

# Climate Change and Municipal Water Supplies

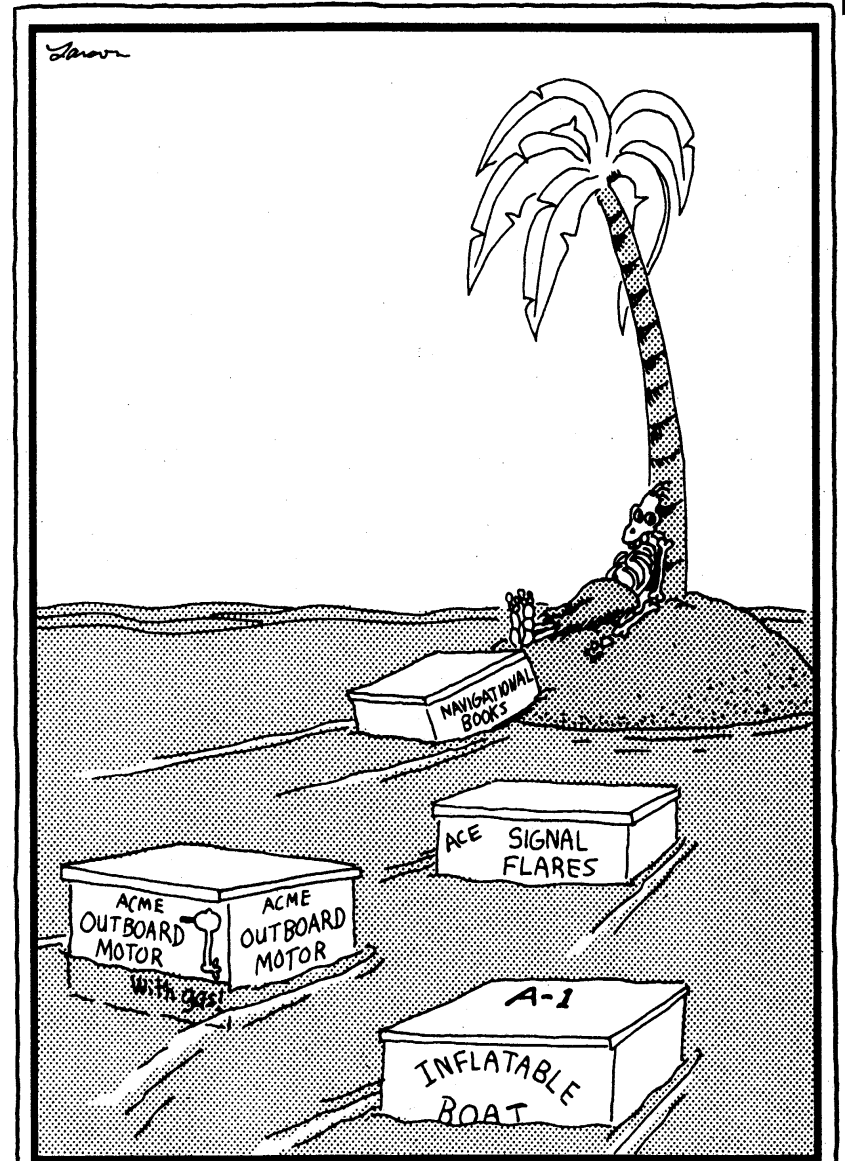
Presented by Lorna Stickel  
Portland Water Bureau

Pacific NW AWWA Section  
Pre-conference Workshop  
*May 6, 2009*  
*Salem, Oregon*

## Climate Change Is it Real or Is it Not?

Do we really want to  
find out too late for  
our solutions to mean  
anything?

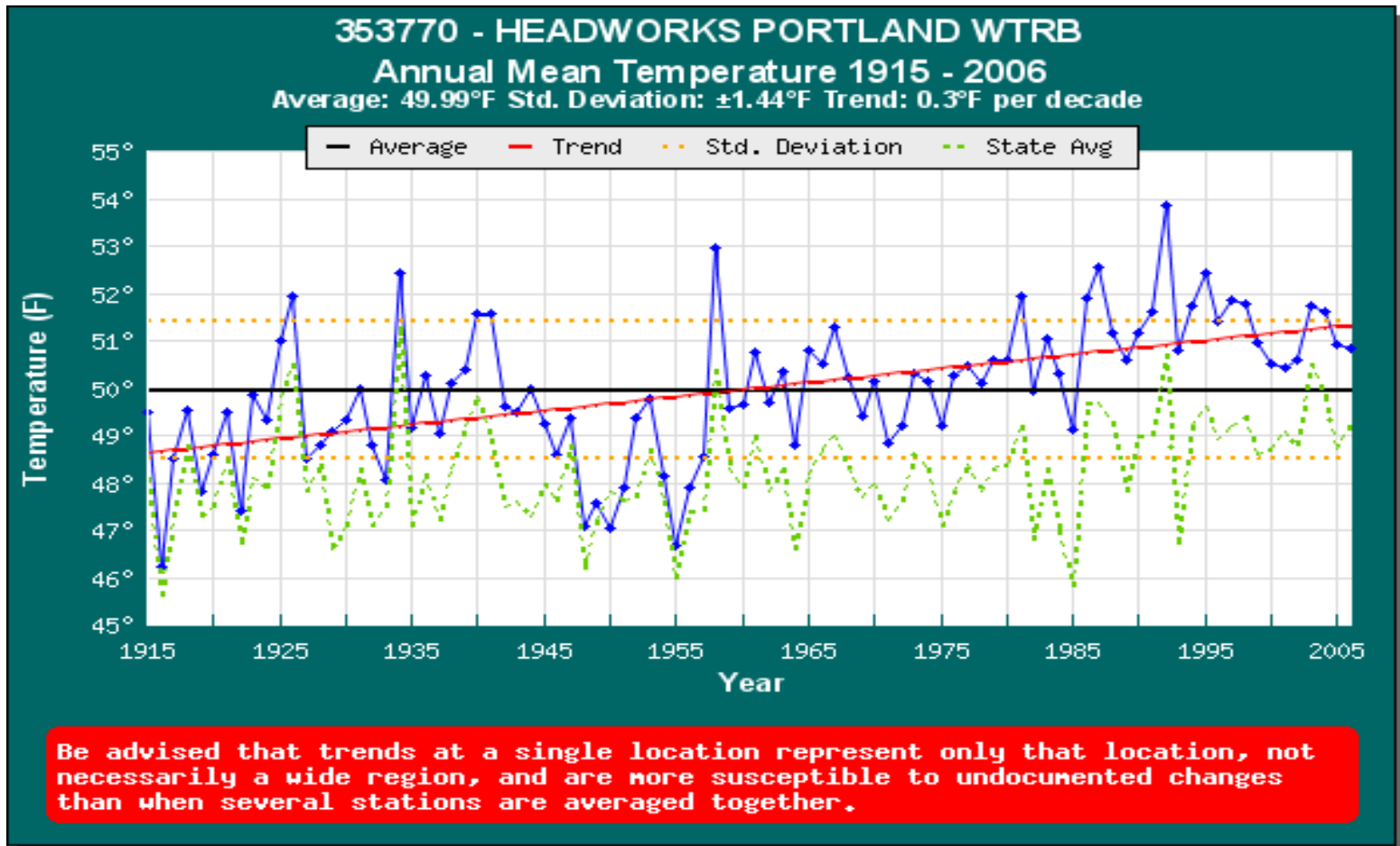
Why sit around waiting  
to be convinced?



