

# NATURAL HAZARD IDENTIFICATION

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# AVALANCHE<sup>1</sup>

## SUMMARY

**The Hazard:** An avalanche is a mass of sliding snow, ice, earth, and rock that grows and collects additional material as it descends.

**Previous Occurrences:** Records searches have revealed that there have been no recorded deaths from avalanches in the mountain areas of the county. There has, however, been minor avalanche damage to mountain roads.

**Probability of Future Events:** Low increasing to Medium - Avalanche fatalities in Washington are a function of resort activity. The increase of visitors to Wilderness areas of the Olympic national forest creates more opportunity for events to happen.

**NATURAL HAZARD RISK RATING:** The average natural hazard risk rating for avalanches for all districts in Jefferson County was estimated at 1.57, which would be considered extremely low.

## HAZARD IDENTIFICATION AND VULNERABILITY ASSESSMENT

The Olympic Mountains receive extensive snow due to their size and orientation to the Pacific marine airflow. During seasons of heavy snow, some of the deepest recorded snow packs in the United States can be found in the Olympics. Beginning in November and lasting until the last remnants of snow have melted in early summer, the danger of avalanche is present. In the highest alpine areas of the Olympics, the avalanche season continues year around.

There are no developed ski areas in Jefferson County that would be endangered by avalanches; however back-packing, cross-country skiing and snowmobiling are widely practiced in the mountains of Jefferson County.

During fair spring weather the avalanche danger is generally lowest during the night and early morning hours when the surface snow freezes due to heat loss to the surrounding atmosphere. During the day, sun effects and warm air temperatures can rapidly melt and weaken surface snow layers and produce an increasing avalanche danger during the late morning and afternoon. Loose wet avalanche activity generally starts on east and southeast facing slopes receiving morning sunshine and progresses to the west and southwest facing slopes during the afternoon. Therefore, the safest time to cross potential avalanche terrain is during early morning hours before the surface snow begins to warm and weaken.<sup>2</sup>

During the period from 2010 thru 2015, tourist volume to the Olympic National Park increased from 2.8 million to 3.2 million per year.<sup>3</sup> As more people access these mountainous areas, the potential for injury and deaths increases. Losses are also potential for the timber industry as avalanches damage forests and higher-level mountain logging roads.

## CLIMATE CHANGE EFFECTS

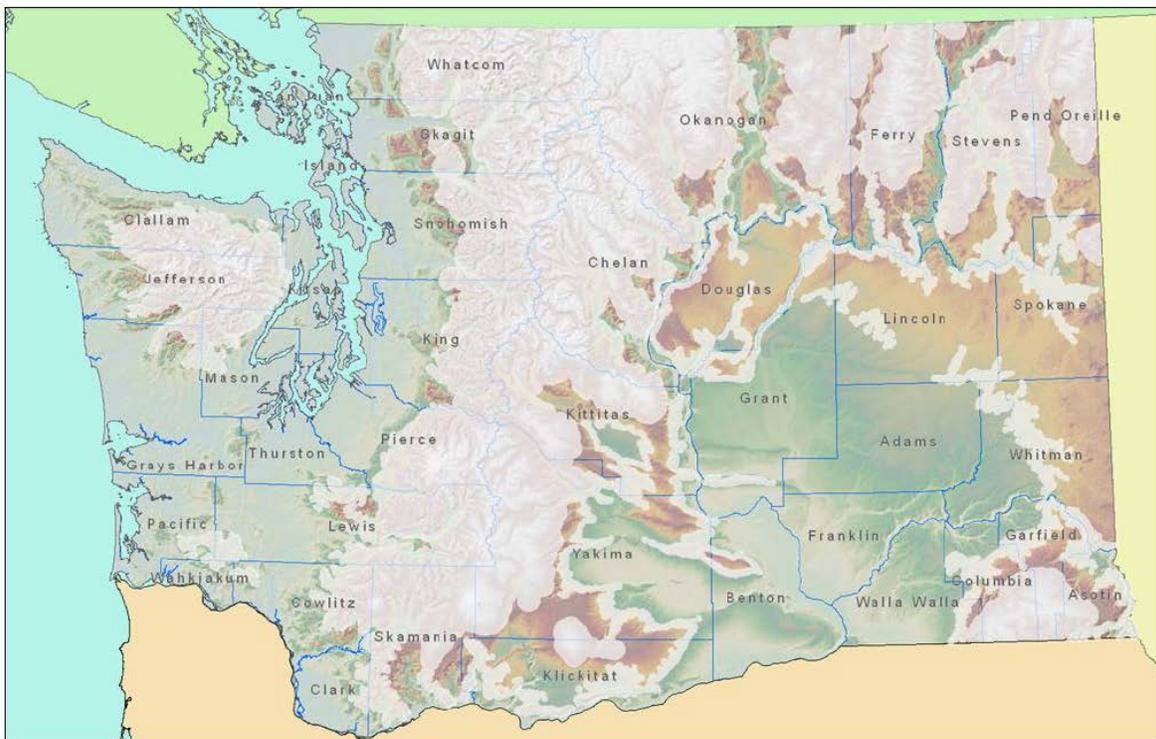
If the region sees a warming trend, there will more rain and less snow across mountainous regions, which will reduce the already low probability of avalanches in the Olympic Mountains that are part of Jefferson County.<sup>4</sup> This may also impact the economy regionally as reduced snowpack discourages winter sports enthusiasts from visiting Hurricane Ridge in the Olympic National Park.

