during 2003/04 winter storms.

Lead Agency: Oregon Emergency Management as grantee for FEMA's Hazard Mitigation Grant Program

Project Cost: $176,280

Project Benefits: Following the 2003-04 winter storms, Emerald PUD reported that all Harness Mountain roads were blocked from fallen timber and it would have taken ten days of work for two crews at $200 per hour per crew to repair overhead line damages.

Photo Credits: Top right and above are OEM; lower right is FEMA.



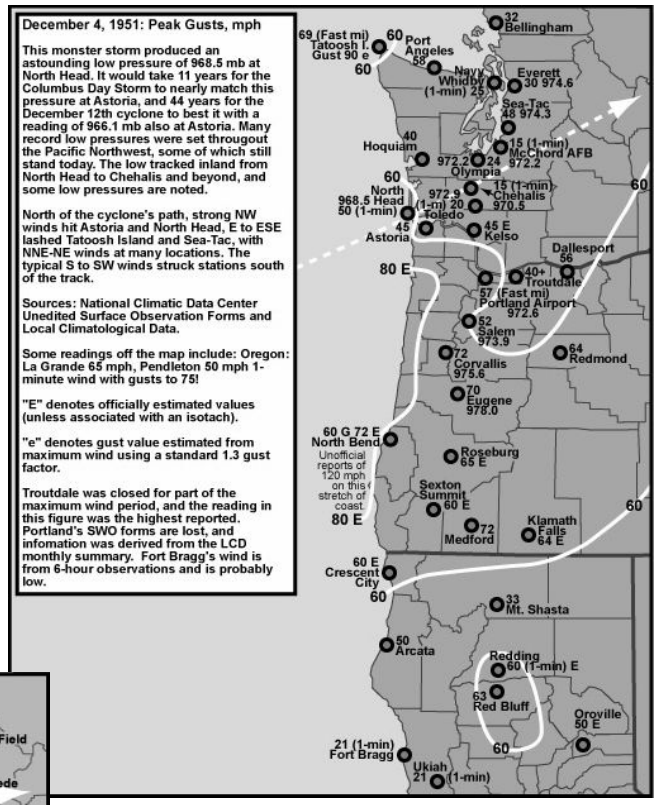
Appendix W-1: Peak Gust Distribution for Selected Storm Events, 1951 to 1993

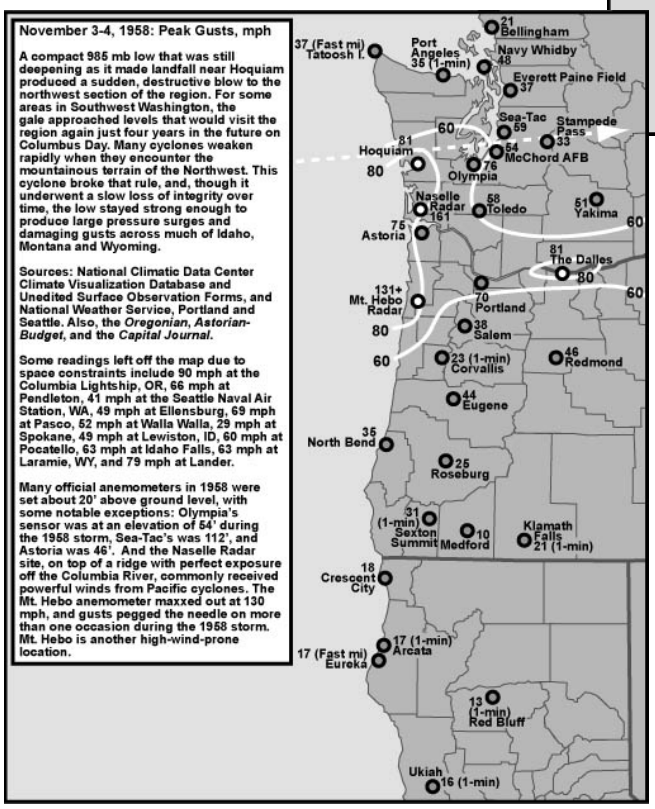
The maps and storm descriptions in this appendix, as well as similar graphics on pages W-4, W-5, and W-10 of this Windstorms Chapter are courtesy of Wolf Read, Climatologist, Oregon Climate Center at Oregon State University. A much more extensive presentation of this material may be found at the following weblink:

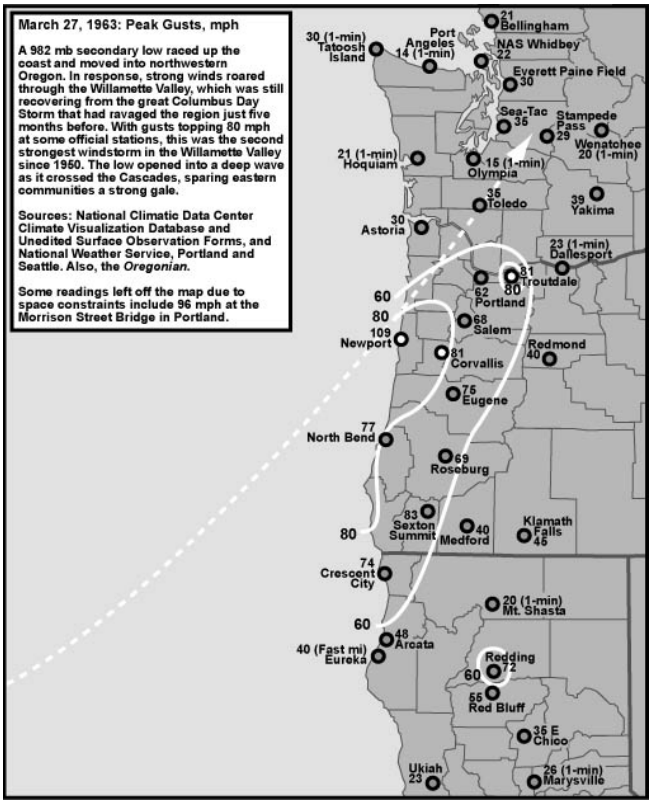
http://oregonstate.edu/~readw/

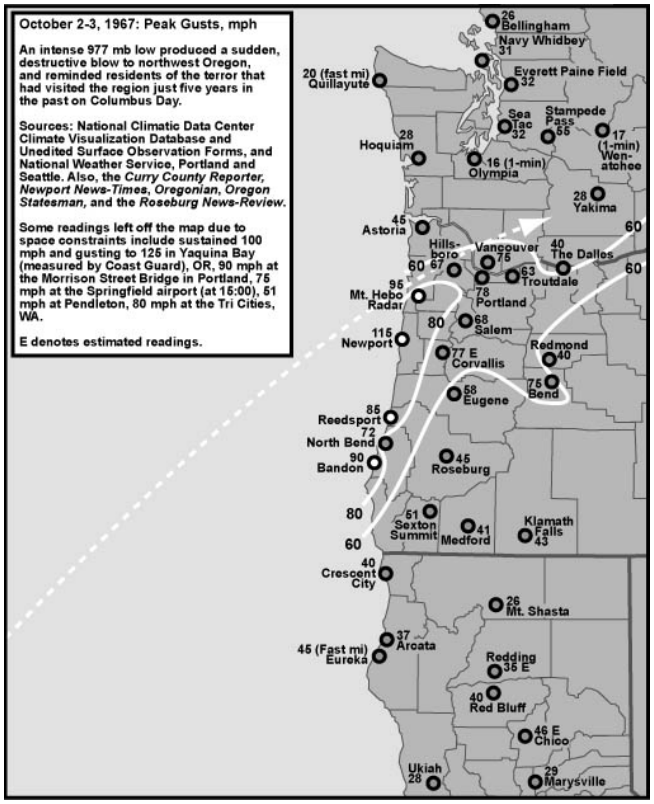
"Many (midlatitude cyclones) have struck the West Coast within the relatively short period of meteorological record… they can throw a cold rain into the Alaska Panhandle while at the same time pummel the San Francisco Bay Area with a warm, saturated gale... This website is here to dispel certain weather myths. There seems to be an idea that severe weather somehow doesn't strike the Pacific Northwest."