# Topics for This Presentation

- Potential Impacts on Municipal Supplies
- Incorporating climate change into water supply planning
- Examples from the Portland Metro Area
- Adaptation & Mitigation Strategies
- Research needs and Collaboration

# Past temperature variability in Bull Run - Is there a trend here?



# Planning for Climate Change, should we or shouldn't we?

- So is the data something we should pay attention to?
- What if we can't get enough information to make decisions?
- Won't this cost us an arm and leg?



"I don't know if this is such a wise thing to do, George."

# Can I Determine How Climate Change Might Impact My Water System?

- The impacts are different for each system studied, in some cases small impacts may be found, while in others the impacts will be significant, particularly over longer periods of time (50 years or more).
- The impacts of global climate change can be difficult to project at the local or regional level, modeled future temperature trends are more consistent than precipitation.
- However, it is possible to assess the range of climate change impacts at the local/regional level.

# One Way to Look at Future Climate Change Analysis

Five step process outlined by Gliick & Frederick (1999)

- Look at several Global Climate Models (GCMs) and look for consensus & ranges
- Downscale results to level needed
- Apply hydrologic models to downscaled results
- Develop integrated systems simulation models
- Assessment of the results of different scenarios (focus on risk & probabilities), can then use decision support modeling or other tools to understand the complexities involved and focus on the issues of most concern.
- Identify “no or low regrets” strategies and evaluate costs of actions against multiple objectives.

# Climate Impacts Science Primer: How do scientists project future climates and their impact on resources in Washington State (WA) and the Pacific Northwest (PNW)?

**1. Estimate future atmospheric greenhouse gas concentrations and other climate drivers.**

*Q1 - What do scientists have to know before they can project future climate?*

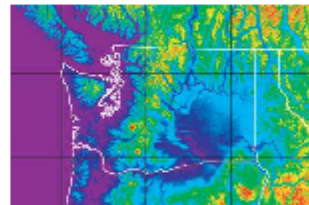
*See Climate Impacts Science Questions for answers to Q1-Q9*

**2. Use global climate models (CMs) to project future climate at a global scale**

*Q2 - How does a CM work?  
Q3 - Why is there so much uncertainty in projected climate changes?  
Q4 - Why can I believe climate change projections if it's impossible to forecast weather beyond two weeks?  
Q5 - Which CM climate projections are most trusted? Which are less certain?*

**3. Downscale CM results to project the future climate of WA and the PNW**

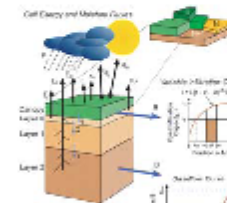
*Q6 - What factors control WA and PNW climate?  
Q7 - How do scientists "down-scale" CM results to a region like WA?*



