

CLIMATE CHANGE*

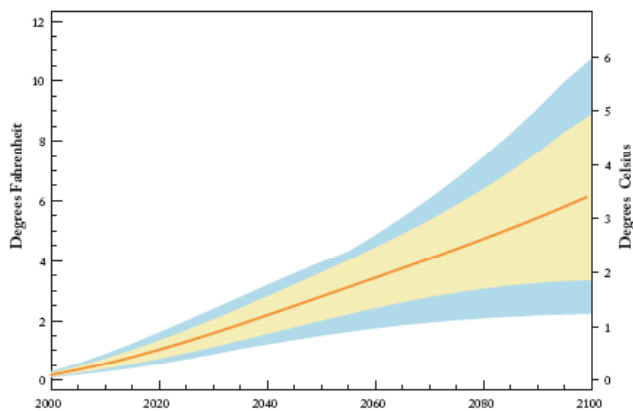
Greenhouse gases, such as CO₂, serve to trap heat in the Earth's atmosphere, which scientists agree is resulting in changes to our climate across the globe and into the future. Climate change has several adverse impacts with respect to temperature, precipitation, snowpack, stream flow, sea level rise, forests, water quality and habitat. That climate change is occurring is certain, what is uncertain is to what degree, where, in what time frame, and with what impacts.

- Today the earth's concentration of CO₂ is about 412 parts per million by volume (ppmv) and climbing.
- Even if we stopped emitting CO₂ today, climate impacts from past activities would still continue for decades to come.

Temperature

During the 20th century the earth's surface air temperature rose about 1.1°F. Projections for the 21st century estimate an additional increase in global average temperature in the range of 3-10°F. The Puget Sound region warmed at a rate substantially greater than the global warming trend—average annual temperature increased 2.3°F (1.3°C) during the 20th century.

The Puget Sound is forecasted to get warmer year round, with even more warming in summer. Low scenario models show an increase of +4.2°F (range: +2.9 to +5.4°F) by 2050, while higher scenario models show +5.5°F (range: +4.3 to +7.1°F). Differences in warming are much more dramatically accentuated by the end of the century.



Northwest Warming Trends

The figure above shows projected changes in annually averaged temperature for the Pacific Northwest, based on ten global climate scenarios. The orange line shows the average of all the models. The blue shading indicates the range from highest to lowest, and the yellow shading indicates the range in which about two-thirds of the scenarios fall.

In addition to trends in average conditions, ecosystems are sensitive to the variation in temperature, between day and night, and between seasons. These changes can damage plants as well as pest species.

- There will be more extreme heat, and less extreme cold

in the region. The number of days a year where the average daily temperature goes above 90 °F increases by 8 days (± 7), while the number of days a year where temperature fall below freezing decrease by 35 days (± 6).

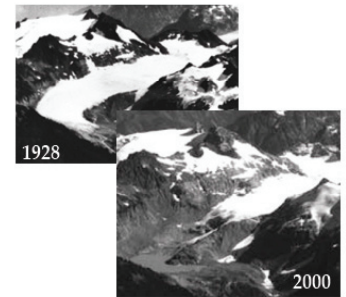
Precipitation

Uncertainties of precipitation come from the divergence of model predictions. The majority of models show annual average precipitation changing by about +3% with individual models ranging from -4.7% to +13.5%. The biggest difference will be a 30% reduction in summer precipitation. Precipitation in the Fall, Winter and Spring is expected to increase.

Snowpack and Streamflow

Understanding how climate fluctuations affect the hydrologic cycle—the timing and amount of rain, snow, snow melt and stream flow—is fundamental to understanding climate impacts on Puget Sound.

These changes include: reduced spring snowpack, earlier spring snowmelt, increased winter flow, decreased summer flow.



These changes can lead to altered habitat for fish and other species, as well implications for municipal and agricultural water supplies.

- Measurements for snowpack show that SWE (snow water equivalent) has declined by more than 25% at most locations.
- Total annual inflow declined 13% owing to changes in precipitation
- The timing of snowmelt shifted earlier by 12 days, or 2.1 days per decade
- The fraction of annual flow entering Puget Sound during the summer decreased 18%
- The likelihood of unusually high daily inflow increased, despite the decline in annual inflow,
- The likelihood of unusually low daily inflow increased

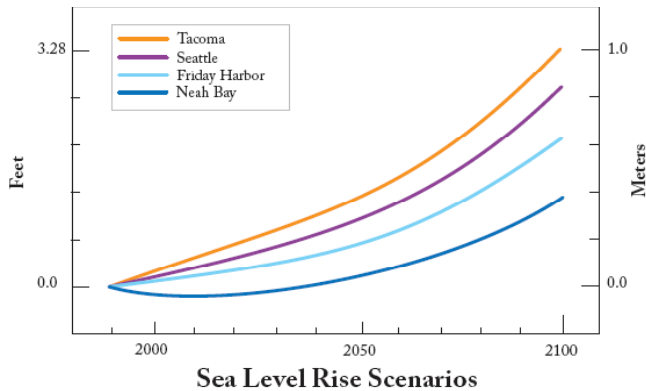
Floods

Higher winter temperatures are likely to increase the chance of flooding in Puget Sound as more winter precipitation falls as rain rather than snow in moderate elevation mountain areas, such as the Cascades. If winter precipitation increases, as some models suggest, the risk of flooding would be compounded. While many areas are protected by dykes and reservoirs, increase in flows could overwhelm these managed systems.

- The 100-year flood event, a 1% annual flood event, is expected to increase by +18% to +55%, on average, by the 2080s in the 12 largest Puget Sound watersheds. Developed areas in floodplains may be particularly vulnerable to the increased flood risk.

Sea level rise

In addition to natural fluctuations, global sea level has been increasing at an estimated rate of 4-8 inches over the 20th century (1.0 to 2.0 mm/yr) as a result of both the warming of ocean waters, which causes thermal expansion, and the melting of glaciers, small ice fields and polar ice sheets. Future global sea level rise is likely to accelerate as a result of human-caused global warming, with changes likely in the range of 4-35 inches (0.09-0.88 m) during the 21st century.



Complex geological factors produce different rates of sea level rise across the Puget Sound region. Land is sinking in much of Puget Sound, with rates ranging from zero in the eastern Strait of Juan de Fuca and north Puget Sound to more than 8 inches per century (2 mm/yr) in south Puget Sound.

Water quality

Key properties that characterize the physical and biological function of fresh and marine waters in Puget Sound include water temperature, salinity, density, stratification (layering), dissolved oxygen, nutrients and fecal coliform levels. These water properties are influenced by fluctuations in Pacific Ocean water, stream/freshwater inputs, and local weather conditions. While human influences are often the primary cause of water quality degradation, climate variability and change may worsen water quality problems when these changes exceed the buffering capacity of the system.

- Many Puget Sound species, such as salmon, oysters and groundfish, depend on cold water.
- Sea level rise will likely lead to saltwater intrusion into groundwater supplies. High summer stream temperatures will make it more difficult to meet water quality standards.
- It is likely that future changes in freshwater inputs will increase salinity in summer and decrease it in winter.
- Stratification affects nutrient supplies to surface waters, phytoplankton growth, the availability of dissolved oxygen to waters at depth, and pollutant flushing. Stream flows, temperatures, and salinity changes will alter future stratification processes.
- Dissolved oxygen, a key habitat suitability indicator, is dependent on temperature, stratification, inflows, and organic content. While more studies are needed, it seems probable that DO levels at depth could decrease, increasing hypoxic conditions in bottom water.

- Surface water nutrient levels are influenced by stormwater runoff, industrial waste discharged, failing septic systems, tributary inflows, coastal upwelling, stratification and organic productivity.
- Climate change could exacerbate problems with fecal coliform contamination, a major contributor of water quality problems, because increased winter rains would likely lead to more stormwater runoff and combined sewer overflow events, as well as increased septic system leakage resulting from sea level rise.

Impacts to nearshore habitat

Climate change implications are likely to cause serious damage to the nearshore ecosystem.

- Sea level rise is likely to increase both the pace and extent of Puget Sound shorelines threatened by slow, chronic erosion.
- Landslides along Puget Sound bluffs may increase because of the heavier winter rainfall projected by nearly all of the global climate models.
- Changes in water temperature, water salinity, or soil salinity beyond the tolerance of certain plants could change the mix of plant species.
- Changes in precipitation could change nutrient loading and sediment accumulation.
- Increases in atmospheric CO₂ levels may stimulate growth in some nearshore plants.

Forests

Due to temperature changes and a higher CO₂ concentration, some plant species will have a longer growing season and increased productivity, while others may decrease due to lack of sufficient water in summer. Wildfire is projected to occur more frequently, which will degrade air quality and affect all outdoor recreation activities. Alongside, insect infestations, tree epidemics, drought-induced dieback and shift of plant species are changing the structure of this region's forests.

- The spatial distribution of suitable climate for tree species may change considerably, making some forest types, such as subalpine forests, extremely limited.
- Over 100,000 acres of forests have been lost in wildfires per year in 2013 - 2015 (as compared to an average of 40,000 over the last three decades).
- Tree mortality was largely attributed to bark beetles, and to a lesser degree, bear damage and root disease.

* Note

Part of the text and images for this document were taken directly from 1. Snover, A. K., P. W. Mote, L. Whitley Binder, A.F. Hamlet, and N. J. Mantua. 2005. Uncertain Future: Climate Change and its Effects on Puget Sound. A report for the Puget Sound Action Team by the Climate Impacts Group (Center for Science in the Earth System, Joint Institute for the Study of the Atmosphere and Oceans, University of Washington, Seattle).

2. Russo, M., Alberti, M. 2016. Puget Sound Trends: A Synthesis of the Drivers Shaping the Future of our Waters. Urban Ecology Research Lab, University of Washington, Seattle.

3. May C., C. Luce, J. Casola, M. Chang, J. Cuhaciyan, M. Dalton, S. Lowe, G. Morishima, P. Mote, A. Petersen, G. Roesch-McNally, and E. York, 2018: Northwest. In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 1036-1100. doi: 10.7930/NCA4.2018.CH24.

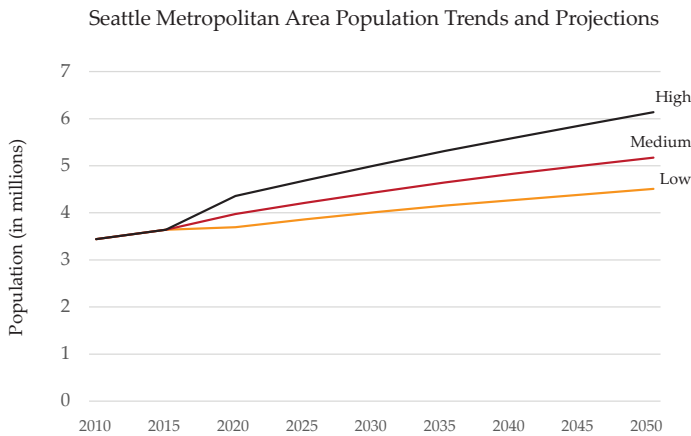
DEMOGRAPHY

Population numbers and rate of change

The number of people is widely acknowledged to be an important variable in influencing ecosystem condition. There is also a growing recognition that how population is distributed across age groups, urban and rural regions, living arrangements, and geographic regions affects consumption patterns and the impacts on ecosystems. The primary determinants of population growth are fertility, mortality, and migration [1].

Past & Future Numbers

In 2018 the Seattle Metropolitan Statistical Area was estimated to have 3.9 million residents. This is a 14.2% increase from the 2008 population. By 2050 the population is expected to grow to between 4.51 (low projection) to 6.14 (high projection) million residents. According to the intermediate projection, this would add an additional 1.5 million people to the region [2].



Source: Office of Financial Management. 2019.

In 2018 King County had 57% of the population in Seattle MSA, and 29% of Washington state. The growth rate of Seattle MSA has paralleled that of Washington state, while both regions have shown a higher population increase than the nation [3].

