DRAFT

Oregon's Integrated Water Resources Strategy
Issue Papers

November 18, 2010
Version Two

Forward

During Summer 2009, four Water Resources Commissioners—Mary Meloy, Jeanne LeJeune, John Jackson, and John Roberts—took the lead researching and writing seven "issue papers" to set the stage for Oregon's Integrated Water Resources Strategy. These papers are designed to convey the urgency of planning for the future of Oregon's water resources. The papers cover several topics from an Oregon perspective, and serve as the "problem statement" portion of the Integrated Water Resources Strategy.

The first version of the issue papers were released for public comment in late 2009. Comments and suggestions based on this version were very detailed and helpful, resulting in entirely new essays, such as "Federal Storage," "Land-Use Decisions," "Groundwater – Surface Water Relationship," and more. As you review this second version of papers, please let us know whether you believe your input is accurately reflected herein.

The Project Team made every effort to incorporate as many suggestions or changes as possible. However, more work is needed to fully develop certain concepts or issues. Sections that need more discussion are highlighted throughout the papers. We anticipate developing four versions of these papers, and welcome any help to expand on existing concepts or to add new discussions.

These papers are open to public review and comment until March 1, 2011. The Project Team welcomes your input and invites you to send any written comments you care to make to waterstrategy@wrd.state.or.us, with "Issue Paper Comments" in the title of the email. Please include your name and contact information, and indicate if you do not want your comments to be made public. We appreciate your interest and encourage your involvement as we move forward.

Introduction: the Need for an Integrated Water Resources Strategy

"A problem well stated is a problem half solved."
Charles F. Kettering

Oregon currently has no formal water management strategy. It is one of many states without an integrated strategy that takes into account water quantity, water quality, and ecosystem needs. An integrated water resources strategy is needed as we develop a vision of what Oregon's livability and economic viability will look like for future generations. While no two communities are identical, they all have similar hydrologic elements, such as river systems, aquifers, springs, and ecosystems. They have other similarities too, including a need to coordinate with neighbors, a need for local solutions to local challenges, and a need for funding. An integrated strategy will provide relevant and consistent guidance to Oregon communities. Implementation of such a strategy should consistently move Oregon toward the preservation, restoration, and development that is necessary to achieve the desired vision of healthy waters everywhere in Oregon.

The state's statutory mandate is to develop a strategy designed to meet Oregon's instream and out-of-stream needs. This language, included in HB 3369 (2009), is a refinement of an already existing mandate to formulate and enforce a coordinated, integrated state water resources policy, designed to encourage, promote, and secure the maximum beneficial use and control of such water resources and the development of new supply. In statute (ORS 536.220), the Legislature directs Oregon's Water Resources Department to work closely with the Oregon Department of Environmental Quality and Oregon Department of Fish and Wildlife to develop the strategy in consultation with other agencies, tribes, stakeholders, and the public. The Strategy is to be an "action" plan for the state now and into the future. For the full text of ORS 536.220, as well as details about process and timeline, please refer to the *Preliminary 2009-12 Work Plan: Oregon's Integrated Water Resources Strategy* .

A Limited Supply of Clean and Abundant Water

Although water supply is considered a renewable resource, in a very practical sense it is a finite resource, further limited by water quality, geographic location, and transport costs. Many of Oregon's built communities, along with Oregon's fish and wildlife, face water scarcity today. Most of the state's surface waters are fully allocated during summer months, and there are several areas where groundwater use is severely limited by supply problems or quality issues. These pressures will likely be intensified by population growth, changes in land use, and climate change.

The degradation of groundwater and surface water quality also decreases the volume of fresh water immediately available to water users and the environment. Freshwater bodies have limited capacity to process the pollutant load from urban, industrial, and agricultural uses. Low stream flows can often mean a greater concentration of pollutants in the water. Water quality degradation often contributes water scarcity.

Without a better understanding and a plan to meet our water needs in a balanced way, Oregonians will likely cross a water scarcity boundary without even knowing it. Recognizing the inextricable link between water quantity and water quality is inherent to the success of this strategy.

The Value of a Strategy

An integrated strategy will provide a blueprint for the state to follow as it prepares to meet Oregon's water needs: instream and out-of-stream; above ground and below ground; now and in the future.

Water is an important component of everything we do in Oregon. The state's industrial and commercial sectors, agriculture, recreation, tourism, electric power, navigation, and residential uses are all dependent on reliable, clean water. Oregon's fish and wildlife depend on clean and abundant water and healthy habitats,

which is supported by functioning and resilient watersheds, wetlands, floodplains, aquifers, lakes, estuaries, and the ocean. Water has incredible value, meaning, and use for many communities, including tribal, agricultural, rural, urban, and coastal communities. Clean and reliable water supplies also ensures the ability to protect public health through safe drinking water, and to protect public safety through fire suppression.

In addition to a focus on the water resource itself, the Strategy presents an opportunity to discuss and assess the infrastructure that diverts, stores, treats, and transports significant volumes of water throughout Oregon. Well-maintained and adequate infrastructure is critical for ensuring the economic, ecological, and cultural benefits mentioned above.

This Integrated Water Resources Strategy will serve several purposes. It will:

- encourage planning at a watershed or basin level, providing a framework for local communities to facilitate and complete their own integrated water management planning;
- balance competing uses of water, by paying attention to environmental costs and benefits, economic impacts, societal values, and trade-offs;
- promote water conservation, water re-use, source protection, and supply development to enhance water quality and quantity;
- encourage participation of all units of government, stakeholders, tribes, and the public;
- provide a framework for local communities to facilitate and complete their own integrated water management planning;
- foster public health and safety; and
- address existing institutional barriers that reduce the ability to effectively manage water resources.

Building on a Foundation of Data

The Strategy benefits from the participation of 14 natural resource and economic development agencies at the state level and another 10 agencies at the federal level. An appendix that outlines the management of water resources among these various agencies is currently in development and will be included in a later version of the issue papers. This "Agency Appendix" will provide more information about the data, tools, and programs currently available through Oregon's natural resource agencies and will help identify opportunities for agencies to jointly develop data on an ongoing basis.

The public and private sectors at the local, state, and federal levels have produced a plethora of plans and studies focused on water quantity, water quality, and other water-related issues from environmental, business, socio-economic, hydrological, and geological perspectives. For instance, municipal water providers and irrigation districts maintain water use data and water demand forecasts, in order to plan and fund water supply and distribution to their service territories. The Water Resources Department has begun to pull this collection of data into a centralized, usable format, through an on-line inventory of potential storage sites, potential conservation programs, and a 50-year water demand forecast. In addition, the Department has made many of its quantitative tools available on-line. However, a wide variety of methodologies, formats, and geographic coverage often makes it difficult to compile and analyze this data at the state level. This Strategy may provide an opportunity for further discussion about standardization and information sharing as a way to build upon the existing information as well as collect new information to help determine Oregon's long-term water needs.

Developing a Strategy through Collaboration

The Water Resources Commission has statutory authority to review and adopt the Integrated Water Resources Strategy, with the Water Resources Department leading the development efforts. An essential part of the Strategy is the collaborative process of building the plan. Water is a subject in which everyone is a stakeholder and must be given an opportunity to participate in and shape the process. A participatory approach is an effective means for achieving consensus and long-lasting agreement. Real collaboration takes place only when stakeholders and the interested public are part of the decision-making process. Incorporating the views of a wide variety of governmental agencies, stakeholders, and the public will be a challenge, but is key to the success of such a Strategy.

At the end of the process, the Water Resources Commission will be responsible for formal adoption of the Strategy, having notified the Environmental Quality Commission, Fish and Wildlife Commission, and Department of Agriculture/Board of Agriculture.

Conclusion

A successful Strategy would result in a persuasive visualization of what Oregon's water and landscape should look like and be like for future generations. This Strategy will provide a framework for future efforts in terms of data collection, information sharing, program development, funding mechanisms, and education and outreach opportunities. It will include a vision for the future of water resources with goals, objectives, and recommended actions to implement a desired outcome. With updates every five years, the Strategy can be adapted or adjusted as better information becomes available, helping Oregon to stay on course with the goals identified. It will necessarily touch upon a wide spectrum of water resource issues and actions that will help the state meet the goal of better understanding and meeting Oregon's water needs.

Sources

Oregon Department of Conservation and Land Development, *Oregon Estuary Plan Book*. 1987.

Oregon Water Resources Department, *Taking a Look at Oregon's Water.* WRD Infosheet No. 5. March 2007.

Oregon Water Resources Department. *A Report by the Water Quality Quantity Task Force*. February 1997.

Water Quantity

Understanding water needs, sources of supply, and available water are necessary building blocks for developing a statewide, integrated water resources strategy. The purpose of this paper is to describe, in general terms, the context and current understanding of water quantity in Oregon for all beneficial uses, and the need to constantly improve upon this understanding. The paper briefly highlights the issues many Oregonians are facing, in terms of meeting their water needs. Further information related to data and technical information requirements, research needs, goals and objectives, and potential solutions will be addressed in future developmental steps of Oregon's Integrated Water Resources Strategy.

Water Rights

Under Oregon law, all water is publicly owned. Any entity wanting to use water must obtain a water right permit from the Water Resources Department to appropriate groundwater, store water, or divert from surface water. Landowners with water flowing past, through, or under their property do not automatically have the right to use that water without a permit from the Department. However, certain uses of surface water, storage, and groundwater are exempt from permitting requirements. These exempt uses are described in Oregon Revise Statute (ORS) Chapter 537.

Any water right to use water must serve a beneficial purpose. A beneficial use of water promotes the economic and general welfare of the people of the state and includes both consumptive and non-consumptive uses from surface water, groundwater, and storage. Such uses include:

Domestic	Fish Life
Industrial	Irrigation
Mining	Municipal
Pollution Abatement	Power Development
Recreation	Livestock Watering
Wildlife	

The major uses of diverted water in Oregon are for municipal use, industrial use and irrigation use. Irrigation for agricultural purposes currently accounts for 85 percent of water diverted in Oregon. Municipal use accounts for 6 percent of diverted water, as does industrial use.

Demands for Water Projected to Increase

Oregon's municipal, business and agricultural communities, along with Oregon's fish and wildlife, are already facing limited water supplies today. Surface water is almost completely allocated during the summer months, when it is needed most. As we rely increasingly on our groundwater resources, water levels have dropped precipitously in some areas. The state has designated critical groundwater areas in the Umatilla Basin, Willamette Valley, and in parts of Central and Eastern Oregon. Population growth, changes in Oregon's climate, and land use changes will challenge our ability to meet our water needs. Without solutions in place, water supply shortages will likely increase in future years.

Prior Appropriation Doctrine

Oregon's water laws are based on the principle of prior appropriation. This means the first person to obtain a water right on a stream is the last to be shut off in times of shortage. In water-short times, the water right holder with the oldest date of priority can demand the water specified in their water right regardless of the needs of junior users. If there is a surplus beyond the needs of the senior right holder, the water right holder with the next oldest priority date can satisfy their needs under their right and so on down the line until there is no surplus or until all rights are satisfied. The date of application for a permit to use water usually becomes the priority date of the right.

The prior appropriation doctrine is the basis of water law for most of the states west of the Mississippi River. East of the Mississippi, the riparian doctrine usually applies. Under the riparian doctrine, only landowners with water flowing through their property have claims to the water. In Oregon, the prior appropriation doctrine has been law since February 24, 1909, when passage of the first unified water code introduced state control over the right to use water. Before then, water users had to depend on themselves or local courts to defend their rights to water.

Each summer as streamflows drop, watermasters regulate junior users of water in order to provide water to senior users and to protect instream uses. There are times when the Water Resources Department must regulate water uses established at the turn of the century as a means to satisfy senior rights. In 2009, for example, the earliest priority date regulated was 1857 on the Little Applegate River in the Rogue Basin.

In 2008, the state commissioned a water demand forecast to estimate demands out to year 2050. According to the *Statewide Water Needs Assessment,* total demand will increase 12.6 percent over the next 40 years, from 9.1 million acre feet to 10.3 million acre feet per year. With the influx of population, the study projects that municipal demand could increase 55 percent, domestic demand (exempt well use) could increase 57 percent, industrial demand will likely remain static, and agricultural demand could increase 10 percent. For more information about the methodology used in Oregon's 2008 water demand forecast, view the *Statewide Water Needs Assessment: Oregon Water Supply and Conservation Initiative* online.

The 2008 demand forecast calculated Oregon's 2008 total statewide consumptive demand at approximately 9.1 million acre feet, and projected that in 2050, the total could increase to about 10.3 million acre-feet, based on projected growth in the municipal, domestic, industrial, and agricultural sectors. Given the many uncertainties, the results actually show a range of demands, between 9.5 and 11 million acre feet for out-of-stream demand.

Figure 1 shows the breakdown of demand by water-use sector. Note that demand for water is projected to rise across all sectors, between now and 2050. Agricultural use for irrigation purposes represents and will likely continue to represent the greatest demand of diverted water in Oregon. The greatest increase in the agricultural sector will likely come from Baker, Gilliam, Grant, Harney, Morrow, Sherman, and Umatilla Counties. The greatest increase in the municipal sector will likely come from Clackamas, Deschutes, Josephine, Lincoln, Polk, Washington, and Yamhill Counties.

Figure 1: Annual Statewide Water Demand Forecast in Acre-Feet

Years	Municipal Systems	Domestic Wells	Industrial	Agricultural	Total
2010	559,123	83,242	533,622	7,880,804	9,056,791
2015	595,570	88,750	533,622	7,983,558	9,201,500
2020	634,641	94,600	535,084	8,088,667	9,352,992
2025	671,637	100,215	533,622	8,196,188	9,501,661
2030	709,440	105,917	533,622	8,306,180	9,655,160
2035	746,890	111,610	533,622	8,418,704	9,810,826
2040	786,675	117,749	535,084	8,533,822	9,973,330
2045	825,817	123,870	533,622	8,651,597	10,134,907
2050	868,885	130,566	533,622	8,772,096	10,305,170

Surface Water

There are 18 river basins in Oregon. Oregon shares three major rivers with other states, the Columbia, Snake, and Klamath Rivers. There are 114,500 miles of rivers and streams, with over 1,400 named lakes. Most of the state's surface waters are fully allocated during the summer months. Over 60 percent of the water rights are for use of surface water.

Surface Water Measurement. The Water Resources Department operates more than 213 stream and reservoir gages throughout the state. About 150 of these gages are operated as near real-time. These gages transmit stream data once every hour. This data is downloaded to the Department's database where it is processed and the streamflow information is updated on the web page on an hourly basis. In addition, information from another 225 gages operated by the U.S. Geological Survey and other agencies is also shared on the Department's website.

The network of stream gages is important in the management of Oregon's surface water. Stream flow data is used for making daily decisions, to protect instream and out-of stream water rights, to forecast floods, plan for recreational activities, to better understand water availability, climate change and plan for future growth. Operating a stream gage network requires trained hydrographic technicians to keep the equipment operating properly, conduct regular measurements at various water elevations, and input the collected information into a central database. Staff review the data, make corrections based on field conditions that may be affected by debris or ice, and finalize the records to meet computation standards established by the USGS. Currently, the state lacks sufficient financial resources to install, maintain, and process data from additional stream gages.

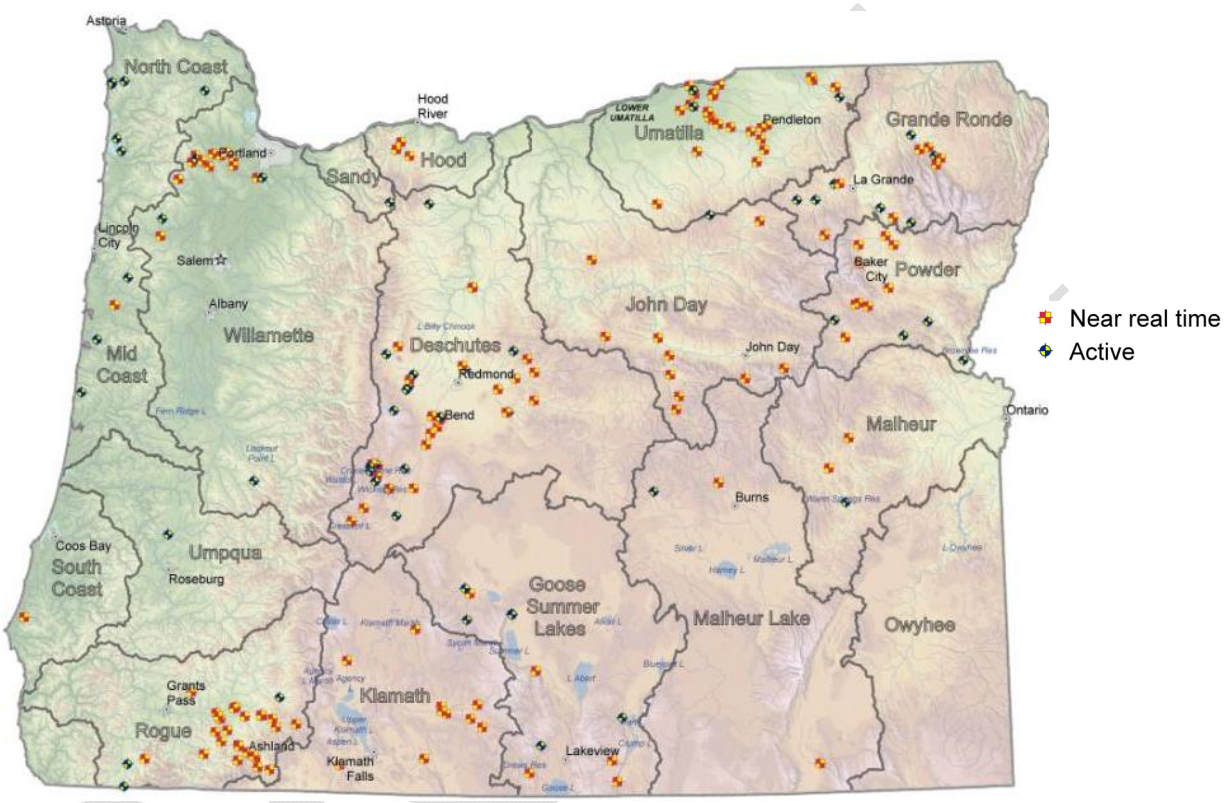

Figure 2: OWRD Gaging Stations

Determining Surface Water Availability. In 1989, the Water Resources Commission directed the Water Resources Department to develop a water allocation policy and to establish a water availability program. The Department developed methodology and data to determine water availability in the context of allocating new water rights. This allocation tool ensures that a new user will be able to use surface water at least 80 percent of the time, or 8 out of every 10 years. The amount of water available for use is affected by natural conditions, such as hydrology and climate, and existing uses of water, including groundwater withdrawals that impact surface water. **Figure 3** shows where water is available for live flow allocation during the month of August, the month most representative of low summer flows and high out-of-stream demands. With some exceptions, the map indicates that throughout the state very little water is available for new direct surface water uses.

