Changing Climate and Ocean Conditions

Outline

- Greenhouse gas emissions - carbon dioxide and other greenhouse gases
- Impacts of the rapid growth in fossil fuel burning and land use changes
- Mitigation – reducing greenhouse gas emissions
- Adaptation – responding to the impacts of climate change and ocean acidification
- State agency role

Statewide Global Greenhouse Emissions

Global GHG Emissions in parts per million:

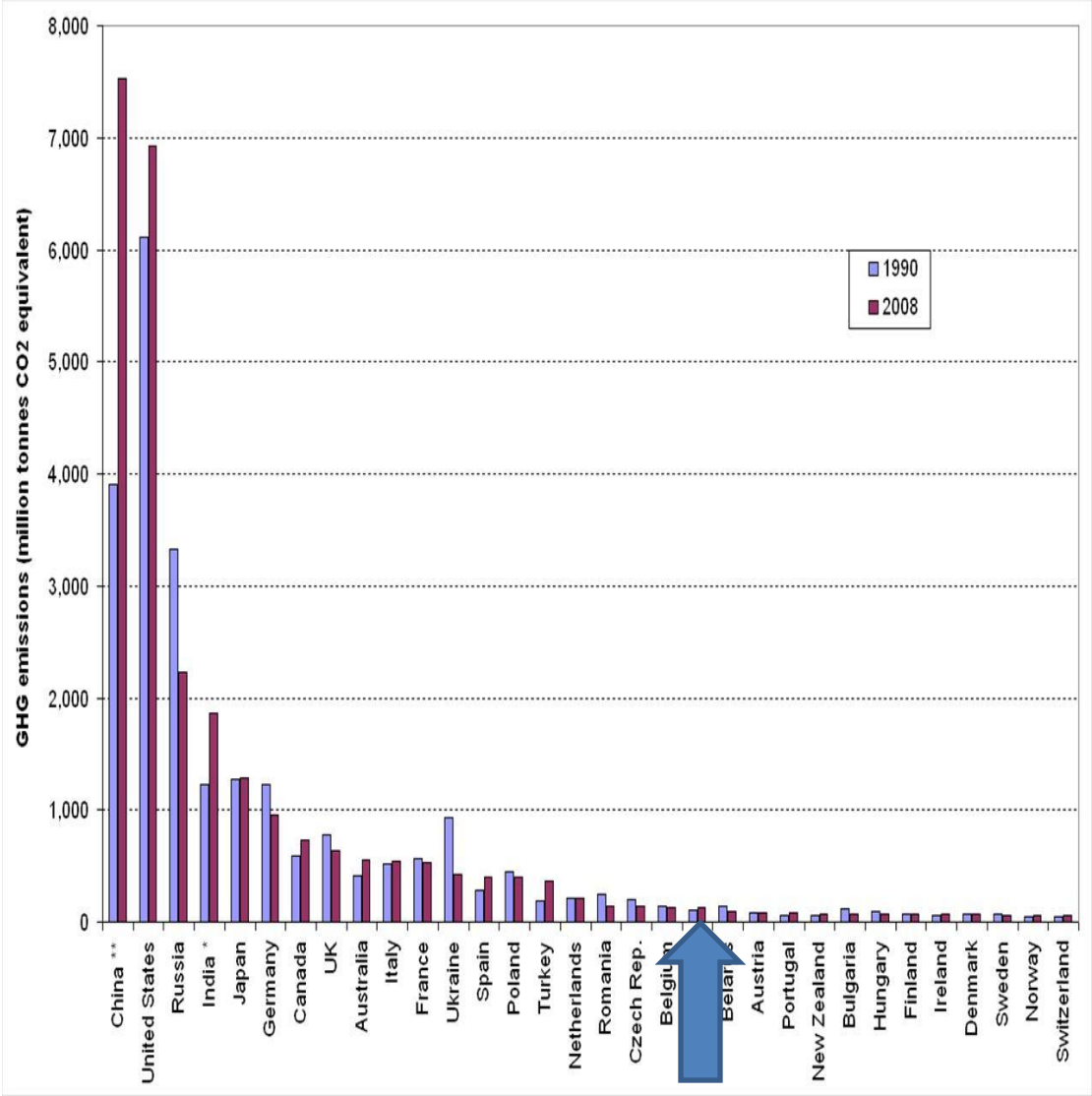
- 280 in 1840
- 392 today
- 700 by 2100

China #1 at 23% of total, 6.2 $MTCO_2e$ per person

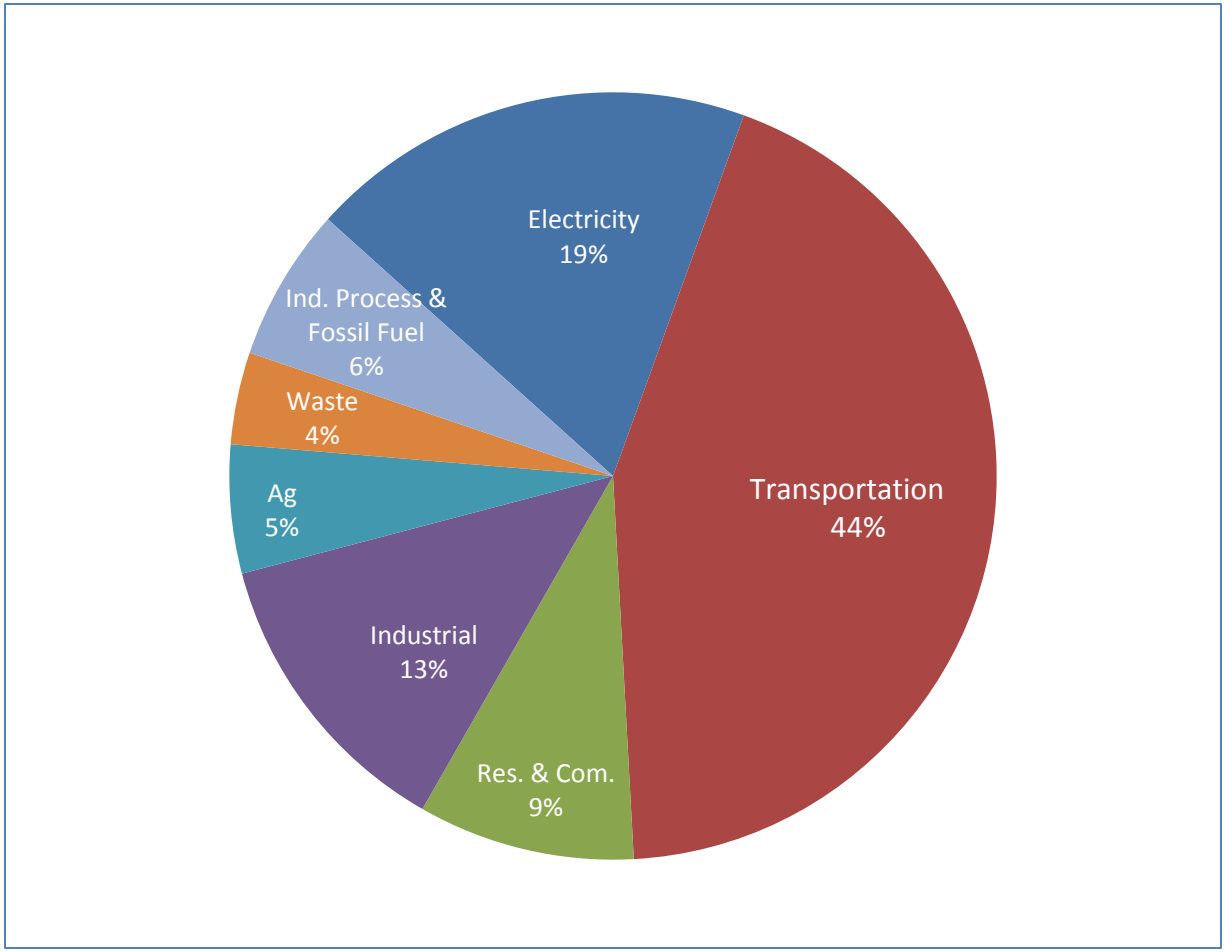
US #2 at 18% of total , 17.6 $MTCO_2e$ per person (up 10.5% from 1990)

WA GHG Emissions 95.1 $MMTCO_2e$ (up 2% from 1990)

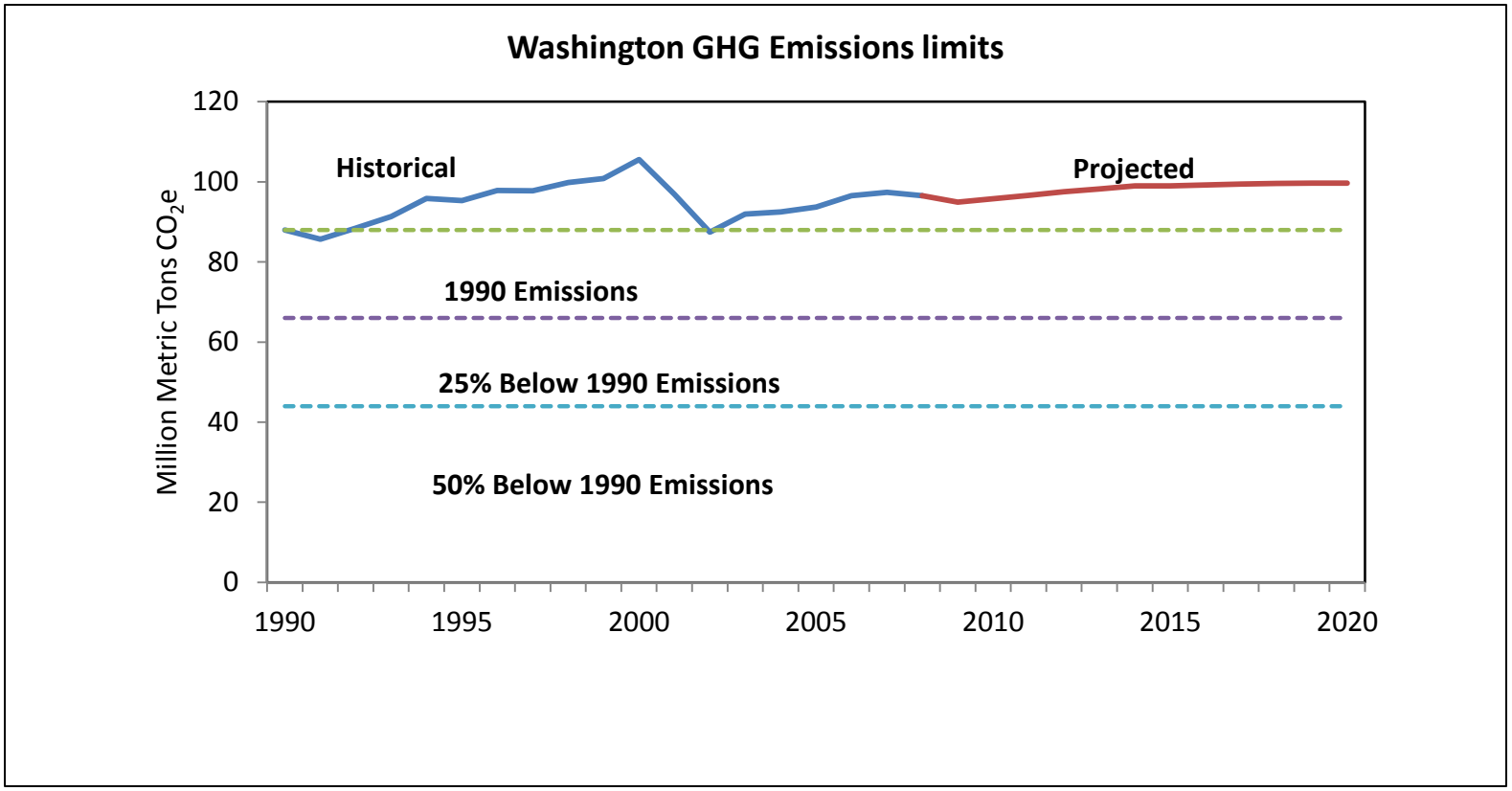
If WA is a country it will rank 38th out of 215



