BUREAU OF RECLAMATION

Draft Environmental Assessment

Implementation of Klamath Project Operating Procedures 2024-2029

Klamath Project, Oregon/California

Interior Region 10 California-Great Basin

U.S. Department of the Interior

September 2024

Mission Statements

The U.S. **Department** of the **Interior** protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated Island Communities.

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.

Draft Environmental Assessment

Implementation of Klamath Project Operating Procedures 2024-2029

Klamath Project, Oregon/California

Interior Region 10 California-Great Basin

September 2024

Prepared for Reclamation by Industrial Economics under Contract No. 140R2021P0047

Cover Photo: Lost River Diversion Dam in Klamath Falls, OR. (U.S. Bureau of Reclamation)

This page intentionally left blank

Contents

Appendices

Figures

Tables

Acronyms and Abbreviations

ACFFOD	Amended and Corrected Findings of Fact and Order of Determination
Act	Reclamation Act
AF	acre-feet
ALB	Agency Lake and Barnes units of the Upper Klamath National Wildlife Refuge
CAHPT	California Anadromous Hatchery Policy Team
CDFW	California Department of Fish and Wildlife
CEQ	Council of Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
CNRFC	California Nevada River Forecast Center
DO	dissolved oxygen
DPS	Distinct Population Segment
EFH	Essential Fish Habitat
ENI	expected net inflow
ESA	Endangered Species Act
ESU	Evolutionary Significant Unit
EWA	Environmental Water Account
FFA	Flexible Flow Account
FONSI	Finding of No Significant Impact
IGD	Iron Gate Dam
IOP	Interim Operations Plan
KBPM	Klamath Basin Planning Model
KDD	Klamath Drainage District
KHP	Klamath Hydroelectric Project
KRRC	Klamath River Renewal Corporation
KRM	Klamath Release Model
KSD	Klamath Straits Drain
LRDC	Lost River Diversion Channel
MSA	Magnuson-Stevens Fishery Conservation and Management Reauthorization Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NRCS	National Resource Conservation Service
NWI	Normalized Wetness Index
NWR	National Wildlife Refuge
OM&R	Operations, Maintenance, and Replacement
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
OWRD	Oregon Water Resources Department
Project	Klamath Project
Reclamation	U.S. Bureau of Reclamation
Secretary	Secretary of the Interior
Services	USFWS/NMFS
SNAP	supplemental nutrition assistance program
SONCC	Southern Oregon/Northern California Coast
SRKW	Southern Resident Killer Whale
TAF	thousand acre-feet

TMDL	Total Maximum Daily Load
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WUA	weighted usable area

Executive Summary

The U.S. Department of the Interior, Bureau of Reclamation (Reclamation) manages the Klamath Project (Project), which has provided water for irrigation, domestic, and related purposes since its authorization in 1905. Reclamation is proposing to modify certain aspects of its water management for the Project under the Proposed Action Alternative. The objective of this Environmental Assessment is to determine whether implementing the Proposed Action Alternative as described here (and in the modified 2024 Biological Assessment (Reclamation, 2024a)) may significantly affect the quality of the human environment within the meaning of the National Environmental Policy Act. In making this determination, the effects of the Proposed Action Alternative are compared to those of the No Action Alternative over a period of 5 years (2025-2029).

New existing environmental conditions and updated datasets have led Reclamation to review and revise its operational procedures, resulting in this Environmental Assessment and the associated Biological Assessment (Reclamation, 2024a). These new existing conditions and datasets include the 2023-2024 removal of four dams downstream of Keno Dam (and the associated need to change the operational compliance point[1] to Keno Dam, under the Proposed Action Alternative), the U.S. Fish and Wildlife Service's (USFWS's) expected reconnection of the Agency-Barnes Unit of the Upper Klamath National Wildlife Refuge (NWR) to Upper Klamath Lake (UKL) within the year, and the availability of updated bathymetric data for UKL.

