CHAPTER 2

UNDERSTAND OREGON'S INSTREAM & OUT-OF-STREAM NEEDS

Photos (clockwise from top): Rick Swart, ODFW; Travel Portland; Kyle Gorman, OWRD; The Knowles Gallery

Out-of-Stream Needs

Instream Needs

Oregon has granted water rights for many beneficial uses, some of which include general agricultural use, irrigation for crops, domestic and livestock use, power development, commercial use, and municipal use. Water rights have also been established to protect instream uses for the benefit of fish, wildlife, recreation, and water quality.

Oregon needs a better grasp of its current and future water needs and demands, both instream and out-of-stream. Without a better characterization of water use today, the State cannot adequately plan to meet these needs sufficiently and sustainably in the future.

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Irrigation west of Tumalo, Deschutes County

Safe Drinking Water

Downtown Portland & Mt. Hood

Photos: K. Gorman, OWRD; B. Bateman, OWRD; Gary Halvorson, Oregon State Archives

Out-of-stream uses are those that divert water from a stream, reservoir, or from below ground to serve a beneficial purpose. The major uses of diverted water in Oregon are to supply the water needed for agricultural, municipal, and industrial purposes. Approximately eighty-percent of water rights authorize the use of surface water from rivers, streams, and reservoirs, with the majority of the water being used for agricultural irrigation. The remaining 20 percent of water rights authorize groundwater use. Uses that divert water are often considered a consumptive use.

The following sections examine in more detail how water put to use out-of-stream contributes to Oregon's economy, public health and safety, and quality of life.

Water Use in Agriculture

A large majority of agricultural irrigation water comes from Oregon's rivers, streams, and reservoirs. The 2008 water demand forecast noted in the accompanying essay indicated that irrigated agriculture uses an estimated 85 percent of the water that is diverted in Oregon. Of that, 66 percent is in the eastern and southeastern counties of the state where large irrigated areas exist: Baker, Crook, Deschutes, Harney, Jefferson, Klamath, Lake, Malheur, Morrow, and Umatilla counties.

Irrigation is applied to about half of the state's total crop land (1.7 million acres). 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.

Contribution of Irrigated Agriculture.
Oregon agriculture provides a bounty of food and fiber products that are sold and consumed in Oregon and around the world. Without water, none of this is possible. Virtually all fruits and vegetables grown in Oregon are produced through irrigation. Yields of other crops, including grains, can increase up to 500 percent, if irrigated.

Irrigated agriculture in Oregon contributes significantly to the economy, food supply, the landscape, and to local communities. Irrigated agriculture produces 77 percent of the total value of Oregon's harvested crops. Preliminary

Ronan Igloria, PE, CWRE,
HDR Engineering, Inc.

Long-Term Forecasting Tools Help Estimate Oregon's Future Water Needs

In 2008, HDR Engineering developed a tool to help the state forecast long-term water demands, estimating an increase in Oregon's water demands from 9.1 million acre feet in 2008, up to about 10.3 million acre-feet in 2050 (assuming that factors such as per capita water use and crop water needs stay the same).

The forecast also accounted for uncertainty by identifying a range of outcomes for baseline, water conservation, and climate change scenarios.

The forecasting tool was designed to be transparent and flexible as more information becomes available, allowing data such as per capita water use, industrial needs, and crop needs to be updated. The tool can be accessed and downloaded online through the Oregon Water Resources Department's conservation and supply resources page.

figures show Oregon's 2010 agricultural production value at $4.4 billion. That figure, and the value of irrigated agriculture, grows considerably if you include food processing, agricultural support services, wholesale trade, transportation and warehousing, retail trade, and food services establishments.

Oregon's farms, vineyards, orchards, nurseries, and ranches contribute significantly to county economies as well, providing jobs, related goods and services, and a tax base critical to county budgets.

The contribution of agriculture to Oregon's environmental health is not insignificant either. Many agricultural fields serve as a view shed of open, green landscapes, and can provide a sanctuary for migratory birds. Well-managed agricultural lands can support a variety of wildlife, providing food, shelter, and habitat. Irrigation can multiply these benefits, further contributing to soil conservation, biodiversity, wildlife habitat, recreational opportunities, scenic vistas, watershed protection, flood control, and groundwater recharge.

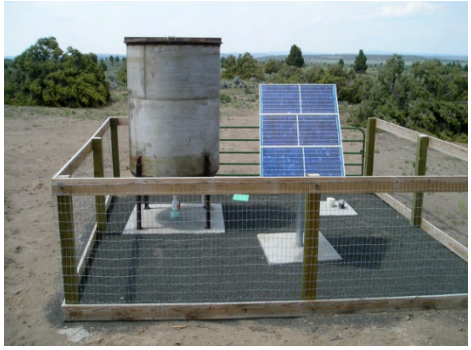
Conservation Successes. Many irrigators have worked extensively with both public and private sector partners to install and model some of the most modern water conservation and habitat restoration techniques. These include fencing riparian areas and building stock water troughs to protect sensitive riparian areas from cattle. It also includes adoption of more efficient water delivery and irrigation practices. The industry boasts a number of successes with fish screen installations as well.

Oregon's 2011 report from the State Board of Agriculture describes Oregon's irrigation systems as some of the most sophisticated in the world, using state-of- the art technology to capture, move, distribute, and place water for use with crops.

Irrigation advancements over the past 25 years include low-pressure systems and sprinklers, variable speed pumps that adjust to water usage needs, soil moisture testing linked to weather data and computer controlled irrigation, and central pivot systems that are efficient and economical.