2010 Washington State GHG Emissions 95.1MMTCO$_2$e



Washington's GHG Emissions



WA is not on track to meet the State's mandatory reduction limits for 2020, 2035 and 2050

Weather vs. Climate

- Weather refers to the day-to-day changes in temperature, precipitation, etc. at a specific location.

- Climate refers to the average of these variables over longer time periods.

- Climate *varies* naturally, affecting temperature, precipitation, snowpack, sea level, storm patterns, etc., at different time scales.

Climate Change vs. Ocean Acidification

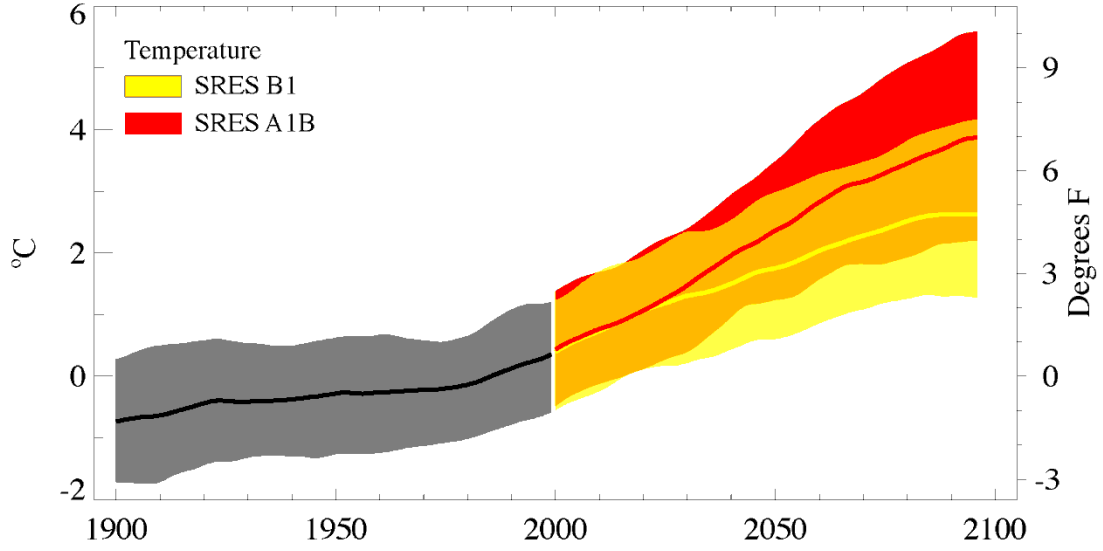
- Ocean acidification and climate change share a common cause — increasing carbon dioxide in the atmosphere.

- Climate change encompasses the effects associated with changes in the Earth's temperature, which cause global warming and changes in weather patterns.