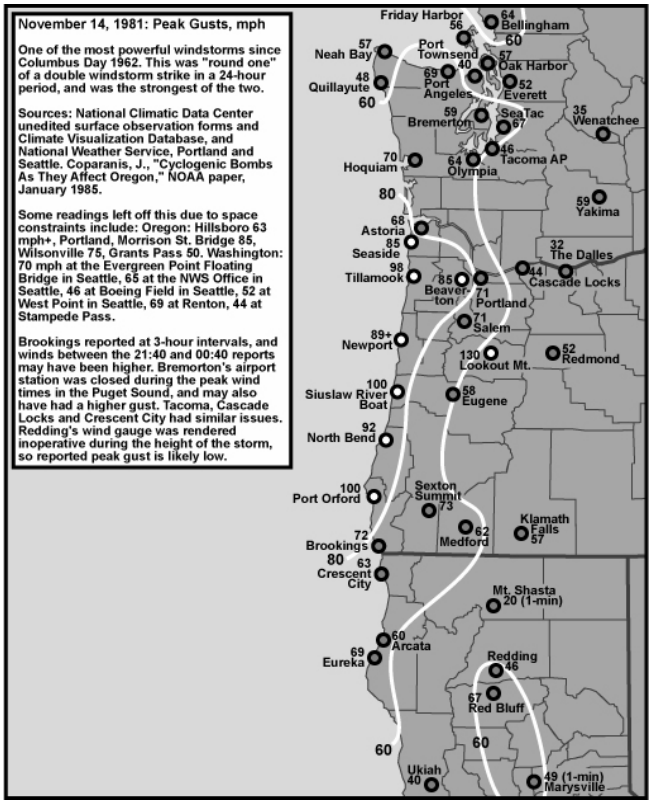
George Taylor, State Climatologist, also contributed to the material in this appendix, and made many other contributions to this chapter.