The No Action Alternative represents an operational approach that is substantially similar to Reclamation's operations in recent years, including the 2020 Interim Operations Plan (IOP) (Reclamation, 2020a). Like the IOP, the No Action Alternative is based on the Klamath Basin Planning Model (KBPM) and has its compliance point for measuring flows at the Iron Gate gage. The No Action Alternative does, however, include certain changes to the 2020 IOP. Some of these changes are necessary to reflect the new existing conditions (e.g., dam removal and Agency-Barnes reconnection), while others are intended to ensure use of the best available information (changes to bathymetry and forecasts are discussed in Section 2.2.2). The Proposed Action Alternative shares many common elements with the No Action Alternative, such as its core management elements, the service area, applicable legal requirements, and Project facility maintenance. Both alternatives reflect the new existing conditions and updated datasets noted above. The two alternatives are also identical with respect to Reclamation's operations on Gerber Reservoir, Clear Lake, and the Lost River above Harpold Dam.

The Proposed Action Alternative would differ from the No Action Alternative with respect to operations affecting lands downstream of Harpold Dam on the Lost River (which are served by water from UKL) and lands south and east of the Klamath River between Klamath Falls and Keno Dam. These operational changes would also affect UKL, the Klamath River, the Lower Klamath NWR, and Tule Lake NWR. The Proposed Action Alternative was developed in collaboration with the National Marine Fisheries Service and USFWS in order to provide benefits to listed species where feasible.

The No Action and Proposed Action alternatives have different operational approaches. Briefly, unlike the No Action Alternative, the Proposed Action Alternative would use a year-round

[1] The compliance point is the location from which flow data are collected to ensure that flows are adequate to comply with Endangered Species Act (16 U.S.C. 1531-1544) requirements.

operational strategy for making water management decisions, which would entail continuous real-time tracking of hydrologic conditions. When compliant with applicable legal requirements, the Proposed Action Alternative would allow for deferred use operations whereby water that could have been used from UKL at one point in time could instead be retained in UKL for a specific future use, including future Project diversions or future releases to the Klamath River. Deferred use operations would create more operational flexibility. In addition, under the Proposed Action Alternative, both Tule Lake NWR and Lower Klamath NWR would have a dedicated supply, while under the No Action Alternative, neither refuge would have a dedicated supply. As such, the Proposed Action Alternative is intended to provide benefits to Tule Lake and Lower Klamath NWRs in support of Endangered Species Act-listed species inhabiting each water body. The following paragraphs summarize impacts to water resources, biological resources, socioeconomic resources, and to Tribal Nations and Tribal economies, as well as environmental justice implications.

Water resources. The Proposed Action Alternative would not affect the overall total quantity of water in the Klamath River Basin relative to the No Action Alternative but would affect the distribution of water among UKL, Klamath River flows, NWRs, and Project agriculture diversions. Modeling suggests that median UKL elevations under the Proposed Action Alternative would be approximately 0.4 to 1.0 feet lower than under the No Action Alternative. The Proposed Action Alternative would likely increase median Project diversions during the primary irrigation season (April-October) by over 10% (i.e., by approximately 23,500 acre-feet [AF]) compared to the No Action Alternative and would provide a dedicated supply to Tule Lake NWR and Lower Klamath NWR, unlike the No Action Alternative. Because large water shortages to agriculture are anticipated under both alternatives, the difference in demand for groundwater pumping between the alternatives would be negligible, resulting in continued impacts to groundwater under both alternatives. Compared to the No Action Alternative, the Proposed Action Alternative would likely also result in slightly higher minimum Klamath River flow levels across all months, somewhat lower median flows in spring (March through May), and slightly higher median flows in other months. The Proposed Action Alternative is not expected to substantially affect water quality relative to the No Action Alternative.