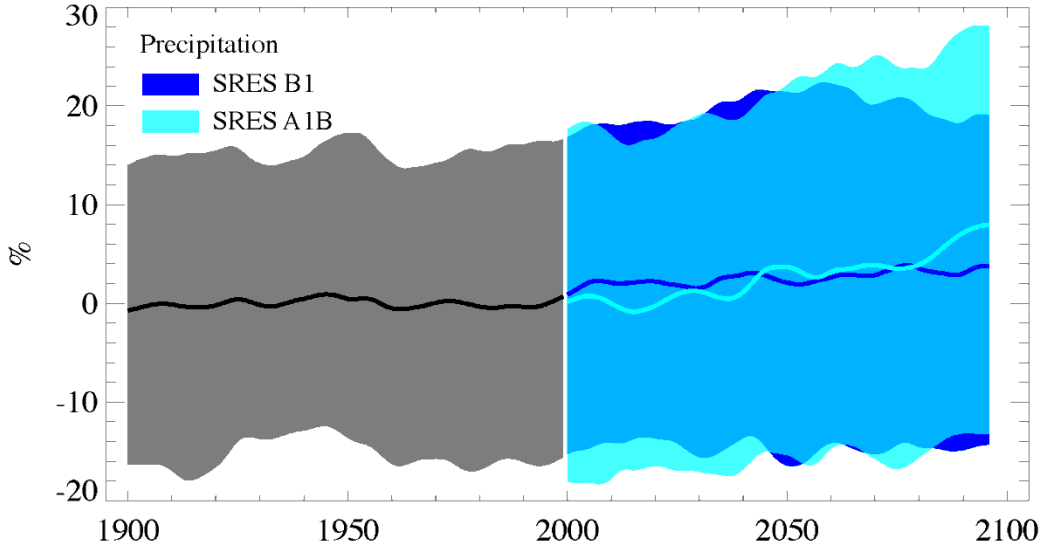
  Ocean acidification refers to the lowering of ocean pH resulting from its absorption of CO_2 from the atmosphere.

- Ocean acidification does not include the warming of the ocean.

Climate Change for the Pacific NW
"B1" low emissions scenario & "A1B" moderate emissions scenario



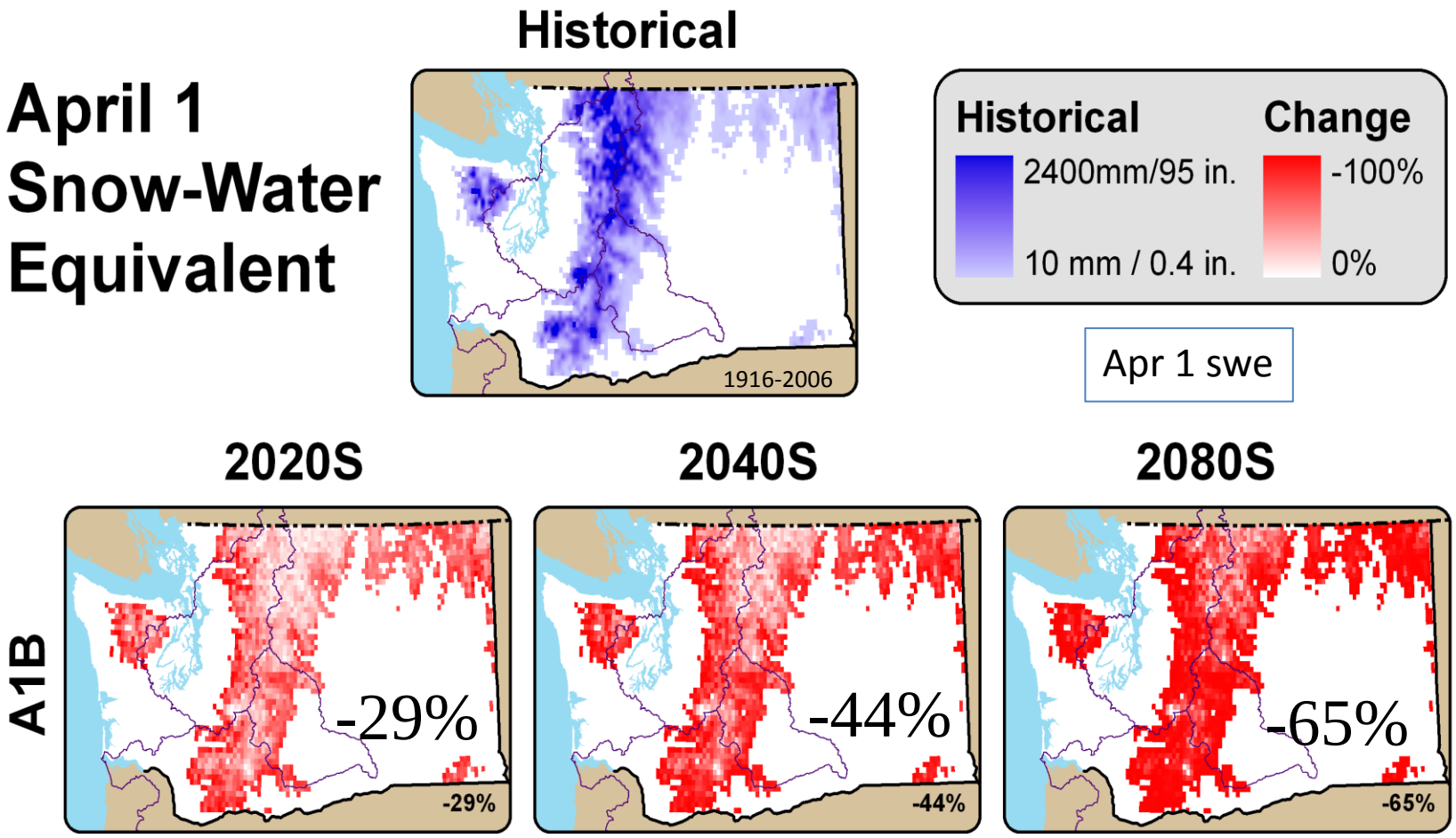
2020s	+2.0°F *(1.1-3.4°F)*
2040s	+3.2°F *(1.6-5.2°F)*
2080s	+5.3°F *(2.8-9.7°F)*