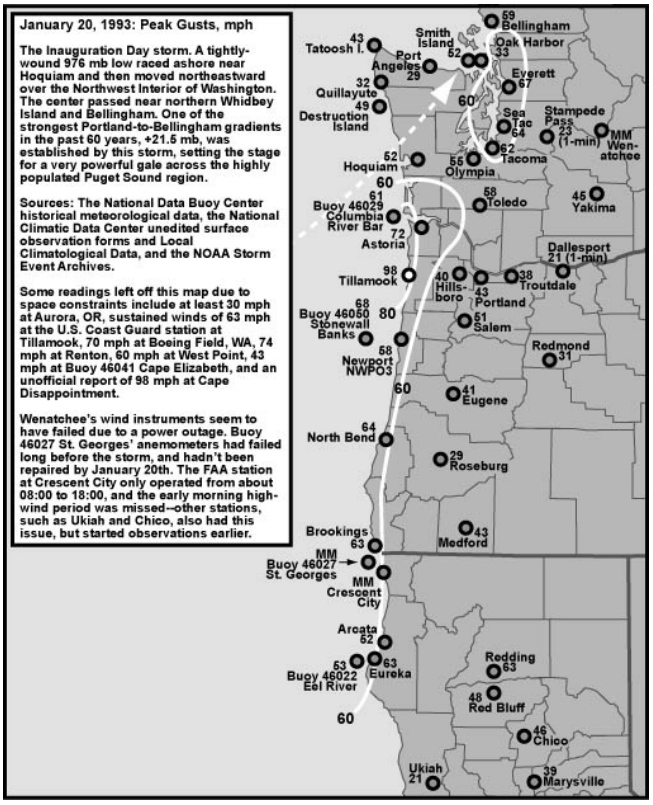





March 27, 1963: Peak Gusts, mph
A 982 mb secondary low raced up the coast and moved into northwestern Oregon. In response, strong winds roared through the Willamette Valley, which was still recovering from the great Columbus Day Storm that had ravaged the region just five months before. With gusts topping 80 mph at some official stations, this was the second strongest windstorm in the Willamette Valley since 1950. The low opened into a deep wave as it crossed the Cascades, sparing eastern communities a strong gale.
Sources: National Climatic Data Center Climate Visualization Database and Unedited Surface Observation Forms, and National Weather Service, Portland and Seattle. Also, the Oregonian.
Some readings left off the map due to space constraints include 96 mph at the Morrison Street Bridge in Portland.
21 Bellingham
30 (1-min) Tatoosh Island
Port Angeles 14 (1-min)
NAS Whidbey 22
Everett Paine Field 30
Sea-Tac 35
Stampede Pass 29
Wenatchee 20 (1-min)
21 (1-min) Hoquiam
15 (1-min) Olympia
35 Toledo
39 Yakima
30 Astoria
23 (1-min) Dallesport
81 Troutdale
80
62 Portland
60
80
68 Salem
109 Newport
Redmond 40
81 Corvallis
75 Eugene
77 North Bend
69 Roseburg
83 Sexton Summit
40 Medford
Klamath Falls 45
80
74 Crescent City
20 (1-min) Mt. Shasta
60
48 Arcata
40 (Fast mi) Eureka
Redding 72
60
55 Red Bluff
35 E Chico
Ukiah 23
26 (1-min) Marysville


October 2-3, 1967: Peak Gusts, mph
An intense 977 mb low produced a sudden, destructive blow to northwest Oregon, and reminded residents of the terror that had visited the region just five years in the past on Columbus Day.
Sources: National Climatic Data Center Climate Visualization Database and Unedited Surface Observation Forms, and National Weather Service, Portland and Seattle. Also, the Curry County Reporter, Newport News-Times, Oregonian, Oregon Statesman, and the Roseburg News-Review.
Some readings left off the map due to space constraints include sustained 100 mph and gusting to 125 in Yaquina Bay (measured by Coast Guard), OR, 90 mph at the Morrison Street Bridge in Portland, 75 mph at the Springfield airport (at 15:00), 51 mph at Pendleton, 80 mph at the Tri Cities, WA.
E denotes estimated readings.
26 Bellingham
Navy Whidbey 31
20 (fast mi) Quillayute
Everett Paine Field 32
Sea Tac 32
Stampede Pass 55
17 (1-min) Wen-atchee
28 Hoquiam
16 (1-min) Olympia
28 Yakima
45 Astoria
60
Hills-boro 67
Vancouver 75
40 The Dalles
60
63 Troutdale
95 Mt. Hebo Radar
78 Portland
80
68 Salem
115 Newport
Redmond 40
77 E Corvallis
75 Bend
58 Eugene
85 Reedsport
72 North Bend
90 Bandon
45 Roseburg
80
51 Sexton Summit
41 Medford
Klamath Falls 43
60
40 Crescent City
26 Mt. Shasta
37 Arcata
45 (Fast mi) Eureka
Redding 35 E
40 Red Bluff
46 E Chico
Ukiah 28
29 Marysville


November 14, 1981: Peak Gusts, mph
One of the most powerful windstorms since Columbus Day 1962. This was "round one" of a double windstorm strike in a 24-hour period, and was the strongest of the two.
Sources: National Climatic Data Center unedited surface observation forms and Climate Visualization Database, and National Weather Service, Portland and Seattle. Coparanis, J., "Cyclogenic Bombs As They Affect Oregon," NOAA paper, January 1985.
Some readings left off this due to space constraints include: Oregon: Hillsboro 63 mph+, Portland, Morrison St. Bridge 85, Wilsonville 75, Grants Pass 50. Washington: 70 mph at the Evergreen Point Floating Bridge in Seattle, 65 at the NWS Office in Seattle, 46 at Boeing Field in Seattle, 52 at West Point in Seattle, 69 at Renton, 44 at Stampede Pass.
Brookings reported at 3-hour intervals, and winds between the 21:40 and 00:40 reports may have been higher. Bremorton's airport station was closed during the peak wind times in the Puget Sound, and may also have had a higher gust. Tacoma, Cascade Locks and Crescent City had similar issues. Redding's wind gauge was rendered inoperative during the height of the storm, so reported peak gust is likely low.
Friday Harbor 56
64 Bellingham
60
57 Neah Bay
Port Townsend 40
57 Oak Harbor
48 Quillayute
69 Port Angeles
52 Everett
60
59 Bremerton
SeaTac 67
35 Wenatchee
46 Tacoma AP
70 Hoquiam
64 Olympia
80
59 Yakima
68 Astoria
85 Seaside
32 The Dalles
98 Tillamook
85 Beaver-ton
44 Cascade Locks
71 Portland
71 Salem
89+ Newport
130 Lookout Mt.
52 Redmond
100 Siuslaw River Boat
58 Eugene
92 North Bend
100 Port Orford
Sexton Summit 73
62 Medford
Klamath Falls 57
72 Brookings
80
63 Crescent City
Mt. Shasta 20 (1-min)
60 Arcata
69 Eureka
Redding 46
67 Red Bluff
60
60
Ukiah 40
49 (1-min) Marysville