Biological resources. The effects of the Proposed Action Alternative on biological resources would result from impacts on surface water resources. Under the Proposed Action Alternative, UKL elevations would likely fall below the habitat boundary conditions[2] targeted in the modeling for listed sucker species at certain times of the year, a situation that is not projected to occur under the No Action Alternative. Endangered Lost River and Shortnose suckers (*Deltistes luxatus and Chasmistes brevirostris*) inhabiting UKL may experience adverse effects with respect to habitat availability with a modest increase in risk of mortality and morbidity from stressors such as desiccation, disease risk, and predation due to water management. Populations of suckers in UKL will likely experience high mortality due to senescence regardless of water management. However, Proposed Action Alternative support for USFWS's efforts to establish redundant populations in Tule Lake sumps and Lower Klamath in the form of a dedicated water supply for those refuges could result in a population-level net benefit.

[2] Boundary conditions, such as certain lake elevations, were used as a modeling target as a consideration for habitat requirements of listed sucker species. Targeted boundary conditions were used for modeling purposes only and are not considered mandatory lake elevation requirements of the Endangered Species Act.

For the threatened Coho Salmon (*Oncorhynchus kisutch*), the expected effects of the Proposed Action Alternative are mediated through changes in Klamath River and are expected to be minor and adverse compared to the No Action Alternative. Southern Resident Killer Whales (*Orcinus orca*) may experience minor adverse effects as a result of decrease in prey availability (Chinook Salmon, *O. tshawytscha*). Compared to the No Action Alternative, the Proposed Action Alternative may affect, but is not likely to adversely affect, other federally listed aquatic species or their designated critical habitats except the candidate species Western Pond Turtle (*Actinemys marmorata*), which may experience adverse effects but about which little is known of abundance and distribution within the Project's boundaries.

Relative to the No Action Alternative, the Proposed Action Alternative would result in minor adverse impacts within UKL on wetland habitats by increasing the proportion of years where those wetlands are projected to be without standing water in fall months. The Proposed Action Alternative would provide benefits to Lower Klamath NWR wetland habitats in most, but not all, years by supplying these wetlands with more water. Structural differences between the No Action and Proposed Action models prevent a direct comparison of deliveries to Tule Lake NWR under the two alternatives. Under the Proposed Action Alternative, however, the Tule Lake NWR would receive sufficient water to support all of its wetlands.

Effects on wetlands are expected to impact their associated aquatic and aquatically linked biota. The minor adverse effects to UKL wetlands are expected to result in minor adverse effects on other fish and wetland birds that make use of UKL wetlands.

Migratory birds and non-migratory waterbirds at Tule Lake and Lower Klamath NWRs would benefit from the availability of more wetland habitat at these refuges. Birds at these refuges often experience disease outbreaks, which have resulted in bird die-offs during the summer(Audubon California, 2020).

Irrigated agriculture. Under the Proposed Action Alternative, median Project diversions (230,227 AF) would be higher than under the No Action Alternative (206,769 AF). However, under both alternatives, Project diversions would be lower than the historical median irrigation demand of 397,912 AF for most of the simulated study period years (i.e., for 30 out of 32 simulated years under the Proposed Action Alternative, and 32 out of 32 years under the No Action Alternative). Under the Proposed Action Alternative, sustainable use of groundwater would meet total irrigation water demands in two additional years, meaning water demands would be met through a combination of surface and groundwater in 13% of the simulated study period (4 of 32 years), compared to 0 years under the No Action Alternative.

Under the Proposed Action Alternative, 43% (on average) of all Project cropland would be fallowed due to water shortages, compared with 56% under the No Action Alternative. Consequently, average annual agricultural revenues would be $30.8 million higher under the Proposed Action Alternative than under the No Action Alternative, corresponding to $45.3 million higher total economic output, $16.0 million higher labor income, and additional demand for 232 jobs in the regional economy. Altogether, the Proposed Action Alternative is anticipated to provide beneficial impacts to irrigated agriculture compared to the No Action Alternative.