	Average Annual Growth Rate		
	2018 Population	1998 - 2007	2008 - 2017
King	2,190,200	1.2%	1.5%
Pierce	872,220	1.6%	0.7%
Snohomish	805,120	2.1%	1.4%
Seattle MSA	3,867,540	1.5%	1.3%
Washington	7,427,570	1.5%	1.2%
Nation	327,167,434	1.0%	0.7%

Source: Office of Financial Management. 2019. & U.S. Census Bureau, 2019

Fertility and Mortality

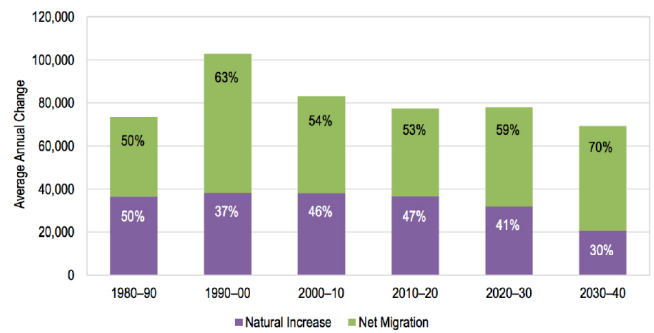
Since 1960 the fertility rate in the State of Washington has dropped from 3.67 to 1.87 [2]. According to OFM Population Forecast, historically, the increase in women's labor force participation and educational attainment has

played a major role in the decline of fertility rates over time. Economic factors such as wage stagnation and student loan debt may also be contributing to delayed childbearing and smaller families. As the population grows and the state continues to attract migrants at the working ages, the number of births is forecast to grow, reaching 95,800 per year by 2025 and 105,400 by 2040 [2].

Migration

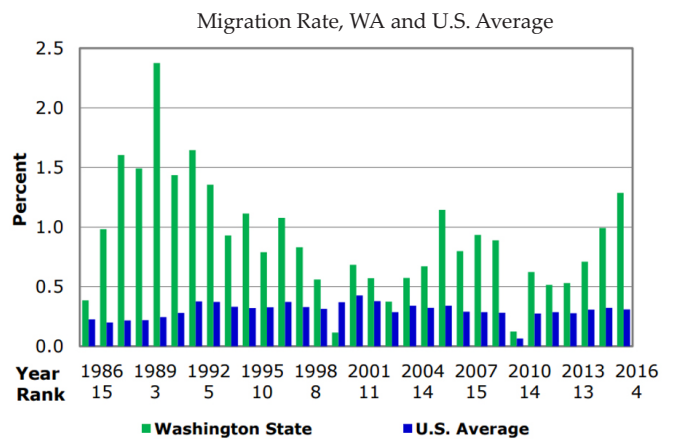
Population growth is dominated by in-migration in response to economic opportunities. In comparison to natural increase (fertility minus mortality), migration trends are harder to predict as they are heavily correlated with economic growth. Short-term social, and political trends also affect changes in migration rates [4].

Components of population change by decade, 1980 - 2040



Source: OFM. 2016. & Russo and Alberti, 2016.

- In 2016, natural increases accounted for 27 percent of the state's growth while 73 percent came from migration.
- Of the state's immigrants, 27 percent were international and 73 percent were domestic. In the U.S. as a whole, 55 percent of population growth came from natural increase while 45 percent from international migration [5].
- In addition to the traditional migration, 'pushing' and 'pulling' factors (such as social relations, jobs, cultural perceptions, and wars) analysts are considering 'environmental refugees' as potential new migrants – people driven by environmental factors.

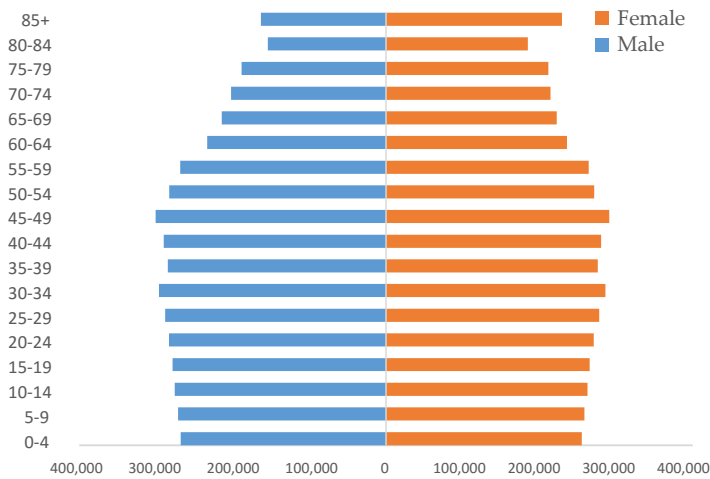


Source: Washington State Economic and Revenue Forecast Council, 2017

Age Structure

We are currently seeing the impacts of the “baby boom” population aging. As this large segment of the population retires this region may experience a significant change in service demands, housing patterns, and even traffic problems. As the “baby boom echo” reaches their late twenties we will start to see changes to our post-secondary education and job market. By 2050, the baby boomers will be mostly gone, and their grandchildren will enter the workforce.

Population Age Structure, Washington State, 2040



Source: OFM, Projections of the State Population, 2016

Household Size

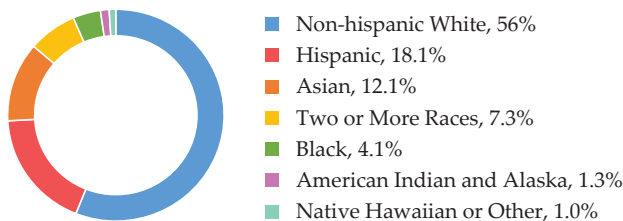
A household is defined as a person or a group of persons who occupy a common dwelling and who provide themselves jointly with food and other essentials. Household size is a good indicator of how the population breaks down in terms of consumption patterns (i.e. number of housing units, energy usage, vehicle trips per day, etc.)

- The average household size in Washington state in 2013-2017 is 2.55 according to the U.S. Census Bureau.
- OFM forecasts that the number of people per housing units will continue its slow and steady decline in the region.

Race

By 2040, Washington State is expected to become more diversified. In 2018 the Non-Hispanic White population was 5,055,144 (68%), by 2040 Non-Hispanic whites will grow in numbers to 5,098,009, but decline in share to 56% of the total population [2].

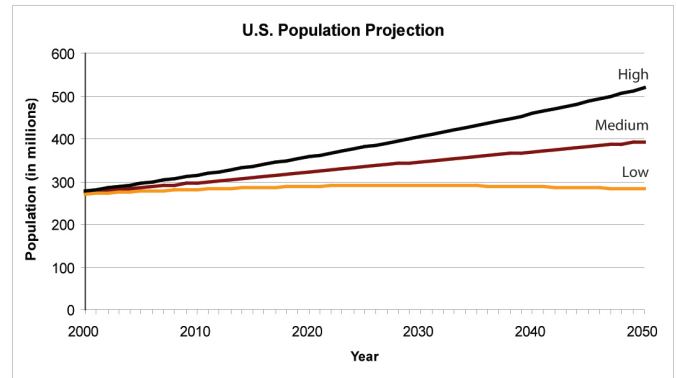
Population by Race, Washington State, 2040



Source: OFM, Projections of the State Population, 2016

The Nation

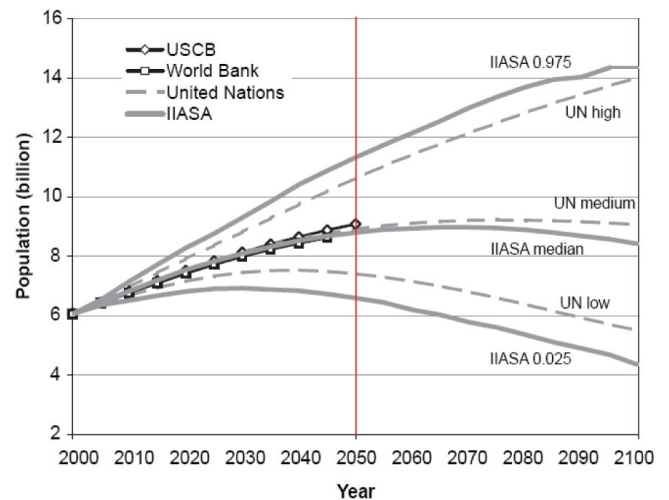
The U.S. Census Bureau projects that the US population will be 392 million by 2050, presuming our current fertility and migration rates [6]. While the high projection estimates over 500 million by 2050, the low projection estimate 282 million, a figure only slightly higher than the 2006 national population (278 million).



Source: US Census

Global Changes

Global population increased by 2 billion during the last quarter of the twentieth century, reaching 6 billion in 2000. Now population growth rates are declining nearly everywhere. The global growth rate peaked at 2.1% per year in the late 1960s and has since fallen to 1.35%. In the next century, depending on the projection, the global population growth may either increase to over fourteen billion or decrease to a level lower than we see today [1].



Global Population Projections, 2005-2100 (Lutz et al. 2001; United Nations 2003c; United States Census Bureau 2003; World Bank 2003)

Source: Millennium Ecosystem Assessment.

Note

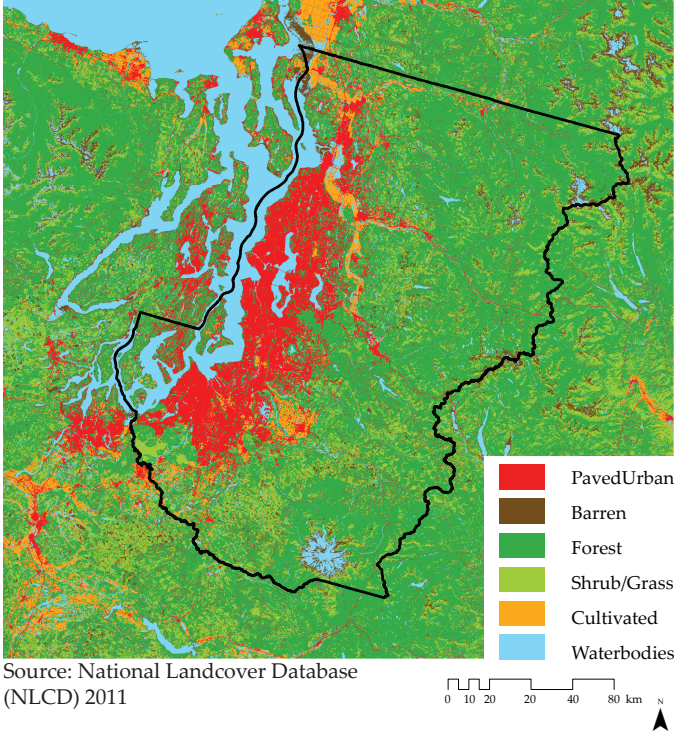
- Part of the text and images for this document were taken directly from
1. Millennium Ecosystem Assessment, Chapter 7 Driving Forces.
 2. Office of Financial Management. Forecasting & Research Division. 2019.
 3. U.S. Census Bureau. Population and Housing Unit Estimates. 2019.
 4. Russo, M., Alberti, M. 2016. Puget Sound Trends: A Synthesis of the Drivers Shaping the Future of our Waters. Urban Ecology Research Lab, University of Washington, Seattle.
 5. Washington State Economic and Revenue Forecast Council, Washington State Economic Climate Study. 2017.
 6. The current net-migration is currently 880,000 new immigrants per year.

DEVELOPMENT PATTERNS

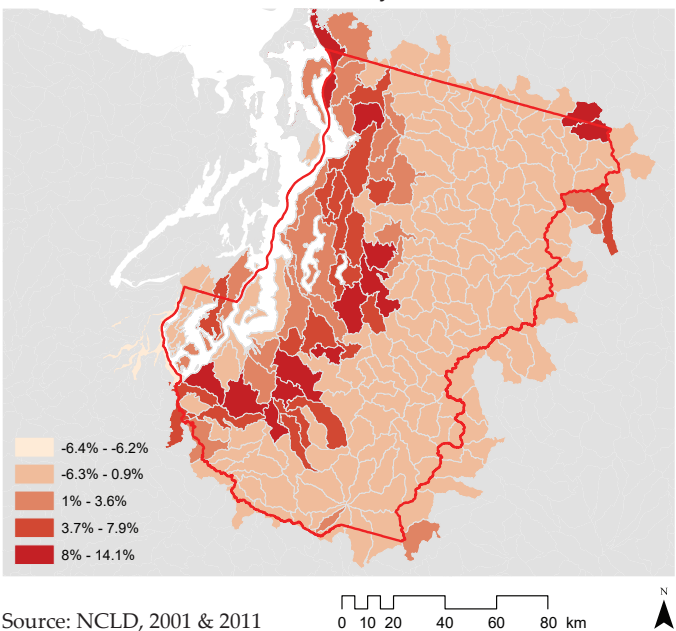
Land Cover in the Puget Sound

The landscape is composed of several different land cover classes, including paved, cultivated, shrubs, forest and bare earth. Forest and urban land cover are two of the most important factors affecting the condition of watersheds in the Seattle Metropolitan area. Between 2001 and 2011, the paved developed area within the Seattle Metropolitan Area increased by 9.6 square miles while forest decreased by 157.4 square miles .

