Animal / Crop / Plant Disease and Infestation Outbreak

	Frequency	50+ yrs	10-50 yrs	1-10 yrs	Annually
	People	<1,000	1,000-10,000	10,000-50,000	50,000+
	Economy	1% GDP	1-2% GDP	2-3% GDP	3%+ GDP
	Environment	<10%	10-15%	15%-20%	20%+
	Property	<$100M	$100M-$500M	$500M-$1B	$1B+
	Hazard scale	< Low to High >			

Risk Level

- Frequency – Minor animal/crop/plant disease and infestation outbreaks occur annually in Washington. The potential for severe outbreak in our state is high.
- People - The population affected in an animal/crop/plant disease and infestation outbreak in the state could affect more than 1,000 people dead or injured.
- Economy – An outbreak could cost our state tens to hundreds of millions of dollars directly and indirectly. International embargos could last years and take decades to recover.
- Environment – An animal/crop/plant disease and infestation outbreak can be expected to exceed 10-20% affect of a species or habitat, particularly domesticated species.
- Property – Property damage could be in excess of $1 billion dollars in the event of a catastrophic animal/crop/plant disease and infestation outbreak.

Hazard Area Map

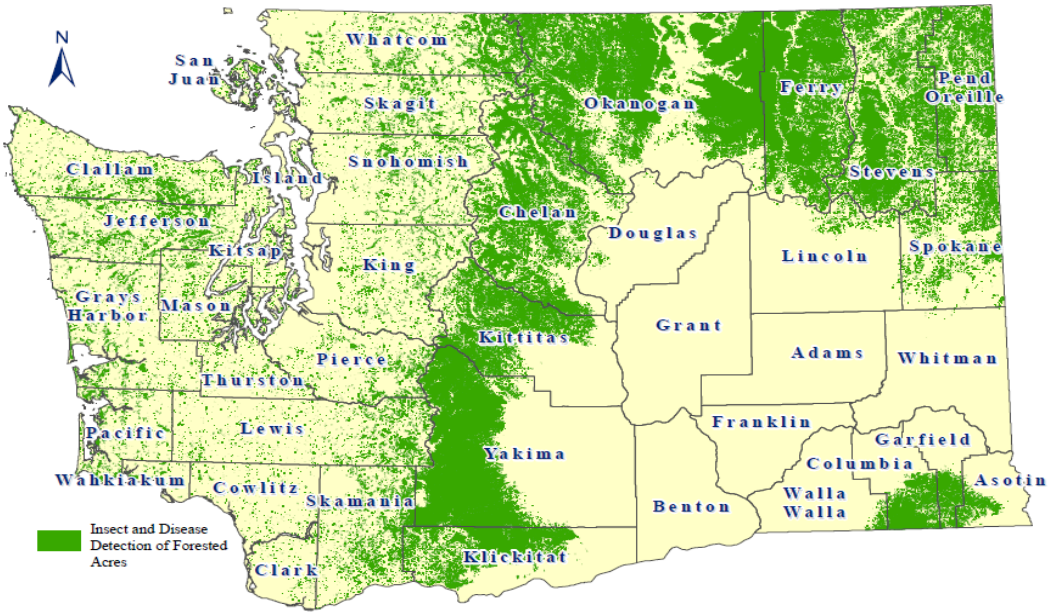


Figure 1 Insect and Disease Detection of Forested Acres in Washington, 1997-2007. Acres were detected via aerial surveillance flown over Washington's forested lands during the summer months of 1997 to 2007.

Summary

- The hazard – Agriculture is our state's largest industry. An animal or crop disease outbreak can occur at any time. Animal and crop diseases are endemic in many parts of the world. These diseases can cause widespread devastation of animal populations and crops. Crops are grown year round, processed throughout the state, imported from around the world, and sold nationally and internationally. Animals are raised, traded, sold, and slaughtered year round. Sale barns for livestock hold sales on a regular basis which can move animals throughout the western United States and British Columbia in any 24 hour period. Given rapid movement of trade products nationally and internationally even with strict bio-security measures, disease outbreaks can still occur. In many cases, diseases may take several days to weeks to manifest resulting in a wider spread outbreak. These animal, crop, plan diseases and infestation outbreaks primarily pose a danger to our economy since they could result in immediate national and international embargos of Washington State agricultural products.

- Perception is reality – In agriculture the perception of safety and wholesomeness of food and food products drives the market. In 2003, one cow was found in Washington with Bovine Spongiform Encephalopathy (BSE or mad cow disease). The beef market for the United States dropped from 18% of the world market to 2% of the market. The United States currently holds about 12% of that market today, and several countries still prohibit U.S. beef and beef products because of the perception of BSE in beef.

- Previous occurrences – Animal and crop disease outbreaks occur frequently each year and kill one to two people annually in the Northwest (about 25-35 deaths annually in the U.S.). The 2003 BSE outbreak in Eastern Washington caused immediate international embargos (some which are still in place today) from over 109 countries and an estimated loss to the U.S. beef industry of over $3.5 billion.

- Probability of future events – Animal and crop disease outbreaks occur regularly every year in Washington State. Many go unnoticed in the news, but on occasion result in serious illnesses or even death. Because Washington is a national and international leader in many agricultural areas the risk is high for future events.

- Jurisdictions at greatest risk – All 39 counties in the state are at risk with special attention to eastern Washington counties.

- Special note – This profile will not attempt to estimate potential losses to industry facilities due to animal or crop disease outbreaks. However, this hazard profile will identify a number of industries that have a potential for closures due to disease outbreaks.

