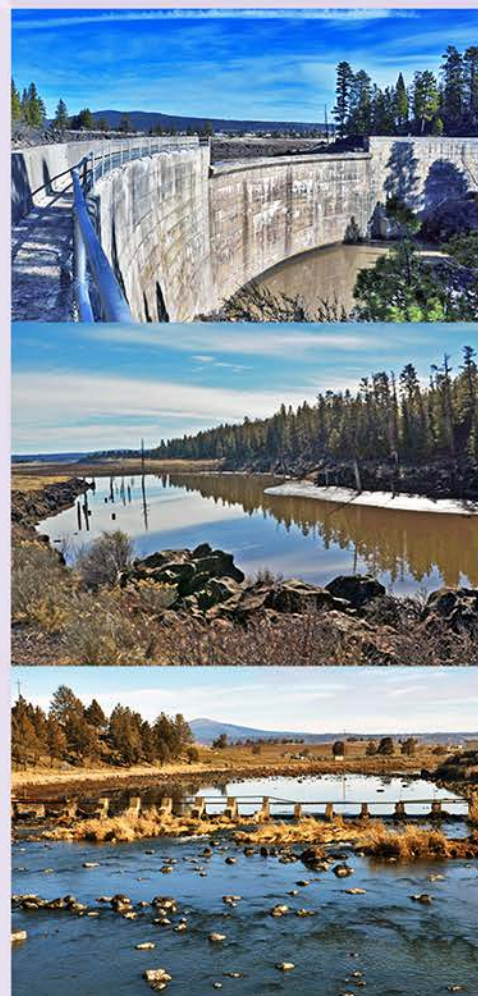
RECLAMATION

Managing Water in the West

SECURE Water Act Section 9503(c)—Reclamation Climate Change and Water 2016

Chapter 5: Klamath River Basin



U.S. Department of the Interior
Bureau of Reclamation

March 2016

Mission Statements

The U.S. Department of the Interior protects America's natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

SECURE Water Act Section 9503(c) Report to Congress

Chapter 5: Klamath River Basin

Prepared for

United States Congress

Prepared by

U.S. Department of the Interior
Bureau of Reclamation

U.S. Department of the Interior
Bureau of Reclamation
Policy and Administration
Denver, Colorado

March 2016

Acronyms and Abbreviations

COPCO	California Oregon Power Company
ENSO	El Niño/Southern Oscillation
KHP	Klamath Hydroelectric Project
NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries	National Marine Fisheries Service
NWR	National Wildlife Refuge
PDO	Pacific Decadal Oscillation
Reclamation	Bureau of Reclamation
UKL	Upper Klamath Lake
U.S.	United States
USFWS	U.S. Fish and Wildlife Service
WWCRA	West-Wide Climate Risk Assessment

About this Chapter

This summary chapter is part of the 2016 SECURE Water Act Report to Congress prepared by the Bureau of Reclamation (Reclamation) in accordance with Section 9503 of the SECURE Water Act. The 2016 SECURE Water Act Report follows and builds on the first SECURE Water Act Report, submitted to Congress in 2011,[1] which characterized the impacts of warmer temperatures, changes to precipitation and snowpack, and changes to the timing and quantity of streamflow runoff across the West.

This chapter provides a basin-specific summary for the Klamath River Basin. This chapter is organized as follows:

- **Section 1**: Description of the river basin setting,
- **Section 2**: Historical background on the Klamath River Basin,
- **Section 3**: Description of the on-going Klamath River Basin Study,
- **Section 4**: Brief description of resources management efforts related to the Basin Study, and
- **Section 5**: Coordination activities within the basin to build climate resilience.