If, within the next six years (from 2016), there are colder winters, the snow level could drop below 2000 feet for a longer portion of the year, encouraging greater winter tourism and creating more opportunities for avalanches within the Olympic mountains. Relative to other areas of the state that have a robust ski industry, the probability of deadly avalanches would increase but remain small.

## CONCLUSION

Jefferson County does not currently have significant transportation routes or recreation areas at risk and subsequently presents a very low probability associated with avalanches in Jefferson County at the current time. Figure AV-1 shows the current avalanche risk areas in the state in white.<sup>5</sup> Figure AV-2 enhances the avalanche risk areas by adding resort locations and highways at risk to the map.<sup>6</sup>

**Figure AV-1: Washington State Avalanche Hazard Areas<sup>5</sup>**



**Washington State Avalanche Hazard Areas:** White areas on the map indicate that those areas are at least 2,000 feet in elevation and most likely to be prone to avalanches. Avalanches can and do occur outside of these areas during unusual conditions.



## References - Avalanche

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3. Olympic National Park, Annual\_Park\_Recreation\_Visitation (1904 – Last Calendar Year), United States Forest Service (USFS). Available at: [https://irma.nps.gov/Stats/SSRSReports/Park%20Specific%20Reports/Annual%20Park%20Recreation%20Visitation%20\(1904%20-%20Last%20Calendar%20Year\)](https://irma.nps.gov/Stats/SSRSReports/Park%20Specific%20Reports/Annual%20Park%20Recreation%20Visitation%20(1904%20-%20Last%20Calendar%20Year))
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5. *Washington State Avalanche Areas*, Source: Washington State Enhanced Mitigation Plan, 2013, Tab 5.2, “Avalanche Profile”, p.2
6. *Washington State Areas Vulnerable to Avalanches with Resorts and Highways*, Source: Washington State Enhanced Mitigation Plan, 2013, Tab 5.2, “Avalanche Profile”, p.14

## Figures - Avalanche

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- AV-1 *Washington State Avalanche Areas*, Source: Washington State Enhanced Mitigation Plan, 2013, Tab 5.2, “Avalanches”, p.2
- AV-2 *Washington State Areas Vulnerable to Avalanches with Resorts and Highways*, Source: Washington State Enhanced Mitigation Plan, 2013, Tab 5.2, “Avalanche Profile”, p.14

## DAMAGING WINDS

### SUMMARY

**The Hazard:** Damaging winds are a result of an atmospheric disturbance manifested in strong winds, tornadoes, rain, snow, or other precipitation, and often accompanied by thunder or lightning. The National Weather Service defines high winds as sustained winds of 40 mph or gusts of 58 mph or greater, not caused by thunderstorms, expected to last for an hour or more.<sup>1</sup> Areas most vulnerable to high winds are those affected by a strong pressure difference from deep storms originating over the Pacific Ocean; an outbreak of very cold, Arctic air originating over Canada.

**Previous Occurrences:** The worst damaging winds on record occurred in the 1962 Columbus Day Storm in which winds of hurricane force hit the Northwest, and resulted in damage to the Hood Canal Bridge.<sup>2</sup> Peak gusts of 160 mph hit the Washington coast, and 138 mph hit Corvallis, Oregon. In February, 1979, sustained winds of 80 mph with gusts up to 120 mph caused the Hood Canal Bridge to collapse.<sup>3</sup> Storms have been so severe in recent years that Presidential Disaster Declarations have been issued in 2007, 2008, 2009 (2), 2015 and 2016(2).



Hood Canal Bridge in a Windstorm. Unknown Date



Hood Canal Bridge – February 13, 1979 (WSDOT)

**Probability of Future Events:** High - Jefferson County experiences damaging winds every year during the storm season from October to April. The average hazard rating developed by Jefferson County jurisdictions is 31.26, which is the highest of all the hazards surveyed, thus showing that damaging winds are a regular and significant concern.