The Hazard [1] [2] [3] [4]

Rich soils, diverse climates and large-scale irrigation systems make Washington one of the most productive growing regions in the world and enables farmers to produce some 300 different crops each year. The state's deep-water ports and its proximity to important Asian markets also provide natural advantages for agricultural trade. These ports also ship a significant portion (approximately 30%) of the nation's grain overseas to the Pacific Rim countries.

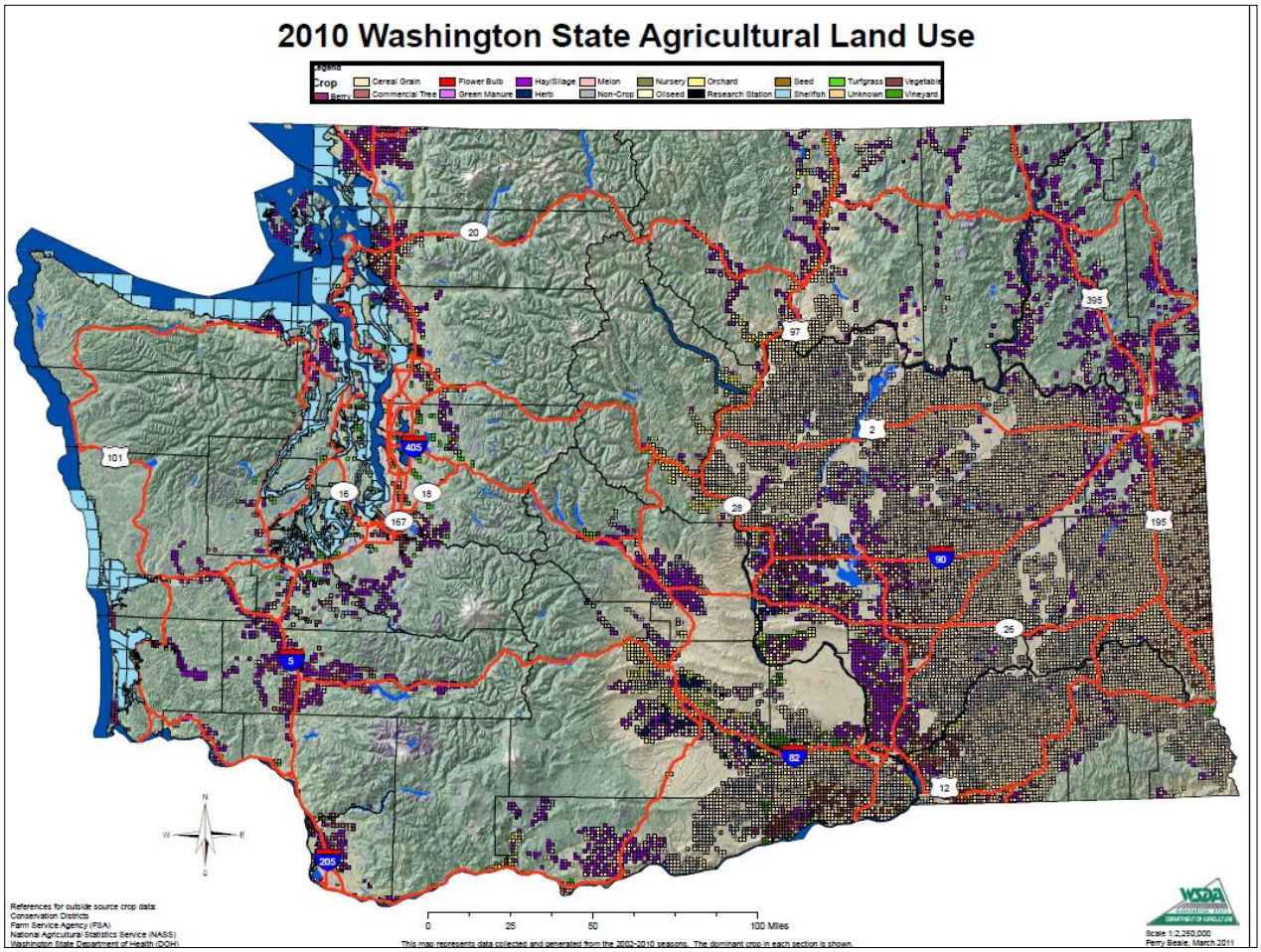


Figure 2 Washington State Agricultural Land Use. Source: WSDA.

Transboundary Animal Diseases – Those that are of significant economic, trade, and/or food security importance for a considerable number of countries; which can easily spread to other countries and reach epidemic proportions; and where control/management, including exclusion requires cooperation between several countries.

Crop/Plant Diseases – Disease is a natural part of every crop production system. This is true for every crop species and for each type of production system; irrigated versus rain-fed, conventional versus reduced tillage, and continuous versus rotating cropping. Consequently, in

any given year, the question is not whether or not disease will occur, but rather which diseases will occur and at what incidence and severity. Many factors influence disease developments in plants including hybrid/variety genetics, age of the plant at the time of the infection, environment (soil, climate), whether (temperature, rain, wind, hail, etc.), single versus mixed infections, and genetics of the pathogen populations. Due to variation inherent in these factors, diagnosis of plant/crop diseases can be difficult at the early stages of disease on individual plants as well as at the early stages of the epidemic.

Pests **-** Any crop can be threatened by pests. Pests can include, wildlife (birds, rodents, humans, etc.), or insects (moths, beetles, caterpillars, grasshoppers, etc

- The state's $40 billion food and agriculture industry employs approximately 160,000 people and contributes 12% percent to the state's economy.
- Nearly $13 billion in food and agricultural products were exported through Washington State ports in 2010, the third largest total in the U.S. Our inland ports, barge systems, and rail systems ship over 4.5 million tons of grain annually to Washington State ports for export.

