Preparing for Climate Change in the

Upper Willamette River Basin of Western Oregon

Co-beneficial planning for communities and ecosystems

Executive Summary

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Executive Summary

Global temperatures are rising primarily due to human activities. No matter how fast human-induced greenhouse gas emissions are reduced, emissions already concentrated in the atmosphere likely will produce significant stress worldwide and, following those global trends, transform natural systems in the Upper Willamette River Basin over the coming decades. Changes in the Basin's climate and natural systems will modify the way the local economy functions and produce new stresses on infrastructure and buildings, challenges to human health, and adjustments in the quality of life of the people who live in and enjoy the Upper Willamette River Basin. Numerous initiatives already are underway within the region to help prepare people and landscapes for these effects. However, expanding these already ongoing activities and launching the additional climate preparation efforts described in this report in an integrated and co-beneficial manner can further build resistance and resilience to climate change across natural, built, human, and economic sectors, and help people and communities in the Upper Willamette River Basin adapt and thrive over the coming century.

In the fall of 2008, the University of Oregon's Climate Leadership Initiative (CLI) and the National Center for Conservation Science & Policy (NCCSP), in partnership with the Mapped Atmosphere-Plant-Soil-System (MAPSS) Team at the U.S. Forest Service Pacific Northwest Research Station, initiated a project to assess the likely consequences of climate change for the Upper Willamette River Basin. The project began by considering projected changes in temperature, precipitation, fire patterns, and distribution of native vegetation, based on three global climate models assessed by the International Panel on Climate Change (IPCC) and a vegetation model developed by the MAPSS Team. The three global climate models applied in this study have been internationally reviewed and are considered scientifically credible and represent a range of climate projections from moderate to severe warming in the coming decades. Projections of future temperature and snowpack are considered to be more reliable than projections of precipitation and fire, which are highly uncertain.

CLI and NCCSP convened a panel of scientists and land managers to assess the likely stressors to natural systems posed by projected changes in climate and to make recommendations for increasing the capacity of ecosystems and species to withstand and adapt to those stressors. Using these projections and recommendations, a panel of policy experts then assessed the risks posed by likely climatic changes to built, human, and economic systems within the Upper Willamette River Basin and recommended ways to prepare for the negative impacts of climate change on those systems. This report provides key findings on the expected impacts of climate change across each of these sectors and provides recommendations, including both long-term strategies and short-term actions that communities and governments can take right now to prepare for and lessen these impacts while there are still viable options.

Key Findings: Future Climate Conditions

Conditions in the Upper Willamette River Basin are projected to change substantially during the coming century. The climate models, which represent complex relationships among global drivers such as air and ocean currents, water vapor, CO_2 uptake by plants, and others, project the following likely changes to temperature, precipitation, wildfire, and vegetation distribution:

Temperature

- Annual average temperatures are likely to increase from 2 to 4º F (1 to 2º C) by around 2040, and 6 to 8º F (3 to 4º C) by around 2080.
- Summer temperatures may increase 4 to 6º F (2 to 3º C) by 2040 and 4 to 8º F (2 to 4.5º C) by 2080, while winter temperatures may increase 1 to 2º F (0.5 to 1º C) by 2040 and 2 to 4º F (1 to 2º C) by 2080.

Precipitation and Snowpack

- One model shows a slight increase in mean annual precipitation while the other two show no real change.
- By 2040, all three models predict slightly less precipitation during spring, summer and fall and two models predict slightly more precipitation in winter.
- By 2080, precipitation patterns could range from a slight year-round decline to large increases causing monsoon patterns in the spring and drought in the summer.
- Snowpack across the Pacific Northwest could decline by 60% by 2040 and 90% by 2095.
- As snow melts earlier in the spring stream flows will peak earlier, but at lower levels than has been typical in recent years depending on the geology of the particular stream reach.

Storms and Flooding

- With warmer oceans and more available moisture in the atmosphere, storm events could increase in intensity, resulting in more flooding in all rivers in the Basin.