### HAZARD IDENTIFICATION AND VULNERABILITY ASSESSMENT

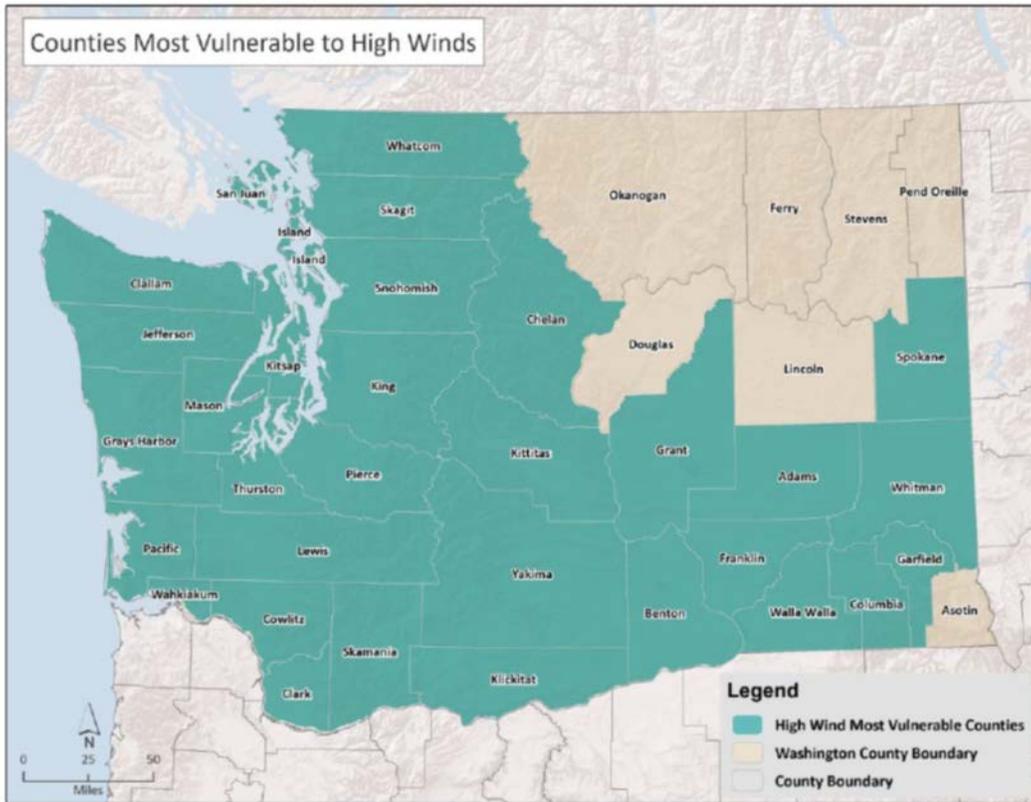
Most storms move into Washington from the Pacific Ocean with a southwest to northeast airflow. Maritime air reaching the Olympic Mountains rises upwards and cools. As this airflow reaches higher elevations and cools, there is less ability to hold moisture and precipitation occurs. Impacts and effects include loss of life damage to homes, businesses and critical transportation infrastructure; loss of timber resources; delays in emergency responses; damage or loss of recreation facilities; disruption of utilities; loss of jobs due to damaged equipment and facilities; school closures and business closures resulting in economic impacts.

Jefferson County is subject to several severe local storms each year. As shown in Figure DW-1, Jefferson County is one of the most vulnerable counties in the state when it comes to damaging windstorms.<sup>4</sup> These storms have included high wind, snow, ice, rain, and hail. Snowstorms or blizzards are the most likely and potentially devastating phenomena, with the ability to isolate people from emergency services and to interrupt utility services and other lifelines. In 1996-1997,

snowstorms were also associated with other natural hazards such as flooding and landslides.

In 2013, the Public Utility District No. 1 of Jefferson County (JPUD) purchased the assets of Puget Sound Energy in Jefferson County, thus entering into the business of providing electricity to the majority of Jefferson County. Since 2015, JPUD has had a volunteer liaison on the Jefferson County Incident Management Team who is present at all activations of the Jefferson County Emergency Operations Center. This has greatly improved coordination among agencies dealing with storm damage and live wires.

**Figure DW-1: Wind Storm Risk in Washington State<sup>4</sup>**



**CLIMATE CHANGE EFFECTS**

As global temperatures rise, the oceans heat up and expand. This provides fuel to increase the power of storms. The northern hemisphere will get more storms and more super storms because of changes in heat transport due to fresh water melt impeding the Thermohaline Circulation (THC).<sup>5</sup> The focus has been on Atlantic storms because the fresh water melt from Greenland glaciers have been well-studied, but the potential for Pacific storms to become more powerful is present, too.

Currently, there is too much natural variability in wind speeds and storm events to be able to make specific projections of future changes to the direction, intensity, or patterns of winds in the region.<sup>6</sup>

## **Conclusion**

Damaging windstorms are a fact of life in Jefferson County, which experiences multiple severe storms every year. The Department of Emergency Management meets with JPUD, and the city and county public works departments for pre-storm season planning and coordination. JPUD has a liaison on the county's Incident Management Team.

The civilian population should be encouraged to have a "storm kit" to be able to sustain themselves for multiple days without power for heating and cooking in the event a severe storm causes power outages.

## References – Damaging Winds

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2. *The 1962 Columbus Day Storm*, Read, Wolf, September, 26, 2001. Available at: <http://www.climate.washington.edu/stormking/October1962.html>
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4. *Counties Most Vulnerable to High Winds*, Source: Washington State Enhanced Mitigation Plan, 2013, Tab 5.7, “Severe Storm Profile”, p.16
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## Figures – Damaging Winds

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DW-1 *Wind Storm Risk in Washington State*

# Drought

## SUMMARY

**The Hazard:** Drought is a condition of climatic dryness that is severe enough to reduce soil moisture and water below the minimum necessary for sustaining plant, animal, and human life systems.