USDA's 2011 National Agricultural Statistics for Washington State (December 2012)

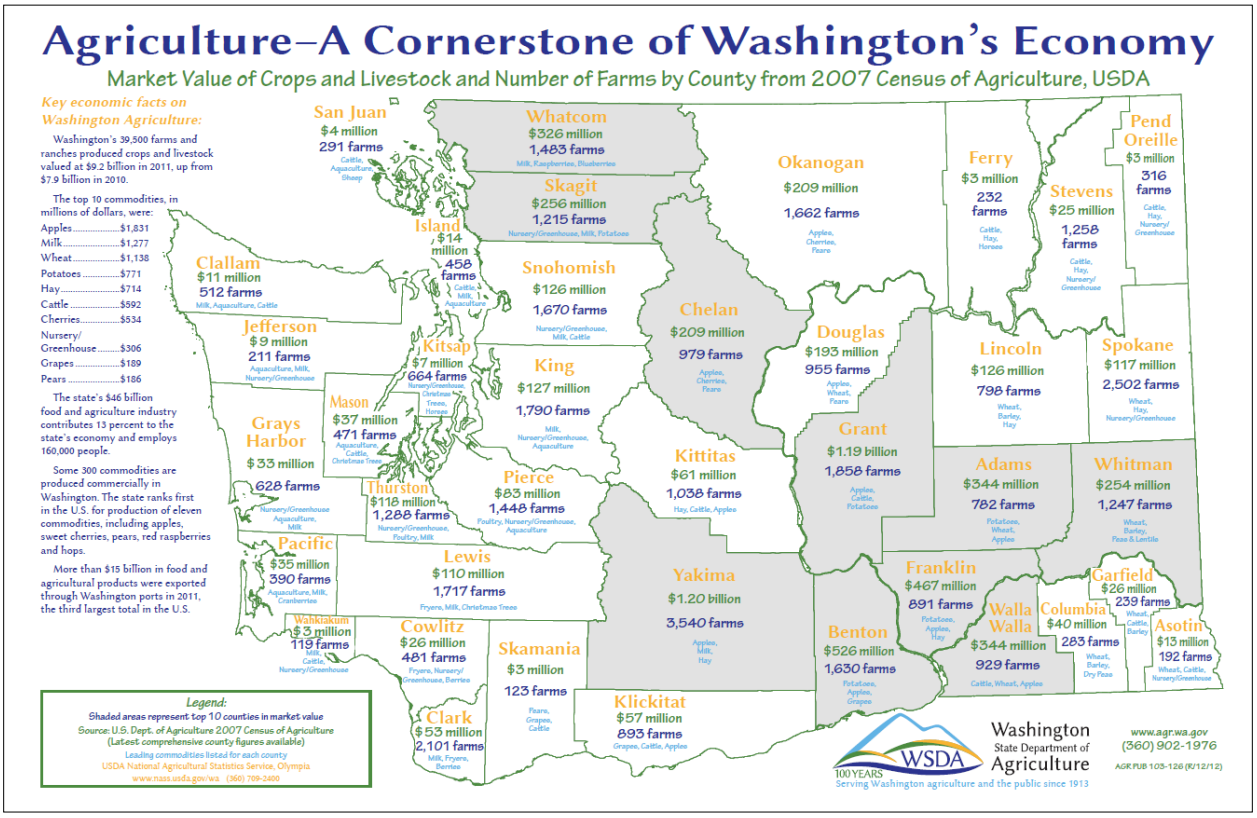


Figure 3 USDA's 2011 National Agricultural Statistics for Washington State**.** Source: USDA.