Other agricultural technologies that extend efficient water use include better seed and crop varieties, improved use of soil amendments and management activities, and innovative mechanization. These practices, coupled with irrigation, have increased yields by more than 500 percent since the 1930s.

Although much of the water is used to irrigate crops, there are many other uses for water within agriculture, such as water for livestock operations, which is necessary to support Oregon's high ranking commodity – cattle and calves – valued at $493 million in 2010.



Photo/description courtesy of Oregon Dept. of Agriculture

This off-grid solar livestock watering system provides a reliable source of water for livestock and wildlife, while also improving rangeland and streamside health.

Food Processing

According to the Northwest Food Processors Association, Oregon's 200 food processors directly employ more than 23,000 people. They play an essential part in food production by cooking, freezing, and packaging products for consumers. In the greater Pacific Northwest, food processing is the third largest manufacturing sector, with annual revenue of $21 billion and more than 100,000 employees.

The food processing industry handles crops from cherries to onions and includes bakery and dairy products, fruits and vegetables, meat, poultry, and seafood. This is a water-intensive industry in which water is needed for washing, processing, and packaging food. Finding a high quality water supply to meet the needs of this industry is sometimes a challenge.

Self-Supplied Industrial and Commercial Water Use

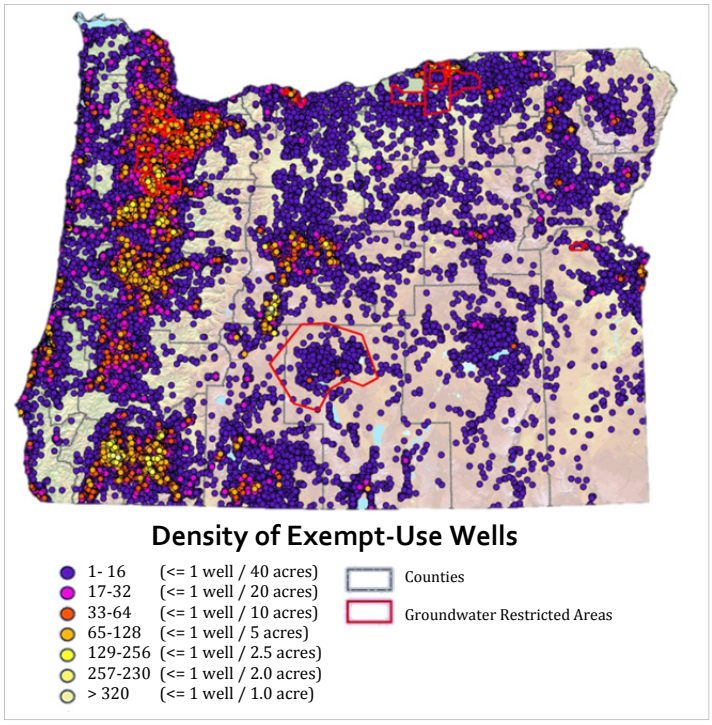
Self-supplied industrial water use in Oregon represents approximately 6 percent of the water diverted in Oregon. This percentage represents industrial and commercial facilities that maintain their own water supplies and water rights independent of public water systems. It is important to recognize that much of the state's industries are not "self-supplied." Most commercial, industrial, and high-tech facilities receive water from municipal water providers.

For self-supplied industrial demand, Multnomah, Lane, Columbia, Clatsop, Clackamas, Marion, and Linn counties comprise 62 percent of the total for this category. Other counties with relatively large self-supplied industrial demands include Coos, Umatilla, Deschutes, and Douglas counties, which comprise 15 percent of the total demand.

Industrial use involves using water within the processing or manufacturing of a product. Water can be used to construct, operate, and maintain industrial sites and facilities. Commercial use is very similar. It includes the use of water for the production, sale, or delivery of goods, services, or commodities, along with the use of water to construct, operate, or maintain a facility.

Self-Supplied Domestic Water Use

Domestic wells, serving populations outside of public water systems, account for about one percent of water demands in Oregon. Although this figure is small in comparison to other out-of-stream demands, the U.S. Geological Survey estimates that in 2005, more than 707,000 Oregon residents relied on groundwater from private wells to meet their domestic water needs.



Such wells, used primarily for domestic drinking water, are prevalent throughout the state. As shown in the accompanying map, these wells are located in both rural and urban areas, and total an estimated 230,000. The largest domestic groundwater demands are in Deschutes, Clackamas, Klamath, and Lane Counties, followed by Jackson, Washington, and Josephine Counties. These counties comprise more than half of self-supplied domestic groundwater demands in the state.

Municipal Water Use

Municipal systems may be shared water systems operated by homeowner associations, larger systems managed by private water companies, or public systems operated by cities, towns, or water districts. Although municipal water use only represents approximately 6 percent of out-of-stream demands, municipal water systems in Oregon deliver drinking water to about 88 percent of the state's population, about 3.3 million people.

Municipal water systems are crucial to the state's economy, serving as a backbone of economic development, public health, and safety in many Oregon communities. These water providers supply clean and reliable water to businesses, residences, schools, parks, hospitals, and other public and private facilities. In the past decade, employment in manufacturing has largely been located in

urbanized areas where access to a public water system has played an important role. As of June 2011, the six metropolitan areas in Oregon (Portland, Eugene, Salem, Medford, Bend, and Corvallis), had 1.4 million jobs, which accounts for the largest portion of Oregon's total non-farm employment. The ability of municipal water systems to deliver reliable, high quality water supplies is one factor that has attracted industry to Oregon.