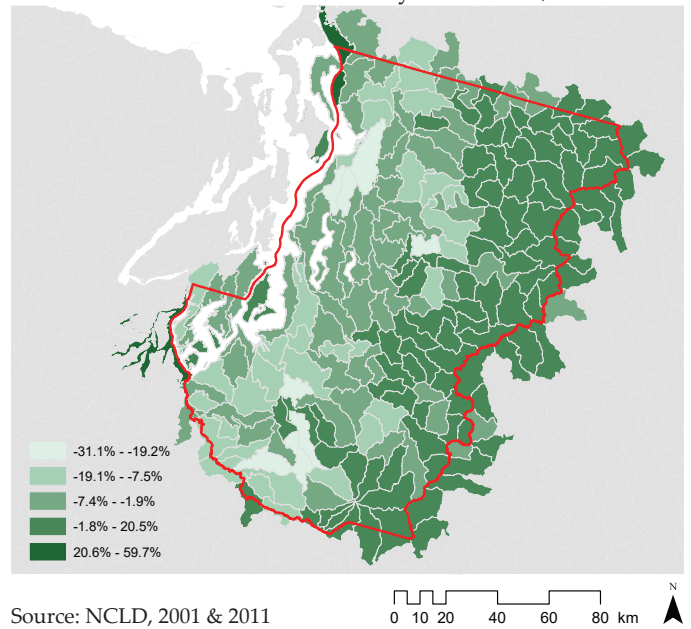
Land Cover of Seattle Metropolitan Area 2011



Change in % Paved Urban by watershed, 2001 - 2011



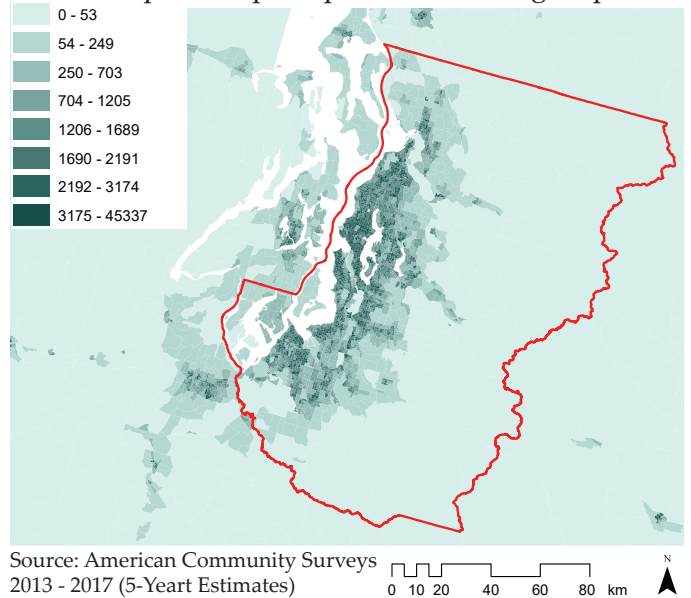
Change in % Forest by watershed, 2001 - 2011



Density Measures

There are several means to measure the amount and change of population density within the metropolitan region. In the following map the most recent American Community Surveys (ACS) 5-year estimate data was used to calculate the number of residents in 2017, divided by the area of each block group.

Population Density persons per square km, block group, 2017



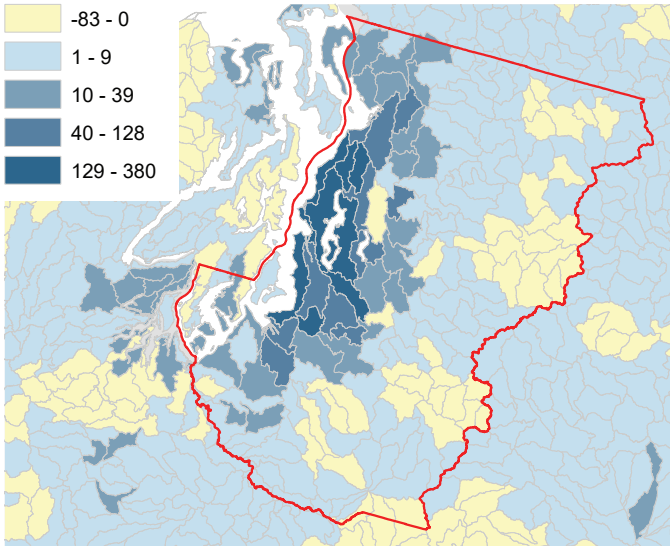
Higher densities can be found along the coast of King, Snohomish and Pierce counties. Densities of less than 53 persons per square kilometers can be found on the eastern side of the region.

Trends in land cover change may be explained by population density change occurring in the region

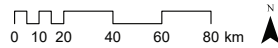
between 2000 and 2010. The Seattle Metropolitan area had an overall density increase of around 21 persons per sq. km, after adding an additional 393,284 people into the area during the past decade. The largest density changes occurred at the urban core, with 380 more persons per sq.km compared to 2001.

- In 2000 there was an average density of 158 people per sq. km in Seattle Metropolitan Area. In 2010, population density increased to 178.6 people per sq. km.

Change in Population Density
persons per square km, by watershed, 2000 - 2010



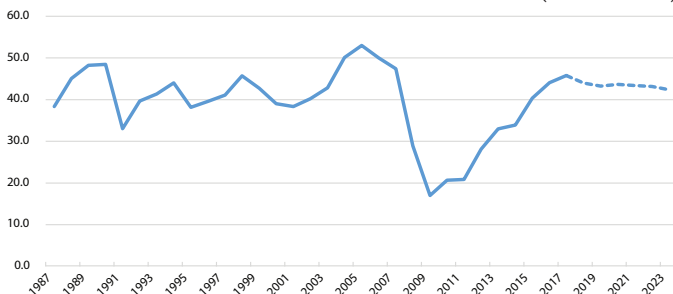
Source: U.S. Decennial Census
2000 & 2010



Housing Permits

Building permits provide the most widely used measure of housing construction activity. The number of issued housing permits in WA rose and fell, largely depending on economic growth factors. After a sharp decline in 2007, the number of permits began to recover gradually from 2009, and in 2015 it returned to the level of issuance before 2007. The region issued permits for a net total of 45.8 thousands housing units in 2017, an increase of 13 percent since 2015.

Trends and Projections of Issued Housing Permits
(thousands)



Source: WA Office of Financial Management. 2017 Data Book.
WA Economic and Revenue Forecast Council. Preliminary Economic Forecast. March, 2019.

The real estate market has been thriving in Washington, and especially in Seattle. Between 2015 and 2018 Seattle market saw an average 15.8% increase in median home sale price [1]. King County housing prices are also high, rising 19.8% from 2015, while the number of available homes is down nearly 30% [2]. Yet in a sign that the housing market may be turning, seasonally adjusted Seattle area home prices fell 1.0% in August of 2018, following a 0.1% decline in July, according to the S&P/-Case-Shiller Home Price Indices [3]. Economic and Revenue Forecast Council indicated that the market in WA is beginning to “slow down” in the coming four years, meaning housing stocks will rise and prices will slowly drop.

Shoreline Permits

In efforts to stave off coastal erosion, Americans have built thousands of shoreline structures to armor the nation’s coastline. Shoreline structures displace sandy beach, limit both lateral and vertical access to the beach, and disrupt the natural flow of sand [4]. As part of a statewide inventory of saltwater shorelines, scientists at the Washington Department of Fish and Wildlife found that approximately one third of all saltwater shorelines in Puget Sound have some kind of shoreline modification structure, such as a bulkhead or seawall [5].

Housing Affordability

The Housing Opportunity Index (HOI), created by the National Association of Home Builders, is a measure of the percentage of new and existing homes sold in an area that a family earning the median income in that area can afford to buy. The Seattle-Bellevue-Everett area had HOIs below the national average (56.6) in the fourth quarter of 2018 with index value of 36.8, ranking 206th in the country [6].

Note

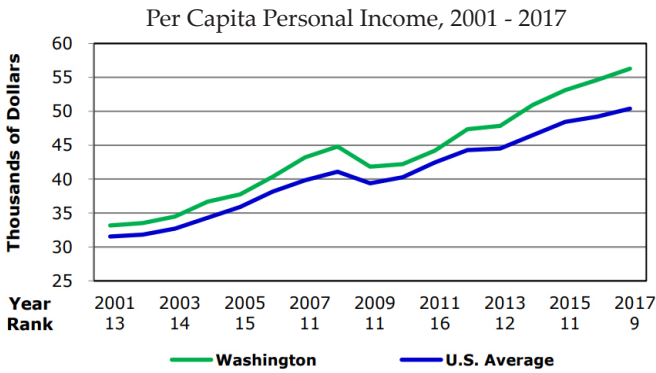
- Part of the text and images for this document were taken directly from
1. Zillow. Seattle Home Prices & Values. <https://www.zillow.com/seattle-wa/home-values/>. Accessed on 2-27-2019.
 2. Russo, M., Alberti, M. 2016. Puget Sound Trends: A Synthesis of the Drivers Shaping the Future of our Waters. Urban Ecology Research Lab, University of Washington, Seattle.
 3. WA Economic and Revenue Forecast Council. November 2018 Revenue Review Meeting Handout.
 4. Surfrider Foundation. State of the Beach Report Card 2018.
 5. Johannessen, J., A. MacLennan, A. Blue, J. Waggoner, S. Williams, W. Gerstel, R. Barnard, R. Carman, and H. Shipman, 2014. Marine Shoreline Design Guidelines. Washington Department of Fish and Wildlife, Olympia, Washington.
 6. National Association of Home Builders. Housing Opportunity Index (HOI). <https://www.nahb.org/en/research/housing-economics/housing-in-dexes/housing-opportunity-index.aspx>. Accessed on 2-27-2019.

ECONOMY

Employment and Wages

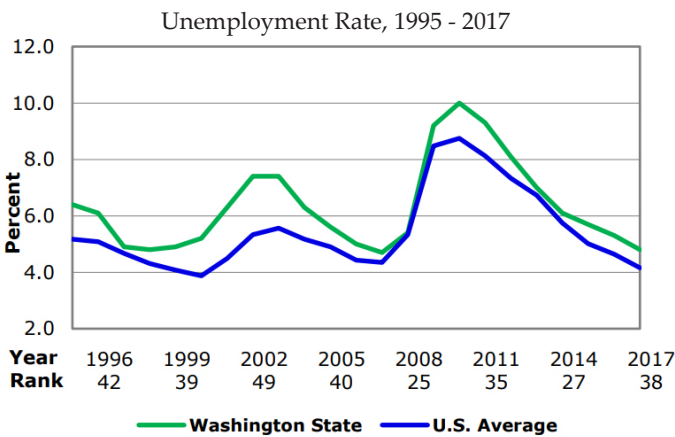
Economic trends, including employment, industry sectors, income and GDP, and trade/exports, function as a dominant driver in the metropolitan area, and globally. The ratio of high wage jobs to total jobs in Washington State is 41.7%, averaged over the past 5 years. It has exceeded the national average since 2007, and has been increasing since 2012 [1]. The above average growth in the high wage share can be attributed to information technology, construction, and aerospace.

- In 2017, per capita personal income in Washington was \$56,283. This is about \$6,000 more than the U.S. average of \$50,392.
- Boeing and Amazon directly and indirectly account for more than 40% of the jobs created in the Puget Sound region in the last five years [2].



Source: Washington State Economic Climate Study 2018.

- Washington's unemployment rate has declined from 9.9% in 2010 to 4.8% in 2017. This is the lowest it has been since the recession. However, Washington's unemployment rate has always been above the U.S. average. In 2017, the U.S. average was 4.2%.