Klamath River Basin Setting
States: California and Oregon
Major U.S. Cities: Klamath Falls, OR (nearby Medford, OR and Redding, CA)
River Length: 254 miles
River Basin Area: 12,100 square miles
Major River Uses: Municipal, Agricultural, Hydropower, Recreation, Flood Control, and Fish and Wildlife
Notable Reclamation Facilities: Trinity Dam, Lewiston Dam, Clear Lake Dam, Gerber Dam, and Link River Dam

The key study referred to in this chapter is the Klamath River Basin Study, which is being conducted through a partnership between Reclamation, Oregon's Water Resources Department, and California's Department of Water Resources to identify strategies to address current and future water demands in the basin. The Klamath River Basin Study is anticipated to be available in 2016. Because the Klamath River Basin Study is not yet complete, portions of this chapter are limited to a description of ongoing activities rather than final results. Additional information relevant to the Klamath River Basin, including the latest climate and hydrology projections for the basin, is included in Chapter 2: Hydrology and Climate Assessment.

[1] The first SECURE Water Act Report, submitted to Congress in 2011 is available on the Reclamation website: www.usbr.gov/climate/secure/docs/2011secure/2011SECUREreport.pdf.

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1 Basin Setting

The Klamath River Basin covers approximately 5,700 square miles in California and Oregon. The Klamath River starts downstream of Upper Klamath Lake and carries these waters approximately 254 miles to its outflow at the Pacific Ocean in Requa, California (Figure 5–1). The Klamath River Basin includes all or parts of Klamath and Lake Counties, Oregon, and Modoc, Siskiyou, Del Norte, Trinity, and Humboldt Counties, California. Five National Forests intersect the Klamath River Basin. From a water management perspective, it is divided into two regions, the dividing line being approximately at the location of Iron Gate Dam (Figure 5–1): (1) the upper portion (Upper Klamath Basin), and (2) the lower portion (Lower Klamath Basin). The Upper Klamath and Lower Klamath Basins generally have different climates and different management challenges.

The Klamath River begins in Lake Ewauna, south of Upper Klamath Lake in the city of Klamath Falls, Oregon. The river reach between Upper Klamath Lake and Lake Ewauna is called the Link River. Contributing flows to Upper Klamath Lake originate from the slopes of the Cascade Range. The primary tributaries to Upper Klamath Lake include Wood River to the north, Williamson River to the north, Sprague River to the east, and inflows from the eastern flank of the Cascades. The Klamath River flows southwesterly into California and then west to the Pacific Ocean. The major tributaries entering the mainstem river include the Shasta, Scott, Salmon, and Trinity Rivers. These four rivers all join the Klamath River downstream of Iron Gate Dam and provide 44 percent of the mean annual flow, which heavily influences the hydrology of the Klamath River Basin. The mean annual flow of the Klamath River is about 17,900 cubic feet per second.

Enactment of the Reclamation Act in 1902, in addition to legislation passed by Oregon and California to transfer ownership of land to the Federal Government, led to the development of the Klamath Project. The initial project was completed in 1907. By 1924, portions of Lower Klamath and Tule Lakes were drained to uncover additional desirable farmland. In addition, dams were built to facilitate diversions and produce hydropower for the region.

Six dams currently stand along the mainstem of the Klamath River (Figure 5–1 and Table 5–1). Link River Dam (Figure 5–2), at river mile 254 in Oregon, maintains Upper Klamath Lake levels and largely replaced a natural reef that historically formed the lake.