2020s	+1% *(-9 to 12%)*
2040s	+2% *(-11 to +12%)*
2080s	+4% *(-10 to +20%)*

Mote and Salathé, 2010

Key Impact: Less Snow



Elsner et al. 2010

Snowpack declined 25% between 1950 and 2006

Why? Spring snowpack is projected to decline as more winter precipitation falls as rain rather than snow, *especially in warmer mid-elevation basins.* Also, snowpack will melt earlier with warmer spring temperatures

Less winter snowpack, earlier spring snow melt

WA state April 1 snowpack: -28% (2020s), -40% (2040s), -59% (2080s; vs. 1916-2006 historical average). *[A1B emissions, model avg]*

Higher winter and lower summer streamflows

More winter flow, less spring/summer flow in many Puget Sound and Cascade mountain rivers. Altered watershed behavior across the state.

Increased flood risk west of the Cascades

More and larger fall/winter floods for many western WA/mountain basins. Decreased spring floods in high/cold basins.

Decreased summer hydropower production

Summer production falls -10% by the 2020s, -15% by the 2040s, -20% by the 2080s, while summer cooling demands increase up to 400% *[A1B emissions]*

Decreased irrigation supply reliability

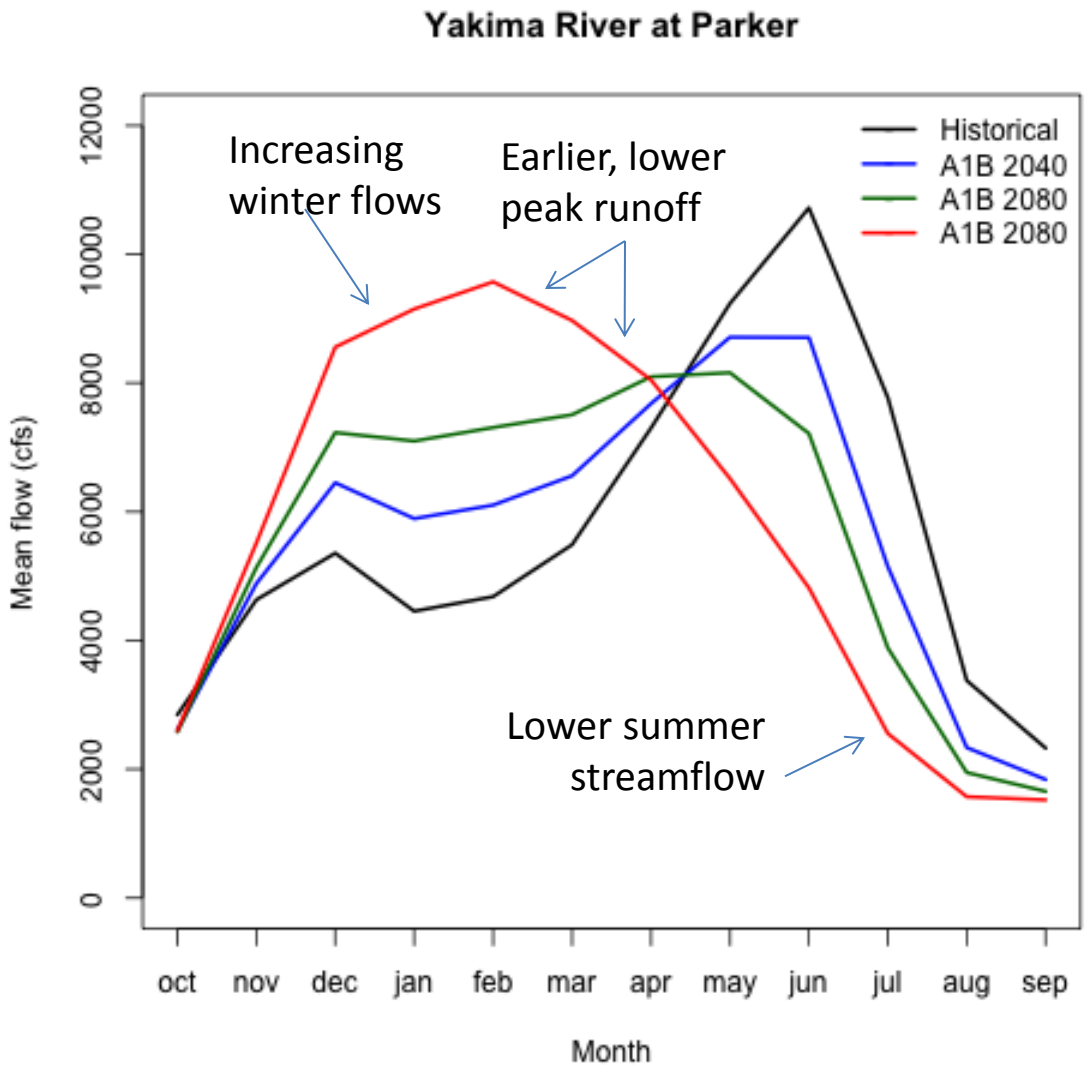
Risk of “water short year” (70% level of prorating) in the Yakima increases from 14% to 32% (2020s), 36% (2040s) and 77% (2080s) *[A1B emissions]*