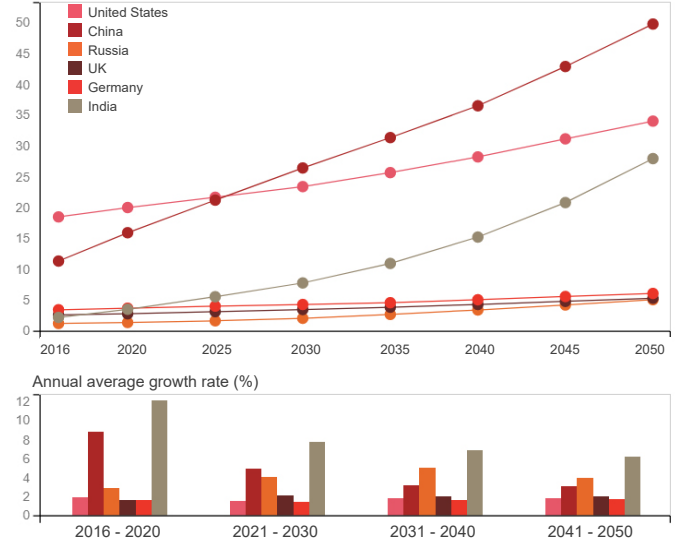


Source: Washington State Economic Climate Study 2018.

Gross Domestic Product (GDP)

GDP is the total value of goods and services produced by a nation. In 1991, GDP became the US Government's primary measure of economic activity.

GDP Projections (US \$ trillions), 2016 to 2050



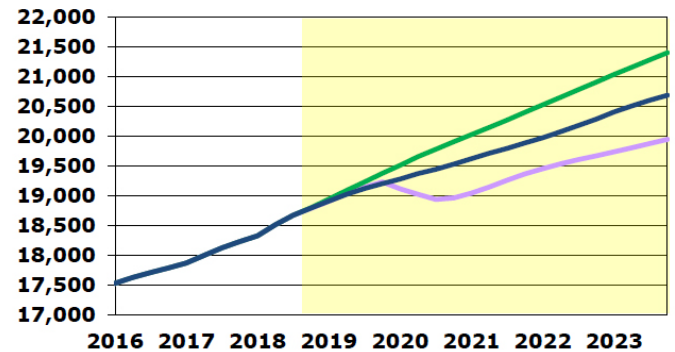
Source: World in 2050. Pwc, 2017.

In 2017, 51% of the Pacific Northwest's economic output comes from Washington State. Washington's economy is the thirteenth largest in the United States [3].

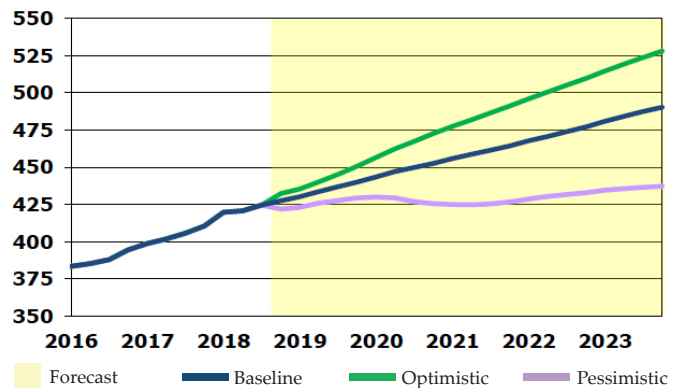
Projected Forecasts

Washington's Economic and Revenue Forecast Council developed three economic forecasts (optimistic, pessimistic, and baseline). In graphs below, the nation's GDP, and total personal income in Washington state is projected quarterly for all three scenarios [4].

Comparison of Alternative Forecasts, U.S.
Real GDP, Billions of 2012 Dollars



Comparison of Alternative Forecasts, WA
Real Personal Income, Billions of 2012 Dollars



Source: Washington Economic and Revenue Forecast, November 2018.

Pessimistic Forecast

- Real GDP declines 1.5% in a recession. The unemployment rate climbs through most of 2019 and 2020, reaching a high of 5.2% in the fourth quarter of 2020.
- Rising prices have left the real-estate market vulnerable, and this market's growth has been slowing. The slowdown turns into a decline, as real estate prices correct and confidence plunges.
- Aerospace employment resumes its decline. Software employment also declines rather than growing moderately as in the baseline forecast. Construction employment peaks in the fourth quarter of 2018 rather than rising through the fourth quarter of 2019 as in the baseline.
- By the end of 2023, Washington nonfarm payroll employment is 186,900 (5.2%) lower than in the baseline forecast and Washington personal income is \$63.0 billion (10.7%) lower.

Optimistic Forecast

- The optimistic forecast assumes productivity rises at an annual average rate of 2.6%. Wages grow more quickly as a result.
- Thanks to improved finances and higher employment, household formation accelerates. This spurs a sharp rise in housing starts, which peak at 1.67 million.
- Aerospace employment gradually rises through 2023. Software employment growth is also much stronger than in the baseline forecast. Construction employment continues to rise throughout the forecast rather than peaking in the fourth quarter of 2019 as in the baseline.
- By the end of 2023, Washington nonfarm payroll employment is higher by 82,800 jobs (2.3%) than in the baseline forecast and Washington personal income is \$48.8 billion (8.3%) higher rather than rising through the fourth quarter of 2019 as in the baseline.

Innovation and New Job Creation

The U.S. remains the leading performer of R&D by the highest amount of investment, ranking first on the total expenditures on R&D. Since 2014, the nation's investment has accounted for more than 26% of the total global R&D spending [5].

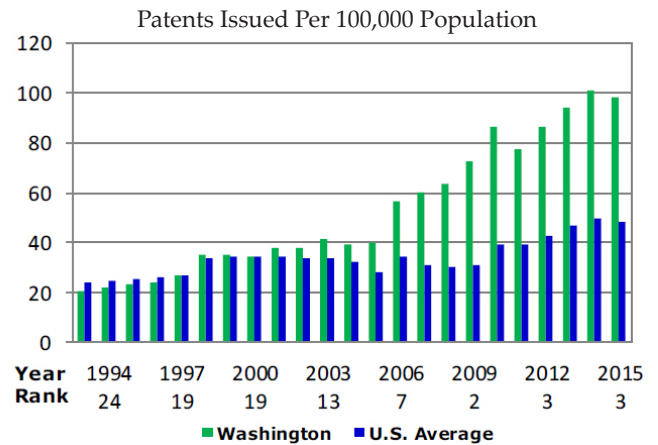
In 2016, Washington's rank in university R&D spending improved to 16th in the nation. In 2016, Washington universities spent \$226 per capita in R&D. Washington remained above the U.S. average of \$220 for the sixth year in a row.

As for industry R&D, Washington ranks 5th in the nation. Washington has kept this ranking for 3 years in a row. The five year average for Washington State is \$2,194, well above the 5 year average of \$1,023.

In 2016, the Washington state government spent \$4.83

per capita for R&D. Government spending in Washington on R&D has been lower than the U.S. average for 3 years. The 5 year average for Washington is \$5.97, and the U.S. average is \$6.58.

Patents are a good measure of actual innovation. In 2015, Washington had 98.2 patents issued per 100,000 residents. The state's patent issue rate is more than twice the national rate of 48.5, ranking the state 3rd in the nation. The two other states outperforming Washington are California (111.4) and Massachusetts (106.5).



Source: Washington State Economic Climate Study 2018.

Trade

Washington's foreign exports were 18.33% of personal income in 2017, well above the national average of 4.51%. Washington's perennially strong performance in this category is due mainly to the presence of Boeing and PACCAR, two of the world's leading manufacturers of commercial aircraft and trucks, respectively. Yet it only includes trade in goods, ignoring trade in service exports, which are difficult to track and credit to specific states. As software giant Microsoft contributes greatly to state personal income while the majority of its exports are not included in the trade data, the measure of Washington exports as a percent of personal income understates the contribution of trade to Washington's economy.

Note

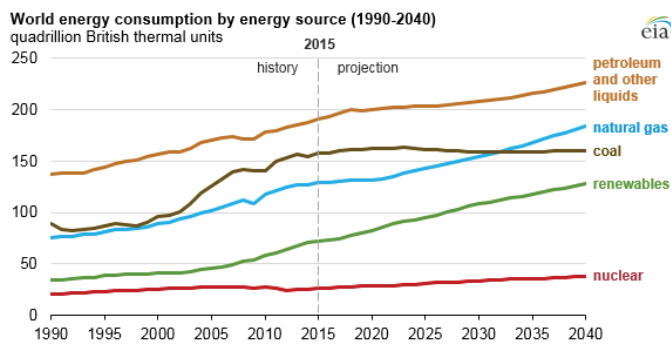
Part of the text and images for this document were taken directly from

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2. Russo, M., Alberti, M. 2016. Puget Sound Trends: A Synthesis of the Drivers Shaping the Future of our Waters. Urban Ecology Research Lab, University of Washington, Seattle.
3. Bureau of Economic Analysis. 2018. Gross Domestic Product by State, Third Quarter 2018
4. WA Economic and Revenue Forecast Council. November 2018 Washington State Economic and Revenue Forecast.
5. Industrial Research Institute. Winter 2016. 2016 Global R&D Funding Forecast. A supplement to R&D Magazine.

INFRASTRUCTURE & TECHNOLOGY

Energy

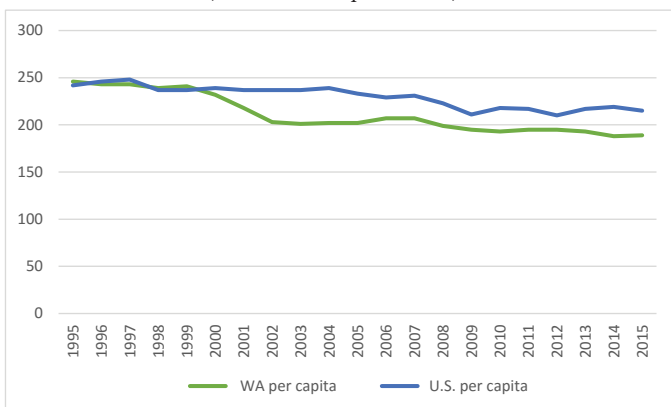
The future of our energy supply will witness a decrease in the use of non-renewable resources such as coal, and an increase in natural gas and renewable resources such as solar power as well as nuclear power. What is rather uncertain is what technology will be used, and how quickly we will transition.



Source: U.S. Energy Information Administration (EIA), 2017.

Washington is the nation's largest producer of hydroelectric power, and routinely accounts for 25% of the nation's annual hydroelectricity generation. It also ranks second in the nation, after California, in the amount of electricity generated from renewable resources [1]. However, hydropower has largely reached its maximum potential and no new large projects are expected to be built. Wind energy is forecasted to grow in importance, with Puget Sound Energy (PSE) already ranked as the second-largest wind power utility producer in the US [2].

Energy Consumption per capita, WA
(Million BTUs, per Person)

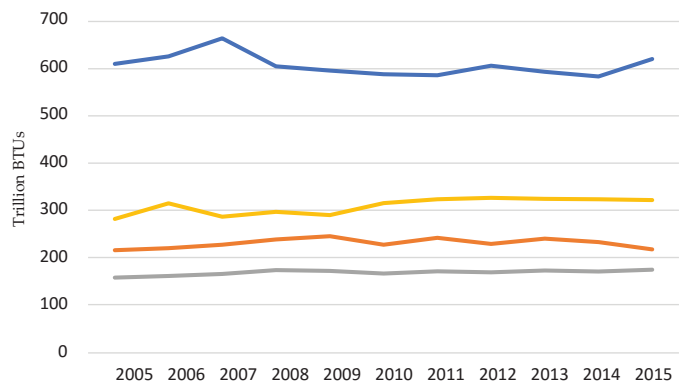


Source: Washington State Data Book 2017.

Per capita energy consumption in Washington is well below the national average after 2000 [3]. The residential sector accounts for 1/5 of the state's total energy, and low household usage corresponds with mild weather patterns. Transportation continues to account for the

largest portion of energy, almost 1/3 of end-use energy consumption in the state, while the industrial sector accounts for more than 1/4 and the commercial sector accounts for 1/5.