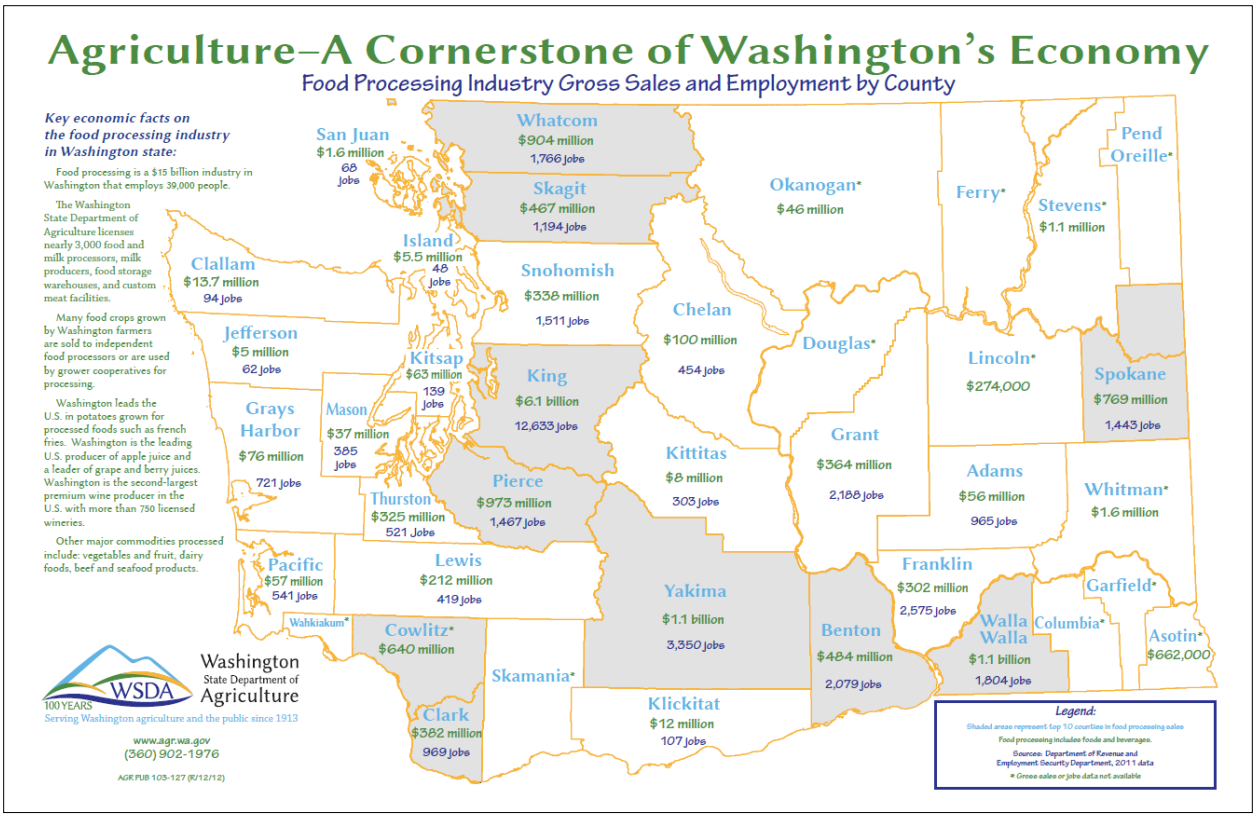


Figure 4 USDA's 2011 National Agricultural Statistics for Washington State. Source: USDA.

Table 1 Top 10 Commodity	2010 Value of Production (In Millions)
Apples [1]	**$1.440**
Milk	**$ 950**
Wheat	**$ 925**
Potatoes [2]	**$ 654**
Cattle/Calves	**$ 568**
Hay	**$ 509**
Cherries	**$ 367**
Nursery/Greenhouses	**$ 300**
Grapes	**$ 214**
Pears [1]	**$ 189**
Total	**$6,116**

[1] First in U.S. production. [2] Second in U.S. production.

Washington's 39,500 farms power a diverse agricultural economy, led by the state's apple industry with 60 percent of U.S. production. In addition to the top 10 commodities listed below, the Evergreen State is a major producer of potatoes, stone fruits, farm forest products, fish, shellfish, onions and mint oils.

An outbreak of disease that can be transmitted from animal to animal or plant to plant represents an animal/crop/plant disease. Some disease outbreaks can have a significant public health impacts. Additionally, the animal/crop/plant infestation will likely to have severe economic implications, cause significant crop productions losses, or cause significant environmental damage.

Another means of disease transmission is everyday human activity, unless stringent bio-security measures are followed. The main vector for the spread of Avian Influenza in British Columbia (2004), Foot and Mouth Disease in the United Kingdom (2001) and South Korea (2011), or gypsy moths in the Pacific Northwest (ongoing) is though everyday activities, such as, routine deliveries, imports of products from overseas, and movement of workers from farm to farm.

The introduction of some high consequence diseases may severely limit or eliminate our ability to move, slaughter, and export animal or animal products. Response and recovery to infectious animal disease outbreaks will be lengthy, and many producers may not be able to return to business. There will be many indirect effects on our economy. Rumors of an infectious animal disease outbreak could cause significant damage to the markets; as was evidenced in the 2003 BSE "Mad Cow" disease outbreak in our state. Markets plummeted and over 109 countries banned import of U.S. beef into their countries, which resulted in over $3.5 billion in losses to the U.S. beef industry.

Crop/plant pest infestations can cause widespread crop/plant loss and severe economic hardship on our state farmers, landowners, and businesses. Once an infestation occurs, the pest may become endemic, causing repeated losses in subsequent growing years. Loss of production will affect all related industries, such as fuel, food, synthetics, processors, etc. in just in Washington State but potentially globally.

Additionally, contamination of food and food products could cause serious damage to Washington's $13.6 billion food processing industry. The loss in this industry would have a national ripple effect, impacting a number of other states. The food processing industry in Washington employs 37,000 people.

Table 2 lists the 17 most damaging animal diseases while Table 3 lists the 13 most damaging crop diseases.

Table 2 Damaging Animal Diseases

Disease	Animal industries affected	Public health threat?
Highly pathogenic avian influenza	Poultry	Yes, may be lethal
FMD	Cattle, swine, sheep, and other cloven-hoofed livestock	No
Rift Valley fever	Cattle, sheep	Yes, may be lethal
Exotic Newcastle disease	Poultry	Yes, minor effects
Nipah and Hendra viruses	Swine (Nipah), horses (Hendra)	Yes, may be lethal
Classical swine fever	Swine	No
African swine fever	Swine	No
Bovine spongiform encephalopathy agent	Cattle	Suspected
Rinderpest	Cattle, sheep	No
Japanese encephalitis	Swine, equine	Yes, may be lethal
African horse sickness	Equine	No
Venezuelan equine encephalitis	Equine	Yes, may be lethal
Contagious bovine pleuropneumonia	Cattle	No
Ehrlichia ruminantium (Heartwater)	Cattle, sheep, goats	No
Eastern equine encephalitis	Equine	Yes, may be lethal
Coxiella burnetii	Cattle, sheep, goats	Yes, may be lethal
Akabane	Cattle, sheep, goats	No

Source: U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Veterinary Services, Emergency Management and Diagnostics, National Veterinary Stockpile.
http://www.aphis.usda.gov/animal_health/emergency_management/downloads/nvs_basic_brief.pdf