The National Weather Service defines drought as a deficiency of moisture that results in adverse impacts on people, animals, or vegetation over a sizeable area.<sup>1</sup>

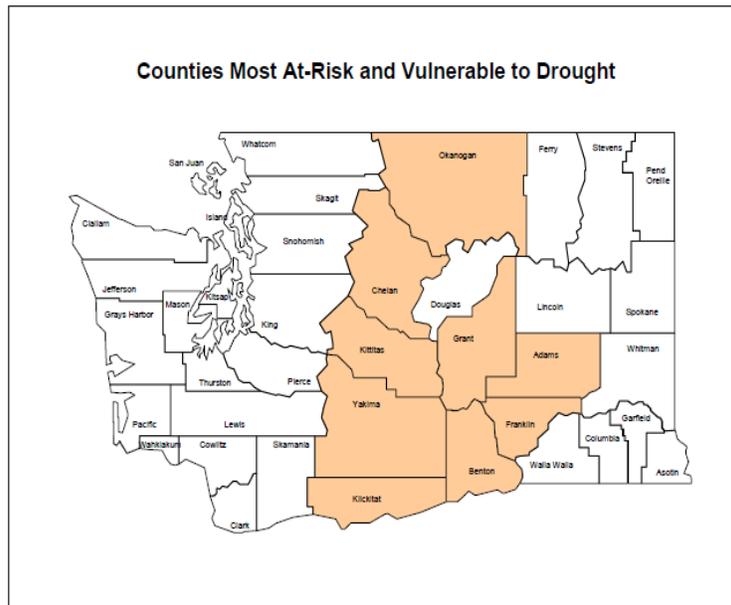
**Impacts and Effects:** In the event of a drought year, the adverse impacts to the local economy can present a broad array of effects to include the following: adverse impact on agriculture, especially dry land farms and grazing lands, increased danger of fires, loss of timber resources and resulting unemployment, serious impacts to recreation areas, soil erosion resulting in heavy silting of streams resulting in damage to salmon and other fishing, shortages of hydroelectric power resulting in higher prices, imposition of water conservation measures, curtailment of industries using large quantities of water causing unemployment, shortages of water for firefighting, increased prices for local produce.

**Previous Occurrences:** The last significant occurrence in Jefferson County was in 2002 through 2003. Two of the driest summers on record—one of five driest winters in past 100 years. Port Townsend Paper Corporation curtailed some operations, and fishing was halted on rivers on the Olympic Peninsula. In 2014 and 2015, drought conditions caused the City of Port Townsend to limit the watering of lawns, but conditions never reached the threshold at which the paper mill would have had to curtail operations.

**Probability of Future Events:** Moderate - Climatic changes may be impacting the frequency and duration of drought conditions on the Olympic Peninsula.

**Natural Hazard Risk Rating:** The average natural hazard risk rating for drought for all districts in Jefferson County was estimated at 9.8, which would be considered low to medium-low. Figure DR-1, below, shows that Jefferson County is not among those Washington counties that are most at-risk and vulnerable to drought.<sup>2</sup> It used to be a joke among Jefferson County fire districts that the Olympic Peninsula was nicknamed “the silicon forest”, not because of high tech companies, but rather because it would never burn during fire season.

**Figure DR-1 Counties Most At-Risk and Vulnerable to Drought<sup>2</sup>**



**Definition:**

Drought is a condition of climatic dryness that is severe enough to reduce soil moisture and water below the minimum necessary for sustaining plant, animal, and human life systems. The severity of drought is measured by the Palmer Index in a range of 4 (extremely wet) to -4 (extremely dry). The Palmer Index incorporates temperature, precipitation, evaporation and transpiration, runoff and soil moisture when designating the degree of drought.<sup>3</sup>

In the most general sense, drought originates from a deficiency of precipitation over an extended period, resulting in a water shortage for some activity, group, or environmental sector.

Unlike most states though, **Washington has a statutory definition of drought (Revised Code of Washington Chapter 43.83B.400).**<sup>4</sup> According to state law, an area is in a drought condition when the water supply for the area is below 75 percent of normal, and water uses and users in the area will likely incur undue hardships because of the water shortage.

Drought affects water levels for use by industry, agriculture, individual consumers, and recreation areas. Water shortages affect fire-fighting capabilities through reduced flows and pressures. Drought also affects power production; much of Jefferson County’s power is produced by hydroelectric dams. When water levels drop, electric companies cannot produce enough power to meet demand and are forced to buy electricity from other sources and higher costs are passed to all consumers.

**History of Drought in Jefferson County**

Drought has not been a serious and frequent hazard for Jefferson County. There have indeed been years that have been exceptionally dry; however there has not been any recent history of several consecutive years where rainfall has been non-existent. Table DR-1 below, lists the most significant droughts affecting the State of Washington, including Jefferson County, since 1930.

