Appendix C: Climate Change Background Information

Climate Change Background Information

The global climate has changed through time and will continue to change. An increasing number of scientific models and methodologies project an increasing rate of climate change in upcoming years. Applying regional climate models to site-specific project areas makes the conclusions less certain. However, some general projections are possible for the purpose of environmental analysis.

The following projections for the Pacific Northwest are derived from the Climate Impacts Group of the University of Washington, Seattle. Models developed by the Climate Impacts Group project temperature increases during the 21st century with the potential for a slight increase in precipitation during the fall and winter months (Mote and Salathe 2009). A 2009 report (Littell et al. 2009) from the Climate Impacts Group updates the 2005 projections with the following probable regional impacts:

- April 1 snowpack is projected to decrease across the state (30 percent less by 2020) with seasonal streamflow timing shifts, which will be especially noted in sensitive watersheds.
- Rising temperatures may result in increases in stream temperatures that will reduce quality and extent of freshwater salmon habitat.
- Increased summer temperatures and decreased summer precipitation may result in large burn areas and increased susceptibility of stands to insect attacks, especially mountain pine beetles (east side of the North Cascades).
- Although there have been limited statistically significant changes in precipitation in the Puget Sound area, mode simulation predicts higher precipitation in the Puget Sound area.

A summary of the Intergovernmental Panel on Climate Change (IPCC 2007) also included projections for a future with fewer cold days and nights, more hot days and nights, more heat waves, increasing area affected by drought, and an increase in precipitation that falls as rain.

On a regional basis, reports from the Climate Impacts Group predict a scenario for the Pacific Northwest with future warming of approximately 0.5°F per decade with temperatures increasing in all seasons, but particularly in June through August. A larger percentage of winter precipitation would fall as rain rather than snow, with an earlier spring snowmelt, lower summer stream flows, droughts becoming more common, and a greater risk of floods and wildfires.

It was noted in the Washington Climate Change Impacts Assessment from February 2009 (Littell et al. 2009) that decisions with long-term impacts are being made every day, and today's choices shape tomorrow's vulnerabilities. This includes decisions related to land use planning and development, habitat management, flood control, erosion control, water supply, and infrastructure design. Many adaptive actions may create cost savings through damage avoidance by modifying development plans in areas likely to experience greater flooding.

Options for adapting to impacts were identified in the Washington Climate Change Impacts Assessment: Enhancing or Supplementing Washington's Preparation, Adaptation Working Group recommendations, released February 2009. Additional recommendations were highlighted in Furniss et al. 2008, Halofsky et al. 2011, and Peterson et al. 2011. The following are suggestions for adapting to projected higher winter flows:

- Develop property in areas that are less likely to experience more flooding as a result of climate change to decrease the risk of flood damage to the new structures.
- Restore hydrologic function in floodplains.
  - Improving or decommissioning roads to reduce erosion, increase flood plain connectivity, decrease peak flows, and reduce temperature impacts.
  - Restoring wetlands and flood plains to improve ecological continuity, increase water storage, reduce flood flows, increase local late-season summer low flows, and decrease stream temperatures.
- Improve flood forecasting and emergency management systems.
- Alter land use policies.
- Strengthen dikes and levees where appropriate.
- Increase reservoir storage.

The Mt. Baker-Snoqualmie National Forest has experienced flood events over several decades and has developed specific road systems adaptations to high flows which promoted resiliency. The following options are from District files, watershed analyses, and restoration contracts:

- Relocating or moving roads away from river systems when possible.
- Increasing culvert sizes for increased flows.
- Increasing number of relief drainage features.
- Increasing use of bridges versus culverts.
- Restore hydrologic functions with fords, dips in road gradient and rock-lined waterbars.
- Storage of roads when not used, with removal of culverts and sidecast roadbed material.
- Decommissioning road systems no longer needed.
- Using bridges that span the wetted channel.
- Incorporating of large wood into projects along riparian areas to encourage capture of additional wood at the stream edge and to work with stream flow patterns.

Specific adaptation options (from Joyce et al. 2008; Millar et al. 2007) for actions to promote resilience to climate change include the following:

- Planning for projected future conditions, and for unexpected conditions as well as experimenting with novel ideas (or reviving old ideas)
- Assessing decisions in context of barriers and opportunities that limit or facilitate local adaptation

References

Furniss, M.J.; Reid, L.M.; Staab, B. 2008. Water Resources and Climate Change. U.S. Department of Agriculture, Forest Service, Climate Change Resource Center. http://www.fs.fed.us/ccrc/topics/water.shtml

Halofsky, Jessica E.; Peterson, David L.; O'Halloran, Kathy A.; Hawkins Hoffman, Catherine 2011. Adapting to climate change at Olympic National Forest and Olympic National Park. Gen. Tech. Rep. PNW-GTR-844. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 130 pp. http://www.fs.fed.us/pnw/pubs/pnw_gtr844.pdf

Joyce, L.A., G.M. Blate, J.S. Littell, S.G. McNulty, C.I. Millar, S.C. Moser, and R.P. Neilson. 2008. National Forests. Chapter 3 in S.H. Julius, J.M. West (eds.), J.S. Baron, B. Griffith, L.A. Joyce, P. Kareiva, B.D. Keller, M.A. Palmer, C.H. Peterson, and J.M. Scott (Authors). *Preliminary Review of Adaptation Options for Climate-Sensitive Ecosystems and Resources.* A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. U.S. Environmental Protection Agency, Washington, DC, USA, pp. 3-1 to 3-127.

Littell, J.S. (ed.), M.M. Elsner, L.W. Binder, and A.K. Snover. 2009a (in review). *The Washington Climate Change Impacts Assessment, Evaluating Washington's Future in a Changing Climate.* Executive Summary (Final Draft), A Report by The Climate Impacts Group, University of Washington. February 2009.

Millar, C.I., N.L. Stephenson, and S.L. Stephenson. 2007. Climate change and forests of the future: managing in the face of uncertainly. *Ecol Appl.* 17:2145-2151.

Mote, P.W., and E.P. Salathé. 2009. Future climate in the Pacific Northwest. Chapter 1 in The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate, Climate Impacts Group, University of Washington, Seattle, Washington.

Peterson, David L.; Millar, Connie I.; Joyce, Linda A.; Furniss, Michael J.; Halofsky, Jessica E.; Neilson, Ronald P.; Morelli, Toni Lyn. 2011. Responding to climate change in national forests: a guidebook for developing adaptation options. Gen. Tech. Rep. PNW-GTR-855. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 109 pp. http://www.fs.fed.us/pnw/pubs/pnw_gtr855.pdf

Whitely Binder, L.C., with contributions from J. Krencicki Barcelos, D.B. Booth, M. Darzen, M. McGuire Elsner, R. Fenske, T.F. Graham, A.F. Hamlet, J. Hodges-Howell, D.D. Huppert, J.E. Jackson, C. Karr, P.W. Keys, J.S. Littell, N. Mantual, J. Marlow, and D. McKenzie. 2009. *Preparing for Climate Change in Washington State.* A report by The Climate Impacts Group, University of Washington. February 2009.