Wildfire

- One model projects conditions that may lead to more wildfire and a much greater proportion of area burned, while the other two models anticipate little change from historic conditions.

Vegetation Change

- The current climate throughout much of the Basin is suitable for coastal spruce and fir, but the future climate in the western portion may be more suitable for mixed pine, hardwoods, and oaks while the eastern portion may support ponderosa pine and Douglas- fir.
- Plant and wildlife communities may take decades or centuries to adjust to temperature changes, making the timing for changes to dominant vegetation difficult to project. Fire is expected to be a major agent of vegetation change, even if fire incidence does not increase.

Key Findings: Consequences of Projected Climate Change on Natural Systems
Based on projections for changing climate conditions, the science panel identified the following likely consequences for aquatic and terrestrial systems and species in the Upper Willamette River Basin:

Aquatic Systems and Species

- Increased winter storm intensity and changes in seasonal precipitation patterns are likely to produce somewhat flashier, more dynamic stream flow patterns that impact a stream's ability to maintain high quality habitat, while the influence of higher temperatures on "effective precipitation" will lead to an expansion of the low flow period beyond summer months into spring and fall and is likely to increase water temperature. Both changes are detrimental to the reproduction and survival of native fish and amphibians. Species that are more resilient to disturbances will be favored.
- A potential shift to extended years of wet weather followed by extended years of drought will likely impair stream system and floodplain function. In combination with floodplain development and predicted changes in vegetation patterns, this shift is likely to critically degrade the natural capacity of the land to store excess water during flood and slowly release it during drought.
- Changes in vegetation, precipitation, snowpack and snowmelt will impact the timing of peak and low flows, and directly impact timing of spawning, hatching, and migration of young salmon and steelhead to the ocean.
- Warmer temperatures are likely to benefit non-native fishes and amphibians while harming native species, resulting in the decline of Chinook salmon, steelhead, and Oregon chub. Warm water native species will be favored over those less tolerant to higher temperatures.
- Some stream reaches are especially vulnerable to climate change effects because they already are over-allocated, experiencing temperature problems, prone to "flashy" runoff responses during which rainfall or snowmelt rapidly moves through a stream system over a short period of time, surrounded by contaminant sources, or impaired or constrained by current land-use practices. In addition, some streams are vulnerable to climate stresses because of their size, shape, substrate, or location in the watershed (e.g., the Coast Fork, headwater streams, and unique or isolated habitats).
- Although flow in the McKenzie River is likely be impacted by climate change, it also has a greater chance of maintaining cool water temperatures and therefore is expected to remain the best stronghold for fish in the Upper Willamette River Basin. The Middle Fork will likely see more moderate changes in flow, which could also potentially support healthy fish populations.
- Because the McKenzie watershed is vital to Eugene's municipal water supply in the summer months, increased summer drought and evapotranspiration could lead to seasonal water shortage.

Terrestrial Systems and Species

- Without sufficient time to adapt or evolve to environmental changes, declines in many plant and wildlife populations found in the unique habitats of the Basin are expected. Warmer temperatures are likely to provide more favorable conditions for disease, insect pests, and invasive species that will impact wildlife and their habitat. Native species that are more tolerant to higher temperatures will be favored.
- Ecosystem services, the goods and services that humans gain from natural ecosystems, are likely to be reduced with the unraveling of ecological communities and loss of species.
- Vegetation could become drought stressed due to higher temperatures, decreased summer precipitation, and potential decade-long droughts. Drought stress would lead to broad scale vegetation die-off and replacement with new vegetation communities or invasive species.
- Some species will be especially at risk, including those at high elevations (alpine and subalpine species), species that depend on old-growth forests (e.g., northern spotted owl), moisture dependent species (e,g., waterbirds, some salamanders and land snails), species that are already rare and declining, and maritime evergreen associated species (e.g., marbled murrelet).
- Areas especially at risk include: lower elevations of the Basin and the Coast Fork, where stressors such as erosion, development, and logging already are higher; and the interface between public and private lands, where management issues such as fire and invasive species control become problematic due to differing objectives.