Table 3 Damaging Crop Diseases

Plant disease	Plants affected	Route of transmission	Impact
Citrus variegated chlorosis	Sweet oranges and other citrus species	Budding using infected budwood sources, natural root grafts, vectored by xylem feeding insects	The potential economic impact is high because the disease lowers yields, makes fruit unmarketable, and there is a likely loss of domestic and international export markets by embargo.
Downy mildews of corn	Corn, sugarcane, some sorghum cultivars, and many weedy grass species	Spores produced by nearby infected hosts or soil borne over-wintering spores, spread by wind and rain	On sweet corn, losses of 100% have been reported in the Philippines. It was estimated that the national yield loss in the Philippines in the 1974-1975 growing season was $23 million.
Huanglongbing of citrus	All citrus plants, including sweet oranges, tangelos, and mandarins	Grafting with diseased budwood, vectored by citruspsyllids	Severe yield losses result from infections of citrus trees, which usually die in 3 to 8 years. Infected trees produce fruit that is bitter and generally unsuitable for sale as fresh fruit or for juice.
Late wilt of corn	Corn	Spread primarily through movement of infested soil, crop residue, or seeds	Corn yield losses approached 40% in Egypt before the introduction of resistant varieties. All areas in the United States could be seriously impacted by the disease, in part, because of favorable environmental conditions.
Laurel wilt of redbay	Trees in the laurel family	Vectored by beetles	The disease poses the greatest threat to the commercial avocado industry. Other economic impact may include decreased property values and lost revenue to nurseries.
Plum pox	Plums, peaches,	Graft transmission, vectored by	The disease can cause significant economic loss due to a

	nectarines, apricots, and almonds	aphids	reduction in fruit quality and yield and due to premature tree death. In 1999, the yearly value of production of peaches, nectarines, plums, apricots, and almonds nationally was approximately $1.8 billion.
Potato wart	Potatoes	Infected seed potatoes, movement of fungal spores in soil or water, infested manure from animals that have fed on infected tubers	The economic impact is not from direct disease losses but from loss of international trade markets, long-term quarantines, and regulatory restrictions placed on infested areas and the buffer zones surrounding infested land.
Ralstonia bacterial wilt of potato and geraniums	Various row crops including pepper, tobacco, tomato, and potato, as well as some ornamentals such as geraniums	Primarily a soilborne and waterborne pathogen	The disease is one of the most damaging pathogens on potato worldwide and has been estimated to affect 3.75 million acres in approximately 80 countries with global damage estimates exceeding $950 million per year.
Rathayibacter poisoning	Forage grasses, often resulting in fatal poisoning of grazing animals	Transferred from infested soils into plants by plant parasitic nematodes	Thousands of sheep and cattle, as well as some horses, died from ailments attributed to the disease in Australia, where loss of production and cost of control has been in the millions of dollars.
Red leaf blotch of soybean	Soybeans	Rain splashes the fungus from soil onto leaf surfaces, where germination and infection occur	Yield losses of up to 50% were reported in Zambia and Zimbabwe. The disease could threaten soybean production anywhere in the United States.
Scots pine blister rust	Eurasian pine trees	Spread by windborne spores, may also be carried on plant material	The greatest economic impacts may be to nurseries and Christmas tree plantations that grow Scots pine. Movement restrictions and eradication of infected material could cause enormous economic losses amounting to millions of dollars.
Stem rust of wheat	Wheat and barley	Rain splash and wind-dispersal	The disease has been one of the most important diseases of cereal crops since the emergence of western civilization. Regional epidemics have occurred numerous times in the United States, with losses of over 50% recorded in Minnesota and North Dakota in 1935.
Phytophthora kernoviae	Forest trees and shrubs such as beech and rhododendron	Dispersed by splashes, through contaminated runoff water, in infested soil, and through long-distance dispersal on logs, wood products.	The potential for the disease to become established in U.S. hardwood forests is considered high, as is the likelihood of it causing extensive mortality, therefore, the potential economic and ecological impact to U.S. natural resources due to pathogen establishment is potentially very high.
Source: U.S. Department of Agriculture. www.USDA.gov			

Agricultural infestation is the naturally occurring infection of crops or livestock with insects, vermin, or diseases that render the crops or livestock unfit for consumption or use. Because of Washington State's substantial agricultural industry and related facilities and locations, the potential for infestation of crops or livestock poses a significant risk to the economy of the state. Some level of agricultural infestation is normal for Washington's farmers and ranchers. The concern is when the level of an infestation escalates suddenly, or a new infestation appears, overwhelming normal control efforts. The levels and types of agricultural infestation appear to vary by many factors, including cycles of heavy rains and drought.

One of the key concerns regarding this hazard is the potential introduction of a rapid and economically devastating foreign animal disease, such as foot and mouth disease or bovine spongiform encephalopathy (BSE) disease. Washington State is a large cattle state with over 1 million head produced locally as well as imported. The loss of milk production or beef production would cause economic losses, unemployment etc. to farmers, ranchers, butchers, and other support professions. In 2003, the first confirmed domestic case of BSE disease was reported in Washington State and required quarantining and/or destruction of several herds.

Wheat is susceptible to leaf rust, wheat streak mosaic, barley yellow dwarf virus, strawbreaker, and tan spot. Sorghum losses can occur when a crop is infected with sooty stripe early in the growing season. Gray leaf spot is a growing problem for corn crops.