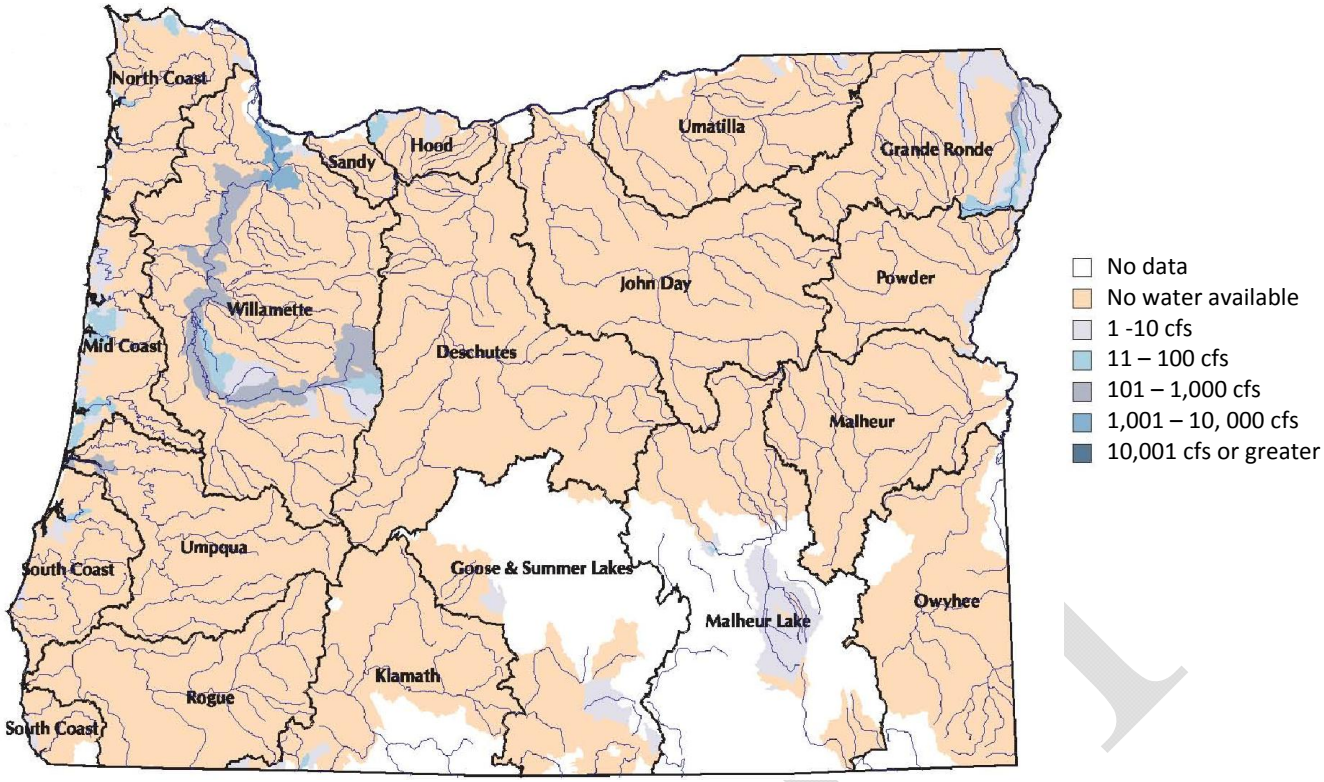

Figure 3: Water Availability for August at 80% Exceedance

By contrast, the map in **Figure 4** shows where water is currently available for allocation during January (the month most representative of higher winter flows and less out-of-stream demand). The map indicates in brown where no water is available, mostly east of the Cascades, but there is a large part of the state where water is available for instream or out-of-stream uses during the winter, denoted in blue.

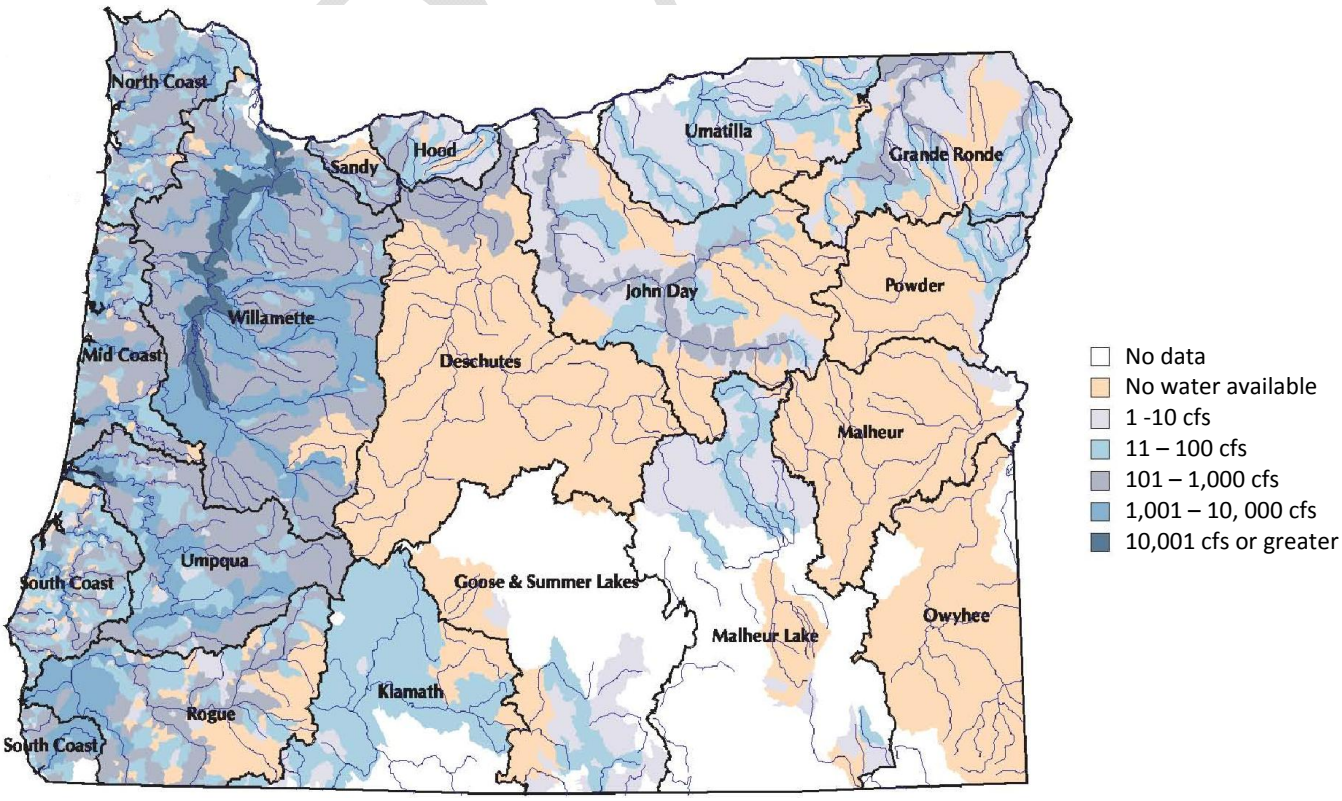

Figure 4: Water Availability for January at 50% Exceedance

Water is a finite resource. It is unevenly distributed in time – plenty of water in the winter when demand is low, little available in the summer when demand is high. Even with a water right in hand, there is no 100 percent guarantee that water will be available when it is needed. For many streams, a new water right would offer little or no access to water, such as in the Malheur, Burnt, and Powder Rivers. If water use increases, more streams will have water available less of the time. The information, tools, and maps in these issue papers represent the baseline data and assumptions available to us today. Changing conditions, including climate, population growth, land-use, and other factors will undoubtedly have an effect on the understanding of water resources in the years ahead.

Storage

There is a mix of both publicly and privately owned storage reservoirs in use throughout Oregon. The largest of these are federal storage projects. There are four significant reservoir systems that are not fully allocated, representing key points of discussion between the state and two federal agencies, the U.S. Army Corps of Engineers (Corps) and the U.S. Bureau of Reclamation (Bureau). In the Rogue Basin and Umatilla Basin, federally owned reservoirs contain available water supplies with solid processes already in place to negotiate contracts for stored water. However, in the Crooked River Basin and the Willamette Basin, it is difficult to secure contracts for unallocated water. Along with options for future out-of-stream allocations, there may be opportunities to adjust dam management in a way that would allow for additional instream flows at critical times.

The Willamette Basin Reservoir System. The Corps operates 13 dams and stores 1.64 million acre-feet of water in the reservoirs located on the Willamette River and its tributaries. Congress authorized the construction of these reservoirs for different purposes, including flood control, navigation, generation of hydroelectric power, irrigation, potable water supply, and for the reduction of stream pollution in the interests of public health, fish conservation and public recreation. In addition, the Corps works with appropriate agencies and groups to determine operating procedures of the reservoirs during the summer months. This coordination helps to maximize recreational use, while maintaining flows in the system at Salem and Albany for water quality, fisheries, and other instream purposes.

Despite the many purposes for which the reservoir projects were authorized, the Bureau filed water right applications (and later received water right certificates) for the entire 1.6 million acre-feet of storage, for irrigation use only. To date, the Corps has not allocated any storage in the Willamette Basin Project reservoirs to for other uses.

The State of Oregon and the Corps recognize that economic development and population growth are creating new demands on water supplies in the Willamette Basin. In 1996, state and federal agencies initiated the Willamette Basin Reservoir Study to analyze water use, project water demand for a variety of uses in the basin, and identify ways to allocate reservoir water to assure the most public benefit within the policies and regulations of the Corps. The Reservoir Study was "put on hold" in 2000 following listing of certain Willamette River fish species under the Endangered Species Act (ESA). The partners in the Reservoir Study agreed that long-term decisions regarding allocation of stored water could not be completed until requirements for listed species were clarified. The ESA consultation process was completed and a Biological Opinion (BiOp) was issued in August 2008.

The 2008 BiOp for the Willamette Basin Project, conducted by the National Oceanic and Atmospheric Administration (NOAA) - Fisheries Service, specified a number of restrictions that will be in place during the 15-year period of the BiOp. These restrictions affect existing irrigation contracts, as well as new contracts for the use of stored water from the Willamette Basin Project reservoirs. The restrictions limit the total amount of stored water that can be provided under existing and new irrigation contracts to 95,000 acre-feet. By comparison, the U.S. Army Corps of Engineers, which manages the Willamette Basin reservoirs, and the U.S.

Bureau of Reclamation, which manages the stored water contracts in these reservoirs have long indicated that there is approximately 1.6 million acre-feet of stored water available for contracts from the Willamette Basin Project. The Water Resources Department continues to discuss these restrictions and potential opportunities with various partners and stakeholders.

Groundwater

Because of increasingly allocated surface water quantities, water users have become heavily reliant upon groundwater resources to meet their needs. This increased pressure, along with other factors, has resulted in the depletion of groundwater levels in several areas of the state. In many instances, applicants for new groundwater appropriations are proposing use from groundwater aquifers that are hydraulically connected to surface water.

Groundwater in Oregon has many valuable uses and functions:

- Groundwater makes up approximately 95 percent of available freshwater resources.
- Approximately 70 percent of all Oregon residents rely solely or in part on groundwater for drinking water purposes.
- More than 90 percent of rural Oregonians rely on groundwater for drinking water.
- Many Oregon businesses rely on clean groundwater for industrial uses, such as food processing, dairies, manufacturing, and computer chip production.
- Groundwater provides water for Oregon agricultural irrigation and livestock purposes.
- Groundwater contributes flow to lakes and streams, providing recreational benefits to humans and supporting species survival and diversity.

Groundwater Investigations. Oregon's groundwater basins roughly correspond with the administrative basins the Department uses to classify its surface water resources. Groundwater studies are iterative and ever evolving. The Water Resources Department generally begins any groundwater study with a "first pass" that develops a water budget for each basin, showing overall volumes of groundwater recharge, discharge, and available water. The Department has completed a "first pass" in three basins: the Deschutes, Klamath, and the Willamette basin. The Department plans to study the following basins as resources become available: the Umatilla Basin, together with its Walla Walla sub-basin; Hood Basin (Eight Mile/Fifteen Mile Creek); Upper Crooked River (High Plains Lavas); Grande Ronde Basin; Malheur Lake Basin; Powder Basin; and Goose and Summer Lakes Basin. As more questions arise or trends emerge (e.g., a focus on "climate change"), the Department updates studies and conducts a "second pass," asking and answering new sets of questions about each basin.

In an environment with limited fiscal resources, groundwater staff members spend a lot of time investigating very specific local questions from county planners, water users, and other local organizations. Additional and still more detailed work is often necessary to address these requests. This involves a somewhat different effort than the Department's traditional "groundwater studies" and represents a significant investment of time for staff. The Strategy could focus on developing partnerships with other state and federal entities that are working to identify and answer the same needs and questions

Restrictions on Groundwater Use – Quantity and Quality. The Water Resources Department has designated 14 *"groundwater limited areas"* in Oregon, 12 of which are located in the Willamette Valley alone. These designations, shown in orange in **Figure 5**, limit future use of certain aquifers to exempt uses of groundwater only. A few limited areas allow minimal irrigation use or withdrawal of groundwater for rural residential fire protection systems. Many of these areas have limited future groundwater uses since the early 1990's.

There are seven existing "critical groundwater areas," in Umatilla, Morrow, Wasco, Washington, and Malheur County. In several of these areas, the Water Resources Department has set specific requirements on the total amount of water that may be appropriated. In some of these critical areas, the Department has the authority to reduce groundwater use, even for existing water right holders. There are two "areas of withdrawal" in Oregon, the Pomona and Priest Rapids aquifers in the Mosier area of Wasco County and the Columbia River Basalt aquifer in the Victor Point area of Marion County. These withdrawn areas prevent any future development of the resource.

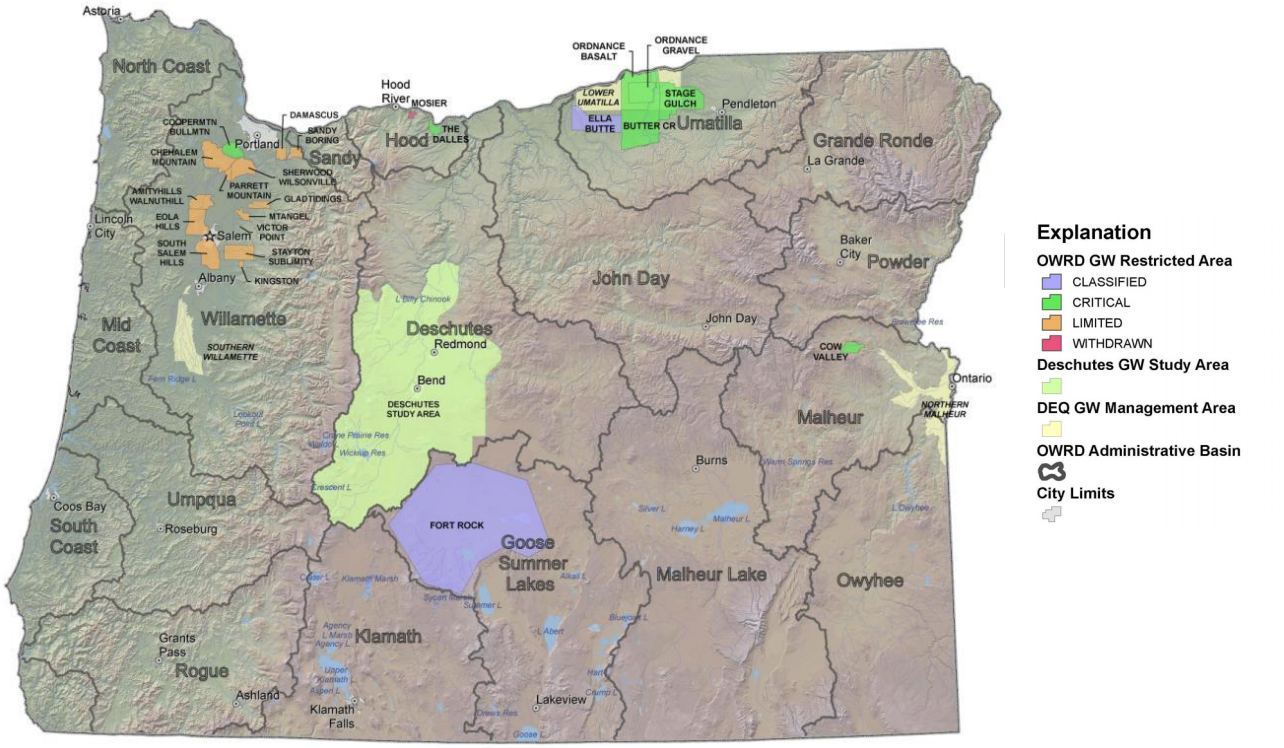

Figure 5: Groundwater Management Areas and Restrictions

The Department of Environmental Quality has authority to declare a groundwater management area (GWMA) when area-wide contamination is found at consistently high enough levels. Oregon has three such areas: the Northern Malheur County GWMA, the Lower Umatilla Basin GWMA, and the Southern Willamette Valley GWMA. DEQ declared all three GWMAs because of widespread nitrate contamination. DEQ is currently helping communities implement action plans that require groundwater quality monitoring, a review of existing data to assess groundwater quality trends, and to support local efforts that implement best management practices (BMPs) to maintain and restore groundwater quality.

All aquifers are susceptible to overdevelopment and contamination. The Columbia River Basalt formations, in particular, are of concern, because their hydrologic and geologic structure makes it easy to pull water out faster than the aquifer can naturally recharge itself. The Columbia River Basalts are deep aquifers, with ancient water that has seeped in over hundreds, if not thousands, of years.

Exempt Groundwater Use. Under Oregon law, "all water within the state from all sources of water supply belongs to the public." In general, a water right permit is required before using water from any well. However, there are exceptions called "exempt uses." These uses are exempt from applying for a water right permit, but must use water beneficially and without waste. Withdrawing groundwater under the exemption carries the same weight as a water right and does have a priority date. An exempt use is subject to the same privileges and restrictions as any water right permit or certificate. Exempt uses are subject to state water law.

In fact, the Department has the authority to regulate, reduce, or halt groundwater withdrawals when they interfere with prior or "senior" water rights.

Common exempt uses of groundwater include:

- Group or single domestic use, up to 15,000 gallons per day (gpd).
- Irrigation of lawn and/or non-commercial garden up to ½ acre.
- Single industrial or commercial purpose not to exceed 5,000 gpd.
- Irrigation of school property up to 10 acres in critical groundwater areas.
- Stock water.
- Down-hole heat exchange.

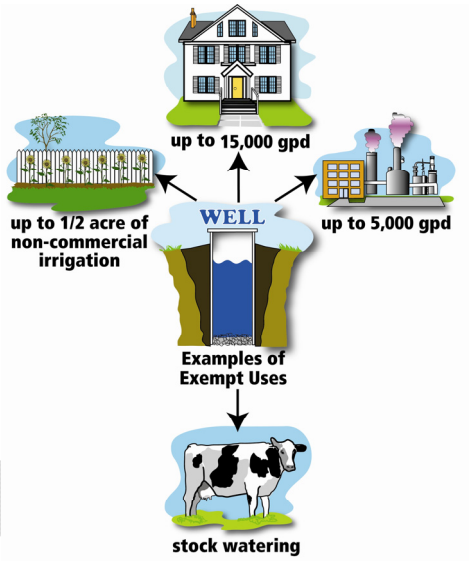

Figure 6: Exempt Groundwater Uses

Oregon has about 300,000 exempt-use wells, with approximately 3,800 drilled each year. The ever-increasing number of exempt use wells has resulted in calls for a closer policy look, including a better understanding of their demands on the resource, their potential for interference with senior water rights, and their overall effect on the health of Oregon's groundwater system. Currently, sufficient data to understand how these wells are affecting groundwater availability and surface water sources is lacking.

Groundwater Aquifer Storage and Recovery and Artificial Recharge. The statutes allowing Aquifer Storage and Recovery (ASR) were enacted in 1995. The ASR statutes allow water users to use existing water rights to store water in an aquifer and then recover that water for the beneficial use specified in the original water right. Initially, a limited license is required for ASR testing to determine if recovery of the water injected into an aquifer is feasible. The statutes for Artificial Groundwater Recharge (AR) were adopted in 1961, and separate permits are required first to appropriate and store water, and secondly, to recover and use the stored water.