<b>Table DR-1: Significant Droughts in Jefferson County and Washington State Since 1900<sup>5</sup></b>	
<b>Date</b>	<b>Occurrence</b>
July-Aug 1901	No measurable rainfall in western Washington from July 23 to August 25.
August 1919	Occurred primarily in Western Washington
July – August 1921	Drought occurred in all agricultural sectors.
June – August 1922	From June 10 to August 10, the statewide precipitation average was only .10 inch.
March – Mid-August 1924	There was a total of 1,532 fires, causing 322,691 acres to burn and destroying 25.3 million board feet of timber.
July 1925	1,275 fires burned 142,355 acres which destroyed 69 million board feet of timber. Wheat and oat crop production was 73 percent and 81 percent of normal, respectively.
June 21 – August 25, 1926	Little or no rainfall reported. 1553 fires burned 375,010 acres. Fire costs greater than any other year.
August 1928 – March 1929	Drought unusually long and severe. Most stations reported less than 60% of normal rainfall for the entire period.
July-Aug 1930	Drought affected the entire state. Most weather stations averaged 10 percent or less of normal precipitation.
April 1934-March 1937	The longest drought in the region's history - the driest periods were April-August 1934, September-December 1935, and July-January 1936-1937
May-Sept 1938	Driest growing season in Western Washington.
1952	Every month was below normal precipitation except June. The hardest hit areas were Puget Sound and the central Cascades.
Jan-May 1964	Drought covered the southwestern part of the state. Precipitation less than 40
Spring, 1966	The entire state was dry.
June-August 1967	Drought occurred in Washington.
Oct 1976- Sept 1977	Worst drought in Pacific Northwest history. Below normal precipitation in Olympia, Seattle, and Yakima. Puget Sound precipitation levels averaged between 30 and 70% of normal, temperatures were higher than normal which resulted in algae growth and fish kills.
Oct 1991-Sept 1994	Stream flows were between 30 and 60% of normal. Agriculture products suffered greatly.
2001	On March 14, 2001, Gov. Gary Locke authorized the Department of Ecology to declare a statewide drought emergency; Washington was the first Northwest state to make such a declaration, which remained in effect until December 31,
2002-2003	Two of the driest summers on record—one of five driest winters in past 100 years. Port Townsend Paper Corporation curtailed some operations, and fishing was halted on rivers on the Olympic Peninsula
2009	One of the driest summers on record failed to adequately recharge Port Townsend's reservoir - City Lake. The city was within days of invoking drought procedures that would have stopped operations at the Port Townsend Paper Corporation (PTPC). In 2009, PTPC was so frail that any stoppage could have been the tipping point to force it into bankruptcy again.

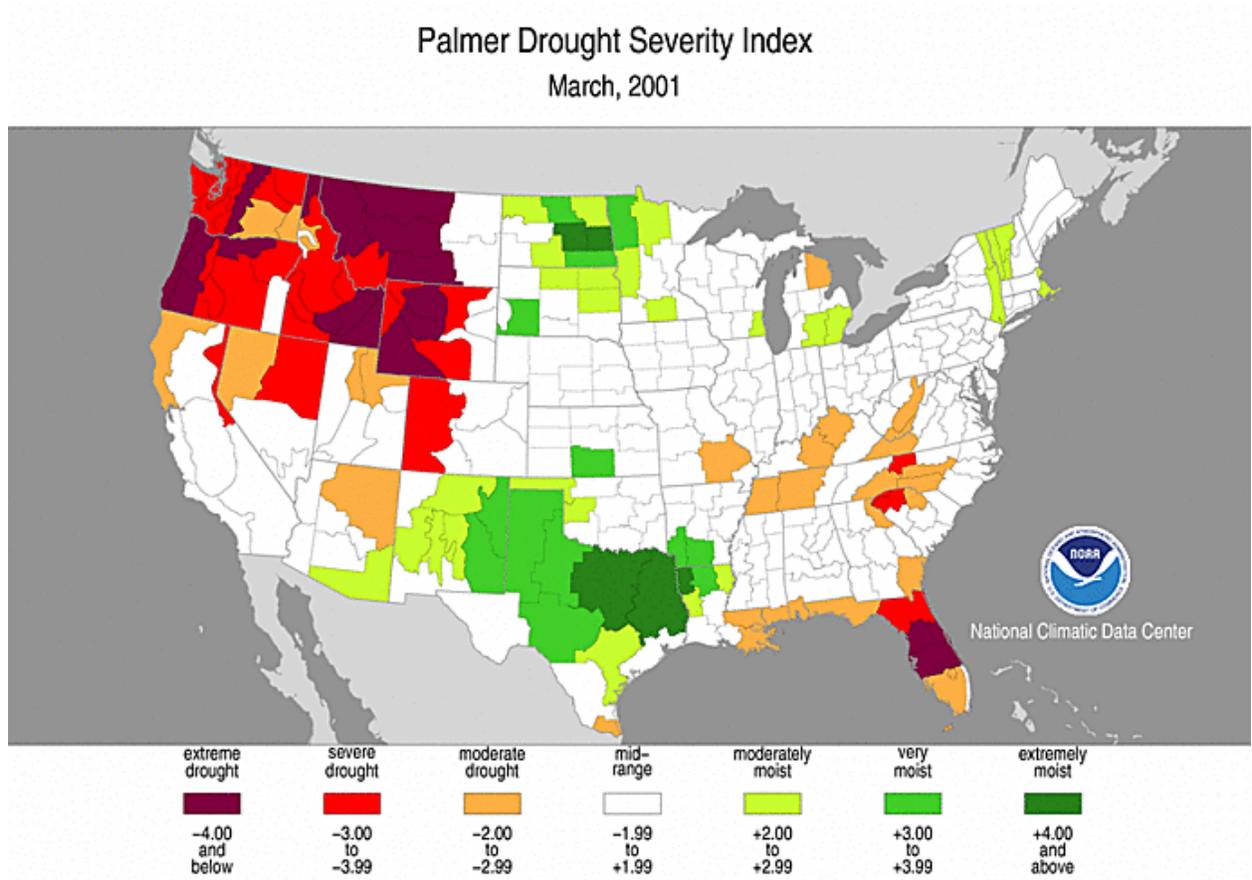
Table DR-1: Significant Droughts in Jefferson County and Washington State Since 1900 <sup>5</sup>	
Date	Occurrence
2014-2015	Characterized as a “snowpack drought”, Governor Inslee declares drought on March 13, 2015 in nine water resource inventory areas (WRIA). Each of WRIA 17, WRIA 20 and WRIA 2 include portions of Jefferson County.