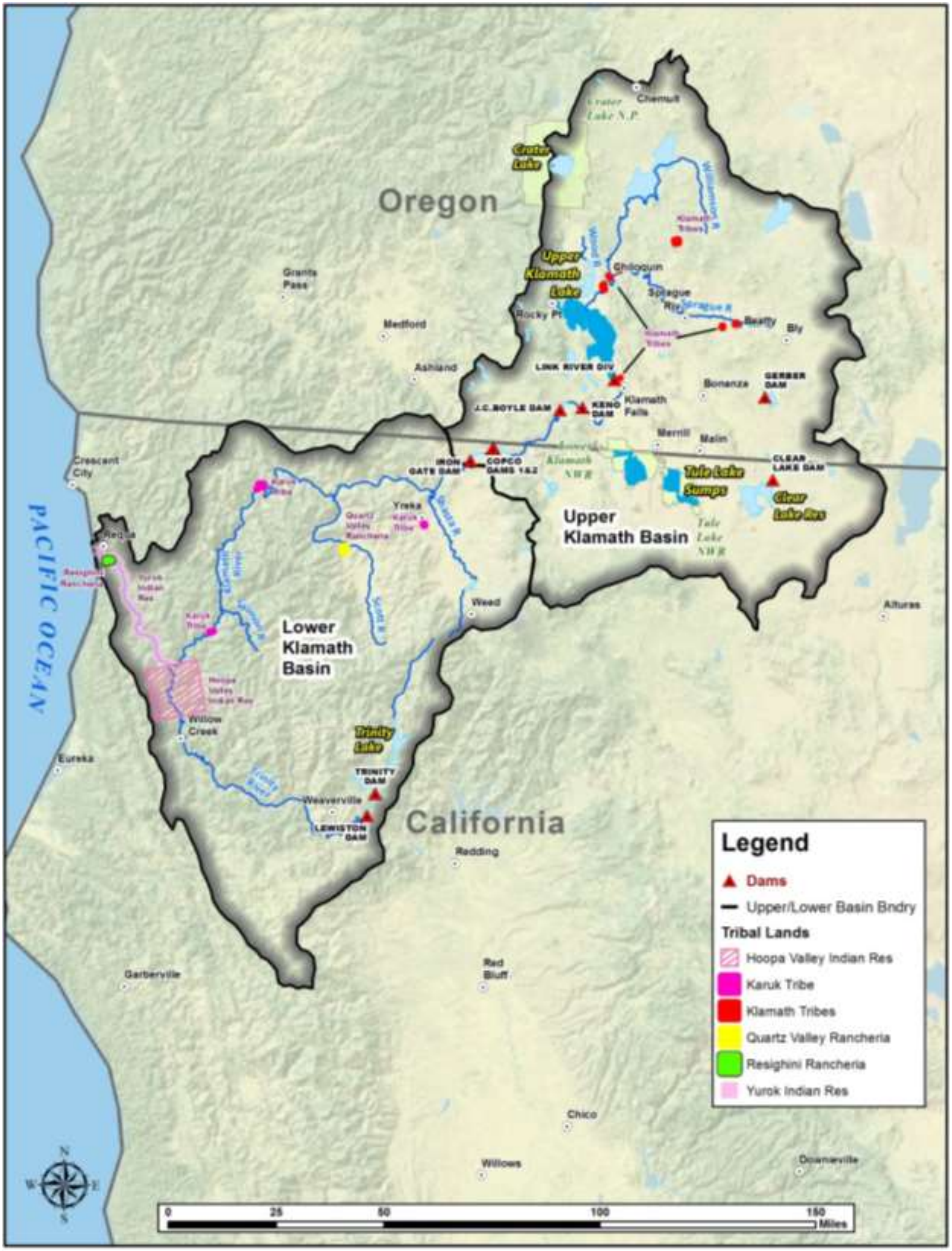

Figure 5–1. Klamath River Basin map.

Table 5–1. Summary of Klamath Basin Dams

Dam Name	Location	Klamath River Mile	Year Completed	Reservoir Capacity (acre-feet)	Primary Purpose
Upper Klamath Basin					
Clear Lake	Lost River	NA	1910	527,000	Irrigation
COPCO No. 1	Klamath River	197	1918	6,235	Hydropower
Link River	Klamath/Link River	253	1921	873,000	Control UKL level
COPCO No. 2	Klamath River	198	1925	73	Hydropower
Gerber	Miller Creek	NA	1925	94,300	Irrigation
J.C. Boyle	Klamath River	227	1958	3,377	Peaking power
Iron Gate	Klamath River	190	1962	58,000	Hydropower
Keno	Klamath River	232	1966	18,500	Hydropower, recreation
Lower Klamath Basin					
Dwinnell Dam	Shasta River	NA	1928	50,000	Water supply
Lewiston	Trinity River	NA	1967	14,660	CVP water supply
Trinity	Trinity River	NA	1962	2,400,000	CVP water supply