Population growth and economic development are pressures that municipal systems must address. According to the Office of Economic Analysis, since 1950, Oregon's population has increased by 150 percent and has done so at a faster pace than the U.S. population as a whole. Today, more than 3.8 million people call Oregon home, and the 2010 Census shows Oregon's urban areas are continuing to grow. By the year 2040, it is anticipated that the state population will reach 5.4 million.

Economic growth in Oregon depends, in part, on the availability of water and wastewater services, and the ability of municipalities to serve these needs. Municipalities in Oregon will continually need to estimate long-range water supply demands and to identify options, including water conservation programs, to meet future needs.

Municipalities are responsible for forecasting water and wastewater demands and providing services to all who locate within their service territory. They estimate the growth that might occur five, ten, even 50 years into the future and they must be ready to serve that need.

Updating the State's Long-Term Water Demand Forecast

Updating Oregon's long-term water demand forecast, improving water use measurement and reporting, and updating basic water right and permitting information allows for good water management.

The State must regularly update its fifty-year forecast of water needs across all sectors. Last conducted in Oregon in 2008, such a forecast includes identifying trends in water use, economic development, agriculture, urban-rural population growth/shift, per capita demands, industrial and energy sector demands, and the anticipated effects of conservation and efficiency improvements.

Recommended Action 2.A
Update Long-Term Water Demand Forecasts

How to implement this action:

- Update the state's long-term water demand forecast 🕮
- Update crop water-use tables 🕮
- Quantify/model economic value of instream and out-of-stream water 🕮
- Enhance the state's water use reporting system

Future demand forecasts should also analyze future needs for the state's key growth industries – advanced manufacturing, clean technology, forestry and wood products, high technology, and outdoor gear and apparel.

Updating the long-term demand forecast should also involve developing water demand projections for areas planned for urban and industrial growth and updating crop water use requirements. In Washington State, extension agents are updating their crop water requirements with new data, and find in many cases that less water is needed than was previously thought.

Another piece of the forecasting picture is to incorporate long-term water demand forecasting into place-based, integrated water resources planning efforts, using methodologies accepted by the State. For further discussion of place-based efforts, refer to page 79.

Quantifying and modeling the economic value of water (both instream and out-of-stream) will add to the value of such forecasts. As already discussed, productivity of land and crop production are increased several-fold with the application of water. This expands the options of crops that can be grown, lowers the risk of impacts from weather and disease, and enables economic growth beyond the farm.

This type of economic analysis is of critical importance to the U.S. Bureau of Reclamation, the Oregon Watershed Enhancement Board, and other major funding agencies, where economic information is needed to assess the costs and benefits of potential projects or proposals.

Improving Water-Use Measurement and Reporting

Good water management decisions are made possible when they are based on reliable information about water resources. Water-use data is a fundamental tool to ensure efficient water management, effective water distribution, and to help plan for future water needs. The information is also used to ground truth demand projections or modeling efforts by state and local entities. Water users who keep track of their use are better able to demonstrate the validity of their water rights to potential buyers.

Oregon requires governmental entities such as irrigation districts and public water providers to measure and report water use. Certain types of water use are also required to be measured and reported, in accordance with the conditions of a water right or permit. The Water Resources Department has not had a consistent budget to oversee and coordinate the State's Water Use Reporting Program for several years.

Budget reductions in recent years have dramatically hampered the Department's ability to review and process water-use data, ensure compliance, and offer technical assistance to water users. Even with an online reporting system in place, recent reports show compliance dropping to as low as 20 percent during periods without staff oversight to provide assistance to those tracking and reporting water use data.

Water Measurement Strategy

In 2000, the Water Resources Commission developed a strategic plan for improving water measurement statewide. The Plan focuses on measurement of diversions with the greatest impact on streamflows in areas with the greatest needs for fish. The Water Resources Department developed a statewide inventory of approximately 2,300 "significant diversions" within 300 high priority watersheds across the state. This represents about 10 percent of the all diversions in these watersheds, but accounts for about 50 percent of all water diverted in the state.

The Department's field personnel are currently working with landowners to fully implement the Commission's Measurement Strategy, installing measurement devices (e.g., weirs, flumes, and meters) at these significant diversions. By 2011, more than 640 measurement devices had been installed.

Cost share dollars for measurement devices are critical to the program's success and reaching the Department's performance target of installing measurement devices on 175 significant diversions each year. These cost share dollars have been available through the Department for the past several years and the funding should be recapitalized on a regular basis.

Recommended Action 2.B
Improve Water-Use Measurement and Reporting

How to implement this action:

- Reinstate a water-use reporting coordinator at WRD
- Fully implement the State's Water Measurement Strategy; offer cost-share dollars
- Encourage businesses to conduct self-evaluations of water use
- Employ remote-sensing

Oregon's business community should also be encouraged to conduct self-evaluations of water use, considering the physical and legal availability of water world-wide is a continuing challenge to businesses of all kinds. Several organizations have made tools available online to businesses who want to benchmark their own water use and assess the risks associated with reliance on water. The *Ceres Aqua Gauge™*, released online in October 2011, provides a benchmark for best practices and enables investors to assess and compare companies on their management of water risk (see ceres.org/aquagauge).

In addition, the use of evapotranspiration data, discussed in the following essay, is an emerging measurement tool that may help the state better understand the location, timing, and quantity of water use in the future.

Hal Anderson,
Idaho Water Engineering

METRIC: A Model for Tracking Evapotranspiration Data Using Satellite Data

Evapotranspiration (ET) is water that transpires from the leaves of plants and evaporates from soil. Evapotranspiration data can quantify the amount of water consumed by irrigated agriculture and by other lands. ET data is generated through a satellite-based model called METRIC (Mapping Evapo-Transpiration using high Resolution and Internalized Calibration). METRIC uses digital images from the Landsat satellite, obtained free from the U.S. Geological Survey.