Energy Consumption by Sector, WA



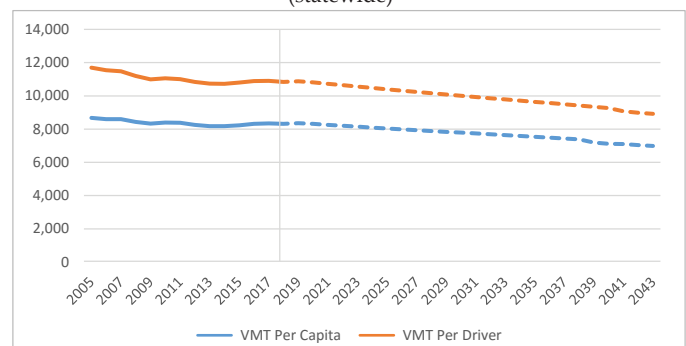
Source: Washington State Data Book 2017.

Transportation

The majority of energy goes into transportation in this region. Gasoline accounts for more than half of the transportation sectors' energy use [2]. Since Washington produces virtually no natural gas, virtually every dollar the region spends on oil and gas leaves the region's economy.

Not only on energy expenditure, our transportation system also influences our time spent in traffic. In 2000, the mean commuting time in Seattle metropolitan area was 26.5 minutes. In 2017, people on average spent 30.7 minutes on road [4]. Nationally, Seattle ranks 6th as one of the most congested urban areas in the U.S. The cost of congestion is \$1,932 per driver [5].

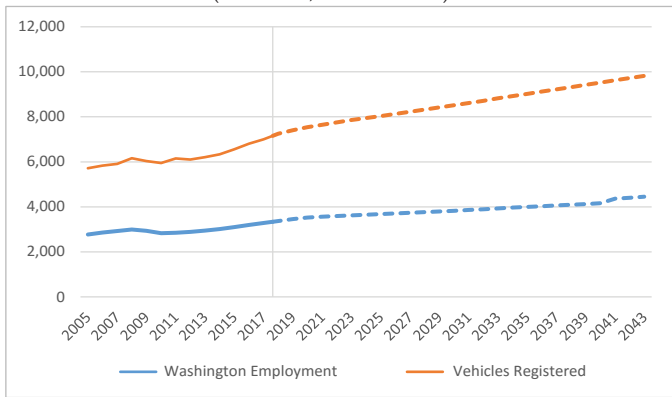
Vehicle Miles Travel (VMT) per capita Forecast
(statewide)



Source: WA OFM, September 2018 Transportation Revenue Forecasts

- VMT history from 1966 through 1990 shows growth averaging 4.5% per year, while from 2002 to 2017 it shows an averaged growth of 0.81% per year. For a long-term increase in VMT between 2020-2043, the projected average annual growth rate is 0.24% [6].
- Travel demands are projected to increase (1.5 million more people in the Central Puget Sound by 2040, supporting about 1.2 million new jobs) [2].

Registered Vehicles Forecast (statewide, in thousands)



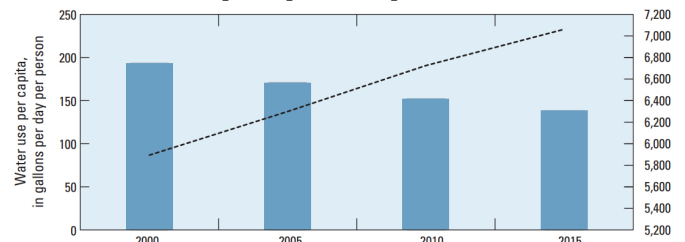
Source: WA OFM, September 2018 Transportation Revenue Forecasts

The future of transportation may radically surprise us and change the way we move through the region: future innovations are expected to dramatically alter the way we move through the city. We are already seeing the use of smart media to more efficiently manage networks – from Uber rides and highway congestion control. In the near future, we may see driverless cars and hovercrafts making what was once science fiction a reality [7].

Water

As the regional population grows, our demand for water services will increase. Increasing temperatures and decreased summer flows could make it more difficult for water suppliers to meet the needs of consumers and in-stream flow requirements, especially in snowmelt-fed watersheds. During the summer, naturally occurring low streamflows, low precipitation, and higher temperatures cause the demand for municipal and industrial water to increase, sometimes exceeding what is available in streams and rivers.

Water Use per capita vs Population Trend, WA



Source: USGS, Water Use in Washington, 2015

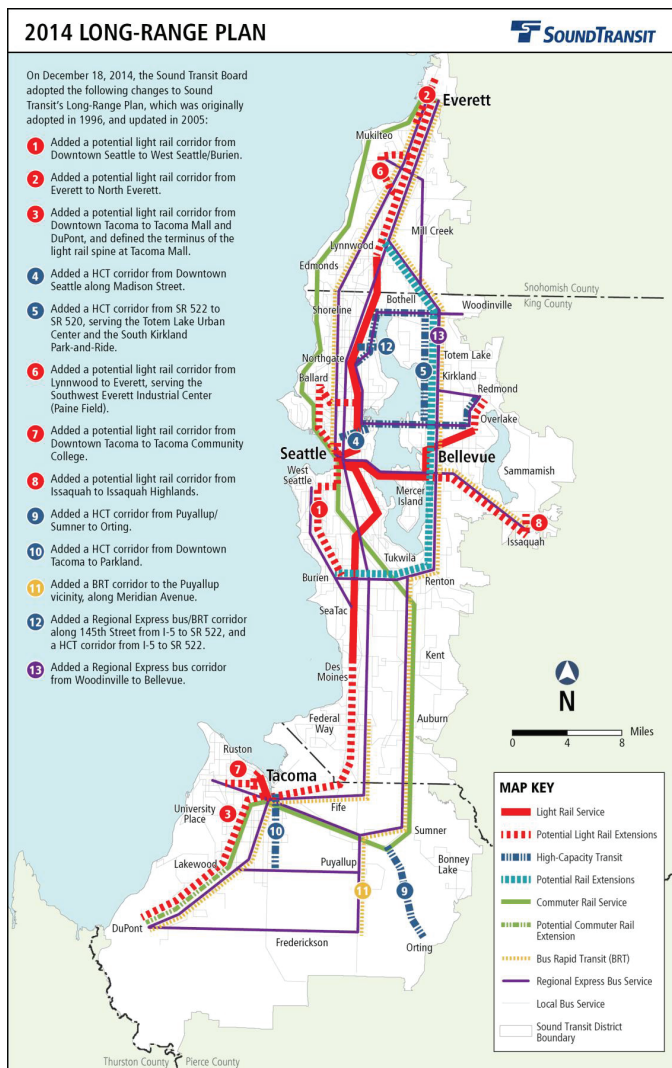
- Population has increased since 2000, however the total amount of water used per capita has decreased during the same time [8].

Waste

Waste generation directly correlates with economic cycles – i.e. the more we make the more we waste. However, waste prevention programs, especially in Seattle, are reducing the percentage of waste that ends up in the landfill. Seattle has one of the country’s best recycling programs, with single family households recycling over 70% of their waste. In addition to recycling, Seattle is focusing on “pre-cycling” – reducing the amount of waste produced in the first place, utilizing composting, reuse, and product stewardship. Despite these advancement, between 2015 and 2016 Seattleites increased their per capita waste generation by ~2.8%. Seattle’s model to estimate future waste generation (the Seattle Discards Model) forecasts a gradual increase in the generation of waste out to 2030 [2].

Note

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- EIA. Washington State Profile and Energy Estimates. 2018. Access on 03/05/2019. <https://www.eia.gov/state/analysis.php?sid=WA#53>
 - Russo, M., Alberti, M. 2016. Puget Sound Trends: A Synthesis of the Drivers Shaping the Future of our Waters. Urban Ecology Research Lab, University of Washington, Seattle.
 - WA Office of Financial Management. Washington State Data Book, 2017.
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 - WA Transportation Revenue Forecast Council. September 2018 Transportation Economic and Revenue Forecasts.
 - Bogost, I. May 2016. When Cars Fly: How driverless vehicles could change meetings, manufacturing, safety, and more. Atlantic. Access on 03/05/2019. <http://www.theatlantic.com/magazine/archive/2016/05/when-cars-fly/476382/>
 - USGS, Water Use in Washington, 2015.



Source: Sound Transit Regional Transit Long-Range Plan, 2014

PUBLIC HEALTH & FOOD SECURITY

State Health Index

The United Health Group State Health Rankings provide a composite indicator, by state, that measures the relative healthiness of each state and the general health of the population in the United States. Rankings are based on states' performance in four components: personal behavior, community environment, health policies and outcomes. The state health index is simply the percentage a state is above or below the national average. Washington's health index worsened to 0.52 in 2017. Although it worsened, Washington still ranks high amongst the other states. The five year average for the index is 0.48, ranking 10th amongst the other states. According to the United Health Foundation, Washington's strengths were: low prevalence of smoking, low preventable hospitalization rate, low prevalence of low birthrate. Washington's challenges were high incidence of pertussis, low meningococcal immunization coverage among adolescents, large disparity in health status by educational attainment [1].

Reported Communicable Diseases

Communicable diseases include infections that can be transmitted person to person, by direct contact with individual's discharges, or by indirect means (i.e. a vector). The most common case reports continued to be sexually transmitted conditions, chronic hepatitis, infections caused by enteric pathogens, pertussis, and tuberculosis. Then number of newly diagnosed HIV cases in Washington State remains stable at roughly 450 cases per year [2].

Total Deaths by Selected Age Groups

Throughout the human lifetime different dangers constitute the leading cause of death. In Washington State accidents remained the leading cause of death for people between the age of 1 and 44, between 2013 - 2015. For babies under one year old, congenital malformations remained the number one cause of death. For 45-84 year olds malignant neoplasms and heart disease ranked at the first and second cause of death, respectively, between 2010 - 2015. Lastly, for ages 85 and over, diseases of the heart and Alzheimer's Disease were the top two causes. Over the total population, Malignant Neoplasms, Diseases of the Heart and Alzheimer's Disease have been the top three causes of death, since 2007 [3].

Cancer Rate

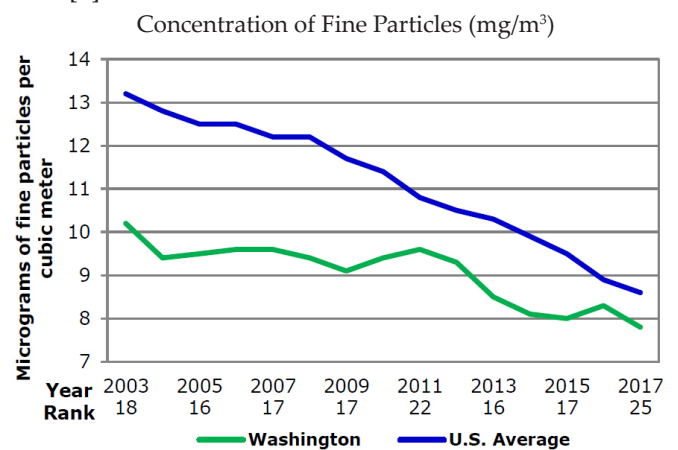
The rate of cancer incidence is 179.3 per 100,000 population, in 2015 [3]. For all cancers combined, age-adjusted mortality rates increased from 1980 to 1993, but since 1993, the trend has been downward. Improvements in cancer treatments, early detection, and the decline in tobacco use have likely contributed to the overall decline [4].

Public Health Program Expenditures

State spending on health services has been increasing rapidly. In 2007, the state spent an estimated \$4.5 billion on health care, up from \$2.7 billion in 2000. Health care, including employee health insurance and medical assistance, is now over 20% of the State's general fund budget [4].

Air Quality Measures

Air quality is measured by the amount of micrograms of fine particles per cubic meter in the air we breathe. The United Health Foundation measures air pollution by particulate matter of 2.5 microns and smaller. The smaller particles are, the more risk there is for health problems. Particulate matter of 2.5 microns or less is known as fine particulate, which is found in smoke and haze [1].

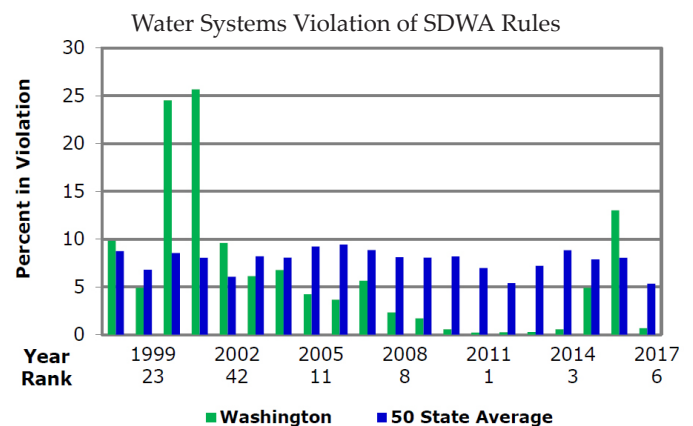


Source: Washington State Economic Climate Study 2018.