Notes: NA= Not Available; UKL = Upper Klamath Lake; CVP = Central Valley Project

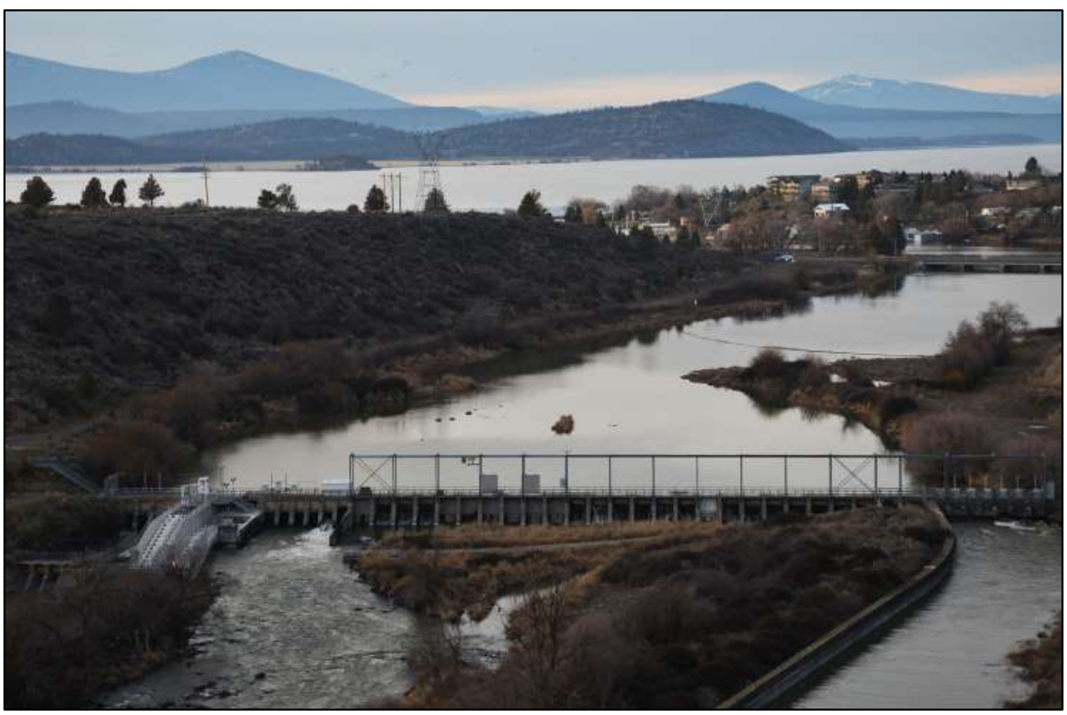

Figure 5–2. Link River Dam, at the outlet of Upper Klamath Lake.

Keno Dam, at river mile 233 in Oregon, replaced a natural reef which historically regulated water surface elevations of Lower Klamath Lake (Reclamation, 2005). The remaining mainstem dams were constructed where the Klamath River enters sections of the canyon through the coastal mountain range. These dams were primarily constructed for hydropower production and include California Oregon Power Company (COPCO) No. 1 dam at river mile 198 (California); COPCO No. 2 dam at river mile 199 (California), which was constructed to reregulate flows out of COPCO No. 1; JC Boyle Dam at river mile 225 (Oregon), which was constructed primarily for producing peaking power upstream of the COPCO dams; and Iron Gate Dam at river mile 190 (California). PacifiCorp owns and operates the hydropower producing facilities on the Klamath River as the Klamath Hydroelectric Project (KHP) No. 2082. Since the 2006 expiration of its license from the Federal Energy Regulatory Commission, PacifiCorp has been operating the KHP under annual licenses.

The Klamath River Basin is unusual in that the largest agricultural development in the basin occurs in the Upper Basin, which receives disproportionately low precipitation compared with the rest of the basin. Implementation and enforcement of state and Federal water allocation policies has been a challenge. The Klamath River Compact (ORS 542.620; CA Water Code § 5900 et seq.; P.L. 85-222) between California and Oregon was ratified by the states and consented to by the United States in 1957, giving domestic and irrigation users in the Klamath River Basin preference for use of water supplies over recreation, industrial, hydropower, and other uses.