**2001 Drought Emergency**

On March 14, 2001, Gov. Gary Locke authorized the Department of Ecology to declare a statewide drought emergency; Washington was the first Northwest state to make such a declaration, which remained in effect until December 31, 2001.

The central part of the state, from the crest of the Cascade Mountains to the east banks of the Okanogan and Columbia Rivers, suffered the most from water shortages.

The Palmer Drought Index for March 2001 (Figure DR-2) graphically displays the height of drought conditions in Western Washington.<sup>6</sup> These maps provide a comparison of drought conditions in Washington with those in the rest of the lower 48 states at the time.



**Figure DR-2 Palmer Drought Index – March 2001**

The scale used for the Palmer Drought Index characterizes severe drought as having likely crop or pasture losses, very high fire risk, water shortages common with water restrictions imposed. An extreme drought has major crop and pasture losses, extreme fire danger, and widespread water shortages or restrictions.

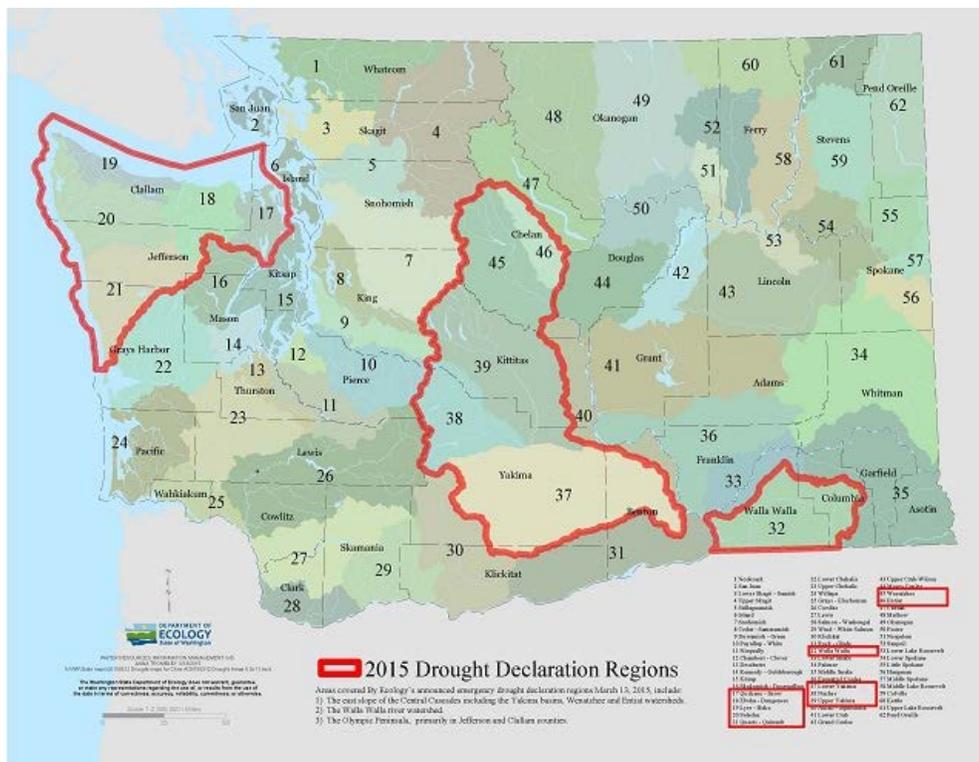
During this period the Port Townsend Paper Mill shut down to conserve the community's water supplies, thus electing to trade the stress of a short unemployment period for the overall community's need for water.