Continued reliability of municipal water supplies

Puget Sound water suppliers project sufficient supply through at least 2050

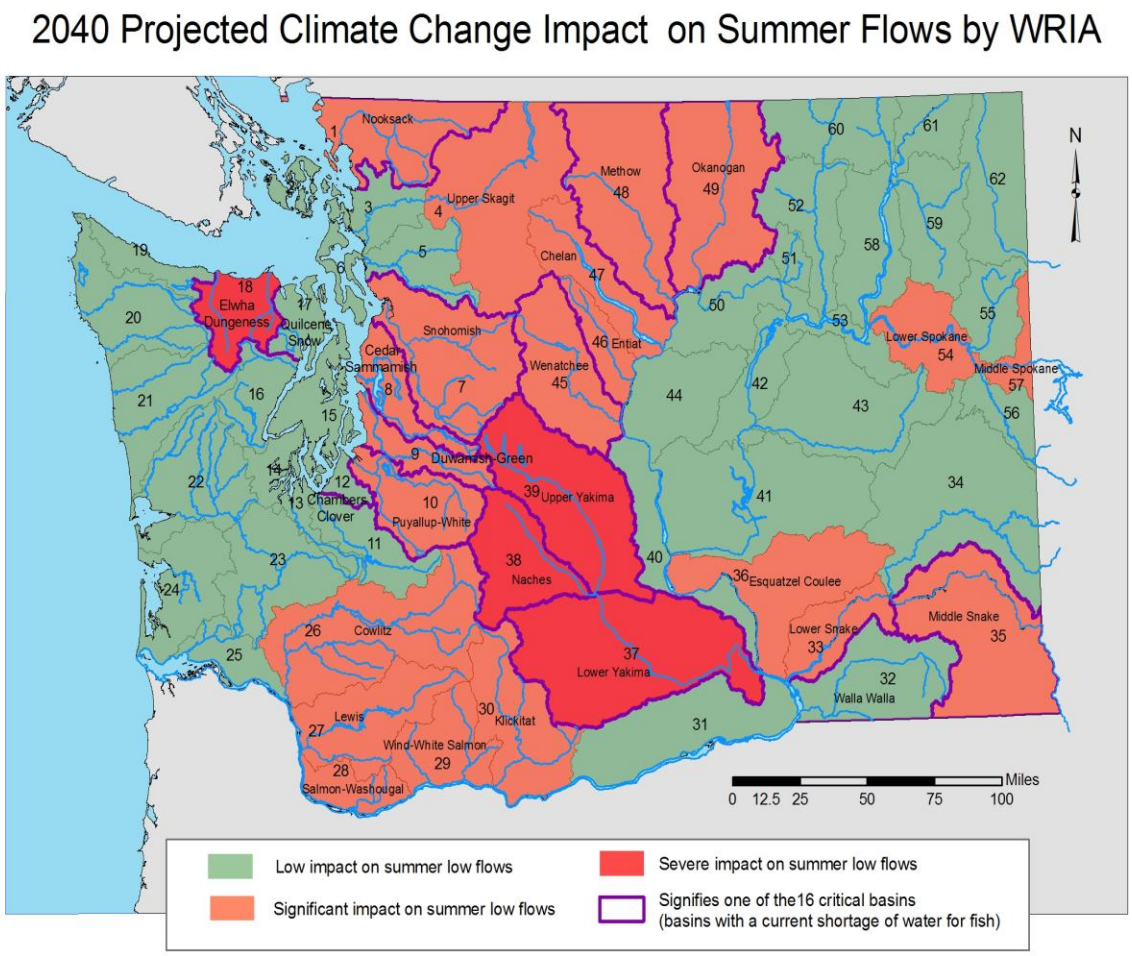
Impacts on Seasonal Streamflow Timing

Mixed Rain/Snow (Transient) Basin



Elsner et al. 2009

Impacts of Climate Change on Water Resources



- Impacts of climate change on summer flows will likely be different in river basins that depend either on snowpack, precipitation or both.
- Water supply for agriculture, people and fish will likely be:
  - ✓ Severely impacted in the red colored basins
  - ✓ Significantly impacted in the pink colored basins; and
  - ✓ Less impacted in the green colored basins.

Increased wild fire risk

Area burned by fire in Col River basin projected to double by 2020s, triple by 2040s, x5 by 2080s. Chance of very large fires increases (probability of fires > 2 million acres increases from 5% to 48% by 2080s).

Increased risk of insect outbreaks

Increased risk of mountain pine beetle outbreaks in drier forests will exacerbate fire risk.

Changes in species distribution expected

Species will re-distribute according to their genetic tolerances for climate variables. Climate suitability decreases in some areas for Douglas fir and other species.