In 2008, the Water Resources Department evaluated 54 aquifers within Oregon, creating a rating system of "geologic suitability for underground storage." This is an original methodology that helps assess the suitability of potential locations for underground storage. The Department evaluated aquifers in terms of their physical ability to store water. The analysis does not include an economic or environmental feasibility analysis, only a hydrogeologic evaluation of how these areas accept and retain water.

On the map below, the areas in green have the highest percent of "ideal" underground storage conditions, while the areas in red have the lowest. The red areas, indicating little storage potential, include Coast Range marine sediments, Western Cascade volcanics, and Klamath Mountain metamorphics, although there may be local exceptions. The green areas indicate areas with high storage potential, and include Columbia River basalts of the Northern Willamette Valley and the Columbia Basin. Other aquifer types with storage potential include volcaniclastic (pumice deposits in the Fort Rock Basin), as well as glacial and fluvial layers (west of Pendleton and throughout southeastern Oregon). The resulting summary map is shown here, and demonstrates the variability in physical storage potential across Oregon.

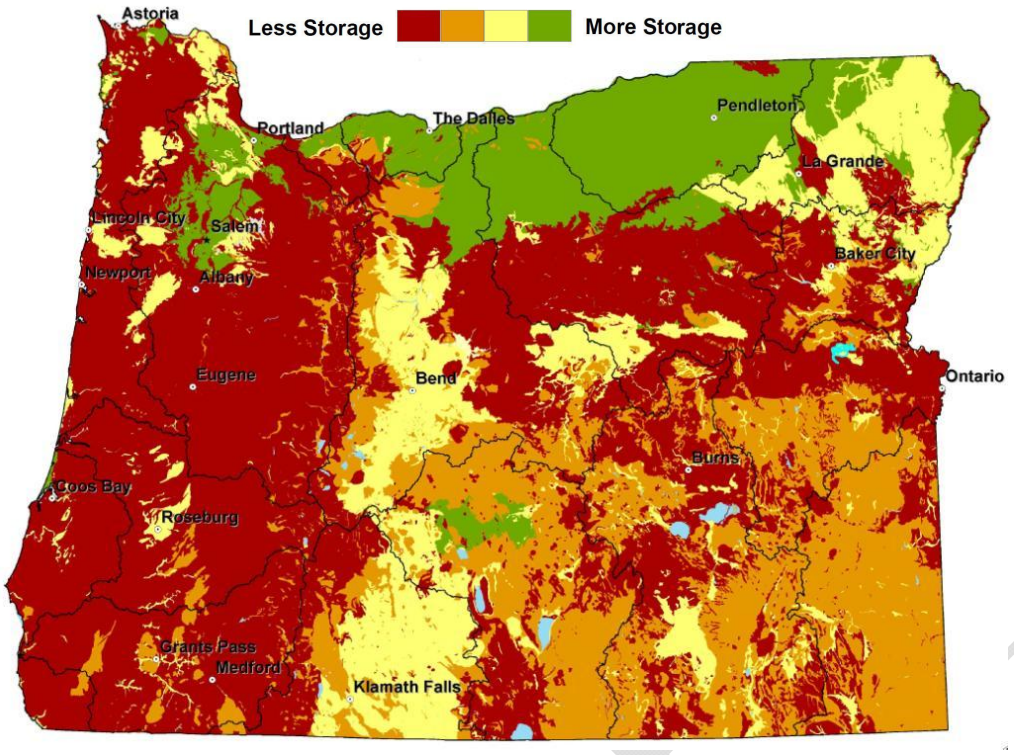

Figure 7: Geologic Suitability for Underground Storage

Communities interested in underground storage have to consider many factors. This storage tool will not be appropriate for every situation. Physical factors to investigate include the ability of the aquifer to accept water, its ability to retain water, and whether there is sufficient storage to reach an economy of scale. Cost/ benefit considerations play an equally important role in ASR and AR feasibility. Construction costs for underground storage are less than surface reservoirs, there are fewer environmental impacts, and there are minimal land requirements. However, site characterization and monitoring, water treatment, infrastructure improvements and ongoing maintenance and monitoring require significant investment.

Currently, about a dozen aquifer storage and recovery (ASR) projects and about half a dozen artificial recharge (AR) projects are authorized throughout Oregon. New projects are added each year as interest in this technology grows. Both municipal and agricultural water users are engaged in underground storage pilot projects and long-term projects as part of their water supply portfolios.

Currently, most ASR is conducted by municipalities and regional water suppliers. Salem, Beaverton, Tualatin, Tigard, Tualatin Valley Water District, Pendleton, Baker City, Clackamas River Water, Sunrise Water Authority, McNulty Water PUD, and Lafayette are implementing ASR. In addition, two agricultural ASR projects are operating in the Umatilla Basin for irrigation supply. AR projects are being conducted by agricultural entities for irrigation, domestic water associations for household use, and a watershed council for streamflow augmentation. County Line Water Improvement District, Buell-Red Prairie Domestic Water Association, Hudson Bay Irrigation District, Madison Farms, Walla Walla River Irrigation District, Deschutes Valley Water District and Avion Water Company are currently conducting AR projects.

The Umatilla Basin Water Commission is developing a plan to test regional AR and possibly ASR in the coming years. This project builds on the experience developed since 1977 at County Line Water Improvement District's recharge canal, and the feasibility study conducted in 2009 under SB 1069. The overarching goal is to augment groundwater supplies that have declined over time.

Conclusion

Nearly all of Oregon's surface water is fully allocated during the irrigation season. Opportunities for new groundwater uses are limited by hydrologic connection to fully appropriated surface water, declining water tables, or water quality issues. Although winter water may be available for storage projects, those opportunities may be limited by the need to protect peak and ecological flows, endangered species, or other environmental attributes. Lack of funding and agency resources are a key challenge to adequate water management in this state. There are many challenges ahead that limit our ability to meet Oregon's water needs. Not all of them can be addressed in the near term. As we develop the Strategy, it will be important to identify the most pressing issues facing our water resources.

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Water Quality

The purpose of this paper is to discuss the quality of Oregon's waters and how management of water quality and quantity interact. This paper describes some of the unintended consequences that occur when trying to manage water quality and water quantity separately. There are frequent conflicts when managing both quantity and quality and opportunities for improved coordination among agencies.

Background

Clean water is fundamental to protect our health, the environment, and our quality of life. We know that water is clean in Oregon when our surface water and groundwater meet the water quality goals that are set to protect beneficial uses. These goals are also known as water quality standards. Various pollutants degrade water quality and can enter the water through direct discharge pipes and by surface runoff from roads, lawns, and fields. Other variables, such as withdrawals of water and removal of streamside shade, can also have a detrimental physical or chemical effect on water quality.

Water quality and water quantity are unequivocally related. The choices we make in the management of water resources affect the balance between water quality and water quantity. For instance, protecting greater quantities of water instream has historically allowed Oregon to more easily satisfy state and federal water quality requirements. More water left instream helps dilute pollutant concentrations. If climate change, drought, increased demands, or other factors reduce the quantity of water in our watersheds, Oregon will have greater difficulty complying with state and federal water quality requirements to protect all of our beneficial uses.

Managing to Protect Water Quality

Water managers in Oregon operate in an institutional and regulatory environment that requires a high level of coordination and collaboration. Responsibility for protecting water quality resides at the federal level with the U.S. Environmental Protection Agency (EPA). The EPA approves water quality standards for each state. While each state has the ability to establish water quality standards, the states must be as strict, or more so, than the federal standards. There are two major federal laws governing water quality—the Clean Water Act and the Safe Drinking Water Act. The authority to implement and enforce these laws is delegated to the states. In Oregon, the Department of Human Services has authority to implement the Safe Drinking Water Act, which regulates the quality of drinking water delivered through community water systems. The Department of Environmental Quality (DEQ) has authority to implement the Clean Water Act, which regulates the water quality of streams, lakes, rivers, and estuaries. The Oregon Legislature has delegated responsibility for water quality protection on agricultural lands to the Oregon Department of Agriculture. The Oregon Department of Forestry regulates non-federal forests to protect water quality. In addition, local jurisdictions (counties and cities) are responsible for protecting water quality through comprehensive planning, stormwater management, and other regulatory programs.

The Department of Environmental Quality is also responsible for implementing various state laws to protect water quality, such as the Oregon Groundwater Quality Protection Act. The goals of the Act are to prevent contamination of groundwater resources, conserve and restore groundwater, and maintain the high quality of Oregon's groundwater resource for present and future uses. The Act also established a policy that all state agencies' rules and programs are to be consistent with this goal of protecting drinking water resources and public health.

Land use Management. With all of its implications for water resources, land-use management is a function that resides with local planners, local planning commissions, boards, and councils, all of which include a public process and oversight from the Department of Land Conservation and Development. These local governments

are responsible for implementing their own Comprehensive Land Use Plan that complies with 19 statewide planning goals, many of which are aimed at protecting water quality and quantity.

Goals that directly affect water include Goal 5 - Natural Resources, Scenic and Historic Areas, and Open Spaces, Goal 6 - Air, Water and Land Resources Quality, and Goal 11 - Public Facilities and Services, and are more specifically described below. Other goals do not directly address water but have an effect on, or are affected by, water quantity or quality.

Goal 5 and its administrative rules require local governments to protect, among other things, "significant natural resources." These include (1) critical groundwater areas and restrictively classified areas designated by the Oregon Water Resources Commission and (2) certain wellhead protection areas. Few local governments have completed the planning under Goal 5 for the former. Completing the Goal 5 process for wellhead protection areas is not mandatory. The Goal 5 provisions for protecting significant riparian corridors are partly there to protect surface water, particularly in urban areas. Goal 5 also has a requirement to protect wetlands.

The 19 Statewide Land Use Planning Goals

1. Citizen Involvement
2. Land Use Planning
3. Agricultural Lands
4. Forest Lands
5. Natural Resources, Scenic and Historic Areas, and Open Spaces
6. Air, Water and Land Resources Quality
7. Areas Subject to Natural Hazards
8. Recreational Needs
9. Economic Development
10. Housing
11. Public Facilities and Services
12. Transportation
13. Energy Conservation
14. Urbanization
15. Willamette River Greenway
16. Estuarine Resources
17. Coastal Shorelands
18. Beaches and Dunes
19. Ocean Resources

Goal 6 is aimed at maintaining and improving the quality of the air, water, and land resources of the state. This goal has no implementing rules. Although the goal directs local governments to consider the effects of land use on water quality, it does not contain specific requirements on how to achieve this aim.

Goal 11 and its administrative rules require cities with a population greater than 2,500 to prepare public facilities plans addressing drinking water, wastewater disposal and treatment, and stormwater management needs. These plans focus on the costs and timing of infrastructure needs and coordination among providers within the jurisdiction.

Each local government in Oregon with responsibility for land use management coordinates with various state agencies to ensure that state agency permitting actions are consistent with local comprehensive plans, including formal action on pending applications for water use and on-site sewage disposal systems. In cities, development is generally subject to design review that includes consideration of water quality through stormwater management. Drinking water quality and wastewater treatment are managed by public entities (the city or a district) in all but the smallest jurisdictions. In rural areas and cities that do not provide water and sewer service, the responsibility for addressing wastewater disposal belongs to the property owner, who is required to secure a permit from the Department of Environmental Quality or its agent to ensure wastewater is properly disposed.

Additionally, development on forestlands is limited by Goal 4 and county regulations. Forests encompass a large part of many of Oregon's watersheds, particularly in the upper reaches. Limiting land uses that could have a detrimental effect on water quality is one of the benefits of restrictive forest zoning.

Setting Water Quality Standards

Water quality standards are the foundation of DEQ's Water Quality Protection Program. Standards establish water quality goals by designating beneficial uses for each water body and setting criteria to protect those uses. These standards can be narrative and/or quantitative criteria and they serve as the basis for all Oregon's

pollution control programs related to water quality. The standards are used to set limits on the discharge of waste into Oregon's waters. Standards are also used to set requirements or establish Best Management Practices (BMPs) for nonpoint source control and land management programs, such as agricultural runoff, forest practices, and urban runoff. Failure to set and implement sufficiently protective standards can result in harm to fish and other aquatic life, human health, or recreational opportunities. DEQ has set water quality standards for approximately 140 pollutants. The Federal Clean Water Act requires DEQ to conduct a standard review at least once every three years to consider new Federal recommendations and to ensure that Oregon's standards are based on the latest science.

Beneficial Uses of Water

The term "beneficial use" provides a good example of how important it is to ensure that agencies and interested stakeholders are speaking the same language. Both the DEQ and WRD use the term "beneficial use" as defined in their statutes and rules. But, these terms are applied differently in a water quality context compared to a water quantity context. As a result, these Departments have to be very clear when talking to one another and to others. In this chapter, "beneficial use" reflects DEQ's terminology.

The Environmental Quality Commission (EQC) determines the beneficial uses for which each water body will be used, and then sets water quality standards for a variety of pollutants, in order to protect the most sensitive use. EPA must approve both the beneficial uses and water quality standards prior to their use in Oregon. Beneficial uses include:

- domestic water supply
- fishing
- industrial water supply
- boating
- irrigation
- water contact recreation
- livestock watering
- aesthetic quality
- fish and aquatic life
- hydropower
- wildlife and hunting
- commercial navigation and transportation

Matching the beneficial uses to water quality is a management strategy that the EQC and DEQ employ in recognition that not all beneficial uses require the same standard of water quality. Take for example a water body where swimming and fishing is expected. Here, DEQ would set bacteria standards to meet human health standards; it would set toxics limits for both human health and aquatic life; and it would set limits for dissolved oxygen, pH, temperature, and turbidity standards for aquatic life. For another water body, designated for other uses, water quality standards may differ substantially.

Surface Water

Every two years, DEQ assesses water quality and reports to EPA on the condition of Oregon's waters. **Figure 8** shows current surface water quality conditions in Oregon. DEQ prepares an integrated report that meets the requirements of the federal Clean Water Act (CWA). CWA Section 305(b) requires a report on the overall condition of Oregon's waters. CWA Section 303(d) requires identifying waters that do not meet water quality standards where a clean water plan, or Total Maximum Daily Load (TMDL), needs to be developed. The integrated report includes an assessment of each waterbody where data are available, and the list of waters identified under Section 303(d) as water quality limited needing a TMDL.

Once a waterbody is placed on the 303(d) list, the CWA requires states to develop a plan to meet clean water standards. This plan is called a TMDL, which describes the maximum amount of pollutants allowed from municipal, industrial, commercial, and surface runoff sources including natural background that can enter waterways without violating clean water standards.

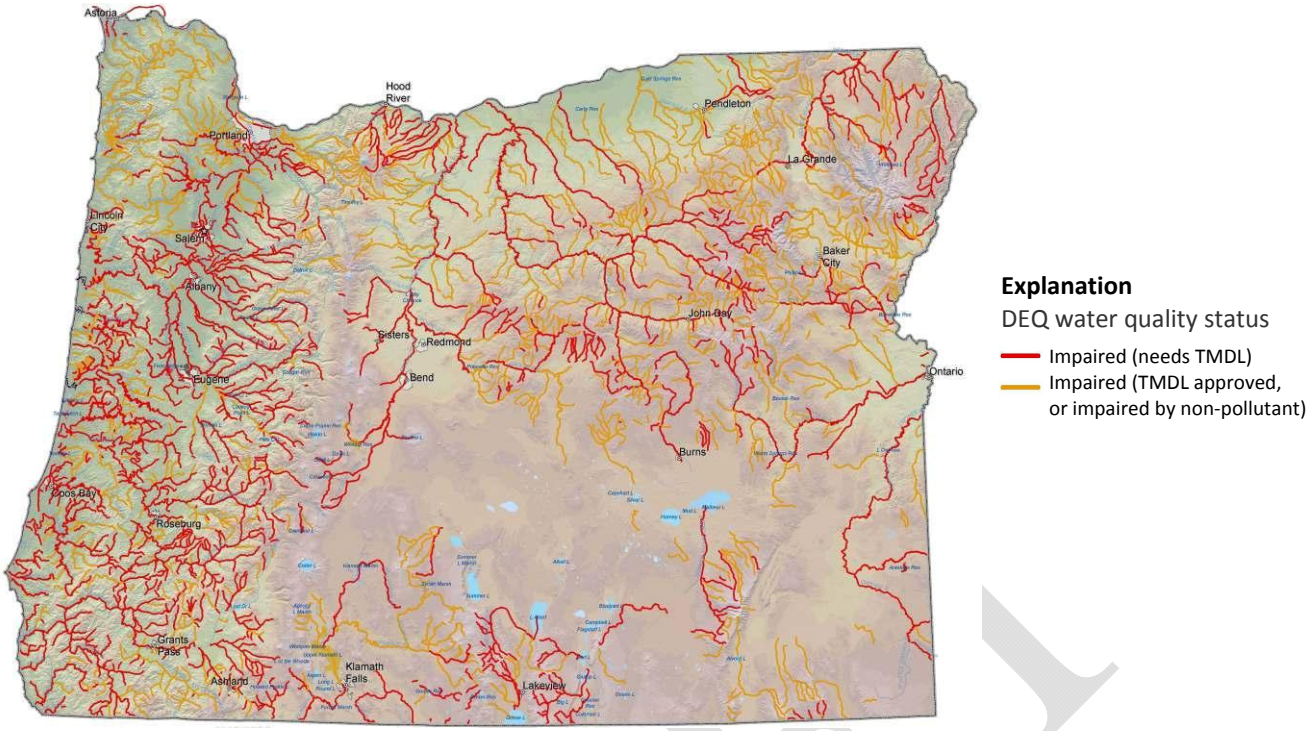

Figure 8: Oregon's 2004/2006 Water Quality Limited Waters

Implementing a TMDL often includes revising industrial and municipal wastewater permits to incorporate revised permit limits. On agricultural and rural residential lands, area plans are developed through the Oregon Department of Agriculture's (ODA) Agriculture Water Quality Management Act. On state and private forestlands, the Department of Forestry has the lead in providing water quality protection through the Forest Practices Act and long range management plans. In urban areas, local governments take the lead in developing TMDL implementation plans. The U.S. Forest Service and the Bureau of Land Management are responsible for developing water quality restoration plans for lands under their jurisdiction.

Under most circumstances, TMDL implementation plans for improved water quality rely on cooperation among landowners and land managers within a river basin. Local watershed councils, Soil and Water Conservation Districts, or other organizations serve as community-based coordination points for these united efforts. TMDL implementation plans describe actions that will be taken to reduce pollution.

Finally, DEQ monitors Oregon's waterways to determine the quality, presence and levels of pollution. DEQ monitors water quality with regular conventional pollutant sampling for more than 50 rivers and streams in Oregon. In addition, DEQ has a toxics monitoring program that regularly conducts special monitoring projects funded by grants from the Environmental Protection Agency and others. The data generated is used to set program priorities, develop TMDLs, the integrated report, permits as well as report on the conditions of Oregon's waters and work with others to reduce water pollution.

The most recent reports regarding Oregon's surface water quality concludes: [add summary here from DEQ's Integrated Report – expected in 2011]

Groundwater

Groundwater makes up approximately 95 percent of available freshwater resources in Oregon. Approximately 70 percent of all Oregon residents rely solely or in part on groundwater for drinking water. Over 90 percent of rural Oregonians rely on groundwater for drinking water.

Groundwater is present beneath almost every land surface and is sometimes at very shallow depths. It is

vulnerable to contamination from activities that take place on the land as well as from discharges of wastes and pollutants at or below the ground surface. Once groundwater becomes contaminated, it is very difficult to clean up. Groundwater contamination can persist for tens, hundreds, or even thousands of years. Likewise, groundwater that is being contaminated today may not affect beneficial uses until some time far into the future. This contamination could impair groundwater for use as drinking water and may affect the quality of the surface waters where it reaches the surface.