- Washington's five-year average was 8.1 micrograms, and had a ranking of 19th in the nation.

Drinking Water

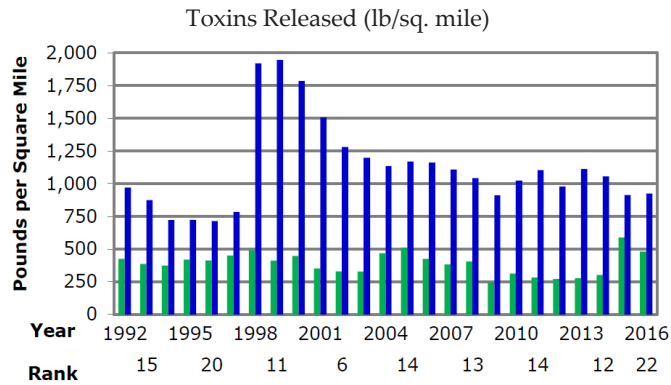
Public water systems must abide by the standards established by the Environmental Protection Agency (EPA) under the federal Safe Drinking Water Act (SDWA). The EPA annually reports the number of systems whose water has violated SDWA standards and the total number of people served by these systems. The chart below indicates the percentage of WA's population served by a water system that is in violation of SDWA rules.



Source: Washington State Economic Climate Study 2018.

Toxins Released

The Toxics Release Inventory (TRI), reported by the U.S. EPA, provides the public with information concerning the amounts of toxic chemical releases from industrial facilities. Starting in 1994, federal facilities began to report to TRI and in 1998 seven additional industries were added to the required report list. This is the basis for the dramatic increases in the national average for toxins released in 1998 and beyond.



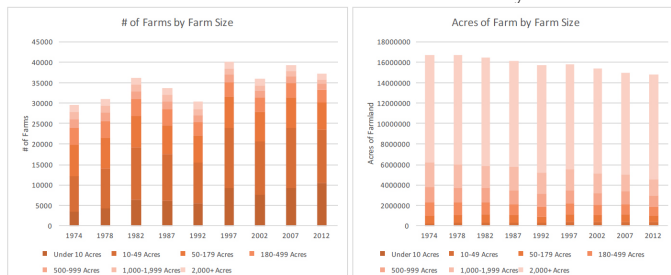
Source: Washington State Economic Climate Study 2018.

- In 2016, U.S. industries reported a 1.35 percent increase in their total releases of toxics, from 3.39 billion to 3.44 billion. This figure includes effluent releases directly into the air, water or land, whether it is on-site or off-site landfills, surface impoundments, land treatment facilities, or underground injection wells.
- Washington's five-year average is 383 pounds per square mile, and the U.S. average in that same period is 997. Washington's five year average ranking is 18th in the nation.

Food Security

Food security refers to the state in which one can obtain a nutritionally adequate and culturally acceptable diet at all times through non-emergency sources, including food from local production. Food security reaches beyond the traditional concept of hunger by including poverty issues with a systemic view of the causes of hunger and poor nutrition as well as identifying the changes needed to prevent their occurrence.

Shift in number of farms and acres of farm by farm size



Source: Puget Sound Trends, 2016. USDA, 2012

- Overall the number of farms has kept steady, but the total acres of farm and the size of farms have both declined.

- According to the agriculture census, between 2002 and 2012 Washington lost nearly 569,901 acres of farmland. The average farm size has decreased 30 acres, from 436 to 396 acres.
- Seattle Metropolitan Area has 4,753 farms in 2012, accounting for 13% of the state's total number of farms, but only 1% of state farm land. The average farm land is 35 acres, less than 1/10 of the state average [5].

Shellfish

Puget Sound is one of the largest shellfish producing regions in the United States. Puget Sound shellfish are vulnerable to contamination by the toxics produced by harmful algal blooms. Toxic blooms can lead to closure of commercial and recreational shellfish beds to protect the public against paralytic shellfish poisoning (PSP), a potentially fatal illness caused by eating contaminated shellfish, and domoic acid poisoning (DAP), which can cause temporary or permanent memory loss [6].

- Washington is currently the leading U.S. producer of farmed bivalves and its wild harvest shellfishery is valued at over \$40 million, in 2014.
- Between 2005 and 2014 the industry value from shellfish has more than doubled, while the value from salmon, sturgeon and steelhead, and other marine fish remained pretty stable, increasing slightly [4].
- However, concentrations of toxins in Puget Sound shellfish and the geographical scope of shellfish closures have increased over the past four-to five decades.
- As climate is projected to result in warmer temperatures, loss of coastal habitat, ocean acidification, and changes in water quality and freshwater input with differential effects on different organisms. Shellfish is likely to be negatively affected by these changes.

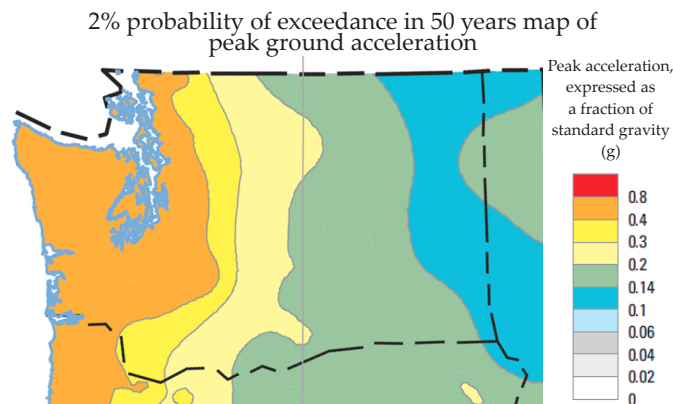
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 3. WA Department of Health. Death Data, 1968 - 2015. <https://www.doh.wa.gov/DataandStatisticalReports/HealthStatistics/Death>. Accessed on 3/1/2019.
 4. Russo, M., Alberti, M. 2016. Puget Sound Trends: A Synthesis of the Drivers Shaping the Future of our Waters. Urban Ecology Research Lab, University of Washington, Seattle.
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 7. USDA, Census of Agriculture, 2002 & 2012. County Summary Highlights.
 8. Snover, A.K., Mote, P.W., Whitley Binder, L.C., Hamlet, A.F., Mantua, N.J. 2005. Uncertain Future: Climate Change and Its Effects on Puget Sound. Climate Impacts Group, Center for Science in the Earth System, Joint Institute for the Study of the Atmosphere and Oceans, University of Washington.

Natural & Manmade Hazards

Earthquakes

The State of Washington is at a collision boundary between two tectonic plates. The Puget Sound region is vulnerable to earthquakes from three types of sources: deep in the subducting plate (Benioff), between the colliding plates, and in the overriding crustal plate. Research has found evidence of prehistoric earthquakes along the outer coast of Washington having magnitudes of 8 to 9.5. There are thousands of earthquakes in Washington State every year, but most are too small to be felt. There have been 15 earthquakes greater than M5 since 1870 [1].



Source: U.S. Geological Survey, 2014 Long-term Model of National Seismic Hazard

The bulk of potential damage from a major earthquake in developed regions would come from building collapse, landslides, liquefaction, or fires. Casualties from an urban earthquake could exceed 1,000 people and economic damage could easily run into billions of dollars [2].

Volcanic Eruptions

There are five active volcanoes in Washington State - Mount Baker, Glacier Peak, Mount Rainier, Mount St. Helens, and Mount Adams. Mt. Rainier and Glacier Peak pose the most significant hazard to the residents of the Puget Sound region. Ashfall from Glacier Peak eruptions (6 in the last 3000 years) have been some of the heaviest in the Pacific Northwest. Heavy ashfall can damage infrastructure and cost millions of dollars to clean up. This is of particular concern for Whatcom County and nearby communities. Lahars - huge mudflows of volcanic ash and debris - are the greatest threat to Pierce County communities below Mt. Rainier. Future lahars will follow river valleys that drain Mount Rainier. Four of the five major river systems flow westward into suburban areas of Pierce County [3]. In King County, almost 10 percent of the county population and less than 5 percent of the population in Snohomish County reside within the lahar hazard zone [1]. Scientists believe there is a one in seven chance that a lahar will reach the Puget Sound lowland in the average human lifespan, assuming future lahars occur at rates similar to those of previous lahars [4].

Tsunamis

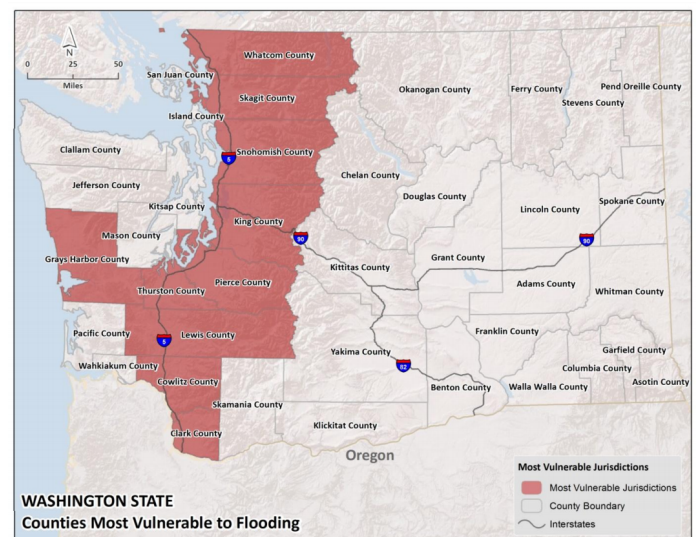
Tsunamis are triggered by earthquakes or large landslides. They contain a high amount of energy and travel as fast as airliners, pushing water far inland with significant force when they hit land. Usually an earthquake must be large (magnitude 7.0 or over) and shallow to cause a dangerous tsunami. There is evidence that an earthquake along the Seattle Fault produced a tsunami and could do so again. Geologic evidence shows an earthquake in A.D. 900-930 on the Seattle Fault caused a tsunami in central Puget Sound.

Drought and Water Shortage

Unlike many hazards, droughts and water shortages occur slowly over time. Since 2000, the longest duration of drought (D1. Moderate Drought - D4. Exceptional Drought) in Washington lasted 116 weeks beginning on January 7, 2014 and ending on March 22, 2016. The most intense period of drought occurred the week of August 25, 2015 where D3. Extreme Drought affected 84.64% of Washington land [5].

Floods

There have been 28 Presidential Major Disaster Declarations for floods in Washington State from 1953 through 2018. Many rivers in Western Washington typically flood every two to five years, with damaging flood events occurring less frequently [6]. Floods generally occur in late fall and winter as a result of prolonged rainstorms. These floods may be augmented by water from snowmelt [1]. Urban development effects flooding through removal of vegetation and soil, surface grading, and channelizing drainage networks.



Source: Washington State Enhanced Hazard Mitigation Plan. 2013. Hazard Profile - Flood.

Landslides

Landslides are a common and frequent problem in many areas of the Puget Sound region, being triggered

by other hazards, such as severe storms (rainfall events) and earthquakes, as well as slope modifications from development. Most slides are small enough that they do not create large-scale problems, but occasionally conditions trigger slides throughout the region within a short period of time.

Civil Disorder

Civil disorder is a public disturbance by a group or groups of people involving acts of violence that cause immediate danger, damage or injury to others or their property. While Seattle is the central stage for political and social activity in the Puget Sound region and the hub of the region's social activities, this condition makes social unrest more likely to occur in Seattle than elsewhere in the region. Incidents can shut down large areas of the City, lead to fatalities and injuries, and cause property damage. Most incidents occur in the downtown area, Capitol Hill and the University District [7].

Hazardous Material Incidents

A hazardous material incident could occur as a result of an intentional or accidental release of toxic, combustible, illegal or dangerous nuclear, biological or chemical agents into the environment. As the transport of hazardous materials increases so do associated risks.