In March 2013, the Final Order of Determination for the general stream adjudication of the Upper Klamath Basin was delivered to the Klamath County Circuit Court, demarking a significant milestone in determining the water rights of the Upper Klamath Basin by confirming the senior water rights of the Klamath Tribes. The adjudication appeals process is ongoing. Water rights for the mainstem Klamath River have not been adjudicated in California, even though adjudication was completed there for the Shasta River Basin in 1932 and for the Scott River Basin in 1980.

The United States must provide sufficient water to sustain and protect Indian Trust Assets, which include sufficient water to meet treaty rights such as hunting, gathering, and fishery purposes. The Klamath Tribes were terminated in 1954 (Klamath Termination Act, P. L. 587) and then regained Federal recognition in 1986. As a result, the Klamath Tribes lost designated reservation land. As part of the Oregon adjudication process, a court has held that the rights protecting Trust Assets of the Klamath Tribes have a priority date of the Klamath Treaty of 1864, which may significantly affect water management in the Upper Klamath Basin.

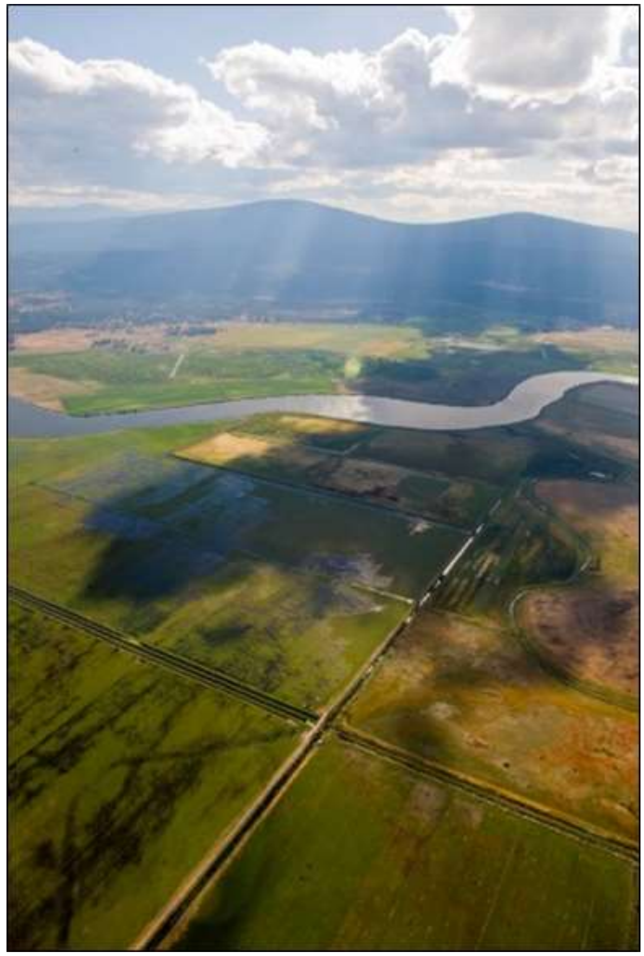

Figure 5–3. Irrigated croplands along both sides of the Klamath River south of Klamath Falls.

Because three Klamath River Basin fish species have been listed under the Federal Endangered Species Act, Reclamation coordinates its Klamath Project operations plans with the U.S. Fish and Wildlife Service (USFWS; responsible for Lost River and shortnose suckers) and with the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NOAA Fisheries; responsible for the Final Recovery Plan for the Southern Oregon/Northern California Coast Evolutionarily Significant Unity Coho Salmon). Accommodations for these species are described in the 2012 Biological Assessment for Proposed Klamath Project Operations (Reclamation, 2012 [Klamath BA]) and the associated 2013 non-jeopardy Joint Biological Opinion for Klamath Project Operations (NOAA Fisheries and USFWS, 2013). The Joint Biological Opinion, for instance, recommends Upper Klamath Lake levels needed to protect endangered Lost River and shortnose suckers, and also sets Klamath River flow rates required for the well-being of threatened coho salmon.