Infestation is not only a risk to crops in the field, but insect infestation can also cause major losses to stored grain. It is estimated that damage to stored grain by the lesser grain borer, rice weevil, red flour beetle, and rusty grain beetle costs the United States about $500 million annually. The largest infestation ever recorded in North America is the mountain pine beetle in lodge pole pine forests. About 42% of federally threatened and endangered species are at risk primarily because of invasive species.[5]

Previous Occurrences

Table 4
Selected Animal and Crop Disaster Declarations in Washington State
2002 to Present

Date	Location	Agricultural Sector Affected/Cause
2002	17 Counties	Crops/Freezing Weather, Drought
2003	Yakima County	Cattle/Bovine Spongiform Encephalopathy (BSE)
	32 Counties	Crops/Freezing Weather, Drought
2004	Whatcom County	Birds/Avian Influenza Outbreak in adjacent British Columbia – Federal Response
	8 Counties	Crops/Excessive Rain, Hail, high Winds
2006	2 Counties	Crops/Wild Fires
	23 Counties	Crops/Severe Storms, Flooding, High Winds
2007	4 Counties	Cattle/Flooding
2007	7 Counties	Crops/Drought
2008	8 Counties	Crops/Freezing Weather
2008	13 Counties	Crops/Drought
2009	6 Counties	Crops/Drought
2009	7 counties	Crops/ Freezing Weather
2010	18 Counties	Crops/Freezing Weather
2010	4 Counties	Crops/Excessive Rain
2010	32 Counties	Crops/Excessive Rain, Freezing Weather
2011	4 Counties	Crops/Freezing Weather

Source: www.USDA.gov

Probability of Future Events

Determining the probability of future animal and crop disease outbreaks is difficult. There are many factors which influence the probability of future outbreaks. The State's potential risk is elevated by several factors: the large number of products arriving on daily basis at any of our air or sea ports; infected animals coming into our region through sales and shipping containers that may not be known to be on board the vessels; animals being imported for sale (both as pets and as a food source); or the sale of imported agricultural products from other countries. Or infected animals and products can cross the border from neighboring states or British Columbia. Avian diseases could be brought in by birds on their annual migration from Alaska

and Canada, or from areas as far south as Mexico or South America. Even travelers to foreign countries who visit agricultural areas may unknowingly transport animal or crop diseases to this country. However, a number of natural and manmade factors can influence future occurrences of animal and crop disease outbreaks:

Weather:

- Extreme weather can affect the existence and spread of animal and crop diseases. Winds can spread Foot and Mouth (FMD) disease up to 35 miles given the right conditions.
- High and low temperatures can set the right conditions for an animal or crop disease to manifest once introduced into the environment.
- Extreme amounts of rain, snow, frost, and drought can make animals and crops vulnerable to disease by weakening their ability to fight off disease.

Accidental Release:

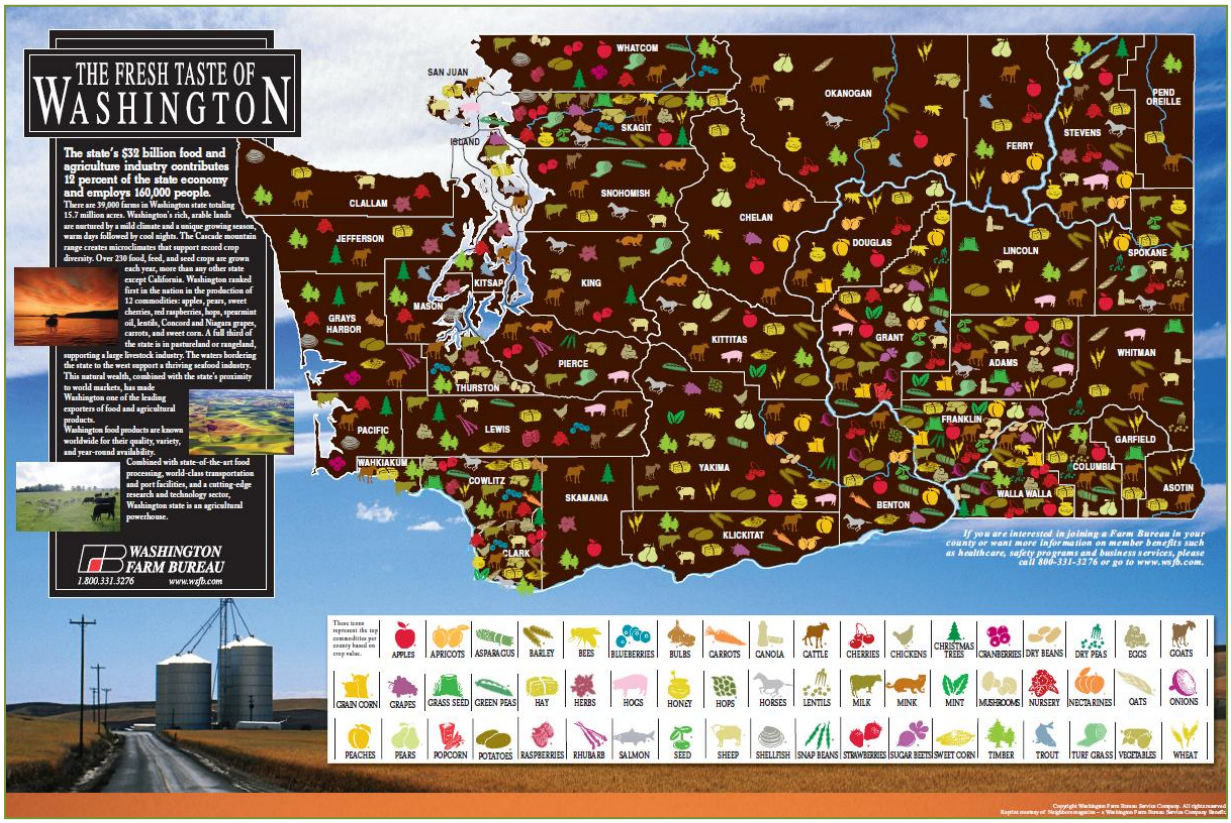
- Farmers, industry, producers, sellers, could accidentally introduce a disease onto a farm, livestock sale yard, processing facility, etc. without knowing it. In the 2003 BSE outbreak, an affected cow entered Washington State as part of a herd from a sale that originated in Canada.
- Infected crops or animals from other countries that are not caught via bio-security screenings or routine inspections during entry into the U.S.