**WA topography with typical GCM grid resolution (~150 miles)**

**4. Use regional hydrology models to project future snow-pack, streamflow, and soil moisture**

*Q8 - How do scientists project climate change impacts on the water cycle?*



**VIC hydrology model**

**5. Use resource management models or empirical relationships to understand implications for WA and PNW resources**

*Q9 - How do scientists project impacts on natural resources?*

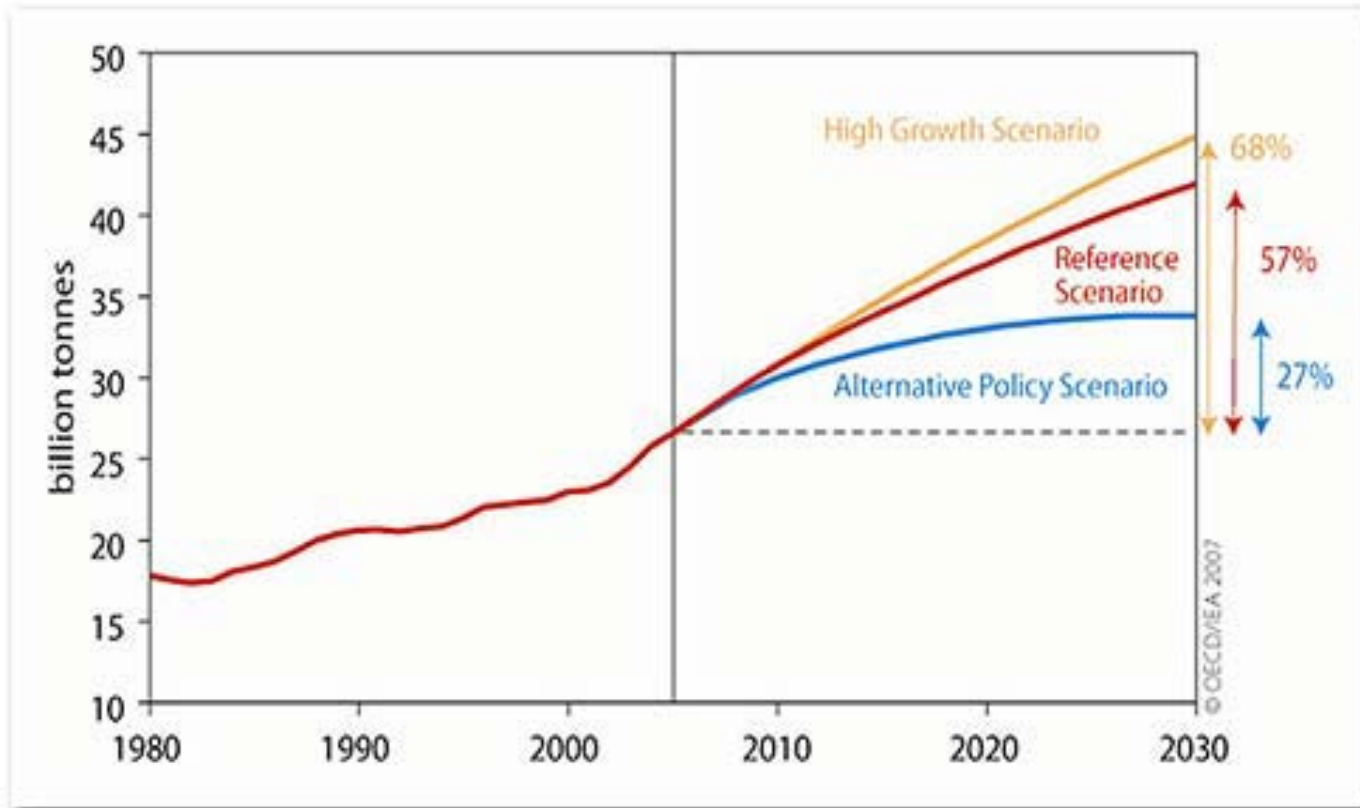


**Salmon in Lake Washington**

Prepared by Jennifer Kay, Joe Casola, Amy Snover, and the Climate Impacts Group (CIG) at the University of Washington for King County's October 27, 2005 Climate Change Conference. This and other conference materials are available at: <http://www.cses.washington.edu/cig/outreach/workshops/kc2005.shtml>