Both Aquatic and Terrestrial Systems

- If not mitigated, the impacts of current ecological stresses, including pollutants, loss of habitat to development, erosion from roads, habitat fragmentation, and many others will become worse as climate change amplifies these impacts.
- Both aquatic and terrestrial species are unlikely to be able to keep up with the rapid rate of climate change due to limits on the rate of evolutionary adaptation and fragmentation of migratory corridors, leading to declines in wildlife populations and extinction of some species.
- Climate change will lead to new and surprising species relationships, as well as unexpected “winners” and “losers.” Many changes are difficult to predict, as competition will increase between species that currently do not occupy the same area and species will adjust in unpredictable ways to the myriad of ecological changes expected from climate change.
- A growing human population, due to people seeking better climate conditions and to continued population growth, will increase demand for water, energy, and land, all of which will stress the landscape’s ability to support natural communities.

Key Recommendations: Preparing Natural Systems for Climate Change

The panels made the following recommendations to prepare aquatic and terrestrial systems for climate change:

- Target for conservation areas – areas that provide ecosystem services, such as recreation, flood control, and water storage; areas that provide "climate refuge" in the form of cooler climates and less vegetation change; and intact ecosystems that have few external stressors.
- Maintain and restore ecosystem function (processes like nutrient cycling, seed germination, etc.) and connectivity, giving priority to the following: mid- to high-elevation wetlands, forested areas with unnaturally high fuel loads, wild fish populations, streams with artificial barriers, floodplains, and active forestry lands that can be managed for connectivity.
- Increase early detection and rapid response efforts to identify, manage, and control invasive species. Develop standards for determining when species are considered invasive and when they are successfully shifting their ranges due to climate change.
- Base resource management decisions on a thorough understanding of the system, climate change projections for the area, and careful consideration of the outcome of alternative management actions with the goal of maintaining maximum resiliency, flexibility, and reversibility.
- Adopt a new conservation approach, using traditional conservation tactics that build resistance and resilience and with an awareness of climate changed realities. For example, restore natural processes, but not necessarily to historical patterns or range of variation; focus instead on ecosystem function under future predicted climate change patterns.
- Update methods for resource monitoring and evaluation in order to detect climate change impacts and trajectories while testing the efficacy of management action. Because ecological communities are expected to unravel, monitoring of individual species, in addition to ecosystems, will become increasingly important.
- Work across jurisdictions to develop interdisciplinary strategies for climate change resilience and resistance.
- Replace the multiple use approach to federal lands policy with a whole systems approach that strives for sustainability, ecosystem function, and maintaining biological diversity.

Key Findings: Consequences of Projected Climate Change on Built, Human, and Economic Systems

Based on projections characterizing a likely climate-changed future and the analysis by the participants of the natural systems workshop, the policy panel identified the following risks to built, human and economic systems in the Upper Willamette River Basin:

Infrastructure, Transportation and Buildings

- Increased flooding and wildfire could threaten buildings, transportation systems, and other public infrastructure.

Energy Systems

- Reduced snowpack and summer water storage in reservoirs behind generation facilities is likely to diminish hydroelectric generation, and wildfire may threaten power lines.

- Wildfire and persistent summer drought may threaten biomass generation supply.

Public Health and Emergency Services

- Increases in ground level ozone, increased allergens, degraded air quality, and increased wildfire likely will cause higher rates of asthma and other respiratory diseases.
- Warmer waters and more mosquitoes and ticks are expected to lead to an increase in insect-related diseases such as West Nile and Lyme disease, as well as water-borne disease such as *Cryptosporidium parvum.*
- Higher temperatures likely will lead to increased heat stroke and cardiovascular disease, particularly for those without air conditioning.
- Warmer temperatures may lead to more food contamination.
- Higher concentrations of populations amplified by growth from climate refugees may create conditions for communicable disease outbreaks.