Intentional Release:

- An intentional release of an animal or crop disease into the U.S. could easily be carried out via a criminal or terrorist act.

Jurisdictions at the Greatest Risk to Animal and Crop Disease Outbreaks

Every county in the state is potentially vulnerable with central and eastern counties slightly higher due to the higher numbers of large farmlands and larger feedlots. While there are human health implications from infected food supply, it is likely the economic consequences of an agricultural infestation that will be most significant. See Figure 5 below listing the many different sectors in their respective counties within Washington State.


THE FRESH TASTE OF WASHINGTON
The state's $32 billion food and agriculture industry contributes 12 percent of the state economy and employs 160,000 people.
There are 39,000 farms in Washington state totaling 15.7 million acres. Washington's rich, arable lands are nurtured by a mild climate and a unique growing season, warm days followed by cool nights. The Cascade mountain range creates microclimates that support record crop diversity. Over 230 food, feed, and seed crops are grown each year, more than any other state except California. Washington ranked first in the nation in the production of 12 commodities: apples, pears, sweet cherries, red raspberries, hops, spearmint oil, lentils, Concord and Niagara grapes, carrots, and sweet corn. A full third of the state is in pastureland or rangeland, supporting a large livestock industry. The waters bordering the state to the west support a thriving seafood industry. This natural wealth, combined with the state's proximity to world markets, has made Washington one of the leading exporters of food and agricultural products.
Washington food products are known worldwide for their quality, variety, and year-round availability.
Combined with state-of-the-art food processing, world-class transportation and port facilities, and a cutting-edge research and technology sector, Washington state is an agricultural powerhouse.
WASHINGTON FARM BUREAU
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PIERCE
THURSTON
PACIFIC
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FRANKLIN
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WAHKIAKUM
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SKAMANIA
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COLUMBIA
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If you are interested in joining a Farm Bureau in your county or want more information on member benefits such as healthcare, safety programs and business services, please call 800-331-3276 or go to www.wfb.com.
APPLES
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BEES
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CARROTS
CANOLA
CATTLE
CHERRIES
CHICKENS
CHRISTMAS TREES
CRANBERRIES
DRY BEANS
DRY PEAS
EGGS
GOATS
GRAIN CORN
GRAPES
GRASS SEED
GREEN PEAS
HAY
HERBS
HOGS
HONEY
HOPS
HORSES
LENTILS
MILK
MINK
MINT
MUSHROOMS
NURSERY
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OATS
ONIONS
PEACHES
PEARS
POPCORN
POTATOES
RASPBERRIES
RHUBARB
SALMON
SEED
SHEEP
SHELLFISH
SNAP BEANS
STRAWBERRIES
SUGAR BEETS
SWEET CORN
TIMBER
TROUT
TURF GRASS
VEGETABLES
WHEAT

Potential Climate Change Impacts[6,7,8,9 10 11]

With the advent of climate change coming into worldwide focus; it is necessary to take into account the potential effects this emerging climate crisis may have on the dangers associated with animal, crop, and plant diseases and infestation outbreaks. According to a 2005 Governor's report prepared by the Climate Impacts Group titled *Uncertain Future: Climate Change and its Effects on Puget Sound*, from "paleoclimatological evidence, we know that over the history of the earth high levels of greenhouse gas concentrations have correlated with, and to a large extent caused, significant warming to occur, with impacts generated on a global scale." While the report also indicates that the "ultimate impact of climate change on any individual species or ecosystem cannot be predicted with precision," there is no doubt that Washington's climate has demonstrated change.

In July 2007, the Climate Impacts Group launched an unprecedented assessment of climate change impacts on Washington State. *The Washington Climate Change Impacts Assessment* (WACCIA) involved developing updated climate change scenarios for Washington State and using these scenarios to assess the impacts of climate change on the following sectors: agriculture, coasts, energy, forests, human health, hydrology and water resources, salmon, and urban stormwater infrastructure. The assessment was funded by the Washington State Legislature through House Bill 1303.

In 2009, the Washington State Legislature approved the *State Agency Climate Leadership Act* Senate Bill 5560. The Act committed state agencies to lead by example in reducing their greenhouse gas (GHG) emissions to: 15 percent below 2005 levels by 2020; 36 percent below 2005 by 2035; and 57.5 percent below 2005 levels (or 70 percent below the expected state government emissions that year, whichever amount is greater.). The Act, codified in RCW 70.235.050-070, directed agencies to annually measure their greenhouse gas emissions, estimate future emissions, track actions taken to reduce emissions, and develop a strategy to meet the reduction targets. Starting in 2012 and every two years thereafter, each state agency is required to report to Washington State Department of Ecology the actions taken to meet the emission reduction targets under the strategy for the preceding biennium.

Recognizing Washington's vulnerability to climate impacts, the Legislature and Governor Chris Gregoire directed state agencies to develop an integrated climate change response strategy to help state, tribal and local governments, public and private organizations, businesses and individuals prepare. The state Departments of Agriculture, Commerce, Ecology, Fish and Wildlife, Health, Natural Resources and Transportation worked with a broad range of interested parties to develop recommendations that form the basis for a report by the Department of Ecology: *Preparing for a Changing Climate: Washington State's Integrated Climate Change Response Strategy*.