# Future Climate Change

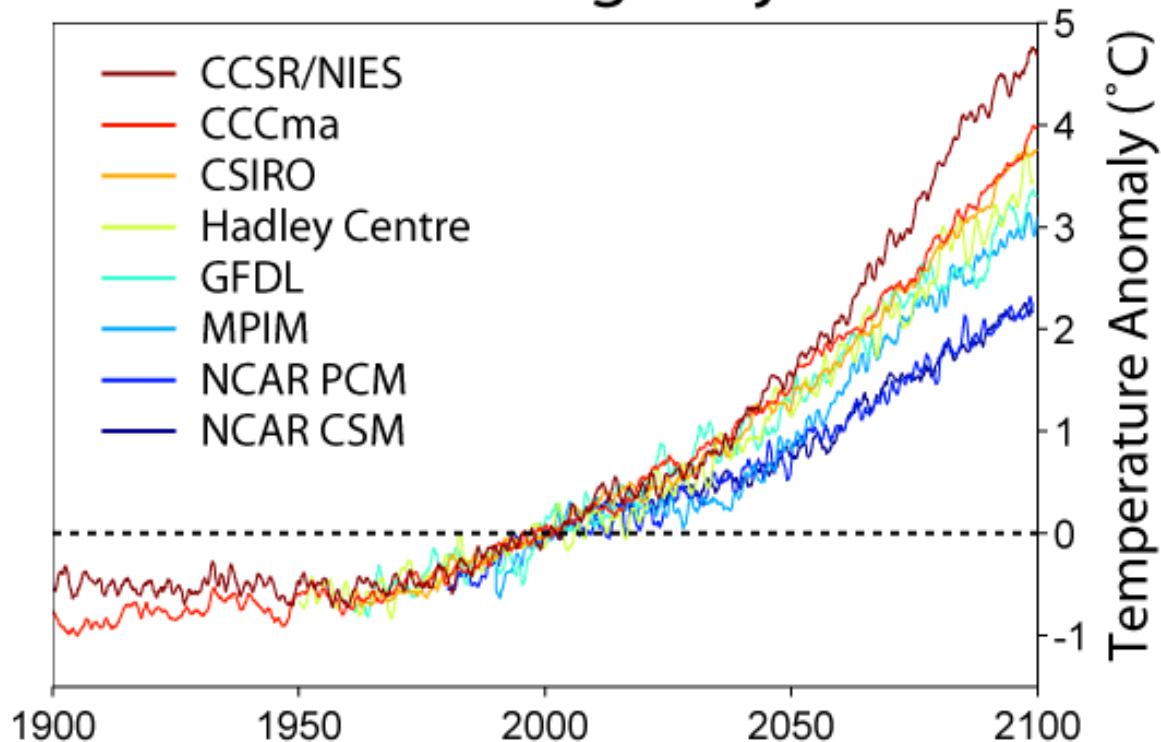


Energy Related CO2 Emissions by Scenario

1. Pick which emission scenario(s) you want to use to bracket uncertainty

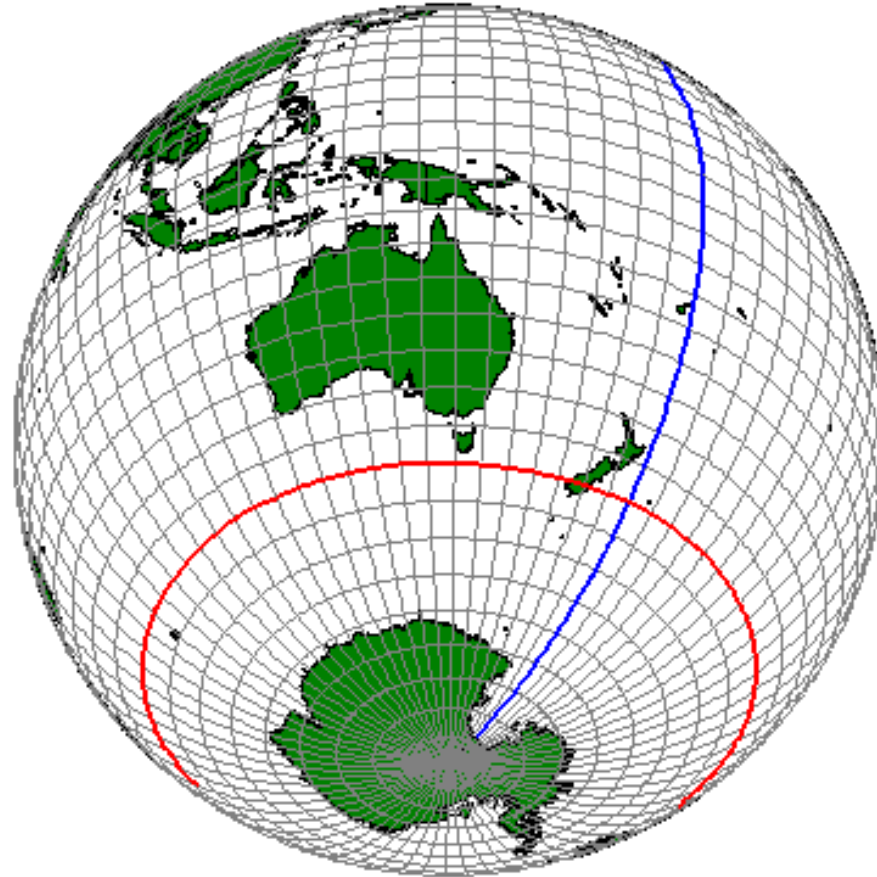
# Future Climate Change

## Global Warming Projections



2. Choose which Global Climate Models (GCMs) to project future climate at a global scale or use Regional Climate Models (RCM's)

# Future Climate Change



3. Downscale model results to project future climate at the local scale

# Future Climate Change



4. Use hydrology model to project future snowpack, streamflow, soil moisture, etc. (Eg. VIC, HEC, Basin, DHSVM, etc.)

# Future Climate Change



5. Use resource management models to determine effect on future supply

# How Might Municipal Water Supplies Be Affected by Climate Change?

- The hydrology of sources will be affected as well as overall demand increases associated with climate change (likelihood of longer summer peak seasons both average and upper peak bounds).
- Competition for water resources is increased, thereby affecting water right status/conflict.
- Lower summer instream flows affects ESA species/HCP requirements and water quality/CWA permit requirements as well as water treatment assumptions/operations.

# Impacts to Types of Municipal Sources of Supply



- Run of River - Changes in snow and rainfall patterns affect streamflows: more intense winter flows and lower summer flows appear to be common outcomes

# Impacts to Types of Municipal Sources of Supply



- Storage - Reliability of storage projects changes
  - Demands likely to be higher in the peak seasons
  - Less inflow affects both filling of some projects annually and reduces the amount of surface water inflow during the summer.



# Impacts to Types of Municipal Sources of Supply



- GW - Less certainty of the impact on these systems, Recent studies indicate varying effects in the Cascades, but still an overall reduction in summer flows.

# Impacts to Types of Municipal Sources of Supply



- Coastline - Saltwater intrusion into coastal water sources due to potential rises in sea level as well as higher interior tidal influence on river levels.

# Added Uncertainty for Municipal Water Supplies

- Most planning for water supplies is based on recent historic climate records, not reflective of longer climate variability thereby creating water supply systems that are not as potentially not as robust as they should be.
- The synergy between lower summer streamflows, less spring/fall rainfall, higher peak season demands creates an effect that is going to stress municipal systems more than in the past.
- Extreme events are likely to be off the historic chart - affecting system reliability due to sea level rises, saltwater intrusion, more intense storm events, fires, water quality changes which changes averages used for planning & design.

# Potential Impacts on Municipal Water Demands

- Temperature and precipitation are major factors that affect daily demand patterns. Climate change scenarios with higher temperatures are likely to mean higher overall demand. In Oregon this will mean higher and longer peak season demand. For some sources, increases in late summer/fall demands may be the most problematic, while some will see multi-year storage reductions.
- Climate change likely to mean higher demand patterns than seen in the past, or greater frequency of “worst” weather years.
- Climate change resonates with customers. Can result in greater acceptance of conservation programs and needed behavioral changes in consumption.

# Climate Change and Water Supply Planning in the Pacific NW

- Some water sources have had climate change studies conducted to look at potential impacts:
  - Bull Run, Portland, Oregon - 2002
  - Tualatin Basin, Oregon - 2004
  - Seattle, Washington - 2008
  - See U. of Washington Climate Impacts Group (CIG) website for copies of the above reports:  
[www.cses.washington.edu/cig/fpt/caseplanning.shtml](http://www.cses.washington.edu/cig/fpt/caseplanning.shtml)
  - Eugene and the upper Clackamas have had studies done relating to geo-hydrology and climate change.
    - Dr. Hejung Chang at PSU (Clackamas)
    - Dr. Gordon Grant at USDA/OSU (McKenzie)