Terrorism

The terrorist threat in Seattle comes from multiple sources. Al Qaeda and related jihadism, the extreme right and radical environmentalism have been the most frequent causes. Recent attacks include the 2001 earth Liberation Front attack on the University of Washington's Center for Urban Horticulture, and Ressay smuggling bomb making material into the country through Washington State in 1999. The 2001 attacks on the World Trade Center and the Pentagon brought heightened awareness of the possibility that any large city like Seattle could become a target. The 2006 attack on the Jewish Federation of Greater Seattle was a recent reminder of our vulnerability to terrorism in Seattle [7].

War as a driver

"War acts as both a direct and an indirect driver of change in ecosystem services and human well-being, as nature becomes the intended victim of 'collateral damage'.

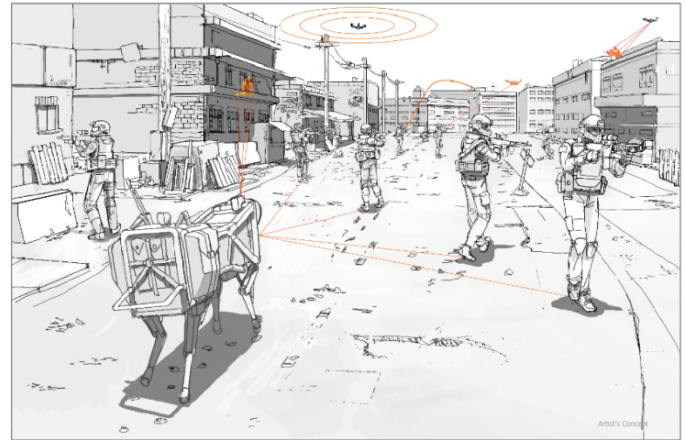
Environmental effects of warfare include damage to animals, defoliation, destruction of flora, degradation of soil, and loss of biodiversity (Pendersen 2002).

Modern warfare, however, has had particularly severe impacts. In the first Gulf War in 1991, Iraq released about 2 million barrels of oil into the Persian Gulf and ignited 736 Kuwaiti oil wells, spreading clouds of black soot throughout the Middle East and the surrounding regions.

Since the fall of the Soviet Union, the danger of nuclear weapons has become a serious threat. It is estimated that a large-scale nuclear war could result in more than 1 billion deaths and injury of an equal number of people due to the

combined effects of blast, fire, and radiation (Ehrlich et al. 1983)." [8]

Squad X Program - Human And Machine Collaboration



Source: DARPA. 2016. Squad X Experimentation Program.

Department of Defense Spending

In 2015 the US military expenditure was \$598.5 billion, which accounted for 54% of the United States' federal discretionary spending. This budget does not include military related items such as weapons research, maintenance and production. In February 2018, the Pentagon requested \$686 billion for FY 2019 [9].

Military Facilities in the Puget Sound

The State of Washington hosts six major military installations. In addition, the U.S. Coast Guard, two Department of Energy facilities, and the Applied Physics Laboratory at University of Washington (APL-UW) have cooperated very closely with the Department of Defense. These major facilities are the work sites for nearly 95,079 military and civilian personnel. The military and defense community supported over \$15 billion dollars in annual procurement, supported by over 1,900 businesses across the state, which represented nearly 4% of the state's GDP [10].

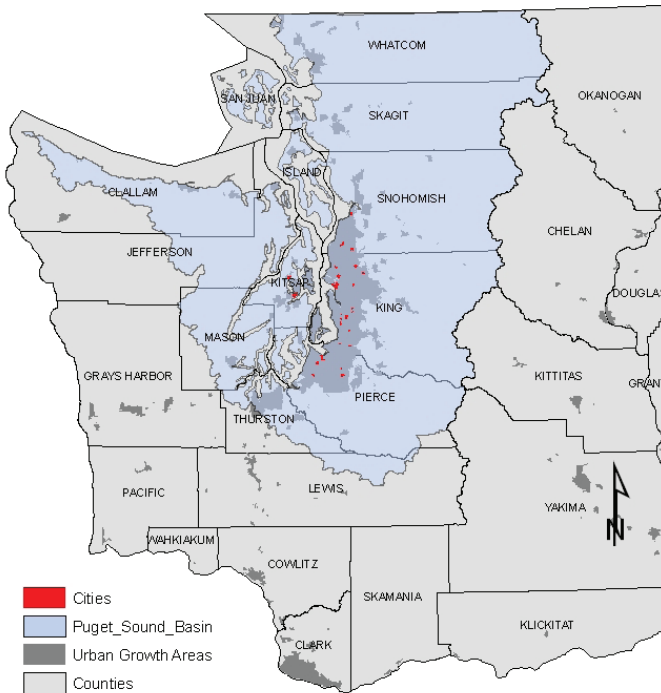
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Jurisdictional control / relationships

There are many areas of overlap between state and federal jurisdictions. The federal government has assumed more responsibility in recent years on issues of health, education, welfare, transportation, and housing and urban development. Jurisdictions often must work together because political boundaries do not coincide with eco-regions or watersheds of the Puget Sound region. This applies to local governments, as well as cross-border relationships with Canada.

Overlapping Units of Government



Source: Urban Ecology Research Laboratory 2006

Core Based Statistical Areas (CBSAs) consist of the county or counties associated with at least one core (urbanized area or urban cluster) of at least 10,000 population, plus adjacent counties having a high degree of social and economic integration with the core, as measured through commuting ties with that core [5]. It became effective in 2003 to refer metropolitan and micropolitan statistical areas collectively. Seattle metropolitan area consists of three counties - King County, Snohomish County and Pierce County.

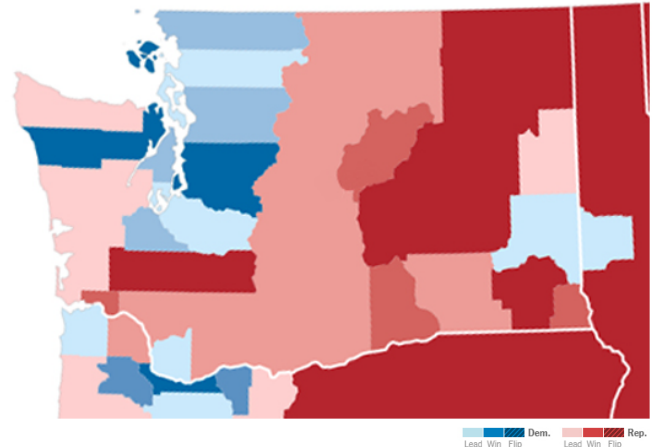
Regulations

Regulation refers to the means in which governments control something by rule, as opposed to prohibition. There are many approaches to regulation including incentives vs. punishments, cohesive vs. fragmented, centralized vs. decentralized, implicit costs or explicit costs, or standards vs. goals. There are many regulations that impact the Seattle metropolitan area across all jurisdictions. The efficacy of such regulations is often tied to the funding and resources available to the agency responsible for administration and enforcement.

Political Leadership

Political leadership can be conceptualized as the leadership through elected representatives (and their appointees) and the political will of citizens and residents. Seattle's politics lean famously to the left compared to the U.S. as a whole, dominated by the liberal wing of the Democratic Party[3, 6]. The outcomes of elections at all levels of government affect who is in charge of policy and budget decisions, which can impact regulatory and socio-economic conditions.

2016 Election Results by Washington Counties



Source: The New York Times. Retrieved 03/07/2019.
<https://www.nytimes.com/elections/2016/results/president>

Political will refers to a commitment to implement something, often a change. Political will can be a characteristic of political representatives and in reference to regulations, but it is more importantly a characteristic of citizens and demand for changes in norms and behavior.

“Each of the great social achievements of recent decades has come about not because of government proclamations but because people organized, made demands and made it good politics for governments to respond. It is the political will of the people that makes and sustains the political will of governments.” -- James Grant, the third Executive Director of UNICEF.

Note

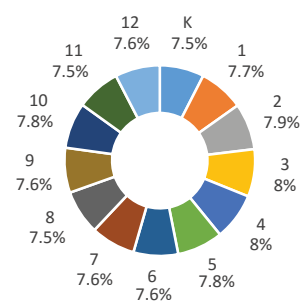
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Knowledge & Information

K-12 Education Enrollment

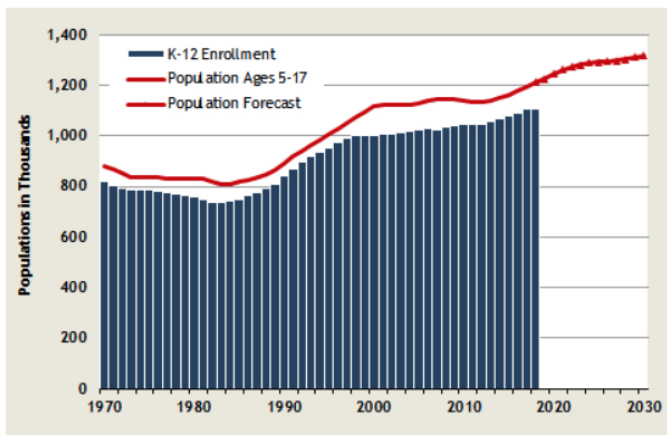
In 2016, 1,079,546 children attended the public K-12 education system in Washington State, and 73,300 enrolled in private K-12 schools. Public K-12 enrollment per grade are evenly distributed, with the most in 3rd grade (86,847) and the least in 11th grade (80,627) [1].

Public K-12 Schools Headcount Enrollment by Grade



Source: Washington State Data Book 2017

K-12 Enrollment, Washington State



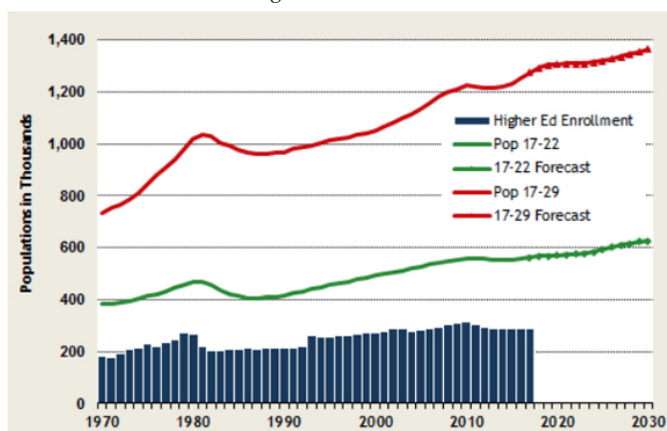
Source: OFM, Washington Trends. 2019.

- 2030 projections forecast that enrollment will continue to increase in the future.
- The number of school-age children increased an average of 10,900 per year between 2012 and 2018 [2].

Higher Education Enrollment

- Demographic pressures on higher education have been strong since the children of Baby Boomers reached college age.
- A flattening of prime college-age populations will encompass much of the 2010 - 2020 period, after which modest growth should resume.

Public Higher Education Enrollment

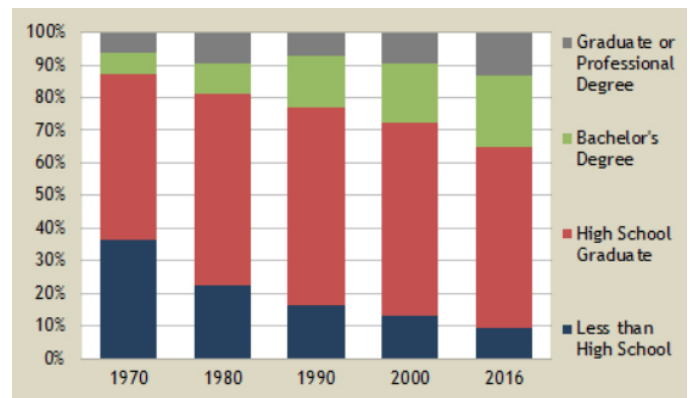


Source: OFM, Washington Trends. 2019.

Education Attainment

Companies infusing technology into their operations or products require an educated workforce. A high school education is necessary for most of these positions, but for many, it is not enough. Availability of a workforce with a higher education background is required in many cases for companies to realize the full potential of new innovations and technologies [3].

Education Attainment



Source: OFM, Washington Trends. 2019.

- In 2016, 90.8 percent of Washington residents age 25 and above were high school graduates or equivalent.
- Washington State experienced a 65.4 percent increase in its population with a bachelor's or higher degree between 2000 and 2016 [2].
- In 2016 Washington ranked 10th among the 50 states in the percentage of persons 25 years and over holding a bachelor's or higher degree [4].