Nitrate Contamination

Serious health risks can result from contaminated groundwater. Nitrate is the most commonly detected contaminant, followed by pesticides, volatile organic compounds, and bacteria. The presence of nitrates in groundwater is a serious health concern, particularly for infants and pregnant or nursing women. Nitrate can interfere with the body's ability to carry oxygen to vital tissues, resulting in "blue baby syndrome." The U.S. EPA has set the maximum contaminant level to 10 mg/l for nitrate in public water supplies.

DEQ has primary responsibility for implementing groundwater protection in Oregon. DEQ uses a combination of programs to help prevent groundwater contamination from point and nonpoint sources of pollution, clean up pollution sources, and programs to monitor and assess groundwater and drinking water quality. DEQ implements some programs though partnerships with the Oregon Department of Human Services- Environmental Public Health (DHS), WRD, ODA, Oregon State University, and other state, local, and private organizations, businesses, and individuals. Investing in groundwater quality monitoring is a cost effective tool for addressing existing and potential future water quality problems.

In 2008, four percent of new wells inspected by Water Resources Department had construction issues, which if left unaddressed, could have caused public health or safety problems. It is more cost efficient to identify and correct problems at the outset, rather than clean up contaminated groundwater and soils afterward. Older wells also present a threat of contamination, as many were generally constructed to lower standards and may have deteriorated over time.

Source Water Protection

DHS and DEQ help to prevent groundwater and surface water contamination by providing Source Water Assessments to public water suppliers. Source Water Assessments identify the critical area around public water supplies: wells, springs and streams (i.e., drinking water source areas) where contaminated groundwater and surface water could have a negative impact on drinking water quality. Source water areas are shown in **Figure 9**.

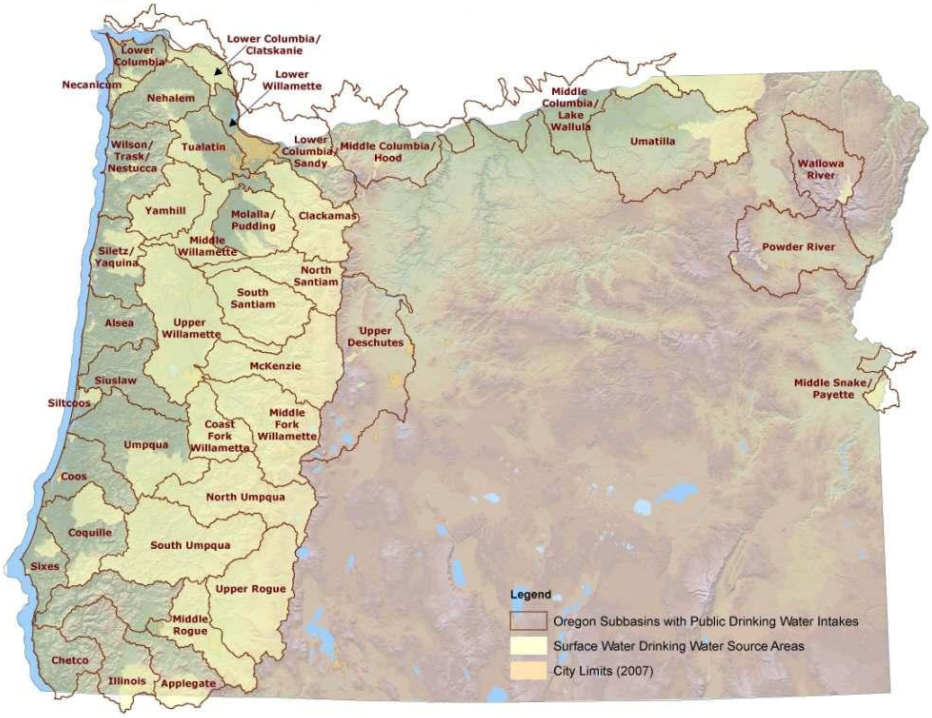

Figure 9: Oregon Subbasins with Drinking Water Intakes

Source Water Assessments also inventory potential human and natural contaminant sources within the drinking water source area and assess the water system's susceptibility to each contaminant source. Based on assessment results, DHS encourages public water systems to pursue best management

practices that reduce risks associated with the contaminant sources representing the greatest potential threat to drinking water quality. DEQ works with potentially human-caused sources of the pollutants to meet applicable standards for the protection of groundwater and surface water.

Issues Facing Water Quality

We know that water quality tends to degrade with lower streamflows. This is evident year after year during the summer months around Oregon when there is less water in rivers and the water temperature rises. What happens if we neglect the potential impacts regarding water quality in the process of planning? These are some of the issues we could face:

- Water quality is degraded to the detriment of water users, affecting Oregon's economy.
- "Water-quality limited" designations and TMDL issuance put in motion regulatory water quality improvement actions. This could mean more stringent pollutant discharge limits for point sources and changes in best management practices for non-point sources of pollution.
- Stricter federal regulations via the Clean Water Act and/or Safe Drinking Water Act.
- Further reductions in available "usable" water due to water quality degradation of sources.
- Costly arguments about how best to resolve the problem after the water quality has degraded. This can be very expensive and disruptive to communities and businesses.
- Increased drinking water treatment costs.
- Negative effects to aquatic species and habitat, including the iconic salmon.
- Increases in state issued human health and fish consumption advisories.

Many of our waters are already degraded to a level where they cannot provide for our most beneficial uses. State issued health advisories that recommend avoiding recreational swimming and reduce fish consumption to certain levels is just one indication that we are facing serious water quality issues today.

Temperature. One of the most widespread water quality issues throughout Oregon is temperature. Elevated temperature levels in rivers and streams can cause problems for fish and other aquatic life. There is a great deal of temperature data available for many parts of the state compared to data for other pollutants. Clean water plans (TMDLs) for temperature are an important tool for addressing salmonids that are listed on the federal Endangered Species List and other challenges faced by fish and other aquatic life that need certain water temperatures to survive. A common way to address temperature issues is through the retention and restoration of riparian areas. Riparian area protection and restoration programs and projects also improve habitat for listed salmonids and could address other pollution problems such as sedimentation and turbidity. In general, a lack of technical assistance statewide and high project costs often limit voluntary restoration efforts.

Restoration Cools Creek 10 Degrees
An Oregon Plan Success

Long-term temperature monitoring at a restoration site on Willanch Creek, Coos County, has shown that the maximum seven-day temperature at the downstream end of the restoration site dropped from 74° F to 64° F in just eight years, 1997 - 2005. Water temperatures of 64° F or lower are essential for the growth and survival of juvenile Coho salmon. Willanch Creek is a Coos Bay tributary that was plagued by eroding banks, old culverts that limited fish access to upstream areas, and high water temperatures caused by a lack of streamside trees and shrubs. From 1991 to 2004, project partners worked hard to remove invasive plants, stabilize slumping banks with natural materials, replace inadequate culverts with bridges, place large pieces of wood in the creek, install livestock fencing, and plant native vegetation.

~ From the Oregon Plan for Salmon and Watersheds, Coho Restoration Stories
http://www.oregon.gov/OPSW/stories/stories.shtml

Toxic Pollutants. Another widespread pollution issue that DEQ is working on is related to toxic pollutants. Many toxic pollutants are ubiquitous and diffuse in the environment and are not released as "point" source pollutants, which poses a significant challenge for DEQ in managing their presence in Oregon's environment. To

address this, DEQ is developing a toxics reduction strategy, with the goal of using a comprehensive approach to reduce toxic pollutants in Oregon's environment. Where possible, the strategy will identify reduction options that address a range of toxic pollutants that move between air, land and water, thereby increasing the efficiency of reduction efforts while ensuring Oregon addresses the problem comprehensively. DEQ will also place a major emphasis on reducing toxic pollutants at the source, rather than managing them after they are released.

Oregon has already made some very significant accomplishments to restore water quality through various public and private partnerships. According to the Oregon Plan Biennial Report, in 2006 and 2007 alone, funding for reported restoration projects totaled $123.8 million. Sixty-seven percent of those funds were provided by federal and state government sources. These funds help support soil and water conservation districts and watershed councils that work directly with private landowners to implement voluntary projects for water quality monitoring, river clean-ups, and various stream habitat improvements such as invasive species removal, plantings, grazing management, and nutrient management.

Next Steps

Opportunities remain to improve water quality through an integrated strategy. The list below summarizes some of the challenging water quality issues that could be addressed in the strategy. This list, while not complete, serves as a discussion point for future work. Identifying the problems that contribute to poor water quality will help us determine what solutions to pursue as we move forward.

- Emerging contaminants.
- Lack of coordination and consistency with state land use planning goals/procedures.
- Water and wastewater infrastructure is old, deteriorating, and in desperate need of repair.
- How to maintain forestland in forest uses and promote the establishment of new forests to support high quality water.
- The cumulative effects of wastewater discharges.
- Total Maximum Daily Load requirements do not fully integrate water quantity and water quality.
- Stormwater management is a challenge that faces many communities and businesses.
- The synergistic effects of multiple contaminants on human and aquatic life are poorly understood.
- Research and analysis of the impacts of water quality degradation on aquatic life.
- Lack of resources to conduct a statewide groundwater assessment and monitoring program.

Integrating Water Quality Needs

Various techniques, such as point source pollution management, non-point source pollution management, and restoration efforts can protect and restore water quality over time. Keeping pollutants out of the water to begin with is certainly the easiest way to protect water quality and help keep water treatment costs down. Often times, unused or expired medications are disposed of by flushing down the drain in homes, care facilities, medical clinics, doctors' offices, and hospitals. Wastewater treatment plants and septic systems usually do not treat pharmaceuticals, which mean these pollutants are present to some degree in our surface water and groundwater supplies. Yet, the proper collection and disposal of pharmaceuticals can be costly and time consuming and poses funding and logistical hurdles that have stymied most communities. Currently, local pharmaceutical collection events are held around the state, although these events are rare.

In addition, there have been a number of legacy pesticide collection events around Oregon to provide an opportunity for farmers and others to bring old pesticides that are no longer used to a central location to properly dispose of them free or at a reduced charge. These collection events help to remove old unused or unusable pesticides that pose a direct threat to Oregon's water quality. Many of these pesticides are stored in deteriorating containers, and if spills, leaks, or other releases of these pesticide wastes occur, there could be significant impacts to surface water and groundwater.

Integrating water quality and water quantity planning efforts could alter how we characterize water that was previously viewed as a "liability" to communities. Recycled water, such as treated effluent, graywater, and stormwater, could be used to supply certain beneficial uses before discharge if the quality of the water is high enough for continued use. Already, conversations regarding recycled water use have started to develop in Oregon. It is important to consider that recycled water and conservation practices, with their more efficient means of distribution and use, could have unintended effects that result in lower return flow to streams, or public health implications. If Oregonians pursue ways to recycle water, it is important to identify the barriers to safe, effective use of recycled water. These may be real, perceived, public reactions to the reuse of treated effluent from wastewater treatment plants.

Conclusion

As society changes, water quality needs and standards will change as well. These standards will have direct impacts on water bodies, beneficial uses, cost, communities, and businesses. Water management decisions must always be made while considering the impacts and needs of both water quantity and water quality. Although many natural resources state agencies, other state agencies, local, and federal agencies already coordinate closely regarding "on-the-ground" projects, there are institutional, legal, and policy barriers in place that prevent us from managing water resources better.

Sources

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Department of Human Services, http://www.oregon.gov/DHS/ph/dwp/gw_swp.shtml#swp

Department of Environmental Quality, http://www.deq.state.or.us/wq/dwp/dwp.htm

Ecology and Ecosystems

The purpose of this paper is to highlight the ecological and ecosystem water-related issues that Oregon may face as it grapples with integrated water resource management in the future. Integrated water resource management addresses not just how much and what quality water is within a stream, but also considers the health and management of habitat.

Human activities such as land-use practices, competing demands for water resources, and pollution can have a significant and detrimental effect on Oregon's ecosystems. Natural processes, such as droughts, floods, and fires affect ecosystem health both positively and negatively. Inadequate legal protections and lack of coordination among state, federal, and local organizations can jeopardize past and future efforts to protect and restore the environment. This paper is not intended to cover all of the issues affecting ecosystems in Oregon, but will focus on some of the significant challenges we can already anticipate, as well as some of the restoration projects that have benefited local communities.

Ecosystem Services

Oregon's ecosystems provide a wide variety of benefits and services to our communities. The term "ecosystem services" is defined as "benefits that humans enjoy as a result of natural processes and biological diversity," (Senate Bill 513, 2009). These services sustain economically viable activities such as farming, ranching, fisheries, timber harvesting, electrical generation, and outdoor recreation, while providing water quality control, carbon sequestration, flood control, fish and wildlife habitat, and productive soils. By further degrading or neglecting functioning ecosystems, we might decrease our own quality of life as well as the fish and wildlife that depend on these systems. This degradation subsequently results in a need to "engineer" solutions and to mimic ecological functions at great expense. For instance, it costs far more to obtain drinking water when provided by a multi-million dollar treatment facility than a relatively healthy natural source; flooding is far more frequent and costly when waters cannot be well absorbed by the physical environment; crop production costs are higher when soil productivity is compromised; and fish populations are more expensive to maintain through restoration actions and hatchery operations than through the maintenance of natural habitat.

Defining Ecology and Ecosystems

Generally, the term "ecosystem" refers to a system of interdependent relationships between organisms and their surrounding environments.

"Ecology" is the scientific study of the interactions among these organisms and their environments.

Groundwater. Ecosystems that are dependent on groundwater are areas that require access to groundwater to maintain their ecological structure and function. Groundwater dependent ecosystems comprise a diverse, complex and often biodiverse subset of the world's ecosystems and can be located in marine, coastal, riparian, in-stream, terrestrial and in cave and aquifer environments. Examples include springs, many wetlands, and base flow to streams and rivers in late summer months. Groundwater ecosystems support a disproportionately large number of plants and animals relative to the area they occupy and offer multiple ecosystem services, or benefits, to humans, such as clean water and recreational opportunities. Many of the cold-water salmonids thrive in Oregon because of the high quality and quantity of water supplied by the springs and groundwater supported wetlands, due to a large extent to the unique geology of Oregon.

Some of the most significant ecosystem services provided by groundwater systems include water supply for human use, as well as cold clean water, and summer low flows for aquatic and riparian dependent species. Other benefits to recreation include river rafting during summer months, wildlife and bird watching. Aesthetic and photographic opportunities associated with water features such as waterfalls and springs, and cultural and spiritual values.

Groundwater - Surface Water Relationship. Surface water interacts with groundwater in three basic ways: streams gain water from inflow of groundwater, via springs or seepage, through the streambed (gaining streams), they lose water to groundwater by outflow through the streambed (losing streams), or they do both, gaining in some reaches and losing in others. Gaining streams represent locations where cooler groundwater emerges and contributes to a stable base flow, helps sustain flows during the summer months, and provides prime spawning conditions. Losing streams provide a potential route of contamination to groundwater quality, as run-off enters streams that eventually percolate back into the ground.

Wells that are hydraulically connected to surface water can deplete streamflows at varying levels and over extended periods, long after pumping ceases. Managing surface water and groundwater conjunctively is a challenge. A lack of data that describes the connection between groundwater and surface water results in an incomplete understanding of available water, groundwater recharge, gaining vs. losing reaches, return flows, sources of contamination, and ability to provide sustainable water supplies over time.

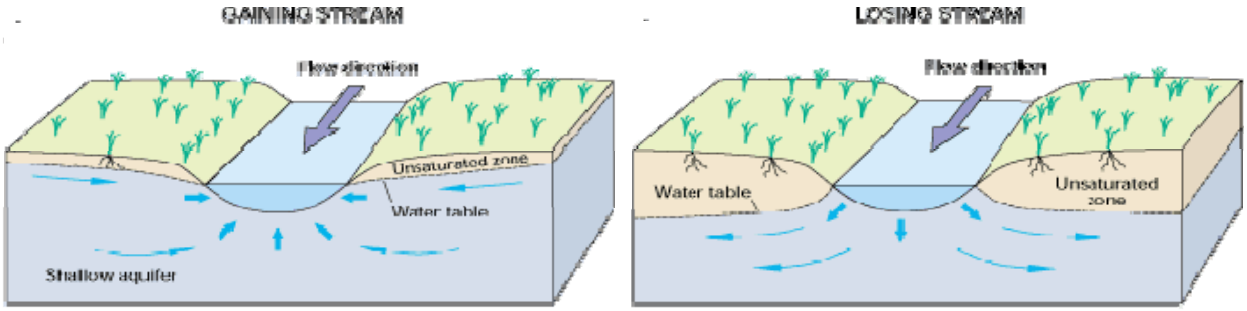

Figure 10: Groundwater Interaction with Surface Water

Surface Water. Surface water sources in Oregon are also complex, contributing to very different ecosystems. Peak and ecological flows are a subset of stream flows that are directly tied to the ecology of the stream system. These flows serve several functions, such as to help maintain the physical attributes of a stream (often flood or peak flows), act as behavioral triggers for certain life stages of aquatic species (migration or spawning), and to overcome threats to aquatic life (harmful pollutants or stream heating). Surface water, like groundwater, supports the majority of out-of-stream uses throughout the state, such as irrigation, municipal use, and industrial use. Surface water also provides for instream needs for recreation, aesthetic values, pollution abatement, and aquatic life.

Natural Storage Systems

Riparian Areas. A riparian area is the zone of transition from an aquatic ecosystem to a terrestrial ecosystem. These areas are located adjacent to lakes, reservoirs, estuaries, wet meadows, and streams. According to the 2000 State of the Environment Report, riparian areas represent a conservative estimate of 15 percent of the total area in the state. Riparian areas help to improve water quality, reduce flooding impacts, moderate streamflow, and provide habitat for fish and wildlife. The plants that grow in riparian areas are essential to preventing erosion, filtering pollutants and sediment, and providing shade to keep streams cool. A healthy riparian area will include a variety of types and ages of plants, including trees, shrubs, grasses and groundcover. A few of the common plants found in Pacific Northwest riparian areas include alder, cottonwood, elderberry, snowberry, willow, and western hemlock. Many human activities take place in riparian areas, in both rural and urban landscapes, such as timber harvesting, reforestation, road construction, herbicide and pesticide use, grazing, mining, agriculture, and residential development. If poorly planned or implemented, these activities can have detrimental effects on the function of these areas.

Wetlands and Floodplains. Through their ability to hold and slowly release water, filter and biologically process nutrients, and provide shade and habitat, Oregon's upland wet meadows, riparian wetlands, and flood

plain habitats have a direct impact on water storage, flow, water quality, habitat quality and water temperature. This can also be said of the relationship between floodplain habitat health and a stream's resilience to damage caused by floods. The habitat structures and functions of wetlands, wet meadow storage, floodplain absorption, vegetated shade, filtration, and peak flows directly influences the quality and quantity of water, and vice versa. Habitat drives water quality and quantity, not simply something affected by them. Oregon has lost an estimated 38 percent of its original wetlands. In the Willamette Valley, approximately 57 percent of wetlands have been lost. A recent study shows that the Willamette Valley continues to lose more than 500 acres per year. The Klamath Basin has lost an estimated 75 percent of original wetlands, primarily due to government-sponsored conversion to agricultural production (Morlan, 2000).

Forest Lands. Oregon is comprised of 61 million acres of land. Nearly 50 percent of the state, or 30 million acres, is classified as forestland. Oregon's forests help filter drinking water, keep water cool, provide habitat for diverse animal and plant species, supply oxygen, moderate temperatures and rainfall, and store atmospheric carbon. Healthy forests promote soils that provide natural filtration to keep streams clean and water quality high. Most of Oregon's municipal water systems use water that originates from forestlands, including those managed for wood production.