Agriculture and Forestry

- Reduction in snowpack will diminish water supplies for irrigation from streams, reservoirs, and groundwater pumping.
- Crops sensitive to higher day and nighttime temperatures, such as wine grapes, will lose viability. Other crops may benefit from a longer growing season.
- Wildfire and persistent drought may reduce levels of timber harvest.
- Disease and drought stress may reduce the productivity of current timber stands, particularly conifers.

Manufacturing, Retail and Service Sectors

- Higher energy prices due to reduced hydroelectric production and reliance on more expensive wind, solar, and biomass energy sources will increase costs for all economic sectors.
- Reduced snowpack and warmer winter temperatures will impair winter recreation, but spring and summer recreational opportunities may expand due to warmer temperatures.
- Increased flooding and wildfire will isolate communities and disrupt transportation systems.
- Increased runoff will increase costs of treating public water supply.
- Because our food system is currently heavily reliant on imported foods, disturbances to transportation systems could have ramifications for food security.

Key Recommendations: Preparing Built, Human and Economic Systems for Climate Change

The policy panel made the following recommendations to prepare human, built, and economic systems for climate change:

Local Government Planning, Public Infrastructure and Building Agencies

- Limit expansion of residential development into areas still dominated by natural vegetation or into floodplains, in order to protect wildlife, reduce flood and

wildfire risk to structures, retain the land's capacity to moderate flood and drought.
- Land use regulation and zoning should account for projected climate changes and reduce sprawl and further stress on floodplains and forests.
- Adopt more effective ways to manage development and expansion of services while anticipating climate refugees.
- Provide incentives for maintaining ecosystems that provide services to people.
- Incorporate energy efficiency and waste reduction in all buildings.

Emergency Management Agencies
- Governments should shift emergency service responsibility to private landowners in areas of high risk for flooding and wildfire to discourage further development in these areas and to reduce costs and risks to personnel.
- Implement educational outreach to private landowners to inform private citizens on risks, methods for protection, and responsibilities.
- Design and implement proactive measures such as bioswales (landscaped areas designed to trap silt and pollutants from surface water), fuel reduction around homes, and others steps that minimize the extent to which new development amplifies natural disturbances (like flood, droughts, and fire).

Public Health Agencies
- Retain flexibility in vector control programs to adapt as the climate changes and new information is obtained. (A vector is an organism that transmits disease, such as a mosquito.)
- Prevent contamination of shallow wells and surface water.
- Plan for cooling centers for extreme heat events, and response to asthma and other respiratory outbreaks.

Agriculture and Forestry
- Agricultural agencies should research and develop new crop varieties suitable for warmer and drier climate.
- Local governments should encourage local food production to build resistance to transportation disruptions.
- Local governments should embrace policies that protect land from urban sprawl and encourage water efficiency.
- The state water resources department should reexamine existing water rights system, assess groundwater resources and well capacity, and reevaluate existing permits in light of climate changed water availability to avoid over-appropriation.
- The Oregon Department of Forestry and the USDA Forest Service should research how transitions in growing conditions affect reforestation decisions and how resilience to climate-induced impacts can be enhanced with revised management strategies.
- Economic development agencies should link preparation strategies to economic development opportunities; for example, integrate interface fuel reduction efforts for reducing the risk of wildfire with biomass energy production through the

development and application of guidelines to ensure sustainable biomass harvesting.

Manufacturing, Retail and the Service Sectors

- Implement energy and water efficiency strategies to encourage a reduction in demand.
- Install on-site renewable energy systems like solar photovoltaic panels to insulate businesses from power outages due to storms or wildfire.
- Protect workforces from climate-induced health impacts like heat stress.

Key Recommendations: Preparing Governance Structures for Climate Change

A consistent theme heard from the panels was the need for new types of information, resource allocations, and decision-making mechanisms. In short, the panels called for new and expanded forms of governance. Specific recommendations include:

- Consider governance that crosses traditional boundaries, for instance from counties and cities to watershed or climate region, and seek options that offer benefits for all sectors
- Because climate change expands the realm of the issues and people that may be affected by projects and policies, expand participation to planning teams for greater benefits.
- Utilize scenario planning and manage for the future range of vulnerability.