Agricultural impacts mixed

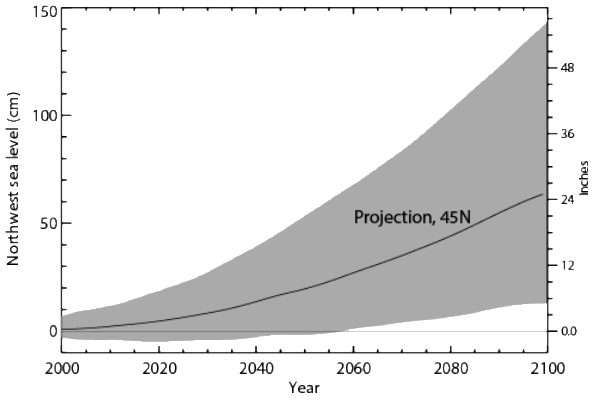
Dry land winter wheat yields could increase 13-15% (2020s), 13-25% (2040s), when warming and CO_2 fertilization are considered. Spring dryland wheat, and potatoes projected to decrease.

More heat-related deaths

101 additional deaths for people over 45 by 2025 and another 50% increase by 2045 in Seattle. Summer air quality affected.

Increased stress on salmon

Lower summer streamflows + warmer stream temperatures + increased fall/winter flooding + ocean acidification



Sea level is projected to rise

Local amount depends on local land movement

2030	2050	2100
-1.5 to +8.9” 2.6” av.	-1.0 to 18.8” 6.5” av.	3.9 to 56.3” 24” av.

Loss of land to rising seas

More than 140,000 acres of coastal lands lie within 3.3 feet elevation of high tide in WA & OR. Some coastal habitat types lost due to “coastal squeeze.”

Erosion and landslide risks increase

Higher storm surge threatens private and public property, urban and transportation infrastructure, and ecological resources.

More acidic conditions in the ocean

Ocean acidity projected to increase 100-150% by 2100. The primary global cause is increasing CO_2 in the atmosphere. Local factors (upwelling, nutrients, organic carbon) contribute to acidification in WA.

Increased mortality for shell-forming organisms

Ocean conditions are becoming more corrosive to shellfish and other organisms that use calcium carbonate to make hard body parts (calcifiers). More than 30% of Puget Sound's marine species are calcifiers.

Marine food webs impacted

Key species in the marine food web (e.g., pteropods) are affected by acidification. Many commercially and ecologically important species affected.

Building Climate Resilience

Mitigation

Adaptation

Foundation Actions and Documents

Executive Order 07-02

2007 Climate Advisory Team

2008: Climate Action Team

2009: The Washington Climate Change Impacts Assessment (HB 1303, 2007)

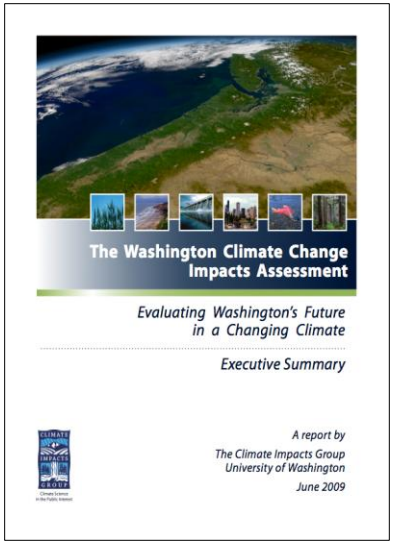
Executive Order 05-09

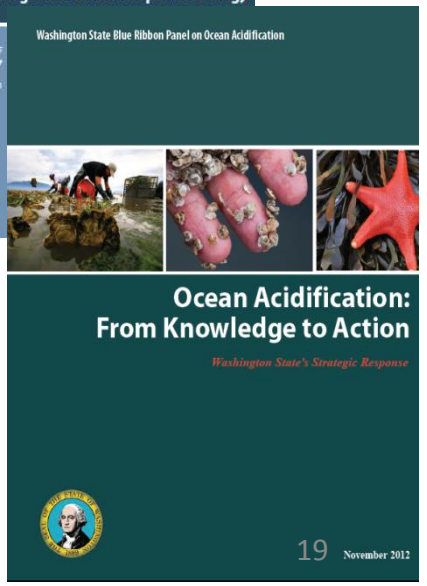
2012: Washington State's Integrated Climate Response Strategy (SB 5560, 2009)

2012: Ocean Acidification: From Knowledge to Action

Executive Order 12-07

From 2005 to 2012 legislature has adopted several policies
http://www.ecy.wa.gov/climatechange/laws.htm





Reducing Greenhouse Gas Emissions

Emissions Reduction Actions Taken

Between 2005 and 2012, the State implemented many policies aimed a reducing greenhouse emissions. Examples include:

- Clean cars, alternative fuel standards, and fuel efficiency standards ;
- Closing state coal power plants;
- Vehicle electrification;
- Renewable energy standard (RPS);
- Tighter energy code;
- Appliance efficiency standards
- Green building and energy efficiency projects for public buildings and low-income properties; and
- Efficient transportation options.