The METRIC model helps to provide accurate water distribution information and identifies trends in agricultural water use. It also helps to confirm compliance with water rights, crop conditions, and can ensure the accuracy and validity of water right transfer proposals.

In Oregon, the U.S. Bureau of Reclamation and local partners use METRIC to better understand the location and quantity of water used in the Klamath Basin.

Updating Water Related Records

This subsection addresses three pressing needs related to the update and modernization of water-related records: determining pre-1909 water right claims, modifying names on water right certificates, and updating Oregon's water-related permitting guide.

Determining Pre-1909 Water Right Claims

Passage of the water code in 1909 established, for the first time in Oregon, a centralized administrative system for acquiring, certifying and documenting rights to the use of water. These water rights are then managed within a prior appropriation system of water allocation.

Recommended Action 2.C
Determine Pre-1909 Water Right Claims

How to implement this action:
- Complete un-adjudicated areas
- Settle federal reserved claims, including tribal claims
- Settle groundwater claims

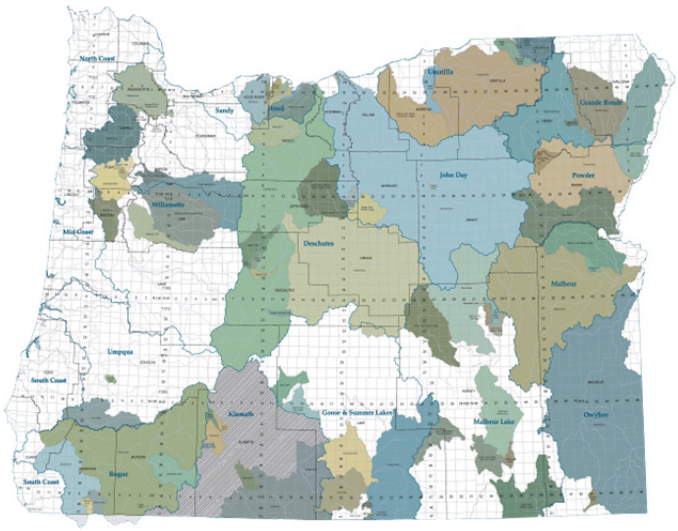
Holders of vested water rights established prior to 1909 include those claimed by Indian Tribes by virtue of treaties with the U.S. Government. These claims are required to go through a formal administrative, judicial process known as adjudication, to have their water right claims quantified, documented, and eventually incorporated into the prior appropriation system. Tribes are important partners in the resolution of water rights claims in basins throughout the West. The need to resolve tribal claims in Oregon are real and significant.

The ability to manage water resources has been greatly facilitated in those areas of the state where adjudications have been concluded. By creating a record of enforceable water rights through the adjudication process, water users have greater security, predictability, and flexibility in meeting their own needs.

Large areas of the state, such as the Klamath River Basin, have not yet been adjudicated. The administrative phase of the Klamath Adjudication, underway since 1975, is scheduled for completion in early 2013. Completion of this phase will greatly enhance the ability to manage water resources in the region.

The remaining unadjudicated areas of the state, which consist primarily of river basins located west of the Cascades, must be completed. See accompanying map.

Related tasks include settling federal reserved claims, including tribal claims, in basins that were previously adjudicated, and establishing priorities for that work. Another remaining task is settling groundwater claims and establishing priorities for that work.



Status of Adjudications in Oregon

- Colored Areas have been adjudicated
- In Progress (Klamath Basin)
- Unadjudicated Areas

Updating Contact Information

Today, there are no statutory provisions allowing the name on a water right certificate to be changed or updated, even if the holder of the certificate has passed away or sold off interests. Approximately 70,500 certificates are held by water users throughout the state. The State needs the ability to respond to holders of water rights who are asking to modify the names on these certificates. This will also help facilitate Department processes, such as communicating with water right holders, researching water rights, mapping water rights, updating the water rights database, and improving compliance with measurement and reporting conditions.

Recommended Action 2.D
Update Water Right Records with Contact Information

How to implement this action:

- Authorize WRD to update names on water right certificates
- Update related water right database and GIS records
- Rule-making should specify acceptable documentation

Updating Oregon's Water-Related Permitting Guide

In Oregon, protecting our natural resources and the benefits they provide us means a variety of permits and reviews from several state agencies may be required for residential, commercial, industrial, or public works projects. The primary purpose of these requirements is to avoid and/or minimize any impacts to Oregon's waters where possible and compensate (or mitigate) where impacts cannot be avoided. Examples of types of permits or requirements include water-use (permits, transfers, limited licenses); compatibility with local comprehensive land use plans (cities and counties); state and federal removal/fill permits; stormwater and wastewater discharge permits for industrial, municipal, and commercial facilities; construction approval activities within a scenic waterway; fish passage requirements; and archeological reviews.

The permitting process can seem complicated to the observer, involving input from multiple agencies and the public. Evaluating an application to use water, for example, is an interagency effort that requires coordination among different natural resource agencies to ensure that water quality, ecological needs, and land use goals and requirements are integrated into the decision-making process.