**2014-2015 Drought Emergency**

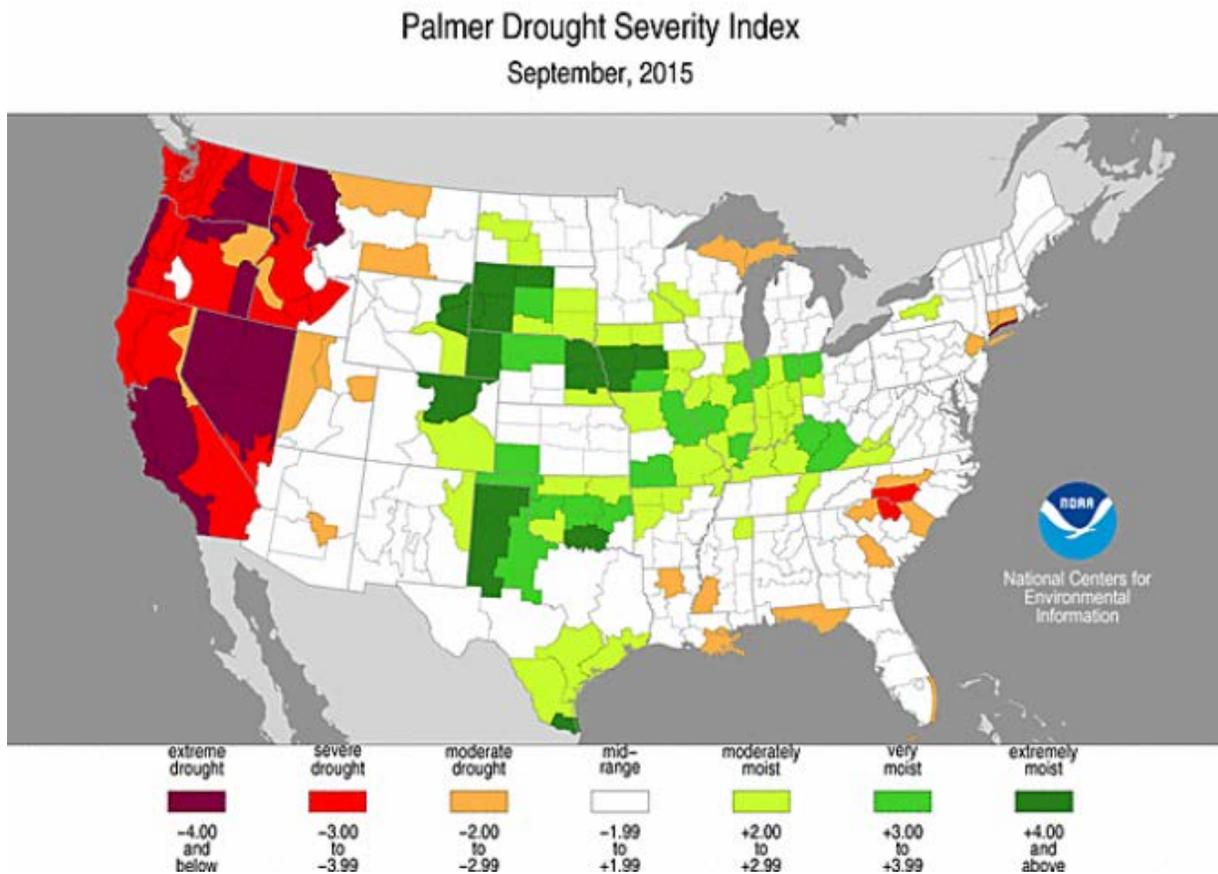
A warm winter in 2014 gave indications that 2015 would be a poor water supply year. By February of 2015, it was clear that the snowpack would not rebound sufficiently. Based on April – September forecasts, the Washington State Association of Counties (WSAC) identified three areas in Washington, including the Olympic Peninsula that would meet the statutory definition of a drought. Based on recommendations, Governor Inslee directed Ecology to declare a drought for the three areas, the East Slope of the Central Cascades, The Olympic Peninsula, and the Walla Walla Basin. Figure DR-3, below, shows the areas of the drought declaration.<sup>7</sup> Figure DR-4 shows the Palmer Drought Index at the peak of the drought for Jefferson County.

Considered full at 40 feet, the Lords Lake Reservoir, water supply for Port Townsend, dropped precipitously. In July the city declared a Stage 1 drought emergency, which required conservation by citizens. By November, 2015, Lords Lake had dropped to 8' 5", and was approaching the level at which the City would activate agreements with Port Townsend Paper to curtail operations. Port Townsend uses approximately one million gallons of water per day; Port Townsend Paper uses 10 million gallons per day from the same sources. Fortunately, heavy rains in December, January and February 2016, broke the drought and brought the reservoir back up to full.

**Figure DR-3 - 2015 Drought Declaration Regions<sup>7</sup>**



**Figure DR-4 – Palmer Drought Index for September 2015<sup>8</sup>**



### Hazard Assessment and Vulnerability Assessment

The most direct impact of drought is economic rather than loss of life or immediate destruction of property. Droughts impact individuals, the agricultural industry, and other related sectors including fishing and recreation.

There is increased danger of wildland fires associated with droughts. Low stream levels have affected reservoirs and hydroelectric power resources, bringing less inexpensive electricity from dams and potentially higher electric bills. Water intensive industries such as Port Townsend’s pulp and paper mill may be forced to curtail some operations in times of severe drought as they did in the drought of 2002.

Oftentimes drought is accompanied by extreme heat. Low stream flows combined with high temperatures, oxygen depletion, disease and lack of spawning areas have severely impacted fish resources within the county.