# Results of the Portland

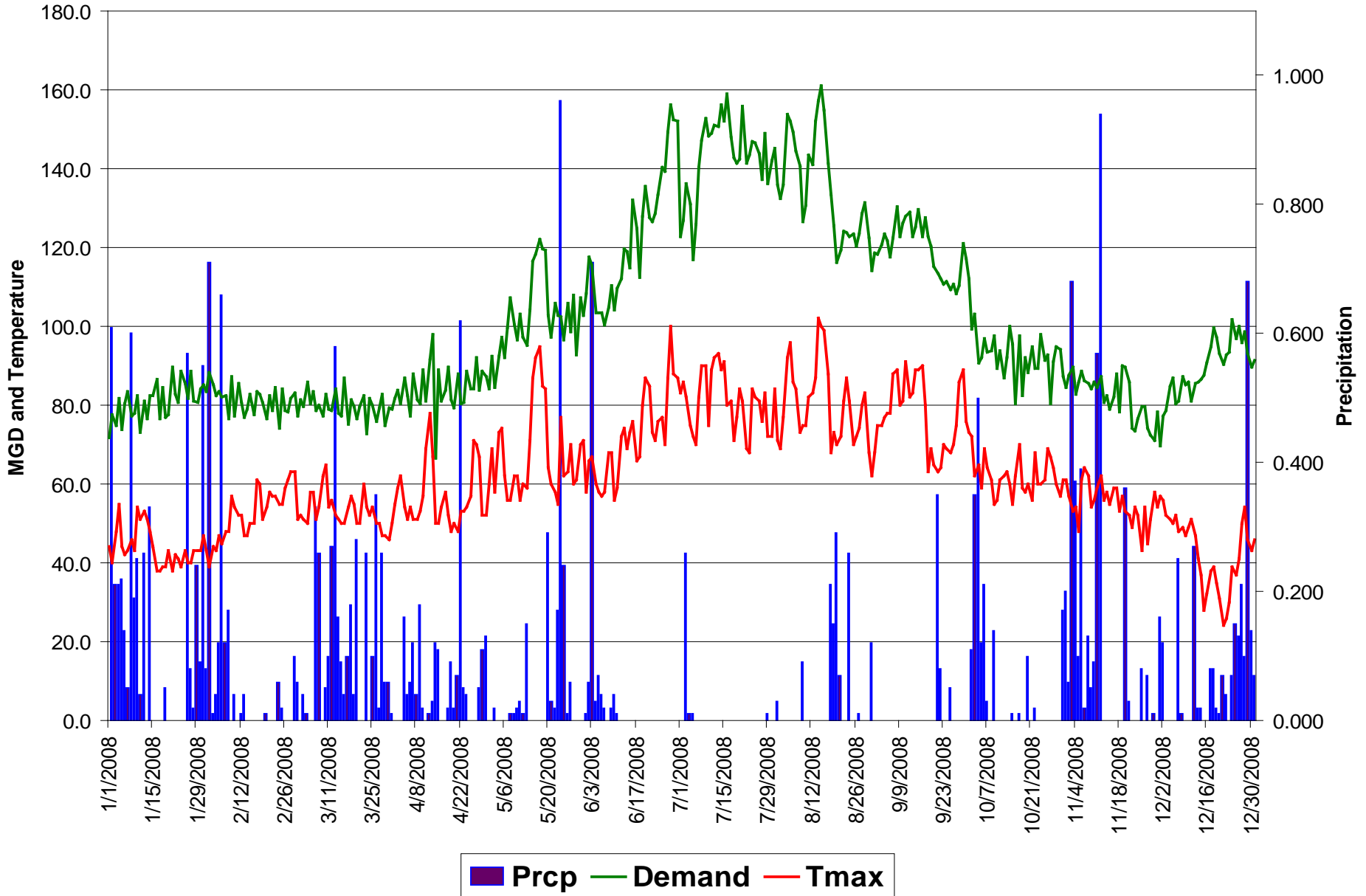


# Results of the Portland Climate Change Study 2002

- The Bull Run is in a transient watershed where climate change scenarios show more water coming as rain in winter and less snow pack to boost inflows in the Spring and longer Fall dry periods.
- The Bull Run reservoirs will still fill in every year, however, the number of years with longer drawdown periods increases.
- Water supplies will be stressed more by future growth, but climate change will compound that impact requiring more groundwater pumping to make up the amount needed.
- This study did not evaluate impacts on groundwater either in the Bull Run or Columbia South Shore

# Portland Water Supply System 2008

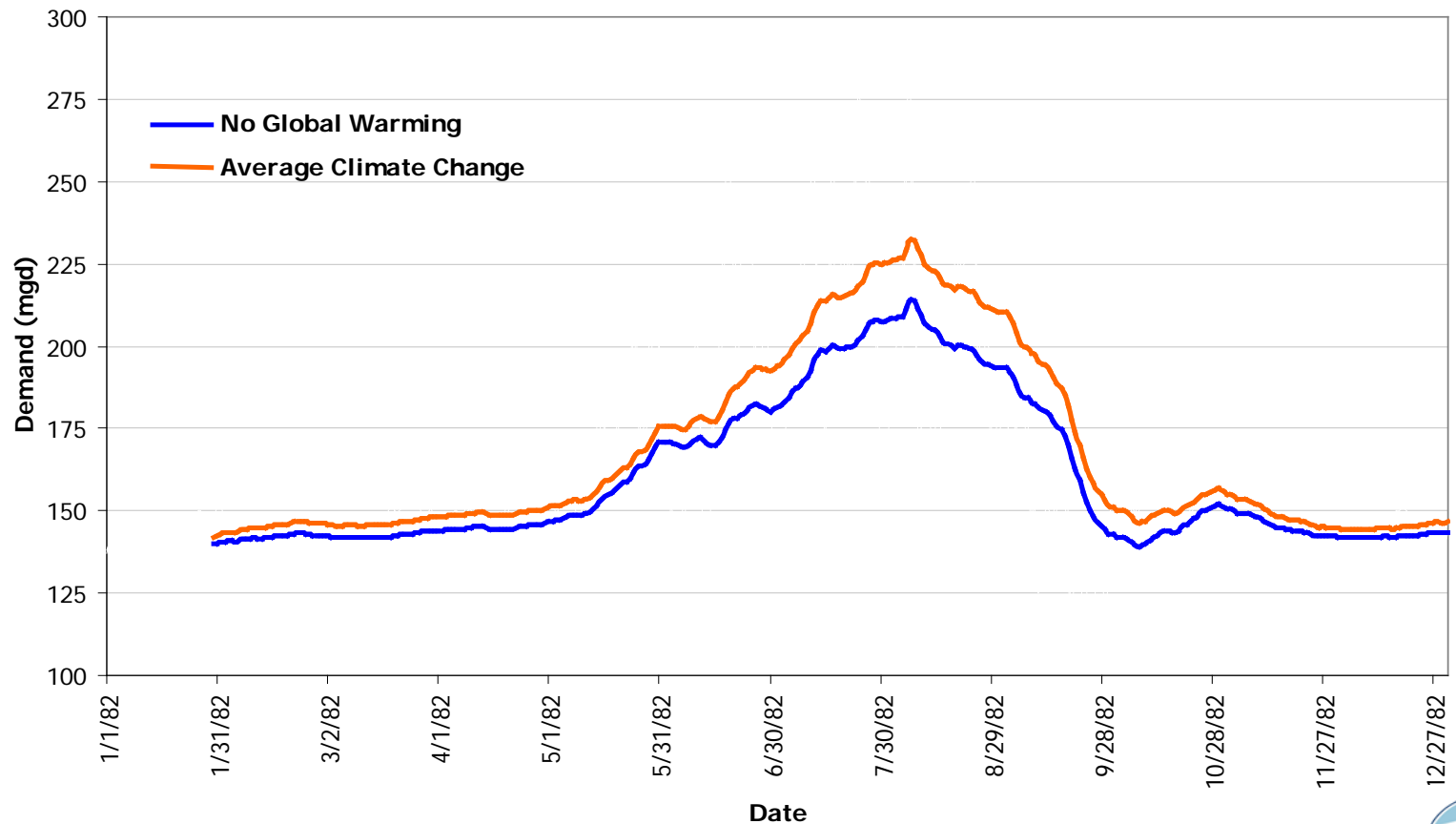
## Daily Demand, Maximum Temperature, and Precipitation