The Klamath Basin National Wildlife Refuges (NWR) are a complex of six refuges, all of which are adjacent to or within Reclamation's Klamath Project, with the exception of the Bear Valley NWR. They were established by various executive orders starting in 1908, and they support many fish and wildlife species and provide suitable habitat and resources for migratory birds of the Pacific Flyway. The Lower Klamath and Tule Lake NWRs, in the upper Klamath Basin, rely on Klamath Project water. The refuges have Federally reserved water rights claims for the water necessary to satisfy their primary purposes, subject to more senior water rights in the basin, including the Klamath Tribes and the Klamath Project. The Joint Biological Opinion (NOAA Fisheries and USFWS, 2013) outlines the availability of water to the Lower Klamath and Tule Lake NWRs.

2 Analysis of Impacts to Water Resources

The Klamath River Basin, like the western United States overall, has experienced a general decline in spring snowpack, reduction in the amount of precipitation falling as snow in the winter, and earlier snowmelt runoff between the middle and late 20th century (Reclamation, 2011 [SWA]). Key findings related to projected changes in temperature, precipitation, snowpack, and runoff are presented below:

- **Temperatures** increased across the region from 1895 to 2011, with a regionally averaged warming of about 1.3° F (Melillo et al., 2014). Climate change models indicate temperatures throughout the Klamath River Basin may increase by approximately 5 to 6 °F over the 21st century.
- Mean annual **precipitation** in the basin ranges from as little as 10 inches at lower elevations to more than 70 inches in the mountains of the Cascade Range (Reclamation, 2011 [SWA]). Precipitation is projected to increase by approximately 3 percent by 2050.
- The annual long-term average **snowfall** in Klamath Falls (1981–2010 average) is about 32 inches per year. Crater Lake (62 miles northwest of Klamath Falls) averages about 483 inches of snow annually. About two-thirds of the precipitation falls as snow between October and March. Historical trends basin wide indicate about a 41 percent decrease in April 1 snow water equivalent, with a range of about 22 to 45 in various parts of the basin.
- Historical **runoff** in the Klamath River Basin is highly variable from year to year. Although precipitation is concentrated in the winter months, water percolates slowly through the volcanic soil such that monthly discharge is almost constant in the Upper Basin (CDWR, 1960). Projected warming might also change runoff timing, with more rainfall runoff during the winter and less runoff during the late spring and summer.

Historical variability in groundwater levels in the Upper Klamath Basin is closely tied with changing groundwater management practices. Under natural conditions, the Upper Klamath Basin lakes had a significant regulatory effect on the river (CDWR, 1960). A review of historical information in the Klamath River Basin suggests that although there may be trends in historical runoff at some sites, they are relatively weak or insignificant (Reclamation, 2011 [SWA]). Natural climatic cycles like the El Nino/Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO) have influenced and will continue to influence these general trends (Thorsteinson et al., 2011).

The projected increase in wildfires also poses risks to water supply through increased sediment loads to lakes, reservoirs, and streams, potential damage to water supply infrastructure, and changes to landscape characteristics that affect water temperatures, infiltration dynamics, and runoff timing, among other things. Some of the causes of increased wildfire risk include projected decreases in late summer streamflows in some parts of the Klamath River Basin, changes in the timing and amount of recharge, increases in evapotranspiration, and declines in the groundwater table due in part to increases in pumping demand. A number of studies have documented increases in fire season duration and fire frequency, and they also project increases in the probability of large wildfires. Although wildfire is a natural process that has historically played a beneficial role in most Northwest forest ecosystems, warmer and drier conditions combined with the effects of fuel buildup resulting from a century of fire suppression have greatly increased the number, extent, and ferocity of wildfires in western U.S. forests since the 1970s (McKenzie et al., 2008).