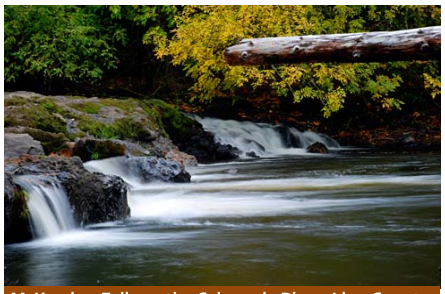
Recommended Action 2.E
Update Oregon's Water-Related Permitting Guide

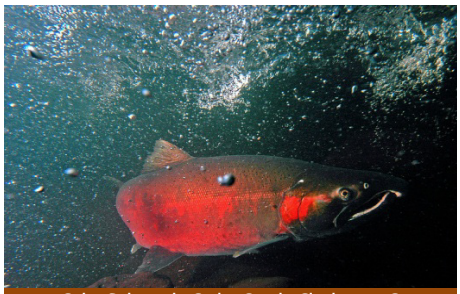
How to implement this action:
- Provide updated agency contacts, policies, links
- Provide industry-specific information where possible

The Water Resources Department acts as the lead, soliciting comments from other agencies and the public, and often conditions new water uses based on those recommendations. New surface water uses are conditioned with fish passage or screening requirements to protect sensitive, threatened or endangered fish species. The Water Resources Department has recently instituted several low or no cost improvements to its application process, resulting in the automation and facilitation of interagency communication, and an easier, more simplified process for water users.

In 2008, the State published a comprehensive, yet simple reference for the regulatory and nonregulatory programs that influence the permitting of projects in wetlands and waterways in Oregon. Oregon's permitting guide should be updated with new contact information, web links to application forms, review standards, and references to applicable rules.

CRITICAL ISSUE: FURTHER DEFINE INSTREAM NEEDS / DEMANDS


McKercher Falls on the Calapooia River, Linn County


Coho Salmon in Cedar Creek, Clackamas County

Columbia River, The Dalles, Wasco County

Photos: Gary Halvorson, Oregon State Archives; and Rick Swart, ODFW

The water resources within Oregon provide endless recreational opportunities, serve as scenic attractions, and directly support the habitat needed for species to live and thrive. Oregon's rivers and streams, its lakes, reservoirs, aquifers, wetlands and estuaries all contribute greatly to Oregon's economy. Without adequate water within the system, instream uses and their associated ecological and economic benefits are threatened.

Water Instream Supports Economic Health

Navigation

The state's waterways have long served as important routes for travel and trade. Even today, many of the agricultural products grown in Oregon and elsewhere in the United States move down the Columbia River by barge, via the Port of Portland. Instream flows have facilitated ocean-going and river-going commerce, and promoted economic activity at many ports and cities in Oregon.

Water-Related Recreation and Tourism

The focal point of many recreational activities in Oregon is often a river, waterfall, lake, wetlands, or a snow-covered mountain. Water resources offer opportunities for skiing, boating, kayaking, rafting, canoeing, camping, hiking, fishing, and observing wildlife, all of which greatly contribute to Oregon's economy.

According to a 2006 national survey by the U.S. Fish and Wildlife Service, 87.5 million residents fished, hunted, or watched wildlife in the United States, spending more than $122 billion and contributing to millions of jobs in industries and businesses that support fish and wildlife-related recreation.

Closer to home, a study completed by the firm of Dean Runyan and Associates looked specifically at county and state expenditures and found that, in 2008, nearly 2.8 million Oregon residents and nonresidents fished, hunted, shellfished, or watched wildlife, resulting in expenditures of $2.5 billion. These expenditures include transportation expenses, accommodations, recreational fees, food and beverage services, and equipment purchases. Many of Oregon's counties, such as Harney, Lake, Morrow, and Wheeler County, receive a significant boost to their local economy from those who travel to participate in fish and wildlife recreation activities. The economic value of fish and wildlife recreation is one of the many reasons for protecting Oregon's water instream for the benefit of future generations.

Many of Oregon's day-use parks and overnight camping facilities reside along scenic rivers and lakes. The Oregon Parks and Recreation Department 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. 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.

There were nearly 2.8 million boat-use days in Oregon during the 2010 boating season, according the Oregon State Marine Board's triennial survey of recreational boaters. A "boat-use day" is any portion of a 24-hour period in which a participant is engaged in boating activities. Boaters divide their time evenly between rivers and lakes/reservoirs. The Columbia and Willamette Rivers are the most popular rivers, and Detroit Lake and Lake Billy Chinook are the most visited reservoirs.

Although water-related activities such as sailing, waterskiing, and wakeboarding have declined about 20 percent since 2004, the use of manually powered boats for kayaking, rafting and canoeing are gaining in popularity. Thirteen percent of Oregonians participated in paddling activities during 2005, according to an Outdoor Industry Foundation report. Nationally, more Americans participate in paddling activities than soccer.

Fisheries

Instream flows support Oregon's recreational and commercial fisheries. Fishing remains the highest use activity for boaters. Native fish such as salmon are an Oregon icon and support a vigorous recreational and commercial fishing economy. According to the American Sportfishing Association, in 2006, there were seven million fishing days spent by Oregon residents and non-resident freshwater anglers and 846,000 fishing days spent by resident and non-resident saltwater anglers. In 2006, the economic impact of sport fishing in Oregon, in both freshwater and saltwater environments, totaled more than $623 million in retail sales, supporting more than 11,000 related jobs in Oregon, and generating an economic output of more than a billion dollars. More Americans—nearly 40 million—spend time fishing, than playing golf and tennis combined.

According to an Oregon Department of Fish and Wildlife briefing report on Oregon's commercial fishing industry, more than 285 million pounds of fish were delivered to Oregon ports in 2011. The harvest

value of Oregon onshore landings was $145.5 million, a 23-year high for the industry. The estimated total personal income generated by Oregon's commercial fishing industry (onshore and distant water fisheries) in 2011 was $518 million. The harvest value of the Dungeness crab fishery typically dominates the commercial fishing industry, and accounted for about 30 percent on the onshore landing harvest value in 2011.