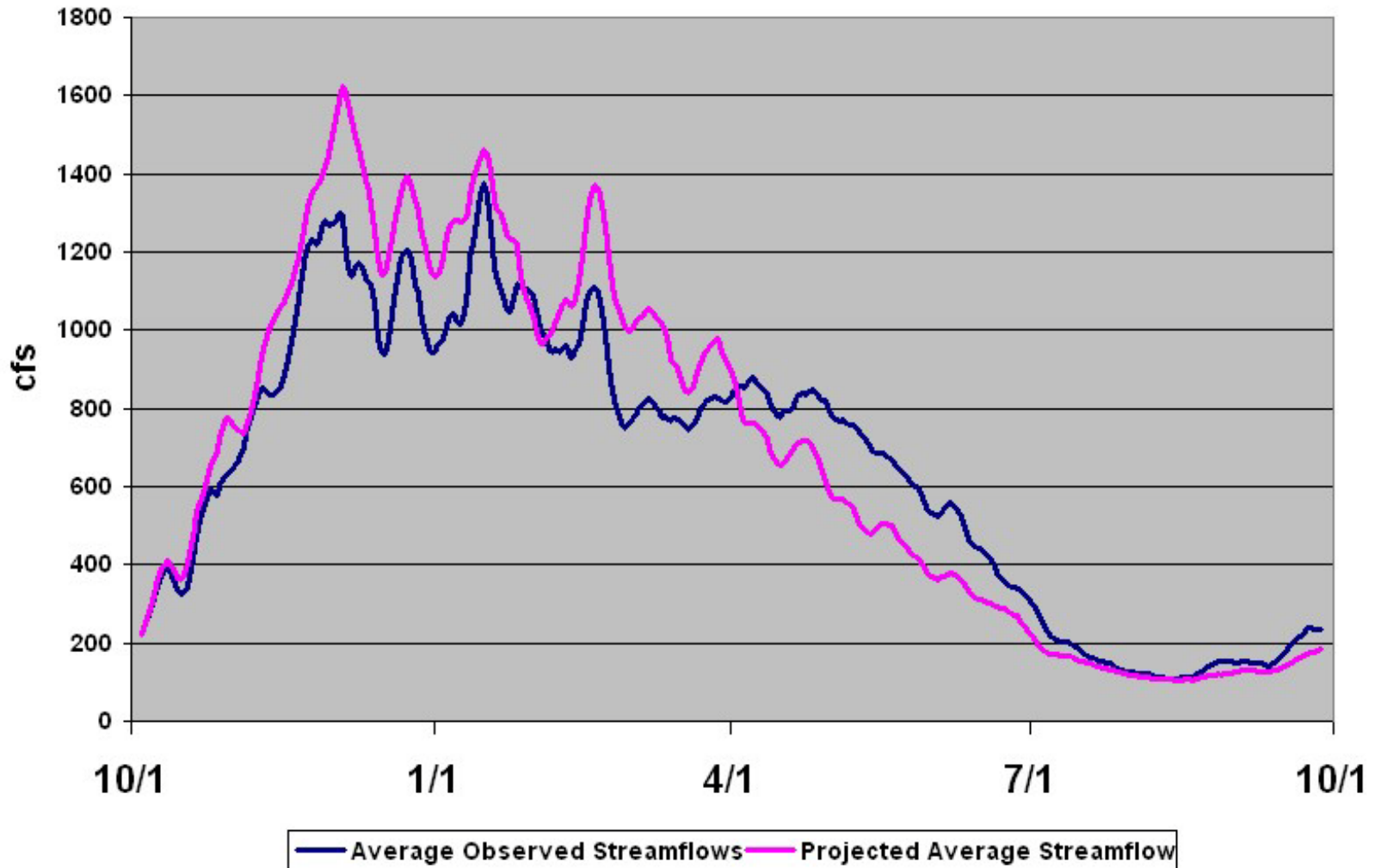
# Modeled Demand on the Portland System in 2040