3 Potential Adaptation Strategies to Address Vulnerabilities

The Klamath River Basin has a long history of water management challenges, and many studies have been conducted there. Reclamation is currently working with partners to conduct the Klamath River Basin Study to evaluate water supply and demand within the basin and identify and evaluate potential adaptation strategies which may reduce any identified imbalances in collaboration with stakeholders in the region. Non-Federal cost share partners and major stakeholders for the study include:

- California Department of Water Resources and the Oregon Water Resources Department
- Major stakeholders include six federally recognized Indian Tribes: the Yurok Tribe, Hoopa Valley Tribe, Karuk Tribe, the Klamath Tribes (consisting of Klamath, Modoc, and Yahooskin), Quartz Valley Indian Community, and Resighini Rancheria
- Other stakeholders including numerous Federal, state, and local entities as well as the general public.

3.1 Klamath River Basin Study Components

The Basin Study will seek to add value to previous and ongoing work in the watershed by evaluating water supply and demand together in a risk-based framework and by exploring a range of adaptation strategy portfolios. The Basin Study is anticipated to be available to the public in 2016. The main components of the Klamath River Basin Study are provided below.

- **Component 1:** An assessment of current and projected future water supplies through the evaluation of (past and projected future) changes in precipitation and temperature, as well as changes in snowpack, evapotranspiration, and groundwater.
- **Component 2:** An assessment of current and projected future water demands. As part of the West-Wide Climate Risk Assessment (WWCRA) (Reclamation, 2011 [BCSD]), this Basin Study will quantify historical and projected future agricultural demands and losses due to reservoir evaporation.
- **Component 3:** An evaluation of the watershed's ability to meet or withstand any identified future water supply/ demand imbalances. Risks and system reliability are determined by testing the system against various defined metrics. These metrics are being developed with input from the Klamath River Basin Study Technical Working Group and interested

organizations and individuals. This component relies heavily on projections from the assessment of current and projected future water supply and demand. The proposed approach includes evaluation of risk and reliability considering multiple scenarios of projected future climate/demand conditions.

- **Component 4:** An identification and quantification of potential adaptation strategies or opportunities to address potential supply/demand imbalances, considering a range of future scenarios. Identifying strategies involves an iterative modeling process whereby future system reliability is evaluated with certain adaptation strategies in place.

In general, the study will identify potential adaptation strategies that could help reduce the supply and demand imbalances that are likely to result from climate change. These adaptation strategies are being evaluated using a trade-off analysis, which involves weighing and comparing strategies. As a result, individual strategies will be compiled into a range of management portfolios that, together, could address imbalances more comprehensively than a single strategy. The Basin Study is intended to be a collaborative planning process, not a decision process, and does not recommend implementation of specific adaptation strategies.

4 Coordination Activities

In addition to the Klamath River Basin Study, Reclamation continues to work with partners on adaptation actions in response to climate stresses. These activities include extending water supplies, water conservation, hydropower production, planning for future operations, and supporting rural water development. Specific examples of coordination and adaptation in the Klamath River Basin include:

- Since the listing of three Klamath River Basin fish species under the Endangered Species Act, Reclamation has also coordinated with the USFWS and the NOAA Fisheries on Klamath Project operations plans that reduce regulated flow impacts to these species.
- The Trinity River Fishery Restoration Program is appraising alternatives that would improve the current cold-water transmission through Lewiston Reservoir, thereby increasing the adaptability for future climate change stressors that may impact cold-water yield to the reservoir from the drainage basin.
- The Klamath Basin NWRs are managed by USFWS under the Migratory Bird Treaty Act (codified as 16 U.S.C. §§ 703-712), National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. §§ 668dd-668ee), National Wildlife Refuge System Improvement Act (Pub. L. 105-57, 111 Stat. 1252-1260), and other laws pertaining to the NWR System. Reclamation manages leases on refuge lands for agricultural purposes in compliance with the Kuchel Act (1964) through a cooperative agreement with the USFWS (Reclamation, 2012 [Klamath BA]).

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