Student - Teacher Ratios

In 2017, the nation's average value for number of enrolled students per teacher is 15.96, while Washington's value is 18.09. It is the 8th highest ratio among the states [5].

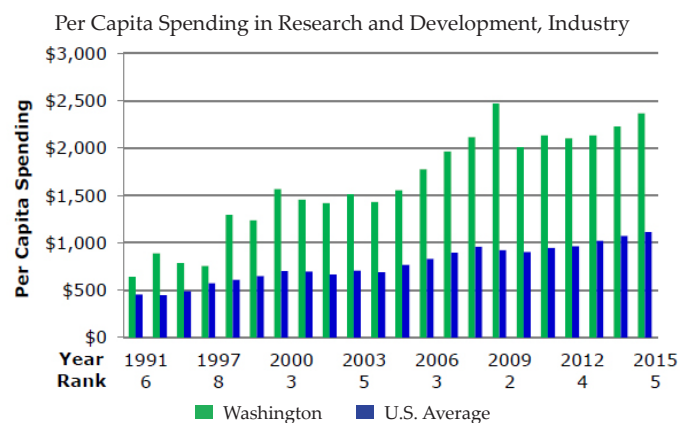
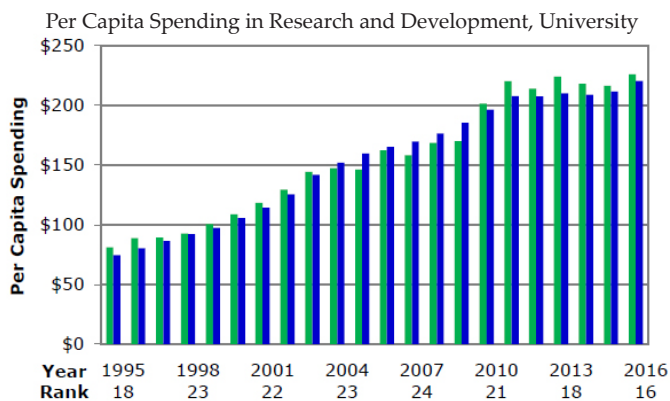
Funding

In 2000, Washington ranked 15th among the states in state and local government K-12 education spending per capita. In fiscal year 2016 Washington was ranked 16th [2].

The Division of Science Resources Studies (SRS) of the National Science Foundation annually compiles surveys of industries, universities, state government, and other agencies into a report titled National Patterns of Research and Development Resources [4].

- In 2016, Washington universities spent \$226 per capita in R&D. Washington remained above the U.S. average of \$220 for the sixth year in a row.
- For industry R&D, Washington ranks 5th in the nation. Washington has kept this ranking for 3 years in a row. Washington's industry R&D for 2015 was \$2,368 per capita.
- Government spending in Washington on R&D has been lower than the U.S. average for 3 years. The 5

year average for Washington is \$5.97, and the U.S. average is \$6.58.



Source: Washington State Economic Climate Study 2018.

Public Library Service

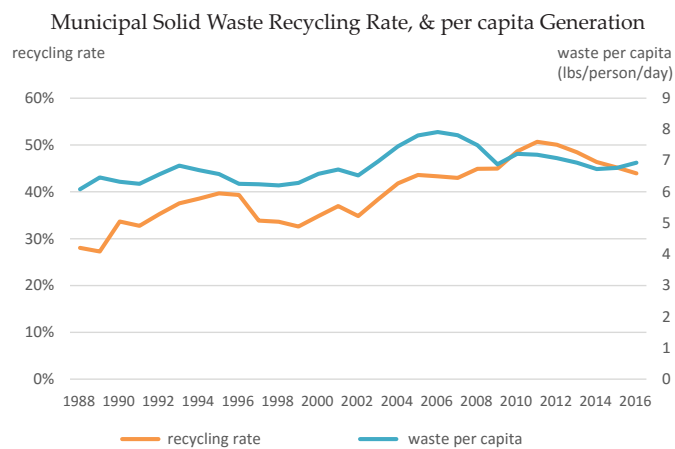
This indicator ranks public library service by measuring the amount of circulation (the checking out of any media such as books, videos, or musical recordings) per capita. These statistics are collected annually by the National Center for Educational Statistics (NCES). Washington has had excellent performance in this arena, ranking for the 3rd in the nation in 2016. The state's per capita circulation was 11.8, and the U.S. average was 7.1. Washington's average for 2012-2016 is also 11.8, and the U.S. average for that same period is 7.7 [4].

Environmental awareness

Environmental education programs try to change people's perceptions about the value of the natural world and to teach how to change environmental behaviors, such as getting people to recycle or how to build eco-friendly dwellings [6].

Environmental awareness was popularized after the first Earth Day in 1970. Education about the environment can come from formal academic institutions or the popular press and has spanned all aspects our lives. In Deborah Guber's book, *The Grassroots of a Green Revolution*, polling data is explored to understand America's environmental awareness, and their willingness to act upon what they learn. She suggests that Americans are more willing to buy green than to vote green; that rather than understanding the solutions we are 'greenwashed'

by symbols and buzzwords [7]. The North Central Regional Center for Rural Development has established 11 measurements for ecosystem knowledge and appreciation of the environment such as intergovernmental collaborations for environmental ends, local newspaper coverage of local environmental issues, number of pounds of trash recycled, etc.



Source: Washington Department of Ecology. Solid waste & recycling data. 2016

If recycling reflects ecosystem knowledge then Washington does have a good awareness as compared to the rest of the US; our 2015 recycling rate was 45.2% as compared to the national average of 34.7% [8]. The region has been a leader in sustainable development, from regional efforts such as the Growth Management Act to city efforts such as pledging to meet the Kyoto Protocol, from recycling, to green roofs, and low impact development.

Information Access

While it is certain that the future information technology will allow for a larger volume of information to be shared in a more decentralized manner, it is much less certain what we will rely on in fifty years.

Note

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Human Perceptions & Behavior

Human perceptions and behaviors are difficult to measure but can prove critical to major shifts in society. Rather than describing trends per se, this factsheet provides definitions for some of the common terminology used when describing shifts in human perceptions and behavior.

Maslow's Pyramid of Needs

Maslow's theory contends that as humans meet 'basic needs' they seek to satisfy successively 'higher needs' that occupy a set hierarchy [1]. The four lower levels are grouped together as deficiency needs associated with physiological needs, while the top level is termed growth needs associated with psychological needs. While our deficiency needs must be met, our growth needs are continually shaping our behaviour. The basic concept is that the higher needs in this hierarchy only come into focus once all the needs that are lower down in the pyramid are mainly or entirely satisfied [2].



Property Rights: According to Adam Smith, the expectation of profit from "improving one's stock of capital" rests on private property rights, and the belief that property rights encourage the property holders to develop the property, generate wealth, and efficiently allocate resources based on the operation of the market is central to capitalism.

From this evolved the modern conception of property as a right which is enforced by positive law, in the expectation that this would produce more wealth and better standards of living.

Property rights are considered an essential freedom protected by the Constitutions and the Bill of Rights in the United States. Libertarians, socialists and communist views diverge on the value of property rights.

- Libertarian view of property: "Just as man can't exist without his body, so no rights can exist without the right to translate one's rights into reality, to think, to work and keep the results, which means: the right of

property." (Ayn Rand, who was not herself a libertarian)

- Socialism's fundamental principles are centered on a critique of this concept, stating that the cost of defending property is higher than the returns from private property ownership. Property rights encourage the property-holder to develop his property, generate wealth, etc. for his own benefit rather than the benefit of other people or society at large.
- Communism argues that only collective ownership through a polity, though not necessarily a state, will assure the minimization of unequal or unjust outcomes and the maximization of benefits, and that therefore all, or almost all, private property should be abolished.

The public trust doctrine is the principle that certain resources are preserved for public use, and that the government is required to maintain it for the public's reasonable use.

Social Capital is defined as the advantage created by a person's location in a structure of relationships. It explains how some people gain more success in a particular setting through their superior connections to other people. Putnam's 2000 book "Bowling Alone" argues that social capital is declining in the United States as exhibited in lower levels of civic participation and trust in government.

Cooperation refers to the practice of people or greater entities working in common with commonly agreed-upon goals and possibly methods, instead of working separately in competition.

Even if all members of a group would benefit if all cooperate, individual self-interest may not favor cooperation. The prisoner's dilemma codifies this problem and has been the subject of much research, both theoretical and experimental.

Fundamentalism is characterized by a sense of embattled alienation in the midst of the surrounding culture, even where the culture may be nominally influenced by the adherents' religion. The term can also refer specifically to the belief that one's religious texts are infallible and historically accurate, despite possible contradiction of these claims by modern scholarship.

Very often religious fundamentalists, in all religions, are politically aware. They feel that legal and government processes must recognize the way of life they see as prescribed by God and set forth in Scripture.

Modernism is a trend of thought which affirms the power of human beings to make, improve and reshape their environment, with the aid of scientific knowledge, technology and practical experimentation. Broadly,

modernism describes a series of progressive cultural movements in art and architecture, music, literature and the applied arts which emerged in the decades before 1914.

A revolution is a drastic change that usually occurs relatively quickly. This may be a change in the social or political institutions over a relatively short period of time, or a major change in its culture or economy. Some revolutions are led by the majority of the populace of a nation, others by a small band of revolutionaries, a so-called palace revolution only touches the ruling elite. Some famous revolutions include the renaissance, protestant reformation, scientific revolution, sexual revolution, agricultural revolution, and the industrial revolution.

Optimism, the opposite of pessimism, exemplifies a lifeview where one looks upon the world as a positive place. Optimists generally believe that people and events are inherently good. The anarchist philosopher William Godwin hoped that society would eventually reach the state where calm reason would replace all violence and force, that mind could eventually make matter subservient to it, and that intelligence could discover the secret of immortality.

Schopenhauer's pessimism comes from his elevating of Will above reason as the mainspring of human thought and behaviour. Schopenhauer pointed to motivators such as hunger, sexuality, the need to care for children, and the need for shelter and personal security as the real sources of human motivation. Reason, compared to these factors, is mere window-dressing for human thoughts; it is the clothes our naked hungers put on when they go out in public.

Convergence denotes the approach toward a definite value, as time goes on; or to a definite point, a common view or opinion, or toward a fixed or equilibrium state.

The term "*reactionary*" is frequently used as a term of opprobrium, meant to assert the idea that the opposition is based in merely reflexive politics rather than responsive and informed views, as well as being based in a desire to not only halt progressive change but to reverse it.

Triandis (1996) defines *individualism* as when "the self is defined as independent and autonomous from collectives. Personal goals are given priority over the goals of the collectives" (p.409). *Collectivism* is defined as "an aspect of a collective; personal goals are subordinated to the goals of the collective... taking into account the needs of others in the regulation of social behavior is widely practiced" (Triandis, p.409)

Lifestyles –Our Behavior

Northwesterners consume their body weight in natural resources every day. While population rates are

dynamic, the region has stabilized its per capita resource consumption, waste generation and number of motor vehicles, and emissions of greenhouse gases [3].

Relationships between knowledge, perceptions and behavior

While knowledge, perceptions and behavior may be correlated, the relationship between them is complex and riddled with feedbacks. One common research question is how will knowledge impact human perceptions and behavioral change (or willingness to sacrifice). The following is a short excerpt from a study analyzing how knowledge about climate change influences risk perceptions and willingness to sacrifice [4]. These statements merely reflect the need for caution when predicting causal relationships such as "increased environmental awareness will increase sustainable behavior".

- People who are knowledgeable about actual causes are more likely to foresee a dangerous future, but so are people who believe that pesticides and nuclear power are causing global warming.
- People who support referenda that would direct societal resources to mitigate climate change are more likely to know the real causes of climate change.
- Believing that everything causes global warming correlates with high levels of perceived risk, but does not imply willingness to vote for sacrifices to address those risks.

Note

Part of the text and images for this document were taken directly from 1. The explanations were taken verbatim from Hierarchy of Motives. Access on 03/05/2019. https://lumen.instructure.com/courses/170090/pages/hierarchy-of-motives?module_item_id=4055336.
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4. O'Connor, R., Bord, R. & Fisher, A. August 1998. The curious impact of knowledge about climate change on risk perceptions and willingness to sacrifice Risk Decision and Policy. Vol 3 (2)