January 20, 1993: Peak Gusts, mph
The Inauguration Day storm. A tightly-wound 976 mb low raced ashore near Hoquiam and then moved northeastward over the Northwest Interior of Washington. The center passed near northern Whidbey Island and Bellingham. One of the strongest Portland-to-Bellingham gradients in the past 60 years, +21.5 mb, was established by this storm, setting the stage for a very powerful gale across the highly populated Puget Sound region.
Sources: The National Data Buoy Center historical meteorological data, the National Climatic Data Center unedited surface observation forms and Local Climatological Data, and the NOAA Storm Event Archives.
Some readings left off this map due to space constraints include at least 30 mph at Aurora, OR, sustained winds of 63 mph at the U.S. Coast Guard station at Tillamook, 70 mph at Boeing Field, WA, 74 mph at Renton, 60 mph at West Point, 43 mph at Buoy 46041 Cape Elizabeth, and an unofficial report of 98 mph at Cape Disappointment.
Wenatchee's wind instruments seem to have failed due to a power outage. Buoy 46027 St. Georges' anemometers had failed long before the storm, and hadn't been repaired by January 20th. The FAA station at Crescent City only operated from about 08:00 to 18:00, and the early morning high-wind period was missed--other stations, such as Ukiah and Chico, also had this issue, but started observations earlier.
59 Bellingham
43 Tatoosh I.
Smith Island 52
Oak Harbor 33
Port Angeles 29
Everett 67
32 Quillayute
60
49 Destruction Island
Sea Tac 64
Stampede Pass 23 (1-min)
MM Wen-atchee
62 Tacoma
52 Hoquiam
55 Olympia
60
58 Toledo
45 Yakima
61 Buoy 46029 Columbia River Bar
72 Astoria
Dallesport 21 (1-min)
98 Tillamook
40 Hills-boro
43 Portland
38 Troutdale
68 Buoy 46050 Stonewall Banks
80
51 Salem
58 Newport NWPO3
Redmond 31
60
41 Eugene
64 North Bend
29 Roseburg
Brookings 63
43 Medford
MM Buoy 46027 St. Georges
MM Crescent City
Arcata 52
53 Buoy 46022 Eel River
63 Eureka
Redding 63
48 Red Bluff
60
46 Chico
Ukiah 21
39 Marysville

Appendix W-2: Comparison of Southeast United States Hurricane to Severe Pacific Storm

Adapted from an address to the Oregon Building Officials Association, March 11, 1993, given by Patrick D. Lewis, BCD (retired).

On October 12, 1962, Oregon was hit with the tail of Typhoon Frieda, an extra tropical cyclone later known as the Columbus Day Storm. It was the worst West Coast disaster since the 1906 San Francisco Earthquake and fire. The storm was 1,000 miles long and 125 miles wide. It destroyed homes, farms, public infrastructure, and businesses. In some counties, up to 90 percent of the farm buildings were destroyed. It uprooted trees, crushed cars, snapped power poles and twisted Bonneville Power Administration transmission towers into piles of scrap metal.