Commercial fisheries support thousands of jobs and a number of communities along the Oregon Coast (Astoria/Warrenton, Garibaldi, Depoe Bay, Newport, Winchester Bay, Coos Bay/Charleston, Port Orford, Gold Beach and Brookings). In some towns, commercial fisheries provide up to a third of all the annual earned income. A healthy fishery can support a cluster of fish processing plants, mechanics, machine shops and welders, refrigeration specialists, marine electronics sales and service firms, and marine suppliers. Healthy fisheries also support the traditional and cultural identity of many Oregon communities. Northwest tribal communities, for example, have historically relied on salmon and other fish species as a major food source, a foundation of life, culture, economy, and spirituality. Because of Oregon's collective interest in the health of its fisheries, management responsibilities are shared among state, federal, and tribal agencies.

Water Instream Supports Ecosystem Health

Along with supporting the economy, water is needed within the environment to ensure overall ecosystem health. Some springs, rivers, lakes, and wetlands are dependent on the discharge of groundwater to the surface. Other ecosystems such as forests, riparian areas, and some types of wetlands are dependent upon a water table located close to the surface. Aquifer and subterranean ecosystems rely on groundwater further below the surface.

There are certain stream conditions that are necessary to support the life cycle of fish species. The water quality, water quantity, and habitat needs also vary by species. Coho, for example, need gravels that are clean with various sizes to create nests and deposit their eggs. They prefer to spawn and rear in small, relatively flat streams. Cool clean water is a requirement for fish rearing, as well. Wetlands, off-channel pools, 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 directly contributes to the health and function of fish-bearing streams.

Understanding Base Flows and Elevated Flows

Flow functions are often grouped into the following categories:

- **Base Flows** are the instream flows needed to sustain basic life stage functions and are important for maintaining habitat conditions, scenic and aesthetic values, and protecting water quality. Often called subsistence or minimum habitat flows, they represent the minimum flow functions of a stream that provide the necessary direct habitat for fish and other aquatic organisms. They may also represent the minimal flows needed to provide sufficient water quantity to overcome the potential for threats to aquatic life from harmful pollutants or stream heating. We currently lack a comprehensive understanding of the base flows needed to support fish habitat. While there is information about base flow needs for the high-profile salmonid species, today, there is not much information about base flow needs for other species including lamprey, chub, white fish, other native fish species, amphibians, or macroinvertebrates.

- **Peak and Ecological Flows** are elevated flows and are a subset of instream flows that are directly related to the ecology of the stream system. These flows serve multiple functions. For example, biological triggering flows represent elevated streamflows that may

trigger a behavior in an aquatic organism that is essential for its survival, such as migration or spawning. Channel habitat maintenance flows, by comparison, are elevated streamflows (often flood or peak flows) that rework the channel or its streambed, rejuvenating or cleaning gravel, reforming habitat features, replenishing or rejuvenating riparian vegetation, and/or re-establishing connectivity with off-channel habitats.

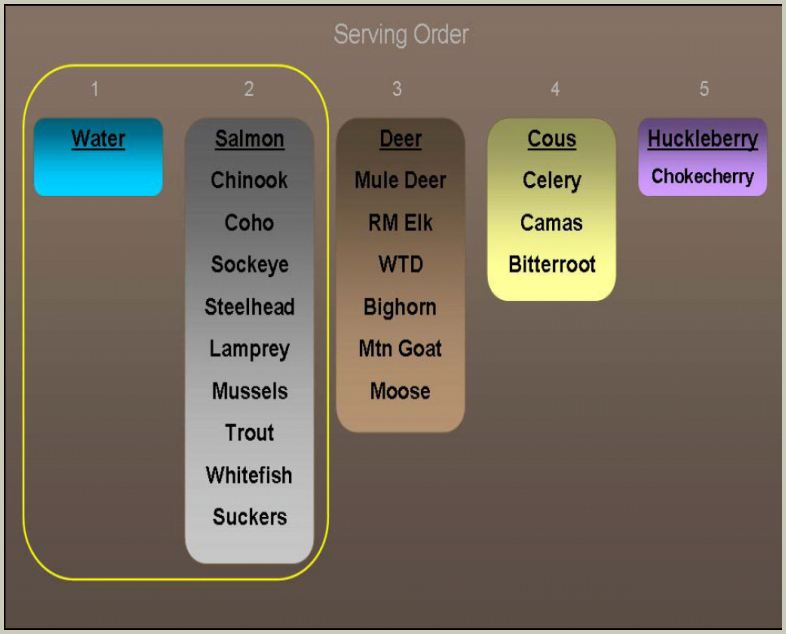
A healthy stream experiences base flows as well as a variety of elevated flows that provide habitat maintenance and other ecosystem functions. The essay below lays out in clear terms the importance of base flows and elevated flows in stream systems.

An excerpt from The Umatilla River Vision
by Krista L. Jones, Geoffrey C. Poole, Eric J. Quaempts, Scott O'Daniel, and Tim Beechie,
May 2011

Streamflows in Context: The Umatilla River Vision

The Department of Natural Resources (DNR) of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) has adopted a mission based on First Foods ritualistically served at tribal meals.

The First Foods mission is to protect, restore, and enhance the First Foods—water, salmon, deer, cous, and huckleberry - for the perpetual cultural, economic, and sovereign benefit of the CTUIR. We will accomplish this utilizing traditional ecological and cultural knowledge and science to inform: 1) population and habitat management goals and actions; and 2) natural resource policies and regulatory mechanisms.