Watersheds

A watershed is the entire land area drained by a stream or system of connected streams where all of the originating streamflow drains through a single outlet.

Sample functions and characteristics of a healthy watershed include streamflow regulation, groundwater recharge, rainfall capture and storage, and minimal erosion. A healthy watershed is able to resist or quickly recover from disturbance events, such as floods, fires, and insect outbreaks. The health of our watersheds contributes to quality soil, water, and an environment that is able to support both native aquatic and riparian species.

Enhancing Oregon's waters through the management of riparian and upland areas is a goal identified by the Oregon Legislature. Numerous Watershed Councils throughout Oregon are working to achieve this goal by improving watershed health through protection, restoration, and enhancement.

The quality of this source water is among the best in the nation. At the state scale, data collected between 1998 and 2007 indicate more than 90 percent of the sampled sites on forestlands showed an Oregon Water Quality Index in good or excellent condition, and the remaining sites in fair or lower condition. Water quality was highest in the Willamette, Middle Columbia, and Lower Columbia hydrologic units. Overall water quality in the North Coast was intermediate compared to the other units. The South Coast showed the lowest overall water quality.

Water quality is typically considered a major issue in several state hydrologic units, such as the Willamette. However, forest sites generally show a lower percent of stream miles in poor or most disturbed conditions compared to agricultural and urban land uses. A 2009 report prepared by the Department of Environmental Quality shows water quality highest for generally higher elevation, higher stream gradient federal sites, with 97 percent in good or better conditions. State sites showed 89 percent in good or better conditions. Private industrial sites had 87 percent in good or better conditions. Private non-industrial sites, which are more likely to be intermixed with other land uses, had 77 percent in good or better conditions, and should perhaps be the highest priority for closer future study. Promoting the maintenance of forestland in forest uses and the establishment of new forests are needed as key elements to ensure high quality water and protection of soil productivity.

Forests are part of the essence of Oregon, and our waters benefit from their sound management. However, Oregon's forest values are also at risk:

- The density of homes in private forests has doubled in the last decade.
- Forests are being fragmented, converted to other uses, and encroached upon by development.
- Rising expenses of owning forestland, and the land's growing value as real estate, creates increasing pressure to sell private forestland for development.

- Invasive species, climate change, more damaging fires, and the neglected condition of some federal lands threaten public and private forests**.**
- Federal forestlands, particularly in drier regions, have massive ecological restoration needs, and resource-dependent rural communities are distressed.
- Oregon's growing, urbanizing population has diverse and changing forest values.

There are solutions. The many environmental, economic, and social values of forests are interdependent and provide a basis for consensus. Diverse forests and a range of benefits result when landowners are able to emphasize multiple values – wood production, nature emphasis, or mixed uses. Awareness is growing that keeping forests in productive forest use should be a primary goal. Keeping forests as forests requires:

- Public support and investment in forestry and resource protection;
- Policies that make continued forest ownership an economically viable alternative to conversion;
- A statewide vision for sound, sustainable forest management, as provided in the Board of Forestry's *Forestry Program for Oregon.*

Estuaries. An estuary is a highly productive environment located at the lower end of a river where the current meets the sea tide. Estuaries provide important habitat for many fish and wildlife species for rearing, nesting, foraging, and as a migration route. Numerous species can be found in Oregon's estuaries, such as salmon, herring, flounder, crabs, oysters, clams, birds, ducks, geese, shorebirds, and harbor seals. There are 22 major estuaries in Oregon; the Columbia River estuary at Astoria is the largest in area at approximately 80,811 acres, although most estuaries along the coast are relatively small. There are several estuary types; some are dominated by rivers with small tideland areas. Most estuaries typically experience high winter floods that deposit large volumes of sediment, coupled with low summer streamflow and high seawater content. Others, such Sand Lake and Netarts Bay estuaries are "bar-built" and receive very little freshwater. Low summer flows from rivers can cause the mouth of an estuary to be completely closed off; they are known as "blind" estuaries. The variety of estuary types also means that habitats vary and include marshes, eelgrass beds, mudflats and tidal channels. Some of the issues affecting the health of Oregon's estuaries include increased sedimentation and nutrient load, introduced nuisance species, development, recreational pressures, and low freshwater inflows.

The Diversity of Oregon's Ecosystems

Oregonians have always been proud of the place they live; proud of the diversity of landscapes and people; and proud of Oregon's strong ties to its natural resources, natural beauty and fish and wildlife. When Oregonians describe the state, we often note the diverse landscapes that range from coast to desert, from mountain to valleys, to rainforest. Areas of Oregon are grouped by similar vegetation and climate and are referred to as "ecoregions." Oregon's 2006 Conservation Strategy, produced by the Oregon Department of Fish and Wildlife, describes 8 ecoregions across Oregon's 98,386 square miles. The Conservation Strategy provides an overview of the land uses, economies, ecology, species and habitat, conservation issues and approaches, invasive species, and various conservation projects for each ecoregion. The diversity of Oregon's landscape that we admire so much presents a challenge for developing statewide water resource solutions.

Status of Oregon's Native Fish Species

The health of an "indicator species," like the proverbial "canary in the coal mine" can be an indicator of overall ecosystem health, and can offer early signs of stress, such as disease or pollution. Oregon's streams and lakes provide substantial habitat and are essential for fish and wildlife to live, reproduce, and thrive. Out of numerous species that depend on Oregon's water resources, the most visible indicator species are native salmonids (salmon, steelhead, and trout) who depend on cold clean water. Using these species as indicators of overall aquatic ecosystem health paints a dire picture: Since 1991, NOAA Fisheries' Office of Protected Resources has listed 27 Pacific salmonid species under the Endangered Species Act (ESA), and have delisted

zero species. Many populations of Chinook salmon, Coho, Chum, and Steelhead are at a fraction of their historic levels and are listed as threatened or endangered. In 2005, the Oregon Department of Fish and Wildlife published a Native Fish Status Report, noting that of 69 "Species Management Units," a population count of Oregon native fish species, 35 SMUs were "at risk," and 9 were already extinct. See **Figure 11**.

Figure 11. Species Management Units for Oregon Native Fish Species

Species	Species Management Units	Not at Risk	Potentially at Risk	At Risk	Extinct	Not Assessed
Salmon						
Coho	5	2	0	1	2	0
Fall Chinook	5	2	2	1	0	0
Spring Chinook	8	0	2	4	2	0
Chum	2	0	0	1	1	0
Sockeye	2	0	0	0	2	0
Steelhead						
Winter Steelhead	4	1	2	1	0	0
Summer Steelhead	7	2	1	3	1	0
Trout						
Redband	7	0	2	5	0	0
Cutthroat	8	3	1	3	1	0
Bull	12	1	1	10	0	0
Other						
Borax Lake Chub	1	0	0	1	0	0
Hutton Springs Tui Chub	1	0	0	1	0	0
Oregon Chub	1	0	0	1	0	0
Foskett Springs Speckled Dace	1	0	0	1	0	0
Pacific Lamprey	1	0	0	1	0	0
Western Brook Lamprey	1	0	0	1	0	0
Green Sturgeon	1	0	0	0	0	2
Oregon White Sturgeon	1	0	0	0	0	1
TOTALS	69	11	11	35	9	3

Limiting Factors / Barriers

The importance of fish to Oregon's ecology and economy cannot be overstated. Native fish such as salmon are an Oregon icon and support a vigorous recreational and industrial economy. Factors that limit the productivity and overall health of fish species are many, some of which include degraded spawning and rearing habitat, poor water quality, dewatered streams, poor riparian conditions, land use practices, climate change, passage barriers, species competition, competing uses for water, overharvesting, and poor ocean conditions.

Stream Conditions. There are certain stream conditions that are necessary to support the life cycle of fish. Stream conditions that are necessary also vary with the species needs. Coho, for example, need gravels that are clean with various sizes to create nests and deposit their eggs and they prefer to spawn and rear in small, relatively flat streams. Cool water is a requirement for rearing, as well. Wetlands, off-channel ponds, and other slackwater areas provide small fish (fry) with safe areas to reside in during the winter season when the current is swift. The complexity of the habitat, which includes both large and small woody debris, directly contributes to the health and function of salmon bearing streams.

Climate Change. Climate change will continue to affect Oregon's ecosystems, as indicated by increasingly sophisticated scientific models. Management of aquatic ecosystems in response to climate change will need to mirror the management designed to perpetuate dynamic processes, including efforts to maintain stream flows, minimize floodplain and riparian diversions, and restore interactions between rivers and uplands.

Land Use. All across Oregon, urbanization, agriculture, and certain forest practices have placed pressures on the overall health of aquatic ecosystems. The Willamette ecoregion, for example, has lost important river features, such as off-channel aquatic habitat, gravel bars, and deep channel pools from changes to land use. Runoff of sediment from poorly designed logging, grazing, roads, urban and agricultural activities enters waterways, which can have detrimental effects on species reproduction and survival.

Water Use. Competing uses of water has resulted in lower flows in river and streams, and in some cases, flows may not even exist in late summer months. Low flows often mean higher water temperatures and increased nutrient concentrations. Historically accessible habitat for many aquatic species has been greatly reduced or eliminated by dams and improperly sized or misaligned culverts, and changes in the hydrologic regime.

Diversions that lack proper fish screening or by-pass devices can increase fish mortality and injury as fish enter diversion ditches, machinery, or irrigated fields. Today, fish screens or bypass devices are often required as condition of a water right permit or transfer. The Oregon Department of Fish and Wildlife operates the state's fish screening program and has helped install over 1,300 fish screens through their cost-share program since its inception in 1991. Maintaining and inspecting fish screens to ensure they are properly working is challenging considering their high exposure to debris, sediment, and changes in temperature that can all cause screen damage and potentially lead to fish loss at the diversion.

Invasive Species. According to the Oregon Invasive Species Council, an invasive species in a non-native species that can cause economic or environmental harm to human health. It can be a plant, animal or any other biological viable species that enters an ecosystem beyond its native range. Invasive species disrupt the natural function of an ecosystem by competing and replacing native species and disrupting the natural habitat. Oregon's rivers, lakes, and streams are greatly affected by their presence. Invasive species can interfere with water use by reducing flow in irrigation canals and drainage ditches, which can result in flooding and damage to canal banks, structures and pumps. Municipal use and power development are also impacted by invasive species, which can cause problems in water intake pipes, filtration equipment, and generation plants. Certain species of cyanobacteria, commonly referred to as blue-green algae, can be both invasive and toxic. It can form thick foam or scum on the water's surface and produces toxins or poisons that can cause serious illness or death in pets, livestock, wildlife and humans. In short, the presence of invasive species is wide ranging, affecting our forests, farms, and our waters, which in turn impacts our economy, ecosystem and human health, and overall quality of life.

Water Quality. Currently, there are almost 15,000 river miles that do not meet Oregon's water quality standards for one or more pollutant. A variety of human impacts, both urban and rural, contribute to the degradation of water quality. Pressures on species and ecosystems will likely increase with the growth of Oregon's population and climate change impacts—with riparian habitat and upland health directly driving the water quality issues of temperature, nutrient removal, and fine sediment filtration. Water quality degradation can put significant pressures on fish, wildlife and ecological systems. Water quality can degrade from habitat loss, various pollutants, and introduced aquatic species. For example, toxics that enter wetlands or waterways poses risks to both fish and wildlife. Some toxics can be lethal to species, whereas others can result in reduced fish egg production, nest and brood abandonment, lower disease resistance, weight loss and other problems that can reduce adult survival and lower population abundance. Another factor affecting the growth and survival of aquatic organisms is stream temperature. Elevated stream temperatures increase the risk of disease-related mortality and also results in increased competition for food. Addressing issues affected by

both water quality and water quantity, including temperature, dissolved oxygen, and sediment transport is a challenge, but will likely be an important piece of the strategy.

Adequate Protections for Instream Needs. Protecting streamflow and lake levels, which are needed to support public uses, is a high priority for the state. There are many rivers, lakes and streams that can provide significant public benefits and protecting these waterways is a long-term goal. While many streams in Oregon are legally protected an instream water right, there are many streams that are not protected. For those streams that are protected by a water right, it is difficult to enforce regulation to protect these rights with limited field staff. The Oregon Department of Fish and Wildlife has plans to apply for new instream water rights where data shows additional need and to generate data on streams where information or data is missing. However, ongoing resource constraints have prevented these plans from moving forward.

There is much about instream needs that we do not yet know. For instance, there is not much information about flow needs, for species other than the high profile salmonid species (e.g., lamprey, chub, white fish, other native fish species, amphibians, macroinvertebrates, etc.). Base flows generally refer to the water required to sustain basic life functions of aquatic species. In Oregon, we have only determined base flow needs for some streams and only for salmonid species. In addition, there are flows required to ensure channel maintenance (the physical characteristics of the stream) and to trigger biological processes (such as spawning and other life stages). Not much information exists at all about these flow needs.

Finally, there are flows needed to maintain water quality throughout a stream system. The state's Department of Environmental Quality has begun work in this area, with "TMDL Modeling" but, again, not much information exists today.

Institutional Coordination. Responsibility for managing, protecting, and restoring Oregon's ecosystems falls across a broad range of local, state, and federal agencies, as well as on private landowners and local organizations. Oregon, perhaps just as much or more than any other state, has a rich history of work in this area, using tools and institutions to help address and improve ecological conditions. Fully accounting for and building upon the myriad programs that already exist will be a challenge, much less creating integrated plans and data sets.

Promoting Incentives. It is becoming increasingly evident that regulations alone will not suffice to mitigate our collective impacts on air, water, and the ecosystem. Regulations and permits have taken us a long way toward meeting goals for specific ecosystem values in Oregon. Despite these advances, however, the collective actions of individuals continue to take their toll on climate, water quality, habitat, and streamflow. A better and broader set of incentives could encourage or allow more Oregonians to restore stream health. There are many tools available to choose from, including creating and regulating markets for ecosystem services, and using the full potential of state and federal programs, such as the Allocation of Conserved Water Program, Conservation Reserve Enhancement Program, Wetlands and Healthy Forest Reserve Programs,

Working for Ecosystems

Many local, state and federal entities are actively working to protect and restore ecosystems in Oregon through programs, partnerships, grants, and on-the-ground projects. They include:

- Oregon Department of Fish and Wildlife
- Oregon Department of Forestry
- Oregon Department of Agriculture
- Oregon Watershed Enhancement Board
- Oregon Water Resources Department
- Oregon Parks and Recreation Department
- Oregon Department of State Lands
- Oregon Department of Environmental Quality
- Watershed Councils
- Soil and Water Conservation Districts
- Irrigation Districts and other Water Users
- The Freshwater Trust
- WaterWatch of Oregon
- Deschutes River Conservancy
- Klamath Basin Rangeland Trust
- The Nature Conservancy
- Bonneville Power Administration
- Columbia Basin Water Transaction Program
- Northwest Power and Conservation Council
- National Fish and Wildlife Foundation
- National Oceanic & Atmospheric Association
- National Marine Fisheries Service
- Natural Resources Conservation Service

etc. Increasing efforts to inform landowners of this various incentives programs could potentially bring significant benefits to ecosystems on privately owned lands in Oregon.

Ecological Protection and Restoration

Although there are many threats facing our ecosystems, Oregon has heavily invested in ecological protection and restoration already, with many successes. Land management is not always a detriment to Oregon's ecosystems, but it can have positive effects, as demonstrated by the voluntary restoration accomplishments documented under the Oregon Plan for Salmon and Watersheds. Below are some examples of streamflow restoration and salmon protection tools and efforts. These examples demonstrate the resiliency of Oregon's ecosystems so long as restoration efforts begin sooner rather than later.

Regulatory Tools

The **Scenic Waterway Act**, established in 1970, recognized that many or Oregon's waters possess outstanding scenic, fish, wildlife, recreation, historic and outdoor recreation values. The Act was passed to maintain the free-flowing character of designated rivers and lakes in quantities necessary to support recreation, fish and wildlife uses. It specifically prohibits the construction of dams or other impoundments. Land use activities that can impact a scenic waterway or adjacent land, such as road or building construction, mining, forest harvesting, are limited or regulated by several state agencies. Oregon Parks and Recreation Department plays a large role in the management of the Scenic Waterway Program. The Oregon Department of State Lands, Department of Environmental Quality, Department of Fish and Wildlife, and the Water Resources Department also share responsibilities for protecting scenic waterways through various permitting and regulatory programs, as do local governments through their comprehensive planning and land use permitting responsibilities.

Oregon's Scenic Waterway Act has led to one of the most extensive scenic waterway systems in the country, with more than 1,100 river miles protected for the beneficial uses of recreation, fish and wildlife. The designation of scenic waterways is a well-established tool that brings benefits to a local economy through tourism and recreation while at the same time protecting water quality and quantity and other ecological values.

Since the adoption of Oregon's 1987 **Instream Water Right Act**, the Water Resources Department has converted more than 500 of the state's minimum perennial stream flows to instream water rights and has issued more than 900 state agency-applied rights to protect water instream for fish use, pollution abatement and recreational purposes. Applications to protect water instream are filed on behalf of the Department of Environmental Quality, Department of Fish and Wildlife, and Parks and Recreation Department and held in trust for public benefit by the Water Resources Department.

Not only can state agencies apply for water rights to protect water instream, water users with existing water rights can transfer water instream using several tools and programs administered by the Water Resources Department. Water users can transfer their out-of-stream use, such as irrigation for agricultural crops, to instream use, on a temporary or permanent basis. The water user can transfer their entire water right instream, or a portion thereof. To date, 61 permanent instream transfers have been approved, representing more than 285 cfs. More than 70 percent of water put instream on a permanent basis in Oregon is senior water, with some certificates pre-dating Oregon's 1909 water code.

Another program that can enhance instream flows is the **Allocation of Conserved Water Program**. This voluntary program has existed for well over 20 years to provide incentives that promote conservation and maximize the beneficial use of water. Common conservation practices include lining canals, moving points of diversion downstream, and changing the water distribution system from flood irrigation to sprinkler or drip irrigation. Under this program, a water right holder who conserves water may use a portion of the conserved

water on additional lands, while a portion of the conserved water is permanently protected instream. To date, more than 44 applications have been approved, resulting in almost 95 cfs permanently protected instream.

Through these programs and partnerships, Oregon has become a national leader in flow restoration, with more than 300 current instream leases, instream transfers, and allocations of conserved water that restore about 1,700 cubic feet per second (cfs) of streamflow for fish, wildlife, recreation, and pollution abatement. This is more than triple the amount for the states of Washington, Idaho, and Montana combined. During 2009, 43 percent of instream leases came directly from customer transactions with the Water Resources Department. The instream program benefits greatly from active partnerships with The Freshwater Trust, Deschutes River Conservancy, and the Klamath Basin Rangeland Trust.

The Oregon Forest Practices Act became law in 1971 and was the first state forest practices act in the nation to regulate commercial forest operations on non-federal forestlands. Both the statutes and the administrative rules for the Act have evolved over time and today provide a comprehensive set of regulations designed to encourage the sound management of soil, air, water, fish, and wildlife resources. Some of the topics addressed by the Oregon forest practice rules include reforestation, forest chemicals, road construction and maintenance, harvesting, sensitive resource site protection, and water quality protection. The purpose of the water protection rules is to protect, maintain and, where appropriate, improve the functions and values of streams, lakes, wetlands, and riparian management areas. Active management is encouraged where appropriate to meet this purpose. These functions and values include water quality, hydrologic functions, the growing and harvesting of trees, and fish and wildlife resources. Voluntary compliance by private forest landowners with the Forest Practices Act remains very high and water quality on forestlands is the highest of all Oregon land uses.