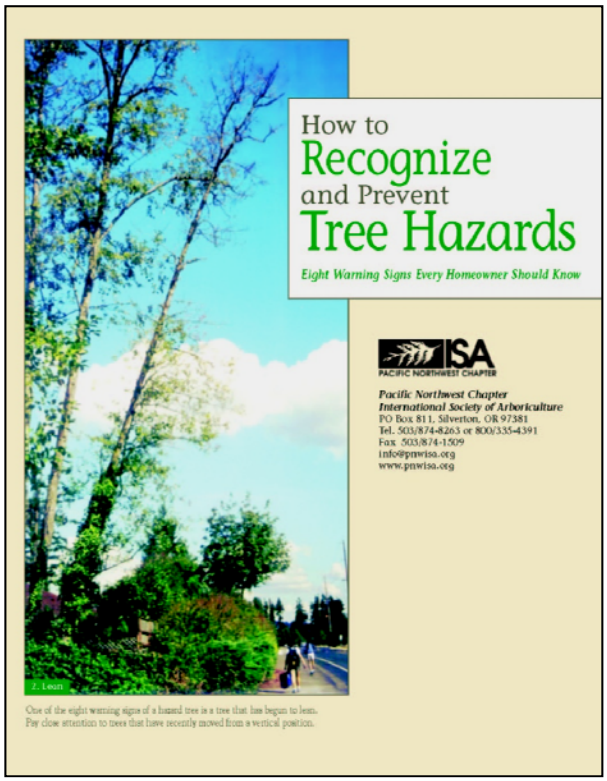
Hardest hit, however, were Oregon's forests. Eleven billion board feet of timber was blown down. Twenty-three million acres were affected, 70 times the size of the 1933 Tillamook Burn. The massive windfall created the worst fire and bark beetle infestation dangers in world history. Eleven billion 1962 dollars in downed timber was unsalvageable, equivalent to $51.7 billion at today's lumber prices. Except for property damage, Oregon's 1962 Columbus Day Storm, was - in most ways - actually worse than Florida's devastating Hurricane Andrew:

	August 24, 1992 Hurricane Andrew, Florida	October 12, 1962 Columbus Day Storm, Oregon
barometric pressure	27.52 inHg (932 mb)	28.41 inHg (960 mb)
eye size	15 miles	125 miles
diameter	300 miles	500 miles
affected area	18,000 square miles	75,000 square miles
maximum wind gust	(Fowey Rocks) 169 mph	(Mt. Hebo) 170 mph
land wind speed recordings	(Virginia Key) 98 mph	(Corvallis) 125 mph
land wind speed recordings	(Fort Lauderdale) 76 mph	(Portland) 116 mph
duration of storm	1 hour, 25 minutes	2 hours
warning	yes	no
evacuation	yes	no
deaths	52	46
homes destroyed	28,120	84
homes damaged	109,080	51,934
damage to structures	$20,000,000,000	$200,000,000
homes without electricity	1,400,000	496,000
state population	11,740,600	1,828,000
insurance company failures	yes	yes
blame	contractors & inspectors	civil defense
federal disaster relief	$7,600,000,000	$1,700,000
looting	yes	no

The Columbus Day Storm wasn't a "freak storm" per se: while the recurrence interval of storms such as this one in the heavily populated Willamette Valley is on the order of a "100-year" storm (1% chance in any year), storms with hurricane force winds occur somewhere in Oregon nearly every year, and storms with sustained hurricane force winds have an approximate 25-year recurrence interval (4% chance in any year) on the Oregon Coast.

Appendix W-3: How to Recognize and Prevent Tree Hazards

One of the successful projects completed after the February 2002 event (see pages W-2 and W-5) involved an educational collaboration between the Oregon Department of Forestry and the Pacific Northwest Chapter, International Society of Arboriculture (ISA). Since that windstorm, these two entities have conducted three Hazard Tree Prevention Workshops[10] that attracted over 140 people who work around, but not necessarily with trees.