The First Foods serving order with an example list of ecologically related species for each serving group. The yellow outline highlights primary components guiding development of the river vision.

The First Food serving ritual is based on Tribal creation belief and reminds people of the promise the foods made to take care of people and the people's reciprocal responsibility to respectfully use and take care of the foods. The longevity and constancy of these foods and serving rituals across many generations and their recognition through First Food ceremonies demonstrate the cultural and nutritional value of First Foods to the CTUIR community.

Water is both a First Food, and a resource required to produce all other First Foods. Thus, within the First Foods management framework, the concept of "water quality" takes on a broader meaning. In addition to using conventional physio-chemical measures, evaluation of water quality in the Umatilla Basin must also include appropriate measure of biotic communities (e.g. native species abundance and diversity) and hydrologic processes (e.g., flow regime) associated with high ecological health.

Essay continued, next page

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We outline a vision for desired ecological characteristics of the river's water quality and water resource management, which will facilitate the sustained production of First Foods. These characteristics are founded on five fundamental "touchstones," including; 1) hydrology – flow quantity and seasonal timing, 2) floodplain geomorphology, 3) hydrologic connectivity, 4) native riparian vegetation, and 5) native aquatic biota. Each of these touchstones includes a robust list of data needs to understand and improve in each of these issue areas. This approach is meant to help both tribal and non-tribal natural resource managers.

Sound river management and restoration are predicated upon the need to develop a systemic and holistic vision of a functional river. Such a vision provides a framework for planning management or restoration efforts and an initial benchmark for assessing management success or failure. Similarly, a river vision provides the context necessary for understanding the role of any specific management decision or action in the context of other decisions or actions. Our vision is as follows:

"A healthy river is capable of providing First Foods that sustain the continuity of the Tribe's culture. This vision requires a river that is dynamic, and shaped not only by physical and biological processes, but the interactions and interconnections between those processes."

A functional river requires preserving or restoring the seasonal timing and volumes of river flows necessary to support the production and harvest of First Foods.

Base flow conditions (low flows during the late summer and early autumn) in the Umatilla River determine the availability of aquatic habitats within the river as well as summertime hydrologic connectivity within the river network. Thus, summertime migrations of salmon, lamprey, and other species are influenced by the magnitude of base flow. Base flows in any given year also influence water quality (since concentrations or pollutants are influenced by flow volume) and even the temperature regime of the river.

In addition to base flows, management planning for desired flow regimes requires consideration of the magnitude and frequency of peak flow events. Peak flow events maintain the dynamic nature of the floodplain morphology and channel pattern, which facilitates the flux of river water through floodplain gravels and maintains a variety of aquatic habitats in the channel and across the floodplain. For example, floods that are sufficient to mobilize the streambed are critical to the ecological function of the river.

Such high-flow events provide temporary surface water connections between main channel and off-channel aquatic habitats, build and rearrange important channel and gravel-bar features across the floodplain thereby maintaining habitat diversity, enhancing water movement through the floodplain aquifer by cleaning and sorting river sediments thereby facilitating hyporheic* water flux, and recharging the alluvial aquifer with water. [**Hyporheic refers to mixing of subsurface and surface water. Note added.*]

A functional river, then, is dependent on the sufficient magnitude and frequency of flood events to maintain dynamic channel patterns and adequate water exchange rates between the channel and floodplain sediments.

Finally, the transitional periods between peak and base flows are also ecologically important. The "falling lim" (reduction in river flow after a period of high water) of the annual hydrograph during the early summer can be ecologically important for spawning of fishes, establishment of cottonwoods, and maintenance of vernal pools on the floodplain for floodplain amphibians. Additionally, when rivers drop too rapidly from a peak flow to base flows, fish can be trapped in transient off-channel habitats on the floodplain that may dry

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up as the flood recedes. The hydrograph of a functional river, then, would include transitions between high flow events and low flow events that are compatible with maintenance of the native aquatic community of the river.

In addition to the volume of water in the channel, a functional river is defined by the physical, chemical, and biological aspects of water quality. The river should be free from pollutants (e.g., toxicants or excess nutrients) that impair drinking water supplies, alter stream water pH, and stress or kill native aquatic fauna.

Maintenance of appropriate water temperature regimes, including cool temperatures during the summer, is especially important because water temperature influences dissolved oxygen concentrations, stress levels of aquatic organisms, growth of pathogens, and the competitive abilities of non-native fishes versus native fishes. In short, a functional river would have nutrient and contaminants levels that do not impede First Foods production and the utilization and safe consumption of First Foods by the tribal community.

The First Foods-focused mission highlights direct linkages between the ecological health of the rivers and the health and well-being of Umatilla tribal members. Degradation of the river, water quality, and associated ecological processes results in the loss of traditional tribal foods. This loss of food resources is linked to increasing occurrences of health issues (e.g., poor fitness or diabetes).

In addition to providing a clean and healthy natural environment for tribal members and other residents of the Umatilla Basin, improving the availability of First Foods can contribute to sustaining tribal ceremonies, knowledge, and traditions that promote the physical health of tribal members. Finally, the First Foods-focused mission provides resources managers in the basin with a framework for involving tribal members in management dialogues. Within such a framework, monitoring and restoration efforts can concentrate on improving the ecological functionality of the river, which ultimately sustains First Foods.

The content of this essay belongs solely to the authors. It does not necessarily reflect the opinions or decisions of the Water Resources Commission or the Water Resources Department.