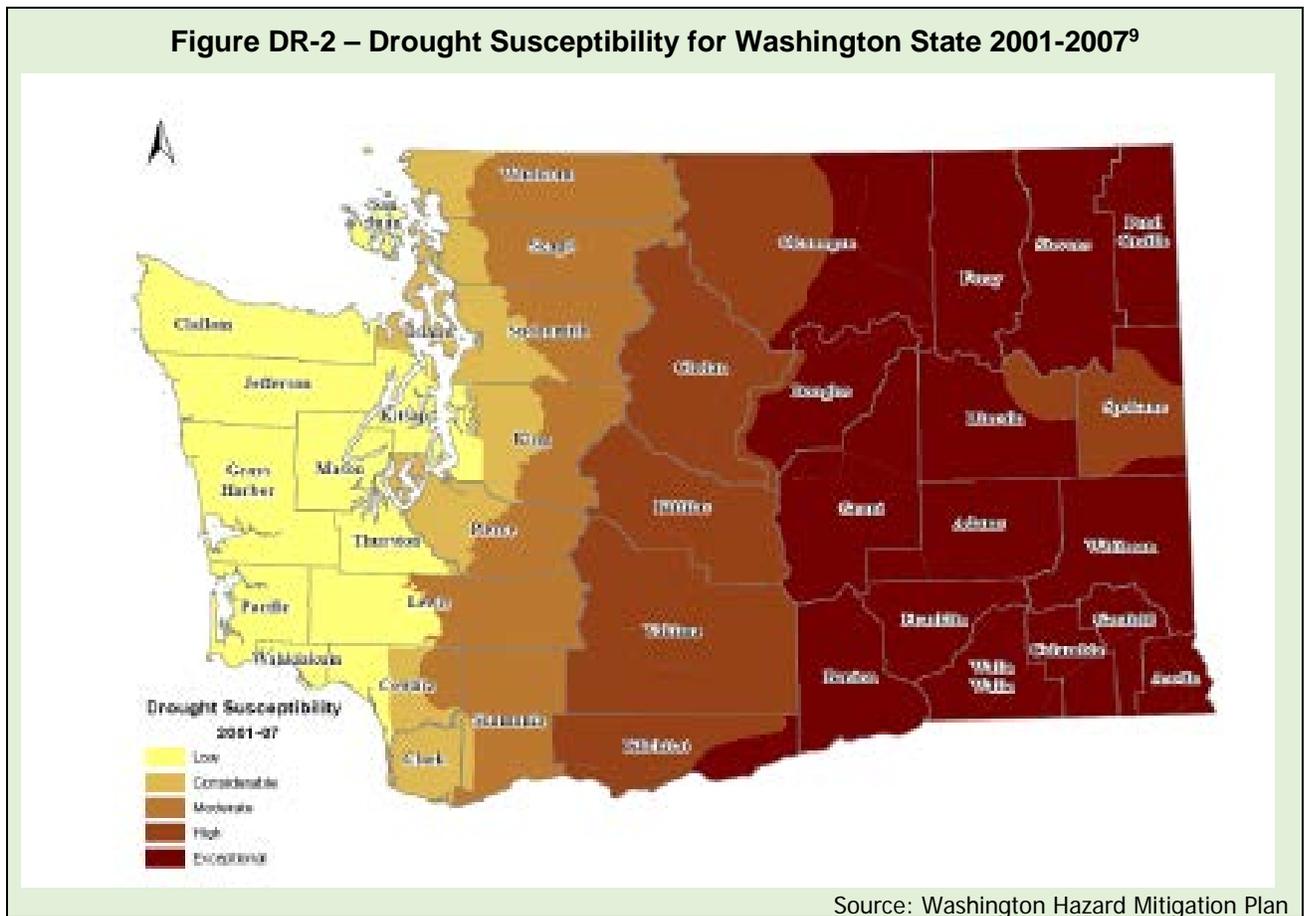
Problems of domestic/municipal water supplies have been historically corrected by the addition of a reservoir, a larger pipeline, a new well, or some other facility. Short-term measures including water conservation practices and using large capacity water tankers to supply domestic potable water have been used. Forest fires, erosion, crop loss, price increases, low water level contamination in shallow wells, power outages, dry pastures, logging shutdowns, and fish kills have been experienced in Jefferson County during times of drought.

All of the above effects result in economic and revenue losses for county residents, and the state.

## Climate Change

Little average annual change – with dryer summers (-6% to -8%) average decrease. Continued declining snowpack with significant loss of snowpack in Olympics by 2080<sup>10</sup>. This has the potential to damage the local economy. The City of Port Townsend and Port Townsend Paper Mill, together, use 11 million gallons of water per day taken from Lords Lake and the Big Quilcene River. The WRIA that recharges the rivers in the summer is dependent on a good snowpack during the winter. If the snowpack is small, there is a possibility for drought conditions to occur in the summer until the rainy season restarts. The City has an agreement that if Lords Lake drops to a minimum depth, the mill curtails operations until the water level comes back. This has the potential to cause the mill, the county's largest private employer, significant economic stress.

As Figure DR-2 shows, the Quimper Peninsula in Jefferson County has considerable susceptibility for drought.



## Conclusion

The Washington Hazard Mitigation Plan identifies the counties most at-risk and vulnerable to drought as those with a significant agriculture base. Accordingly, Jefferson County's risk and vulnerability are low to moderate, depending on the economic climate for paper and wood products at the time.

## References – Drought

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2. “*Counties Most At-Risk and Vulnerable to Drought*”, Washington State Enhanced Mitigation Plan, October 2012, Tab 5.3, “Drought Profile”, p.11
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## Figures – Drought

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- DR-1 “*Counties Most At-Risk and Vulnerable to Drought*”, Washington State Enhanced Mitigation Plan, October 2012, Tab 5.3, “Drought Profile”, p.11
- DR-2 “*Palmer Drought Index – March 2001*”, National Climatic Data Center – National Oceanic and Atmospheric Administration, August 2016. Available at: <http://www.ncdc.noaa.gov/temp-and-precip/drought/historical-palmers/psi/200103-200103>
- DR-3 “*2015 Drought Declaration Regions*”, 2015 Wa Drought Map Gov Declaration.png.
- DR-4 “*Palmer Drought Index – September 2015*”, National Climatic Data Center – National Oceanic and Atmospheric Administration, August 2016. Available at: <http://www.ncdc.noaa.gov/temp-and-precip/drought/historical-palmers/psi/201509-201509>

## Tables – Drought

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DR-1 “*Significant Droughts in Jefferson County and Washington State since 1900*”, Jefferson County Department of Emergency Management, 2016.

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