Statewide Initiatives and Partnerships

The Oregon Plan for Salmon and Watersheds (Oregon Plan) is a statewide initiative launched in 1997 to help restore healthy watersheds that support the economy and quality of life of Oregon. Agriculture, forestry, recreation, fisheries, and industry all need healthy watersheds, along with every person and community in Oregon. The Plan has a strong focus on salmon, largely because of the significant cultural, economic, and recreational importance to Oregonians - and because they are important indicators of watershed health. The Plan organizes specific actions - called "measures" - around the factors that contribute to the decline in fish populations and watershed health. Most of these measures focus on actions to improve water quality and quantity and restore habitat. Landowners and other private citizens, community organizations, interest groups, and all levels of government come together to organize, fund, and implement these measures. Oregon's watershed councils and soil and water conservation districts (SWCD's) assist landowners with projects and lead restoration efforts in many watersheds. Many projects, including financial support for watershed councils and SWCD's, are funded primarily by lottery dollars administered by the Oregon Watershed Enhancement Board. Maintaining continued political and funding support for the Oregon Plan for Salmon and Watersheds is a challenge.

The voluntary actions and willingness of private citizens to implement restoration projects on their own property has been and will continue to be fundamental to the success of the Oregon Plan for Salmon and Watersheds. For 2006 and 2007, nearly 1,300 restoration projects were completed on private land. During that same period, landowners enrolled over 11,000 acres in state and federal partnership programs to improve riparian conditions for fish habitat and water quality.

The Oregon Plan has also bolstered inter-agency and state-federal coordination and collaboration. In 2002, for example, the Oregon Water Resources Department and the Oregon Department of Fish and Wildlife completed a joint project that identifies priority areas for streamflow restoration in basins throughout the

state. These priority areas represent watersheds in which there is a combination of need and opportunity for flow restoration to support fish recovery efforts under the Oregon Plan for Salmon and Watersheds.

Regional and Local Efforts

The Umatilla Basin Project, authorized by Congress in 1988, is one example of a successful effort to reintroduce salmon after 70 years of absence from the Umatilla River. This effort, involving the Confederated Tribes of the Umatilla Indian Reservations, local irrigators, the U.S. Bureau of Reclamation, Bonneville Power Administration, Oregon Water Resources Department, and Oregon Department of Fish and Wildlife, relied on a number of policies and practices, including: use of Columbia River water instead of Umatilla River water for irrigation, fish passage improvements, stream habitat enhancement, and a fish hatchery. Today, enough adult spring Chinook have returned to the Umatilla River to provide a spring Chinook fishing season for both Indian and non-Indian fishers.

A lot of hard work has been done to restore stream flows in the Deschutes Basin. Approximately 128 cfs has been placed back instream through various conservation practices and the reduction of out-of-stream uses. Many irrigation districts in the basin have either lined many miles of open canals or replaced them with pipes, which means less water diverted and more water instream. The Deschutes River Conservancy has worked with five irrigation districts on such projects, resulting in 54 cfs of permanently protected streamflow in the Deschutes River and its tributaries. Restoring stream flows in the Deschutes Basin has been a success in large part to the cooperative efforts of very diverse interests and stakeholders working together to balance the needs of urban, rural, and ecosystem needs.

In 2009, the Savage Rapids Dam was removed from the Rogue River. Once used as an irrigation diversion dam, Savage Rapids stood 39-feet high with a 500-foot long range across the Rogue River, 5 miles upstream of Grants Pass. Known as "the biggest fish killer on the Rogue River," the dam denied access to 500 miles of fish spawning and rearing habitat.

The dam removal project, which spanned over two decades, involved entities at the local, state, and federal levels: WaterWatch of Oregon, US Fish and Wildlife Service, National Marine Fisheries Service, Oregon Water Resources Department, Oregon Department of Fish and Wildlife, US Bureau of Reclamation, and Grants Pass Irrigation District. Significant funding for the project came from the Oregon Watershed Enhancement Board and the federal government. The result of this joint effort has many benefits, including the protection of 800 cfs of water instream. With the dam removed, fish now have access to habitat for the first time since the dam's construction in 1921. Boaters and river recreationalists have opportunities to enjoy the river in new ways. The local economy and fishing industry will also benefit in future years.

Salmon in the Pacific Northwest evolved in highly variable environments to develop life histories, behavior, physiological characteristics, and genetic diversity that result in highly resilient populations that have the capacity to re-colonize vacant habitats. Maintaining sufficient water quality, water quantity, and desirable habitat characteristics are essential components of salmon conservation and recovery efforts. Oregon Department of Fish and Wildlife spawning ground surveys conducted in 1997 showed that Oregon Coast Coho salmon occupied just 16 percent of potential spawning habitat. By 2003, a combination of improved ocean conditions, natural stray rates, and efforts to maintain or improve habitat led to the occupation of more than 80 percent of potential spawning habitat. More than 75 percent of the sites that were unoccupied in 1997 had spawning Coho in 2003. It is no doubt that efforts to restore habitat and streamflow are having a positive effect on Oregon's ecosystems.

Conclusion

Oregonians' interest in maintaining ecological services has resulted in developing public policies that increase efforts and demand to maintain healthy ecosystem services. These policies rely on voluntary efforts as well as

laws and regulations. In turn, this interest in healthy ecosystems has provided economic opportunities to landowners and managers to provide these needed ecological services through restoration and conservation projects on their land. Oregon's ecological health is not only a matter of aesthetic or recreational benefits, but also a matter of vital economic importance.

It is time for Oregon to plan for, preserve, and enhance its ecosystems through integrated planning. Ecosystems and the services and value they provide are inextricably linked to land-use, water use, and water quality. Water plays a vital role in almost every type of ecosystem from deserts to rain forests. Because land use and habitat management affects the quantity and quality of water, both above and below ground, Oregon needs a strategy that addresses water quantity, quality, and habitat, not only to acknowledge ecological realities, but also the legal realities at issue, including state water law, the Clean Water Act, and the Endangered Species Act, to name a few.

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Economic Development

The purpose of this issue paper is to discuss the linkage between water and Oregon's economy. The discussion focuses on the major business segments and activities that rely on clean and adequate water supplies to prosper and maintain a presence in Oregon.

Agriculture

A 2008 water demand forecast commissioned by the Water Resources Department notes that irrigated agriculture uses more than 85 percent of the water that is diverted in Oregon. Of that, the largest demand (66 percent of agricultural demands) is in the eastern and southeastern counties of the state where large irrigated areas exist. These include Malheur, Lake, Baker, Klamath, Harney, Umatilla, and Morrow counties.

Oregon's economy relies heavily on the viability of its agricultural sector, generating $25.8 billion to Oregon's economy, or 10 percent of the state's economic activity. In Oregon, agriculture represents nearly $5 billion in farm gate value (farm gate refers to the value of the crop or livestock when it leaves the farm, minus any marketing cost incurred). There are 14 commodity categories that represent annual sales of at least $100 million each, with nursery crops representing the leading sector in terms of value at nearly $1 billion. One of every 10 jobs in Oregon is associated with the agriculture/food industry.

Agriculture in Oregon depends greatly on water delivery for crop use and farm production activities. Specifically,

- About 78 percent of Oregon's agricultural irrigation water comes from rivers and streams, fed by snow pack runoff.
- Nearly two million acres of Oregon agriculture is irrigated and nearly 45 percent of Oregon farms irrigate some or all of their land.
- Oregon ranks third of all states in the number of farms that use irrigation, and ninth of all states in the number of acres irrigated.
- Irrigated farms produce 77 percent of the total value of harvested Oregon crops.
- Virtually all fruits and vegetables grown in Oregon are produced with irrigation.
- Yields of other crops, including grains, can increase up to 500 percent with irrigation.

~Oregon Dept. of Agriculture, 2010

Food Processing

Oregon's 200 food processors account for an additional $3 billion in value-added sales revenue. According to the Oregon Business Plan Agriculture Cluster data, nearly 17,000 workers are employed in Oregon's food processing sector, generating a payroll of more than $500 million annually. Food processors play an essential part in food production by freezing, cooking, packaging, and transforming produce into other product forms for consumers. As the third largest manufacturing sector in Oregon, it is no surprise that the food processing industry handles a variety of crops, from cherries to onions, and includes many companies that specialize in bakery items, dairy products, other fruits and vegetables, meat, poultry, and seafood. Food processing is a water intensive industry because of the vast amounts of water required to wash and process the food. Finding a fresh water supply to support and meet the needs of this industry is a challenge.

Recreation and Tourism

Tourism is important to Oregon's economy, particularly on the Oregon Coast and in Central and Eastern Oregon. There are many recreational activities and tourist attractions where the focal point is a lake, river, stream, a snow-covered mountain, or the ocean. Water resources in Oregon offer many recreational opportunities, such as boating, kayaking, rafting, canoeing, camping, hiking, fishing, and observing wildlife, which greatly contribute to Oregon's economy. Some highlights:

Boating and Fishing. Nearly 3 million boat-use days. A "boat use day" is any portion of a 24-hour period in which a participant is engaged in boating activities. Fishing remains the highest use activity for boaters at 63 percent of all activity days. According to the American Sportfishing Association, in 2006, there were 7

million fishing days spent by resident and non-resident freshwater fishermen and 846,000 fishing days spent by resident and non-resident saltwater fisherman, which generated nearly $454 million in retail sales and provided approximately 8,000 related jobs in Oregon.

Water Sports: sailing, waterskiing, and wakeboarding have declined about 20 percent since 2004, while non-motorized boating such as kayaking, rafting and canoeing have continued to increase. These activities involved an estimated 386,000 people in Oregon in 2005 according to an Outdoor Industry Foundation report.

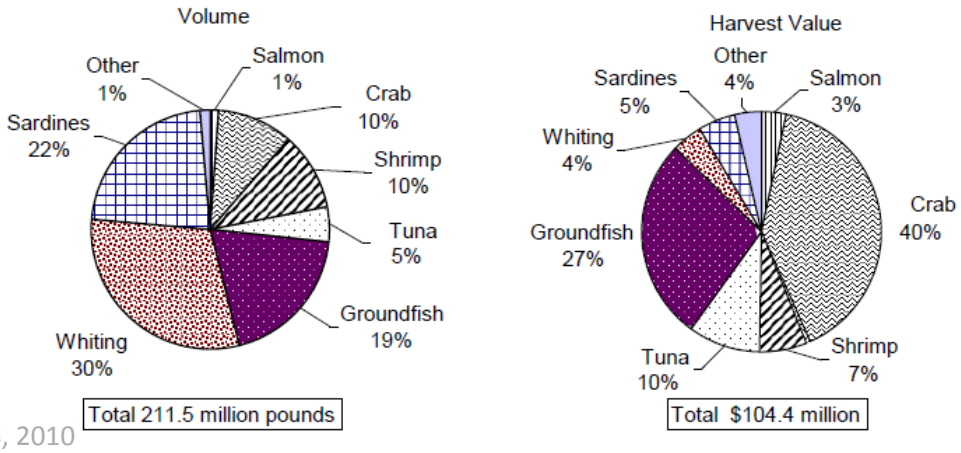
Fish and Wildlife Recreation: In 2008, nearly 2.8 million Oregon residents and nonresidents participated in fishing, hunting, shellfishing, and outdoor recreation focused on wildlife viewing throughout Oregon, resulting in expenditures of $2.5 billion. These expenditures include transportation expenses, accommodations, recreational fees, food and beverage services, and equipment purchases. Many Oregon counties, such as Harney, Lake, Morrow, and Wheeler County, receive a significant boost to their local economy from those willing to travel to participate in fish and wildlife recreation activities. The economic value of fish and wildlife recreation adds to the importance of protecting Oregon's water instream for continued enjoyment. Invasive species, changes in land-use, and habitat loss threaten our opportunities for fish and wildlife recreation.

Camping. There are hundreds of day-use parks and overnight camping facilities in Oregon, many of which reside along scenic rivers and lakes. The Oregon Department of Parks and Recreation manages more than 360 properties that include day-use areas and overnight camping facilities available for public use. In 2009, more than 2.5 million people stayed overnight and 41 million people visited day-use areas. Oregon ranks among the nation's top ten in state park overnight and day-use attendance. Not only are people willing to pay to visit and stay in these parks, many Oregonians volunteer thousands of hours a year to help maintain park lands and facilities (In 2009, there were 497,537 volunteer hours). Combining visitor expenses for both state and federally managed parks, visitors spent $222 million on travel-related expenses to use public campground facilities in 2009.

Commercial Fisheries

In 2009, more than 211 million pounds of fish were delivered to Oregon ports. The harvest value of Oregon onshore landings was $104.4 million. The estimated total personal income generated by the Oregon commercial fishing industry in 2009 was $398 million, supporting an estimated 12,000 jobs. The Dungeness crab fishery dominates the commercial fishing industry, accounting for more that 40 percent on the onshore landing harvest value. The industry is facing pressures that limit access, such as the need to protect ocean areas for marine research and wave energy. Competition among other user groups (recreational and tribal fishing), can affect the allocation of commercial harvests. Increasing costs for fuel, safety equipment, insurance, and moorage are also burdening the industry.

Figure 12: Oregon Onshore Landed Volume and Harvest Value by Species Group in 2009



Municipal Use

Municipal water providers deliver a variety of benefits on behalf of the public, serving as a backbone of economic development in many communities. Examples of benefits include protecting public health and safety by providing water in the necessary quantities and pressure to allow for fire suppression; and support for the local economy is achieved by delivering a reliable supply of water that is used in all facets of providing goods and services. In addition to these responsibilities, municipal water suppliers have one thing in common — the need to continually plan for their system's development.

Municipal suppliers (cities and districts) are formed by a vote of the affected people to provide services. Municipal suppliers can function as independent special districts or as part of larger cities. Municipal systems deliver potable drinking water supplies, and typically have their own source of funding (ratepayers). The municipality is duty-bound to serve all citizens and customers who locate within the boundary. Municipalities cannot wait to see how growth occurs. They can only make good-faith predictions of what growth might occur and be ready to serve that need before it occurs.

Municipal systems in Oregon account for about six percent of diverted water, according to a 2008 water demand forecast completed for the Water Resources Department. The largest municipal demands are in Multnomah, Washington, Clackamas, Lane, Jackson, Marion, and Deschutes Counties, which have the fastest population growth rates in the state. These same counties are projected to continue to have the greatest increase in municipal water demand through the year 2050.

DHS' Drinking Water Program partners with the Oregon Business Development Department to administer and carry out the State Drinking Water Revolving Fund (SRF). The SRF program is funded with annual capitalization grants from the U.S. Environmental Protection Agency (EPA) and is aimed at helping communities construct safe drinking water projects. These SRF projects are considered small-to-medium in size and do not typically include large, regional projects. The EPA released a February 2009 report, calculating a total drinking water infrastructure need in Oregon of $2.8 billion over the next 20 years. The Oregon Business Development Department conducted an older survey (February 2008) for the Oregon Legislature, identifying a $500 million need for drinking water infrastructure for 116 Oregon communities over the next 20 years, not including population growth.

Manufacturing

While many manufacturers purchase their water from the municipalities described above, others "self supply" their own water. Self-supplied manufacturers represent approximately six percent of water diverted in Oregon, and are located in counties that have population centers that can provide the work force and ports to support such industries.

Manufacturing plays a prominent role in Oregon's economy; its annualized growth rate of 10.7 percent between 2003 and 2007 helped solidify its position as the largest single contributor ($30.2 billion) to Oregon's 2007 $138.9 billion private sector gross domestic product.

Computer and electronic products, wood products, and food manufacturing account for almost half (46 percent) of Oregon's private sector manufacturing employment (203,242) in 2007. The high tech manufacturing sector, the focus of intense recruiting efforts in Oregon, is a water-intensive industry because of the volume of water required for cleaning and cooling. (One of the largest semiconductor chip manufacturers in Oregon reports the use of almost 10 gallons of water – much of it recycled – to produce a semiconductor chip one square centimeter in size.) In addition, the highly toxic chemicals used in the manufacturing process pose challenges for wastewater treatment processes and disposal.

Transportation

Several ports in Oregon serve as water-borne cargo ports for ocean-going vessels as well as for barges traversing the Columbia River. For example, the Columbia River is the United State's largest wheat export system. Oregon's ocean ports, located in Portland, Coos Bay, Astoria, and Newport, serve as international gateways for imports and exports of numerous products. Oregon's manufacturing, agricultural, and commercial fishing industries rely heavily on Oregon's ports as they all have economic ties to overseas customers in Asia, South America, and other overseas locations. A substantial number of Oregon's jobs are directly or indirectly dependent on Oregon's port system. Maintaining Oregon's waterways for shipping purposes is greatly affected by sedimentation. Deepening a river channel is sometimes necessary to facilitate transportation of today's larger vessels, however, the process can be extremely expensive.

The Water – Energy Nexus

Water resources and energy resources are interdependent. In many cases, energy is required to divert, treat, and distribute surface water and groundwater. Water, in turn, is required for energy production. Power plants, such as natural gas and coal products are often sited near streams because they require water to cool their facilities. In Oregon, water resources have their greatest impact on the energy economy when they power hydroelectricity.

Hydropower. Oregon and the Pacific Northwest are heavily dependent on hydroelectric generation for energy supplies. According to Oregon Department of Energy's *Renewable Energy Action Plan* (2005), hydropower meets about 44 percent of Oregon's electricity demands. Small public utilities rely on the Bonneville Power Administration (BPA) to deliver relatively inexpensive power generated at federal dams to keep power rates among the lowest in the nation, while large public utilities and private utilities may own and operate their own large-scale hydropower dams and receive secondary power benefits from BPA.

Most large-scale hydroelectric development occurred in the 1940s through the 1960s. Since that time, there has been a recognition that the river ecosystems that fuel this energy source can no longer withstand large-scale development. This recognition spurred action at the state and federal level to protect and restore rivers from the physical, chemical, and biological degradation caused by hydropower development. The effect? Water power development has evolved toward small-footprint localized hydropower, using existing water delivery systems or existing dams.

By storing water, hydropower dams can act as a battery for our energy grid, generating power at the time that we need it, matching the peaks and curves of our daily energy needs. Hydropower's unique ability to shape its generation to our load makes it an extremely valuable companion fuel source. In Oregon, hydropower serves as base load, balancing out the intermittency of current wind power and new wind power coming online in eastern Oregon.

Wave Power. Ocean energy is also a promising new sector for Oregon. The Oregon Business Development Department has named wave power as a key initiative and has funneled significant financing through the Oregon Wave Energy Trust. At this time, only test buoys are permitted to deploy from Oregon's coast. The passage of Senate Bill 195 (2009) authorized the first wave energy project to connect to the power grid. The Department of Energy offers special tax credits and low-interest loans and grants for this renewable power resource.

Bioenergy. Oregon's bioenergy industry is a diverse and growing industry. Facilities in Oregon include woody biomass co-generation facilities, lumber mills utilizing wood for energy, anaerobic digester facilities installed at wastewater treatment facilities and farms, solid fuel manufacturers and liquid biofuel producers. The use of biofuels can help protect air quality through lower emissions of particulate matter, hydrocarbons, sulfates and other toxics. With gains in efficiency in recent years, the production and use of

biofuels can reduce our energy demands. Biofuels are biodegradable and pose little risk of directly contaminating water. However, biofuel production can negatively impact water quality, from fertilizer runoff, pesticide use, and soil erosion. Negative impacts to water quality can be minimized through best management practices, such as cover crops, rotational plantings, maintaining stream buffers, and integrated pest management. Lastly, biofuel production is generally water intensive. Ethanol plants use large amounts of water for cooling and wastewater discharge purposes, although design improvements have been made in the last 10 years to reduce water use.