Determining the Flows Needed to Support Instream Needs

This section looks at next steps for understanding base and elevated streamflows and for assessing groundwater-dependent ecosystems.

Fill in Knowledge Gaps – Instream Needs

Oregon's ability to meet instream needs is limited by our understanding of these needs. While scientists know that ecosystems and species depend upon both surface water and groundwater, they have not yet identified or quantified all of the ecological functions that rely on groundwater and surface water. Nor have they fully quantified the ecological degradation that occurs with differing qualities and quantities of water.

The Oregon Department of Fish and Wildlife, Department of Environmental Quality, and the Parks and Recreation Department are authorized to apply for instream water rights for specific purposes, such as protection of fish habitat, water quality, and scenic values. Such applications require scientific analysis and modeling to determine the base flows and elevated flows needed to support instream functions. This science allows the agencies to pursue appropriate instream water rights.

Instream water rights in Oregon today have been designed to address situations of low flow and they focus almost exclusively on depth, velocity, and substrate criteria. In general, instream water rights have not been issued to protect elevated streamflows.

Base Flow Studies. The State needs to identify which streams already have base flow needs studies completed, then prioritize and complete those that are still needed and those that require updates. Established methods already exist for these studies.

Recommended Action 3.A
Determine Flows Needed (Quality and Quantity) to Support Instream Needs

How to implement this action:
- Conduct base flow needs studies
- Develop elevated flow requirements
- Develop models/studies on economic value of instream and out-of-stream water 🕮

Elevated Flow Studies. More information is also needed regarding the elevated flows (peak and ecological flows) necessary to maintain the physical characteristics of a stream or to facilitate biological processes. The State can begin studies of elevated flow needs by developing criteria to determine what elevated flows are needed in each water basin/watershed. These include both biological triggering flows as well as channel habitat maintenance flows. The State should develop recommended flows for each water basin/watershed based on the developed criteria. Although the State has begun to develop methodologies in this area, information collection is still in the beginning stages.

Fill in the Knowledge Gap - Assessment of Groundwater-Dependent Ecosystems

Groundwater is a vital source of water that sustains both ecosystems and human communities worldwide. Wetlands, rivers, and lakes often receive discharge from groundwater; it provides late-summer flow for many rivers, and creates cool-water upwellings critical for aquatic species during the summer heat. The species and habitats that rely on this source of water for some or all of their life cycle are known as groundwater-dependent ecosystems, or GDEs. These ecosystems form the interface between groundwater and surface water, and due to their unique hydrology, they often harbor many rare and endemic species. A recent study found that 12 percent of species listed under the U.S. Endangered Species Act were groundwater-dependent species found in Oregon (Blevins and Aldous 2011).

Recommended Action 3.B
Determine Needs of Groundwater-Dependent Ecosystems

How to implement this action:
- Identify and characterize groundwater-dependent ecosystems statewide 🕮
- Complete groundwater basin studies

Oregon can start to identify and characterize groundwater-dependent ecosystems statewide by using a variety of available tools and methods, such as those developed by The Nature Conservancy and U.S. Forest Service. Tasks include determining which aquatic ecosystems are groundwater-dependent, mapping their occurrence across the landscape, and identifying their groundwater requirements for both water quantity and water quality. See accompanying essay for more information on groundwater-dependent ecosystems.

Allison Aldous and Leslie Bach,
The Nature Conservancy

Inventorying and Monitoring Groundwater-Dependent Ecosystems

Oregon has a wide distribution of groundwater-dependent ecosystems. Most are in basins such as the Deschutes, Klamath, John Day, and Willamette, as well as along the High Cascades both east and west of the crest. Oregon – with nearly 32,000 mapped springs – has the highest density of springs in the western United States (Stevens & Meretsky 2008).

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English Sundew, an obligate wetland species

©Allison Aldous/TNC

Lesser Bladderwort, an obligate wetland plant

An obligate wetland plant species is almost always found growing in water or a water-saturated environment like a wetland (at least 99 percent of the time). English sundew and lesser bladderwort (see photos) are obligate wetland plants whose occurrence and survival are dependent on the water and nutrients provided in wetland habitats fed by springs.

As a major step toward protecting groundwater-dependent ecosystems like these, basin scale data collection and protocols are needed to provide more precise information about the location and character of groundwater-dependent ecosystems, as well as their requirements for a clean supply of groundwater.

Some of this work is underway. The Nature Conservancy, working with the U.S. Forest Service, has been working on a series of methods and protocols for inventorying and monitoring groundwater-dependent ecosystems. This work can be done at the state-scale using readily available data (Brown et al. 2009; 2010), as well as at the basin scale (U.S. Forest Service 2012), and at the site scale (US Forest Service 2012). Because available data are often inadequate, results from the inventory and monitoring methods can be refined with remote sensing tools and techniques, such as imagery from the National Agriculture Imagery Program (NAIP) and Light Detection and Ranging (LiDAR).

Once the distribution of groundwater-dependent ecosystems is understood, the next important step is to quantify their groundwater quantity and quality requirements. This information can be used to balance the groundwater needs of people with those of ecosystems and species.

Recommended Actions at a Glance

Objective: Understand Instream and Out-of-Stream Needs	
Out-of-Stream Needs/Demands	2.A. Update long-term water demand forecasts 2.B. Improve water-use measurement and reporting 2.C. Determine pre-1909 water right claims 2.D. Update water right records with contact information 2.E. Update Oregon's water-related permitting guide
Instream Needs/Demands	3.A. Determine flows needed (quality and quantity) to support instream needs 3.B. Determine needs of groundwater-dependent ecosystems