2040 Forecasted M & I Demand (includes conservation)  
30-day Moving Average



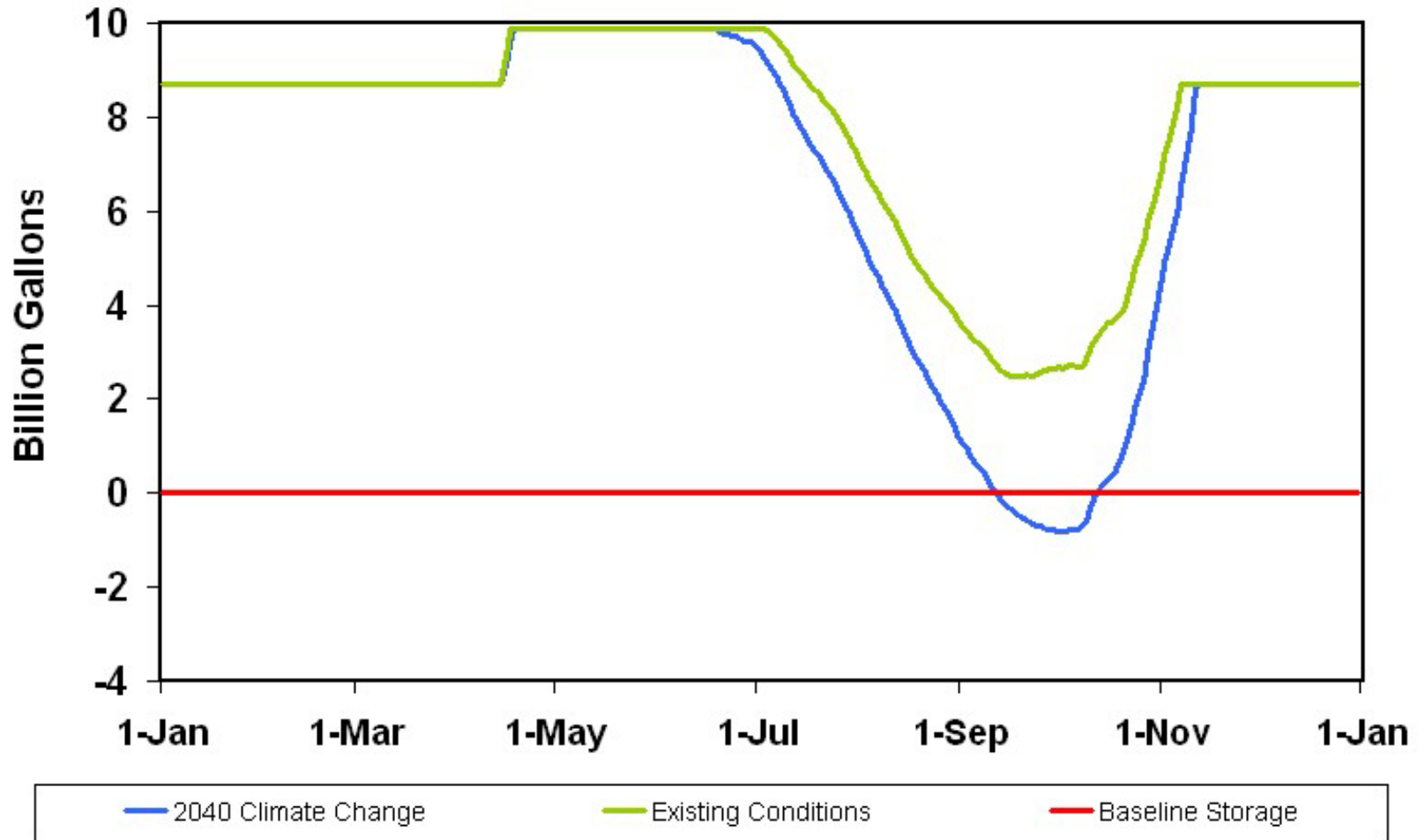
# Bull Run Study: Impacts to Streamflow

7-Day Moving Average Streamflows (1951 - 1998)



# Bull Run Study: Impacts to Supply

## Remaining Usable Storage Comparison



# Adaptation Strategies

- Planning
- Infrastructure Development & Use
- Programmatic & Institutional Actions



# Adaptation Strategies - Planning

- Larger supplies as well as supplies on rivers that have multiple intakes and inflows should consider modeling climate change impacts, particularly where supplies (surface or ground) are impacted by changes to transient watersheds.
- Assess the effects on multiple sources at the same time if possible, otherwise you have disparate decision making information.
- Include climate change effects on both hydrology and water demand patterns.
- Assess the changing cost/benefit ratios for conservation that may result from increased demands and increased costs for new supplies.

# Adaptation Strategies - Planning

- Use integrated models to simulate climate impacts on supply operations including fish flows and water quality parameters (e.g. CWA/TMDL's).
- Look at the newer climate change models developed for the 2007 Intergovernmental Panel on Climate Change Conference, for the Pacific NW these indicate a somewhat slower pace of temperature increases than earlier models, but could be different for other areas. Look at range of model outputs. New modeling happening for next IPCC.
- Evaluate uncertainties involved. Decision making models may be useful to deal with the complexities of uncertainty involved with multiple issues.
- Identify "No Regrets" strategies which deal with both climate change and other current issues (e.g. growth, fish, vulnerabilities, new regulations, wastewater, maintenance) so that there are multiple benefits involved.

# Adaptation Strategies - Infrastructure Development & Use

- Consider more conjunctive use of sources including surface, groundwater, ASR, and non-potable supplies.
- Build more system reliability and robustness through interconnections and backup supplies for emergencies and to capture different regional impacts of future climate change/variability.
- Assess climate impacts on fire regimes in municipal watersheds (including vegetative changes due to climate change)
- More close monitoring & modeling of short term system operations and put in place strategies for dealing with summer supplies in real time.

# Adaptation Strategies - Infrastructure Development & Use

- More storage (dams and ASR) may be necessary to capture the higher winter flow events.
- Assess the potential impacts of changing flood rule curves on municipal and multiple purpose storage projects.
- Evaluate the extreme events possibilities that apply to your situation, particularly multi-year droughts, flooding and sea level rises, and assess various system vulnerabilities.
- In some areas climate change could positively change the cost/benefits of reuse and non-potable supplies.



# Adaptation Strategies - Programmatic and Institutional Actions

- Work with statewide and multi-state entities to engage multiple stakeholders:
  - Look to NOAA Regional Integrated Sciences and Assessment (RISA) at U. of Washington, OSU Climate Change Institute, U. of Oregon Climate Leadership Institute.
  - Western Regional Climate Center in Reno, NV. Covers all of the Western states.
  - Sponsor or participate in local, state, and regional climate conferences and workshops.

# Adaptation Strategies - Programmatic and Institutional Actions

- Use Conservation Programs and pricing to moderate demand effects, particularly during the peak season.
- Develop curtailment plans in a regional context.
- Encouraging more active use of transfers, water markets, water banking, limited duration permits, and “interruptable” water rights to provide added flexibility to deal with change.
- Use full cost or triple bottom line accounting for decision making (economic, social, environmental).
- Provide more dual programs for conservation that reduce energy and water use for individual customers. Link the two issues more.
- There may be even more innovative ideas such as a “cap and trade” program for water that would create fiscal incentives for entities to share supplies and foster more efficient use.

# Mitigation by Utilities

There are mitigation strategies that utilities can adopt:

- ✓ Assess sustainability actions and adopt practices that incorporate reducing greenhouse gas emissions.
- ✓ Use full cost or triple bottom line accounting for decision making (economic, social, environmental).
- ✓ Reduce fossil fuel use, switch to other sources for fleet or electrical energy (solar, wind, other renewable sources), change out vehicles
- ✓ Reduce energy use overall (lighting, paper, etc.)
- ✓ Provide more dual programs for conservation that reduce energy and water use for individual customers. Link the two issues more.
- ✓ Purchase carbon offsets if available

# More Research Needed- 1

There is a lot that isn't known about climate change impacts on municipal supplies:

- Only limited studies have been done, and even then broad assumptions have to be made about the local effects. More paleoclimate studies should be done to understand past variabilities, this will make future predictions more cogent.
- The impacts on hydrology are the most important unknowns that need to be researched, particularly for urban water sources. Impacts of storm tracks and geographic features need to be better understood.
- Research on the impacts on groundwater should to be expanded in Oregon, particularly the relationship of changes between groundwater recharge and surface water flows.