Mining

Oregon's mining industry is vital to the state's economy. Aggregate is the most widely used building material in Oregon, over timber, steel, plastic, or glass. It can be sand, gravel, or crushed rock, all of which are needed to construct roads, build foundations, buildings, and other structures. In 2007, there were more than 300 mining operations in the state, providing a total of 12,330 jobs with total direct earnings of $140 million. Mining in the state account for 0.1 percent of the state's gross domestic product. The majority of mining sites in Oregon are aggregate sites, with gravel extraction commonly occurring along rivers in Western Oregon.

Like many industries, water is used as an input in mining operations for crushing, screening, washing, and for the extraction of minerals. The removal of water, particularly groundwater, is an essential part of resource extraction in many operations. According the U.S. Geological Survey, mining activities accounted for 0.2 percent of water used in Oregon during 2005. Larger gravel bars in rivers and streams have also been a source of aggregate since the early 20th century; however, in-stream gravel removal is decreasing due to the need to protect fish species and spawning habitat.

Conclusion

Access to reliable and clean water is directly tied to the health of Oregon's economy and way of life. The demand for water, both in terms of quantity and quality, varies between industries due a number of factors that include the efficiency of the water system, operational methods, and the multitude of products and services that use water, from agricultural goods to computer products. Because of this variability, the Integrated Water Resources Strategy should consider water and wastewater issues on an industry-by-industry basis. In the future, water could increasingly be a defining factor – and also a competitive advantage - if Oregon manages its water resources well.

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Culture, Community, and Water

The purpose of this paper is to discuss how water influences the culture and way of life in Oregon. The role water plays, how Oregonians view and use it, differs depending upon its availability, quality, and our needs. Water plays a major role in Oregon's agricultural, tribal, rural, urban, and coastal communities. Each community faces a different set of challenging water resource issues. Some communities struggle to meet their basic domestic needs, whereas others have the luxury of safe and abundant supplies. Developing a strategy can help to foster public health, safety, and education related to water. It is important to recognize that needs and solutions will differ among regions, and within communities. Improving the understanding of Oregon's water needs, and the pressures that affect those needs (population growth, land use, climate change) will help satisfy today's needs, and prepare for the needs of future generations. Lastly, ensuring that communities have the best technical information available to them to improve participation and decision-making

Background

All living things need water. People, animals, and plants will live and thrive where water is available and abundant for them to function through their life cycle. Water is an underpinning for our own quality of life. Humans use water to bathe, wash clothing, prepare meals, and to replenish our bodies. Tribal and religious communities view water as a cultural resource and use water within ceremonial activities. Water provides for many recreational needs, such as fishing, rafting, kayaking, swimming, and wildlife viewing. Many aesthetic pleasures are also dependent on water - watering lawns, washing cars, filling swimming pools, and simply enjoying the landscape that water features provide. Understanding a community's need for water, *use* of water, and *view* of water will help the state develop solutions to meet their water needs.

Determining "need" for water versus "demand" for water will be important for developing solutions. These terms have very different meanings and implications at the household level, the city level, the watershed level, and at the state level.

A lack of water can have a devastating effect on the cultures and livelihoods of those who depend on it. Without sufficient water, competition between water users can increase, which means the economic value and cost of water may also increase. As one example, policy skirmishes that curtailed federal project irrigation water in the Klamath Basin decimated agricultural production and the communities that depend on this agricultural income, and then endangered fish populations and the Indian Tribes, and commercial and recreational fishing industries that depend on healthy fish runs.

Use of Water. In Oregon, a water user has the flexibility to use water for any activity allowed under a water right. During the past century, the state has issued water rights for many uses, some of which include: agricultural use, irrigation, domestic and livestock use, power development, commercial use, municipal, and instream uses for fish, wildlife, recreation, and pollution control.

When surface water and groundwater supplies are scarce, the state distributes water based on the seniority of the water right.

Water Use in Oregon

Water use in Oregon is typically described in broad terms, such as "irrigation use" or "municipal use." However, water use is quite diverse and includes:

- Temperature Control
- Frost Protection
- Cranberry harvesting
- Forest management
- Fire Protection
- Riparian Habitat Restoration
- Wetland Construction
- Air Conditioning or Heating
- Anadromous and Resident Fish Habitat
- Fish Hatcheries
- Road Construction
- Nursery Operations
- Food Processing
- Camp Site Facilities (restrooms, showers, water fountains)
- Dairy Barn Purposes
- Manufacturing
- Pollution Control
- Aesthetics

Many municipal water providers and irrigation districts offer conservation programs to help their customers become more efficient and decrease their overall water use. Under certain emergency situations, individual water right holders, such as municipalities or irrigation districts, can implement their own curtailment plans that impose even further restrictions on their own customers. In the case of municipalities, one example of this could include the prohibition of outdoor uses such as watering lawns, washing cars, or running water features. In a Governor-declared drought declaration, the Governor has additional tools available to restrict water use to essential uses, such as drinking and stock watering.

The Role of Water in Oregon

Water quantity, water quality, ecology, economy, and climate change issues touch every community in Oregon. These water issues cut across all citizens in Oregon, as water is an integral part of daily life in many social, cultural, and economic ways. Managing water in a sustainable and balanced way to meet our many needs is important to the health of our communities.

Tribal Communities. Many cultures use water in their rituals, ceremonies, and other activities. Important cultures that bear particular attention in Oregon are the Indian Tribes, which are recognized as sovereign nations. Oregon has nine federally recognized Indian Tribes throughout the State. Legally binding treaties, federal statutes, and numerous court decisions explicitly or implicitly acknowledge the central role water and related resources play in promoting the effective self-determination and self-governance of tribal nations because they form the base of the tribal cultural and natural resources pyramid. From the tribal perspective, natural and cultural resources were plentiful and in a healthy condition during the 10,000 years of history, prior to the formation of the State of Oregon 150 years ago.

Protecting Cultural Resources

By law, the State of Oregon is steward of the state's cultural resources and considers archeological sites as irreplaceable, finite, and a direct contribution to Oregon's heritage. A significant number of archaeological sites and sacred sites are located on or near waterways and water bodies within the State. The excavation, destruction, or alteration of any archaeological site or collection of objects on public or private lands is prohibited without the proper permit or landowner permission.

For most tribes, cultural resources include traditional culture and the resources needed to sustain that culture. It is not limited to historical or archeological sites, or to the tribes ceremonies and traditions. Cultural resources also includes native fish, wildlife, trees and plants, the habitat and watershed needed to sustain those, and ultimately, water itself.

Tribes need to be able to participate in and practice the traditions that define who they are as a people. Water is central to many of these traditions. As one example, elders teach young tribal members basket making techniques, which entail gathering grasses found in wetlands and pulling the grasses through their teeth to create basket string. If the water is polluted, the grasses and these traditional lessons may sicken both the tribal elders and their young students. As another example, tribal diets are heavily dependent on fish consumption, making water quality a fundamental concern of the Tribes. The quality of tribal traditions and diet depends on the quality of water in Oregon. As one tribal leader has noted, "the beginning and end of all life is *water."*

Many tribal communities are actively working with partners to protect water quality and water quantity. The Confederated Tribes of Warm Springs (CTWS) has partnered with Portland General Electric to contribute $10 million toward watershed restoration and another $100 million to fish passage efforts. The Tribe has many interests in the protection of water quantity and quality, particularly in the Deschutes Basin, as they rely on water for domestic needs, fisheries, hydropower, habitat for traditional plants, wildlife, and other cultural and spiritual purposes. For the CTWS, water is considered sacred – it is the basis for all life.

Agricultural Communities. Oregon's economy benefits greatly from the agricultural community, which has been integral to Oregon's culture and way of life since statehood. In 2009, Oregon was home to nearly 38,600 farms, encompassing more than 16 million acres. Ninety-eight percent of farms in Oregon are family-owned or individually operated. More than 1,100 farms in Oregon have been family-owned for more than a century, according to the Oregon Department of Agriculture. The economic viability of many Oregon farms and ranches is heavily dependent on water. Water allows Oregon farmers to bring an incredibly diverse group of fruits, vegetables, and other crops to Oregon tables and families around the world.

Agricultural communities vary widely across the state, in terms of their size, average income, farm activity, and need for water. Take for example, the number of farms in three Oregon counties in 2007: Tillamook County – 302 farms; Sherman County – 208 farms; and Malheur County – 1,250 farms. The average net income per farm varies as well, from $101,512 for Tillamook farms, to $91,398 for Sherman County farms, and $40,309 for Malheur County farms. (USDA, 2007 Census) Cattle ranching and farming is the largest farming activity in Oregon, representing largest land-use activity in Oregon.

The variety and success within agriculture, from farm size to crop production, is partly attributable to its long history of water use in Oregon. The ability to use water to irrigate crops has led to well established agricultural communities across the entire state. Many large-scale irrigation projects, such as dams, diversion structures, and delivery systems (canals, ditches), were constructed during the early 20th century.

As the largest water user in Oregon, the agricultural community has a role in protecting water quality and water quantity. Activities, such as canal lining, piping, and replacing gravity diversions with pumps are taking place in parts of central and eastern Oregon. Use of drip irrigation is common in many agriculture applications, including nurseries, poplar plantations, vineyards, carrot seed production, and other row crops. To improve water quality, projects can include the construction of settling ponds, or wetlands to capture or filter irrigation runoff and the installation of pump-back systems. Many Oregon farm and ranch operations work closely with the Oregon Department of Agriculture and county Soil and Water Conservation Districts to meet water quality standards by managing animal wastes and non-point source pollution. In 2007, more than 1,700 farms in Oregon participated in federal conservation programs to protect water quality and conserve water (USDA, 2007 Census).

The Agricultural Community in Oregon is very diverse. This diversity allows us to enjoy a variety of commodities produced here in Oregon, some of which include:

Potatoes	Raspberries
Sugar beets	Loganberries
Wheat	Grass Seed
Apples	Nursery Plants
Blackberries	Christmas Trees
Blueberries	Hops
Cherries	Peppermint
Cranberries	Oats
Hazelnuts	Barley
Pears	Hay
Peaches	Peas
Plums	Corn
Prunes	Onions
Strawberries	Grapes
Milk	Tomatoes

~ USDA, Oregon Agriculture: Facts and Figures, June 2010

The cost of implementing various conservation measures can be a barrier to improving water efficiency, such as the electrical costs to pump water and distribution equipment costs (sprinklers, pumps, pipes, etc). This barrier not only affects the ability of agricultural communities to conserve water, but also affects municipalities, counties, cities and other water providers that are looking for ways to use water efficiently. The agriculture communities' dependency on water makes it highly susceptible to natural events, such as drought and change in precipitation patterns. Agricultural communities also face competition for water from both urban and rural development. Agricultural water needs also vary regionally, depending upon water availability, storage capability, and overall demand.

Rural Communities. In simple terms, a community is considered "rural" if there are less than 2,500 people, according to the U.S. Census Bureau. Rural communities vary across Oregon, differing in geographic and demographic characteristics, and as such, face a different set of pressures. A 2008 report by the Governor's Office of Rural Policy describes rural communities using four categories: Urban-Rural, Rural, Frontier Rural, and Isolated Rural. *Urban-rural* communities are slowly losing their agricultural base to increased development, which means additional municipal infrastructure demands. There is a struggle by some rural communities to finance water and wastewater infrastructure and system upgrades. *Frontier rural* communities are dependent on agricultural and other natural resources activities to sustain their local economies. Isolated rural communities are extremely self-reliant and dependent on volunteer services to protect public health and safety.

Typically, rural communities rely on groundwater, either through a small community water system or through individual wells that supply water to a single household. Isolated or individual use of groundwater makes it difficult for homeowners, business, and small water providers to address both water quantity or water quality issues. When the well output drops, most often a back up source of water to supply household needs is not available. Drilling a new well, or repairing an existing one, to increase supply can be extremely expensive to an individual user.

The assumption is often made that where the Water Resources Department has not specifically restricted development of the ground water resource, the resource is capable of sustaining additional water use. This assumption is often incorrect and land use decisions made pursuant to that assumption may exacerbate water supply problems by allowing additional water-dependent development. For these reasons, the Department and local land use planners must work together to prevent rural water supply problems.

Environmental Justice Communities. Environmental Justice is defined as equal protection from environmental and health hazards, and meaningful public participation in decisions that affect the environment in which people live, work, learn, practice spirituality, and play. In Oregon, environmental justice communities include minority and low-income communities, tribal communities, and other communities traditionally underrepresented in public processes. Through Senate Bill 420 (2007), twelve natural resource agencies are required to consider environmental justice implications within their programs. An Environmental Justice Task Force was formed in part to advise natural resource agencies on environmental justice issues and to define what issues the state is facing.

Some agencies have focused on environmental justice issues for many years now. For example, the Department of Environmental Quality adopted an environmental justice policy in 1997. Since then, the agency has been committed to the principles of environmental justice, ensuring that agency actions (i.e. permitting, cleanup, policy, planning, outreach and education, compliance and enforcement) address the interests of Oregon communities, especially minority, low-income and other traditionally underrepresented communities, as much as state and federal laws allow.

The Oregon Water Resources Department, Oregon Department of Agriculture, and the Oregon Department of Fish and Wildlife are also responsible for considering environmental justice issues. Collectively, these agencies have focused on engagement with tribal representatives, farmworker pesticide exposure, andextensive public outreach to stakeholders, small business owners, and members of the general public during policy formation.

Coastal Communities. Oregon's coastal communities comprise 186 miles of Pacific Ocean coastline and encompass nearly 60 public beaches**.** Many coastal communities are located in rural or sparsely populated areas. Approximately 210,000 people call the coast "home" full time. Coastal counties include Clatsop, Coos, Curry, Lincoln, Tillamook County, and portions of Douglas and Lane County. The five largest coastal communities are Astoria, Lincoln City, Newport, Coos Bay, and North Bend. Many coastal communities are

prime tourist destinations for recreational fishing and crabbing, sight seeing, and wildlife observation. Twenty-two major estuaries along the coast support communities by offering access for shipping, commercial fishing, port facilities, and recreational opportunities, along with many ecological benefits. Virtually all of Oregon's coastal rivers support anadromous fish species, such as salmon and cutthroat trout, many of which are listed under the Endangered Species Act.

Coastal communities depend on relatively small watersheds, where the streams are short, high gradient, and very seasonal, with low overall yields. Water use in coastal communities is seasonal as well, where demand dramatically increases during the summer tourist season. Domestic water use represents 35 percent of withdrawals, agriculture represents 30 percent, irrigation use 23 percent, and industrial use accounts for 12 percent. Agricultural use in the coastal areas include dairy farms for milk and cheese production, as well as cranberry operations on the south coast. Commercial and recreational fishing in coastal communities rely on abundant and healthy oysters, mussels, clams, salmon, halibut, ling cod, snapper, bass, Dungeness crab and scallops, which directly benefit coastal economies.

Coastal water systems rely heavily on surface water, rather than groundwater. To meet drinking water quality standards, communities often rely on treatment plants. Financing upgrades or expansions to water systems is a challenge in many communities. Outdated or undersized treatment facilities, combined with sewer outflows, are considered to be the greatest regional threat to coastal water quality. When coastal waters are unsafe for public use, the Department of Human Services issues a public health advisory that informs visitors what waters and activities to avoid, such as swimming, wading, or direct contact.

In recent decades, increases in population and development have placed a considerable amount of pressure on Oregon's coastal communities. There has also been an increase in the intensity and frequency of winter storms, resulting in significant damage to buildings and homes from flooding and erosion. These severe storms can also destroy water pipelines and diversion structures. Because of this, coastal communities are very vulnerable to climate change.

Metropolitan and Urban Communities. Metropolitan areas are often defined as communities with at least 50,000 people. The Portland Metro, Eugene-Springfield, Salem-Keizer, Medford, Bend, and Corvallis areas are considered metropolitan communities.

Metropolitan communities contain about 60 percent of Oregon's residents and are the location of most of state's population and employment growth. These areas have traditionally relied on surface water for domestic and other urban water needs and operate sophisticated infrastructure for managing and treating drinking water, wastewater and stormwater. The costs of managing these systems has become increasingly burdensome in recent years.

There are 69 cities in Oregon with a population over 2,500 (see "Rural Communities," above) that are not part of a metropolitan area (see "Metropolitan Communities," above) according to 2009 data. This is about 30 percent of Oregon's cities and 17 percent of the state's population. Urban communities vary across that state, differing in geographic and social characteristics. Most residents and businesses in these communities have the benefit of water and wastewater disposal service, either from the city or a district. There is a wide range of circumstances, however, related to growth and the jurisdiction's capacity to deal with development from a public facilities standpoint. *Add more description here…*

Public Health and Safety

Every community in Oregon has a responsibility to protect natural resources in such a way that ensures the health of its citizens. One of our most precious natural resources is water and keeping it safe and available is

key to protecting public health. The quality of our water also affects the food we consume, such as fish, oysters, clams and mussels. Water system operators in Oregon are instrumental in making sure the water that enters our homes is safe for consumption and use. Likewise, various state agencies, such as the Department of Human Services and the Oregon Department of Agriculture, help Oregonians determine when it is safe to eat fish and shellfish from Oregon's rivers, lakes and oceans.

Safe Drinking Water. On average, a person will consume more than a quart of water each day. Drinking water contaminants, such as bacteria, can cause acute health effects that generally occur within a few hours or days. Prolonged exposure of chemical contaminants, such as lead or arsenic, can cause cancer or organ damage.

Public water systems, with state oversight, are a key protector of public health. Approximately, 88 percent of Oregonians rely on community water systems as a primary drinking water source. These systems treat water to control pathogenic organisms, harmful contaminants, and constituents that affect the quality of the water. Traditionally, water treatment methods focus on particulate removal through flocculation, sedimentation, and filtration and include disinfection by using chlorine and ultraviolet technology. Often times, fluoride is added or harmful chemicals, such as arsenic, are removed, to protect public health.

In Oregon, public water systems with greater than three hookups or serving more than 10 people year-round are regulated. There are more than 3,500 public water systems in Oregon. Fifty-five of these public water systems serve 67 percent of the population. Oregon's public water systems are fed by more than 200 surface water diversions and almost 3,000 groundwater wells. Protecting the sources of water from contamination, combined with treatment, are both important components of protecting public health. Each year, drinking water providers must report the results of the mandatory water quality testing they perform on their potable water supplies. Since the 1970s, waterborne disease outbreaks in Oregon have fallen dramatically, from 15 in the 1970s, to two outbreaks during the 2000s because of the oversight and protection standards public water systems must meet.

Food Consumption. Many Oregonians consume locally caught fish and shellfish. Unfortunately, some of these species accumulate toxic chemicals, posing health risks to individuals that consume them. Shellfish, for example, can be contaminated by toxic algae blooms or sewage spills. The Oregon Department of Environmental Quality is the agency responsible for establishing the level of protection needed to ensure public health, through water quality standards. DEQ is responsible for defining the fish consumption rate that is safe for humans.

Over the last two years, DEQ has worked with partners and other agencies to revise the fish consumption rate with an understanding that Oregonians actually eat more fish and shellfish than previously thought. This process lead to adjusting the fish consumption rate to 175 grams per person per day, 10 times higher than the previous rate. As a result, DEQ has been working to revise human health water quality standards for toxic pollutants. Revisions to water quality standards, as a result of a higher fish consumption rate, will likely mean stricter limitations on pollutant discharge by industrial and municipal uses.

The Department of Human Services (DHS) also protects public health by issuing fish consumption advisories throughout the state's rivers and reservoirs. Most DHS issued advisories are for moderate to high mercury levels and PCB's (polychlorinated biphenyls). The Oregon Department of Agriculture and the Oregon Department of Fish and Wildlife jointly issue shellfish safety closures to protect recreational shellfish harvesters from consuming clams or mussels contaminated with harmful biotoxins.