Governor's Inslee "Carbon Pollution Action Bill" 2013

- Independent/objective contractor(s) will evaluate approaches to reduce GHG emissions based on effectiveness; impacts on the economy, consumers, and businesses; and opportunities for cleaner energy investments.
- Report must be provided by Oct. 15, 2013 to the Governor and the Climate Legislative and Executive Workgroup.
- Workgroup is created - "5 corners": house, senate and Governor
- Workgroup will recommend a program to achieve the state's GHG emission limits
- Workgroup report must be completed by 12/31/2013

Building Climate Resilience
Responding to Climate Impacts

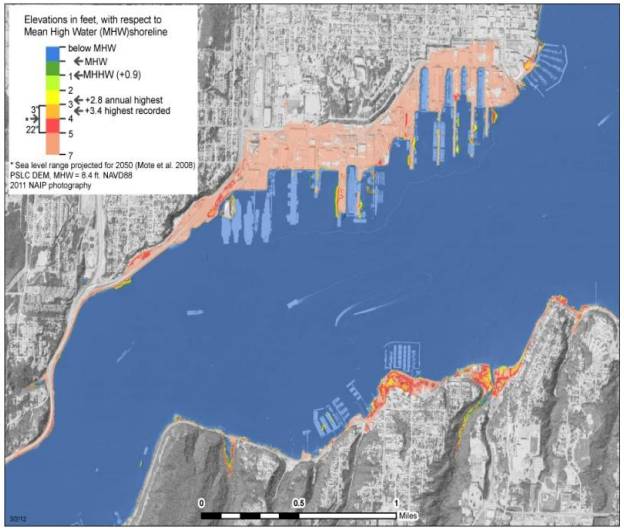
Strategies for Coastal Areas

- Guide future development away from vulnerable areas
- Enhance emergency preparedness and response to address increasingly extreme events
- Accelerate efforts to protect and restore nearshore habitat and natural processes
- Protect vulnerable infrastructure by considering climate risks in planning, funding, designing, and constructing infrastructure
- Build local capacity by providing information, tools and guidance

Strategies for Water Management

- Promote integrated water management in vulnerable basins
- Implement enhanced water conservation and efficiency programs
- Enhance emergency preparedness and drought response
- Ensure sufficient cold water in salmon-bearing streams by accelerating efforts to protect and restore stream flows
- Incorporate climate change realities (change in timing and availability of water) into agency decisions-making

Strategies for Infrastructure



Inventory and identify critical and vulnerable infrastructure.

Protect vulnerable infrastructure by strengthening dikes and levees and by using other hard or soft structural approaches (must consider unintended consequences.

Strengthening infrastructure through improved materials, design and construction.

Relocating, decommissioning or abandoning selected infrastructure where the costs of protection and maintenance outweighs the benefit.

Require consideration of climate risks and response strategies in the site selection, design, and construction of state-funded infrastructure projects.

Incorporate climate risks into emergency management plan, state hazard mitigation plan and hazard identification and vulnerability analysis.

Strategies on Research, Monitoring and Communication

- Improve scientific knowledge and ensure it is responsive to the needs of policymakers, public and others
- Partner and collaborate with various governments and organizations to enhance monitoring, data collection and communication
- Support development and use of applied tools for decision makers and land and water managers to help them understand risks and consequences and select effective adaptation options.
- Create coordinated and cohesive communication messages and tools on climate change, ocean acidification, energy independence, public health and safety and economy.
- Engage the public in climate change/ ocean acidification conversations and solutions.
- Expand clearinghouse of data and case studies.

State Agency Requirements

State Agency Climate Leadership Act

"All state agencies shall meet the statewide greenhouse gas emission limits established in RCW 70.235.020 to achieve the following, using the estimates and strategy established in subsections (2) and (3) of this section: …" RCW 70.235.050

"Beginning in 2010, when distributing capital funds through competitive programs for infrastructure and economic development projects, all state agencies must consider whether the entity receiving the funds has adopted policies to reduce greenhouse gas emissions. Agencies must also consider whether the project is consistent with: …" RCW 70.235.070

"State agencies shall strive to incorporate adaptation plans of action as priority activities when planning or designing policies and programs. Agencies shall consider the integrated climate change response strategy when designing, planning, and funding infrastructure projects; and incorporating natural resource adaptation actions and alternative energy sources when designing and planning infrastructure projects." RCW 43.21M.040

Responding to These Requirements

- Build support and understanding by agency leadership and staff
- Continue to reduce our energy and fuel use
- Use existing state, local and federal laws to reduce risks of climate change and ocean acidification:
  - SMA, GMA, CZMA, Watershed Planning Act, SEPA, Floodplain Management Act, Clean Air Act, Clean Water Act, Water Pollution Act, Water Resources laws …
- Use "climate lens" to reduce risks of climate change
  - Is the policy, program, or investment sensitive to current and future changes in climate, such as increased temperature, reduced snow pack, increased precipitation, and severe and frequent storms?
  - What is the level of risk and vulnerability to climate impacts?
  - Will climate impacts alter the effectiveness of the existing plan, policy, program, or project?
  - Are adjustments or modifications needed to account for climate impacts and to help achieve the intended objectives?
- Develop a short-term and long-term approaches and actions to implement the response strategy for both climate change and ocean acidification.

Resources

- http://www.ecy.wa.gov/climatechange/index.htm
- http://www.ecy.wa.gov/water/marine/oceanacidification.html
- http://www.ecy.wa.gov/climatechange/ipa_resources.htm