# More Research Needed- 2

There is a lot more that needs to be known about climate change impacts on municipal supplies:

- Impacts on rainfall patterns need to be better understood in the PacNW, as well as extremes.
- Reliable longer term data on production, stream flows, and consumption needs to be collected and available for analysis.
- Synergistic climate effects between flows, fish, flooding, hydro, and water demand patterns present a complex picture that needs more study.
- The role of conservation, reuse, and curtailment need to be better integrated into long supply planning.

## More Research Needed- 3

- Will there be significant population displacements both internationally and within the US? The aspect of “climate refugees” is only just beginning to be assessed. Comparing areas of the US most affected by climate change and areas of high population concentration would seem to indicate that some aspects of climate change will factor into where people move over this century, particularly to the PacNW.

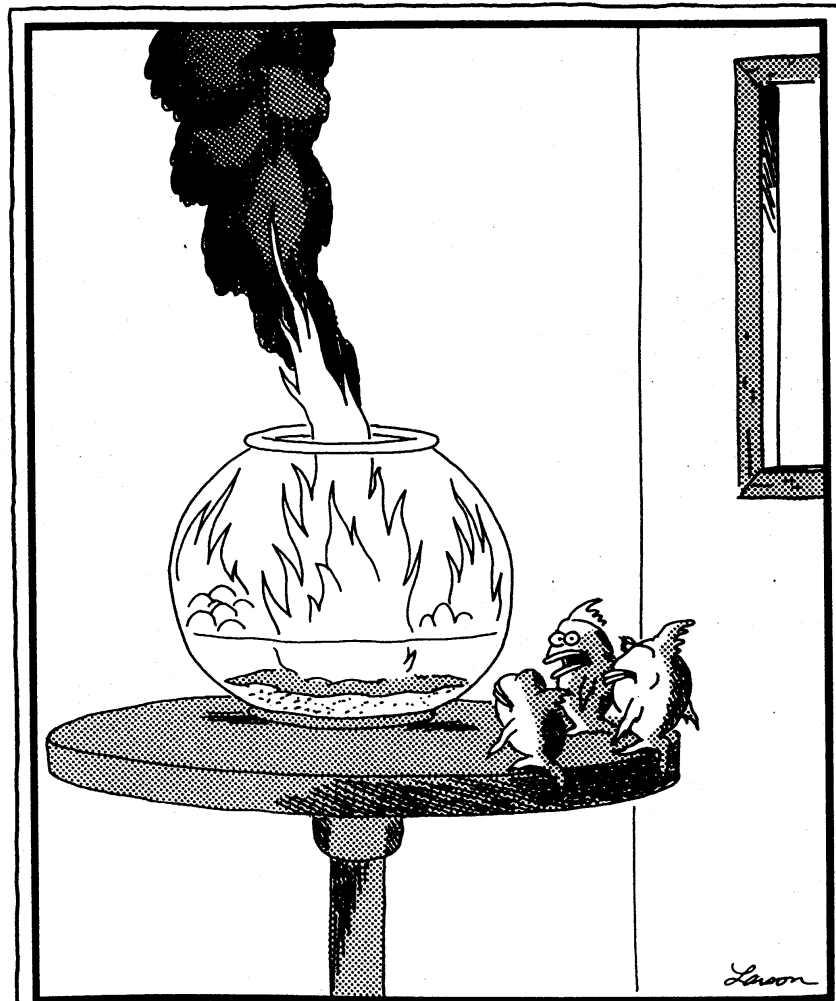
# Recent Climate Change Resources

- University of Washington Climate Impacts Group-  
Guidebook on Climate Change for State, Regional,  
and Local Governments 2007 & Washington  
Climate Impacts Assessment 2009  
[www.cses.washington.edu/db/pdf/snoveretalqb574.pdf](http://www.cses.washington.edu/db/pdf/snoveretalqb574.pdf)  
<http://cses.washington.edu/ciq/res/ia/waccia.shtml>
- Water Research Foundation - Primer for municipal  
supplies (*Climate Change and Water Resources: A  
Primer for Municipal Water Providers #2973*) as well as  
a significant multi-year initiative on climate  
change for water industry application.
- Water Research Foundation Climate Change  
Clearinghouse website:  
<http://www.theclimatechangeclearinghouse.org/Pages/ClimateChangeClearinghouse.aspx>

# Water Utility Climate Alliance

- Officially announced in February 2008
  - Portland Water Bureau
  - Seattle Public Utilities
  - Denver Water
  - San Diego County Water Authority
  - Metropolitan Water District of Southern California
  - Southern Nevada Water Authority
  - San Francisco Public Utilities Commission
  - New York City Department of Environmental Protection
- Website for mission statement and comments on WUCA and other materials:  
<http://www.wucaonline.org/html/>
- Contracting studies on decision support modeling white paper and developing one on the science of downscaling global climate models





"Well, thank God we all made it out in time. ... 'Course, now we're equally screwed."

**Climate Change Coming to a Water Supply Near You!**

# Contact Information

Lorna Stickel

Portland Water Bureau

1120 SW 5<sup>th</sup> Ave., Room 600

Portland, Oregon 97204

Phone: (503) 823-1566 (Dave)

(503) 823-7502 (Lorna)

E-mail: [Istickel@water.ci.portland.or.us](mailto:Istickel@water.ci.portland.or.us)

# Action Items for Portland

- Existing and permitted supplies between Bull Run and the Groundwater system are sufficient to meet needs for the next 20+ years, but wholesale contracting is important consideration since other supplies are being planned in the Portland region.
- Using water more efficiently is an important strategy, strong conservation program both at the Portland retail level and regionally.
- Studies on decision support modeling will be done in early 2009 by the WUCA group that Portland belongs to, this work will inform our future study as well as work being funded by the State of Oregon Water Resources Department.
- Portland wants to redo the climate impacts study in a couple more years based on newer GCM's and developing updated hydrologic modeling.
- Advocate for a larger scale look at climate change impacts on municipal supplies in the Portland/Vancouver region.