Recreation. Public health and safety concerns associated with recreational use of lakes and other waters, has been growing over the past several years. When toxic algae blooms are detected in the water, activities such

as swimming, water-skiing, or any other direct contact with water should be avoided. The Oregon Department of Human Services, Oregon Department of Environmental Quality, Portland State University, Oregon State University, along with federal partners, have been working together to gain a better understanding of toxic algae blooms. Part of this work includes monitoring, public education and outreach, and informing the public regarding health and safety risks.

Barriers to Efficiency

Using water more efficiently (i.e., accomplishing the same task with less water) can manifest itself in a number of ways, including water conservation and water re-use. In 2008, the Water Resources Department surveyed water users to better determine the greatest barriers to increased water use. The most often-heard response was "cost," as re-tooling processes and systems often require a large capital investment up front. Other cost-related barriers can include higher energy bills, whenever electric pumps replace gravity fed delivery systems, or whenever drip irrigation systems replace flood irrigation or other methods.

Other barriers include fears of lost water rights. The adage "use it or lose it" is widely quoted in these instances. However, the Water Resources Department has a conservation program called "Allocation of Conserved Water," that allows water users to spread water over more lands and also place some instream, as part of a voluntary conservation program. Many water users are still unaware that such a program exists and those who have participated report that the process and paperwork can be difficult to maneuver.

Finally, there can be administrative barriers to water efficiency, as water conservation, water re-use and other techniques are still in development. Statutes and rules often lag behind these technologies, making implementation difficult.

Deteriorating Infrastructure

Deteriorating infrastructure is a universal problem. Water loss, public health concerns, combined sewer overflows, and inefficient systems typically result from such deterioration. Although many of Oregon's water, wastewater, and sewer systems are newer than their counterparts in the Eastern United States or Europe, they may still be more than a century old. Some older communities still have old wooden pipes in place underground. Barriers to infrastructure maintenance replacement include the capital investment required, as well as the inconvenience of digging up existing streets and pavement to lay pipes.

By some counts, Oregon is need of about $44 million in investments for public drinking water systems and about ten times that amount for wastewater and sewer systems. Although federal and state funds have historically helped communities meet some of these costs, a significant funding gap remains. *Add more detail on other infrastructure needs…*

Institutional Capacity

Placeholder

Barriers to Water Supply Development

Placeholder

Conclusion

It is sometimes easy to take for granted the abundance of clean water to drink, wash, recreate, and conduct business. If we do not pay attention to social aspects when we make decisions that affect water quality and water quantity, we can harm our cultures, our communities, and our livelihoods. And, since water knows no boundaries, a decision made upstream may have lasting direct or indirect detrimental effects on those persons

and communities downstream. As we move through the process of developing an integrated water resources strategy, we should continue to examine our social value of water, as well as the economic importance and ecological benefits it provides. As our Tribal partners have reminded us, we have a shared interest in the health, well being, and public safety of our state's waters.

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The Implications of Climate Change

The purpose of this issue paper is to explore the implications that climate change may have on water resources in Oregon. One important point to note is that while quite a bit of scientific work has focused on the Pacific Northwest there is very little information available that relates to Oregon specifically. More research is required to understand how Oregonians, our water supplies, and our environment will be affected by climate change over the decades to come. The Water Resources Commission identified this as an important emerging issue for the state and adopted its initial climate change policy in February 2009. The strategy serves as an opportunity to develop reasonable adaptation strategies now, while at the same time continuing research to advance scientific knowledge relative to climate change.

Background Information

Studies and Partnerships. There are many institutions, local – state – and federal, that are conducting studies on climate change. The Oregon Climate Change Research Institute (OCCRI) has been tasked by the Oregon Legislature to foster climate change research among faculty of the Oregon University System. OCCRI/Oregon State University was recently awarded a grant, which could surpass $3.5 million, from the National Oceanic and Atmospheric Association to address climate assessment needs for businesses, state and federal agencies, municipalities, tribal leaders and non-governmental organizations in the Pacific Northwest.

The Climate Leadership Initiative is a social science-based global climate change research and technical assistance collaborative between The Resource Innovation Group and the Institute for a Sustainable Environment at the University of Oregon. For the past four years, the Climate Leadership Initiative has been implementing a series of Climate Future Forums and Watershed Resiliency Trainings across Oregon's river basins. The goal of these programs is to develop models for building climate resiliency and adaptation literacy, while also delivering the tools and resources needed to assist all levels of governments, the private sector, and nonprofits to proactively prepare for climate change.

In July 2009, the Land Conservation and Development Commission adopted an interim climate change strategy that directs the Oregon Department of Land Conservation and Development to begin working on a framework for a state-level climate change adaptation plan for Oregon's built environment, and to coordinate that work with other efforts already underway in other Oregon agencies. The intent of this effort is to identify: (1) likely future climate conditions and the risks those conditions represent for resources, infrastructure, and communities; (2) actions agencies are taking to address those risks; (3) gaps in state capacity to address those risks; (4) priority short-term actions to address those gaps; and (5) some basis for identifying longer-term priority actions.

The consensus among climate scientists is that climate shift is occurring more rapidly than can be attributed to natural causes and that significant impact to the environment will be felt in this century. For instance, the annual average temperature over the Northwest United States (Oregon, Washington, Idaho and western Montana) is projected to rise 3 to 10 degrees Fahrenheit during this century (visit www.globalchange.gov/usimpacts). Another critical impact will be the changes in precipitation patterns in the western United States. This will affect water availability, not just for agriculture and food production, but also for the most basic drinking water and domestic water needs of communities in many areas. Impacts related to changes in snowpack, stream flows, sea level, forests, and other important aspects of life in the Northwest are already visible, with more severe impacts expected over the coming decades in response to continued and more rapid warming.

Potential Consequences of Climate Change

Declining springtime snow packs could lead to reduced summer streamflow, straining water supplies. Oregon and all the Northwest is highly dependent on temperature-sensitive springtime snowpack to meet

growing and often competing water demands such as municipal use, industrial use, irrigation for agriculture, hydropower production, navigation, recreation, and instream flows that protect aquatic ecosystems including threatened and endangered species. Higher temperatures are causing more winter precipitation to fall as rain rather than snow and are contributing to earlier snowmelt. Further declines in snowpack are projected, reducing the amount of water available during the warm season. The amounts of flow reduction, for a given amount of warming in winter or spring, are highly variable from one part of the state to another, depending in part on the mean elevation of the river basin in question.

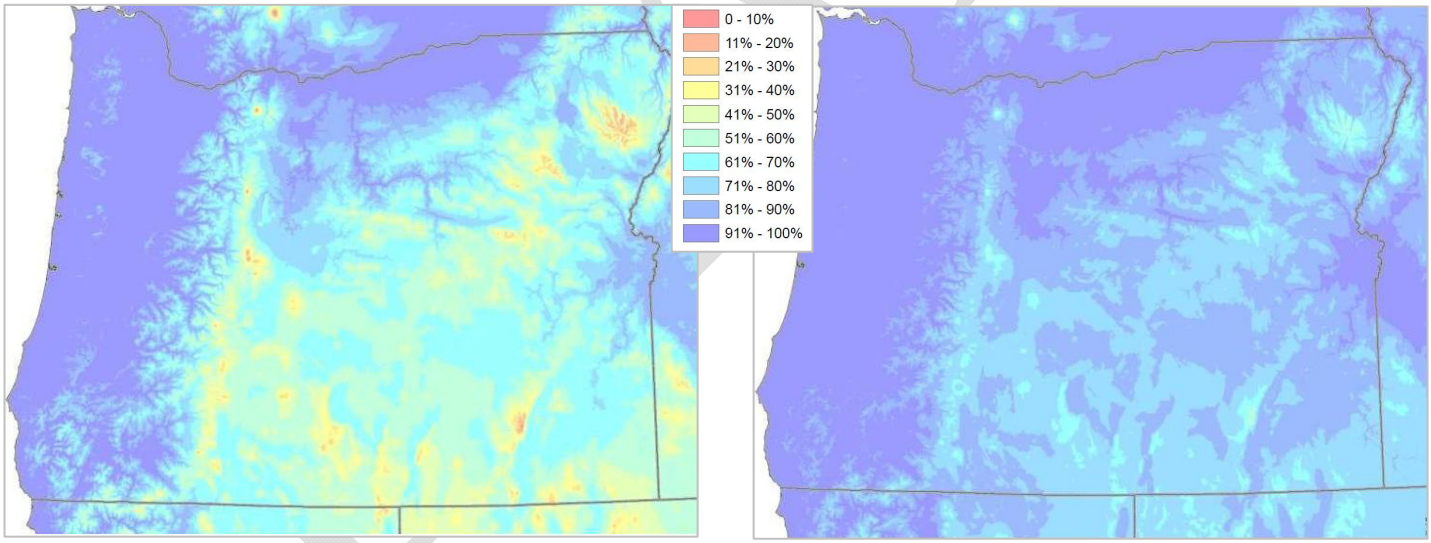
Most climate models suggest that amounts of winter precipitation will continue to arrive—but as rain rather than snow. **Figures 13a and 13b** show the percentage of precipitation that falls as rain in two scenarios, conditions today and conditions with a rise in temperature. If temperatures increase 3 degrees, the percentage of precipitation that falls as snow is visibly less (**Figure 13b**).

Snow Today. *Snowpack, stored naturally during the winter and melting slowly during the spring, represents a significant source of water for all types of uses and functions. We rely on snowpack to recharge streams and reservoirs, to provide cold water for fish habitat and overall stream health, and to provide water supplies to agricultural, industrial, municipal, and other uses in the late spring and summer.*

Rain Tomorrow. *Climate change models predict warmer temperatures in the coming decades, potentially changing precipitation that normally fell as snow to rain. The map directly below shows the effect warmer temperatures might have on snowpack in Oregon. This could create problems for all users, including fish, dependent on summer streamflows*

Figure 13a: Current Precipitation Conditions

Figure 13b: Future Scenario (3°Temp Increase)



The rainfall patterns under some of the Global Climate Model outputs indicate that rainfall, even if it increases, will come in a more concentrated period in the winter months (Dec-Feb). In addition, most models suggest decreases in the amount of summer precipitation. Most critically, for streamflow, regardless of the changes in seasonality of precipitation, runoff will almost certainly increase in winter and decrease in summer in any basin with a significant snowmelt component. This timing change will likely increase the need for natural and manufactured storage areas, and it will also likely increase the risk of incidences of extreme or peak flow events that cause flooding, erosion, and less capability to recharge groundwater aquifers in some parts of Oregon.

Increased Demand for Water. Climate change is expected to cause a larger and more complex wave of human migration. It is quite possible that Oregon will see a rise in population from "climate migrants." Naturally, population growth places a larger demand on water resources, and therefore, increases competition between uses and among users. Water demand for irrigation may also increase as transpiration increases and growing seasons are extended. Water users that depend on low elevation watersheds for water supply may find difficulty meeting future water needs, where a slight temperature rise can turn snow into rain. Roughly, just under half of Oregon's population depends on water from "snow-transient" basins (CLI, 2007).

Rising water temperatures and declining summer streamflows could seriously stress salmon and other coldwater species. Northwest salmon populations are already at historically low levels. Studies suggest that about a third of the current habitat for the Northwest's salmon and other coldwater fish will no longer be suitable by the end of this century because of climate change. Areas particularly at risk in Oregon are the southwest and southeast, and north central area along the Columbia River. Projected temperatures through 2040 suggest that the habitat for these species is likely to decrease dramatically. *Discuss other impacts on aquatic species?*

Sea-level rise along vulnerable coastlines will likely result in increased erosion and the loss of land. Climate change is expected to exacerbate many of the stresses and hazards facing the Oregon coastal zone. Rising sea-levels will increase the erosion of the coast and cause loss of beaches and significant coastal land areas. A number of populated areas and towns along the Oregon coast are also at potential risk. Sea level rise also will increase the impacts of severe storm events through both wind erosion and flooding. Rising sea level and increasing storm intensity will increasingly stress infrastructure facilities built under different engineering standards. For water resources, these include water treatment plants, diversion facilities, and wastewater plants. The intrusion of salt water to those facilities built close to the coast will be a factor as well as potentially to groundwater wells that are close to the coast. Climate change impacts along the coast will not be limited to sea-level rise. Increased wave heights during storm surges and increased frequency of intense storms are already occurring and are affecting Oregon's coastlines, developed areas, and estuaries. Sea level rise will serve to exacerbate those impacts.

Increased insect outbreaks, wildfires, and changing species composition in forests will pose challenges for ecosystems. Higher summer temperatures and earlier spring snowmelt are expected to increase the risk of forest fires by increasing summer moisture deficits; this pattern has been observed in recent decades. (McKenzie et al., 2004; Westerling et al., 2006; Littell et al. 2009.) The ability of vegetative species to adapt to changing conditions is slower than that for more adaptive and mobile animal species. Stress on vegetative patterns will present significant challenges and hazards for water management. Drought stress and higher temperatures will decrease tree growth in most low and mid elevation forests and will also increase the frequency and intensity of mountain pine beetle and other insect attacks, further increasing fire risk and reducing timber production, an important part of Oregon's economy. Tree growth at higher elevations will likely be enhanced owing to longer growing seasons, currently limited by snowfall.

Research and Technical Questions

"Actionable science" is necessary for successful future decision-making at the State and local levels. While significant research has been done on climate change both globally and within the United States, and specifically with the Pacific Northwest, there is still a significant lack of clarity on the specific impacts at the regional and local level. In order to gain more clarity from the Global Climate Modeling (GCM) downscaling process and regional modeling, improvements are needed within the models themselves, and further research is needed on the extreme events such as intensity of precipitation during short periods of time that present significant challenges to water resource managers. In Oregon, more research and studies are needed to project climate change impacts throughout the state using the best available science. We must also expect and plan for uncertainty and flexibility, as climate conditions will fall within a wide range of scenarios.

Water Management

The change in timing and availability of water as a result of climate change may affect whether or not water users are able to utilize their water rights for the amount allowed. Less water may mean that juniors users are more frequently regulated to meet the water needs of senior water right holders. Water rights that protect water instream for a certain amount and time period may be also be at risk from precipitation changes and decreased snowpack. An increase in regulation to meet senior rights, protect instream needs, and water quality could result. Water managers and users will need to look for ways to conserve water, reduce demand, and consider alternatives or new ways to meet needs in a changing climate.

Public Awareness and Education

The media has dominated the public's perception of climate change to the point that polarized positions remain about the cause and severity of climate change impacts. There are some generally accepted conclusions about climate change that need to be refined and more effectively communicated to stakeholders. The use of more relevant research to inform Pacific Northwest stakeholders could be incorporated into the dialogue on this issue. Outreach should emphasize the need to move forward on developing reasonable adaptation strategies now rather than waiting for "perfect science."

Climate Change Policy
Oregon Water Resources Commission
February 25, 2009

Be It Resolved by the Oregon Water Resources Commission:

That Oregon's long-term water resources strategy should anticipate the potential effects of Climate Change on Oregon's water resources. Such a long-term strategy should directly increase the likelihood of fully achieving the co-equal goals of the Commission and the Department by:

- relying on the best available scientific data and research;
- monitoring the continuing effects on the amount of available water and the changing water needs of humans and natural systems;
- collaborating and leveraging other resources with Federal, state, local, and private partners who are also pursuing climate change mitigation and adaptation policies;
- ensuring adaptation and resiliency for Oregon's water resources and the natural function of the watersheds in which they reside;
- engaging other natural resource agency expertise as appropriate to develop and ensure an integrated approach to managing the state's water resources; and
- developing a policy toolbox that includes water conservation, streamflow enhancement, demand reduction, and water supply development, including natural and environmentally appropriate constructed storage.

Due to a changing climate, the Water Resources Commission reserves the right to review and modify this policy at any time.

Objective Stakeholder Involvement

There is a strong need to achieve mutually beneficial solutions. This includes identifying potential climate change scenarios and solutions without having perfect information. It is important to stress to adapt to a future that may be quite a departure from the historic past. This state should strive to develop an adaptation strategy that will address the many challenges of climate change. Strategies can be developed and implemented that address multiple objectives simultaneously.

Conclusion

Building partnerships to address the issue of climate change will be vital if Oregon is to be successful in dealing with the risks of climate change. Oregon should position itself to take advantage of the increasing awareness of the risks of climate change and the resources that are now becoming available to address the issues. Specifically, Oregon should look at adopting strategies that will adapt to the risks of potential climate impacts without waiting for the perfect science.

The Water Resources Commission may opt to review and update its policy statement on climate change, adopted February 25, 2009, to include a climate change element in the Integrated Water Resources Strategy.

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Glossary of Acronyms and Water-Related Terms

Acronym/Term	Description
ACRE-FOOT (AF)	One acre-foot is the volume of water that will cover one acre to a depth of one foot and is equivalent to 325,851 gallons.
AR	Artificial Recharge
ASR	Aquifer Storage and Recovery
BiOp	Biological Opinion
BMPs	Best Management Practices
Bureau	U.S. Bureau of Reclamation
CFS	The rate of water flow that will supply one cubic foot of water in one second. Equivalent to a flow rate of 7.48 gallons per second (448.8 gallons per minute or 646,272 gallons per day).
CORPS	U.S. Army Corps of Engineers
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
DEQ	Oregon Department of Environmental Quality
DEQ	Department of Environmental Quality
DHS – DWP	Oregon Department of Human Services – Drinking Water Program
DLCD	Oregon Department of Land Conservation and Development
DOE	Oregon Department of Energy
DOGAMI	Oregon Department of Geology and Mineral Industries
DRC	Deschutes River Conservancy
DSL	Oregon Department of State Lands
DWA	Deschutes Water Alliance
EPA	U.S. Environmental Protection Agency
EQC	Environmental Quality Commission
ESA	Endangered Species Act
GWMA	Groundwater Management Area
IFA	Infrastructure Finance Authority
MGD	Million gallons Per Day
NOAA	National Oceanic Atmospheric Administration, U.S. Dept. of Commerce
NPDES	National Pollutant Discharge Elimination System
OAR	Oregon Administrative Rule
OBDD	Oregon Business Development Department
ODA	Oregon Department of Agriculture
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
OHA	Oregon Health Authority
OPRD	Oregon Parks and Recreation Department
ORS	Oregon Revised Statute
OWEB	Oregon Watershed Enhancement Board
PUD	Public Utility District
TMDL	Total Maximum Daily Load
USGS	United States Geological Survey
WRC	Water Resources Commission
WRD, OWRD	Oregon Water Resources Department

Placeholder: Appendices

Appendix 1: Management of Water Resources – Agency Appendix

Soon to Come!

This purpose of this section is to illustrate how state and federal natural resource agencies coordinate on water resource management in Oregon. An outline of each agency's mission, plans and programs will allow the public to access information all in one place.

Appendix 2: Data and Information Gaps

The following link directs you to a document that outlines data and information needed to manages Oregon's water resources. This document was prepared for the April 14, 2010 Policy Advisory Group meeting. Recommendations that were made by advisory members during that meeting are not currently reflected in the document. http://www1.wrd.state.or.us/pdfs/04_14_10_Presentation_Materials.pdf

Appendix 3: Key Studies and Plans

The Integrated Water Resources Strategy Agency Advisory Group, compiled a state-wide overview of major plans or strategies that drive economic development and natural resource management in the State of Oregon. This overview was prepared for the July 13, 2010 Policy Advisory Group Meeting. http://www1.wrd.state.or.us/pdfs/7_13_Presentation_Materials.pdf

Appendix 4: Funding Gaps

(Forthcoming – 2011)

Appendix 5: Education and Outreach Gaps

(Forthcoming – 2011)