One of the educational materials developed in conjunction with the workshops is *How to Recognize and Prevent Tree Hazards*, a full-color brochure available from the Pacific Northwest Chapter ISA. The publication is organized around "Eight Warning Signs Every Homeowner Should Know." It includes pictures and descriptions of tree hazards. In addition to being available via the Internet, this brochure is available in quantity for distribution by city or county park departments, public works, planning staffs, etc.

The brochure notes "every year, our landscape changes as trees fall or break causing property damage, injuries, and power outages. While some tree failures are unpredictable, many can be prevented. By inspecting your trees for warning signs, many potential problems can be corrected…

Trees should be inspected on a regular basis, especially before and after storms. Larger trees have a greater hazard potential than smaller trees. A hazardous tree is a tree that has significant structural defects that are likely to lead to failure, and possibly cause injury or damage."

To obtain a copy of the brochure, go to the following website:

http://www.pnwisa.org/HazTree.pdf

or contact:

Pacific Northwest Chapter ISA
P.O. Box 811
Silverton, Oregon 97381
info@pnwisa.org
telephone: 503-874-8263 facsimile: 503-874-1509

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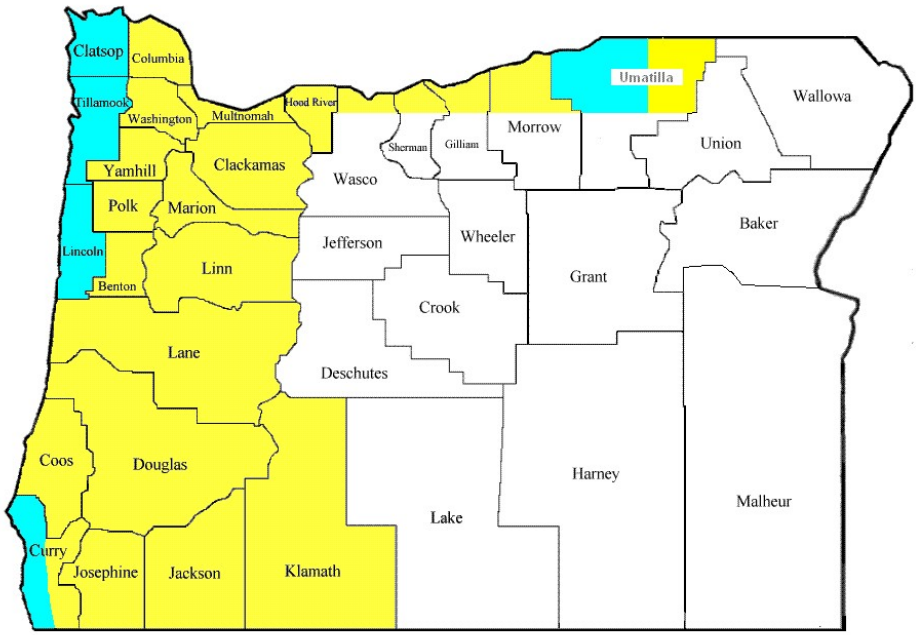
[10] Materials from the workshops are posted to the Internet (www.pnwisa.org/htp/index.html) and continue to be used as a public education resource to help homeowners understand how the actions they take around trees can prevent future hazard trees from developing.

Appendix W-4: Building Codes Division Wind Speed Map for Oregon



a. All areas with full exposure to the ocean winds shall be designated 110 mph areas.
b. Values are nominal design 3-second gust wind speeds in miles per hour at 33 feet above ground for Exposure C category.
c. Areas in Multnomah and Hood River Counties with full exposure to Columbia River Gorge winds shall be designated 110 mph areas.

110 mph

100 mph

85 mph

The current building code in Oregon (both residential code and other code) is based on the 2003 edition of the International Residential Code and International Building Code as produced by the International Code Council. These codes in their un-amended model code language have adopted wind speed maps contained in the American Society of Civil Engineers (ASCE) 7-02 standard, which provides very low wind speeds for Oregon. The Building Codes Division in Oregon has modified the wind speed maps contained in ASCE 7-02 to reflect wind speeds Oregon actually expects to experience. The Oregon-specific wind speed map above reflects the amendments Oregon has made.