Over the next 50 - 100 years, the potential exists for significant climate change impacts on Washington's coastal communities, forests, fisheries, agriculture, human health, and natural disasters. These impacts could potentially include increased annual temperatures, rising sea

level, increased sea surface temperatures, more intense storms, and changes in precipitation patterns. Therefore, climate change has the potential to impact the occurrence and intensity of natural disasters, potentially leading to additional loss of life and significant economic losses. Recognizing the global, regional, and local implications of climate change, Washington State has shown great leadership in addressing mitigation through the reduction of greenhouse gases.

The forces that shape the climate are also critical to farm productivity. Human activity has already changed atmospheric characteristics such as temperature, rainfall, levels of carbon dioxide (CO_2) and ground level ozone. Warmer climate may give positive effects on food production like the possibility of longer growing seasons; however, the increased potential for weather extremes will pose challenges for farmers. Increased frequency of heat stress, droughts and floods negatively affect crop yields and livestock. Moreover, water supply and soil moisture could make it less feasible to continue crop production in certain areas. The potential loss of snowpack in the Cascades will diminish water needed for summer irrigation for crops in the Columbia Basin and impact salmon recovery across the Northwest. Finally, climate variability and change will modify the risks of fires, weeds, pests, and pathogen outbreaks.

Yakima Valley

2004 research at the Pacific Northwest National Laboratory (PNNL) determined that the $1.3 billion output in the Yakima River Basin was due to water availability. Past droughts caused 10-15% losses of economic output, not including the accumulation of water loss over the years. Compared to a "good year" where the outputs are estimated at $901 million, droughts and crop losses will become more prevalent due to water shortages increasing from $13 to $79 million per year by mid-century. Water shortages will cause higher costs for farmers and amplify economic losses during drought years. Expected global increases in temperatures will have economic effects not easy to quantify. Decreased snowpack and earlier runoff will decrease stream flow. Higher temperatures will increase evaporation in the soil and decrease its capacity to hold moisture for plants during the hottest parts of the growing season. Insects will find a haven in warmer temperatures, and become a greater problem. Increased numbers of hot days (over 100 °F) are expected to cause increased levels of heat related illness, which makes the agricultural workers population especially vulnerable.

Studies that focus on the water availability to the 370,000 acres (1,500 km^2) of orchards, vineyards, and food crops within the Yakima River Valley are dependent on irrigation which draws water from only five reservoirs. These in turn are dependent on snowpack from the Cascade Mountains. With the arrival of early snowfall, warmer temperatures, and a premature runoff, irrigation water supply is predicted to drop 20-40% by mid-century. The loss to agriculture in the Yakima River Valley would be $92 million for a 2 °C increase and $163 million for a 4 °C increase.

Dairy production

A significant rise in global temperatures will negatively affect dairy production in Washington State which had a total of 560 dairy farms at the end of 2004. Each region will be affected differently based on the different climate and temperature fluctuations. Current predictions forecast that by 2075, milk production in the Yakima River Valley will drastically decrease during the summer months. The worst effects of climate change will be a decrease in daily milk production from 27 kg to 20 kg in the month of August. Whatcom County dairy farms are predicted to be less affected by climate change than Yakima Valley. Summer milk production in Whatcom County is projected to fall from a little under 27 kg per cow per day to slightly more than 25 kg per cow per day. In both regions the lower milk production is directly correlated to the decrease in consumption of food stuffs. The decrease in food availability during summer is due to increasing annual temperatures that shift precipitation levels and cause a faster run-off of snowpack. With less food for the cows, milk production drastically decreases during the summer months. Higher temperatures cause a decrease in milk production.

Wine

Washington State currently holds second place, following California, for U.S. wine production. A change in climate will cause vineyards to move. In 2004, wine grapes accounted for $127.5 million and were the state's 4th largest fruit group in terms of value. In 2005, the wine industry as a whole was a $3 billion industry, providing the equivalent of 14,000 full-time jobs.

The Yakima and Mid-Columbia valleys are the most heavily populated vineyard regions. The predicted water shortage within the next decades could lead to a potential crop loss from $13 million to $79 million by mid-century. Because wine varieties are highly sensitive to temperatures, an increase could cause several Eastern Washington areas to move out of the ideal range for certain varietals. The climate shift could make western areas such as Puget Sound more ideal for wine production. If the magnitude of the warming is 2 °C or larger, then a region may potentially shift into another climate maturity type, which is the specific climate favorable to maturing a certain type of grape. For instance, the chardonnay grapes of Western Washington mature well at 14-16 °C, while merlots typically produced in Eastern Washington do best at 16-19 °C. The shift of vineyard concentration to the coastal regions would mean a shift in local land value and use, production, revenue and employment.

Wheat

Eastern Washington produces a large amount of wheat that is affected by climate. In a recent study, winter wheat productions were taken at different elevations, both with and without irrigation, and the best yields were in areas with a lot of rainfall, temperate conditions, and at elevations from 1000 to 1500 meters. Both non-irrigated and irrigated harvests have increased with global warming, which has also allowed for increased production at higher elevations. The harvests also improved with the presence of higher levels of carbon dioxide.

Cranberries

Washington is the fifth largest supplier of cranberries in the U.S., producing 3% of total U.S. production. There are three growing regions in Washington: Whatcom County, Grays Harbor County, and Pacific County. These berries could be affected by higher winter temperatures and rising sea levels due to climate change.

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