Recreation. To the extent that increases in flows under the Proposed Action Alternative would improve conditions for wildlife such that visitor experiences at the refuges would be improved, the Proposed Action Alternative would be beneficial to recreation, including wildlife viewing in particular,

in these areas. Changes to flow conditions under the Proposed Action Alternative that would increase flows in some months could provide marginal benefits to some recreational boating activities. Because flow rates at Keno Dam would be similar to the No Action Alternative, impacts on whitewater rafting under the Proposed Action Alternative relative to the No Action Alternative are anticipated to be negligible. Recreational fishing is considered below.

Population. Effects of the Proposed Action Alternative on irrigated agriculture relative to the No Action Alternative would be beneficial, resulting in a beneficial impact on population size.

Income, employment, business, and industrial activity. As noted above, implementation of the Proposed Action Alternative as compared to the No Action Alternative would have beneficial impacts on irrigated agriculture. As such, the Proposed Action Alternative would have a beneficial impact on regional economic activity.

Commercial, recreational, and Tribal fishing. Because there would be negligible to moderate adverse effects on salmonid species populations under the Proposed Action Alternative compared to the No Action Alternative, there could also be adverse impacts to commercial, recreational, or Tribal fishing opportunities.

Tribal Nations and Tribal economies. Fish are an important traditional food source as well as components of cultural, spiritual, and economic health for the Klamath Basin Tribes.

While suckers are not currently harvested in large numbers due to the existing condition of the species in UKL, implementation of the Proposed Action Alterative may further limit the likelihood of recovery of sucker populations in UKL to harvestable levels due to the adverse effects on suckers relative to the No Action Alternative. As such, the Klamath Tribes may experience adverse effects related to the potential for the species to reach harvestable levels despite the potential net benefit to the species due to establishment of redundant populations in the Lower Klamath and Tule Lake NWRs. When compared to the No Action Alternative, the adverse effects would be minor because conditions under both alternatives related to recovery of the species to harvestable levels would be similar. Adverse effects to the Karuk, Hoopa Valley, and/or the Yurok tribes and Tribal economies could result from implementation of the Proposed Action Alternative because negligible to moderate adverse effects on Klamath River salmon populations relative to the No Action Alternative may further limit the likelihood of recovery of listed species populations.

Environmental justice. On average, the population in the three-county study area (Klamath, Modoc, and Siskiyou counties) has lower median household incomes, a higher unemployment rate, a higher poverty rate (adults and children), more households receiving food stamps/supplemental nutrition assistance program (SNAP) benefits, lower educational attainment, and more elderly residents compared to larger Oregon and California and United States populations. The Klamath Falls and Altamont populations are and would continue to be more vulnerable than either Klamath County or the study area as a whole and are considered to be communities with environmental justice concerns. These communities have the potential to be affected by changes to UKL suckers, Klamath River salmon, and agriculture, as described below.

Because suckers inhabiting UKL may experience adverse effects from the Proposed Action Alternative relative to the No Action Alternative, and because these fish are an important traditional food source as well as components of cultural, spiritual, and economic health for the Klamath Tribes,

adverse effects to Klamath Tribes and Tribal economies could result from implementation of the Proposed Action Alternative. As noted above, Proposed Action Alternative support for USFWS's efforts to establish redundant populations in Tule Lake sumps and Lower Klamath in the form of a dedicated water supply for those refuges could result in a population-level net benefit, which would provide benefits for Klamath Tribes and Tribal economies.

Because the Proposed Action Alternative is expected to result in negligible to moderate adverse impacts to Klamath River salmonids, implementation of the Proposed Action may have minor impacts on local communities with environmental justice concerns that value these fish for recreational or cultural purposes.

When compared to the No Action Alternative, the Proposed Action Alternative is anticipated to have beneficial impacts to irrigated agriculture and beneficial impacts on regional economic activity. Impacts of the Proposed Action Alternative are expected to range from negligible to beneficial to communities with environmental justice concerns, compared with the No Action Alternative.

This page intentionally left blank

1 Introduction

U.S. Department of the Interior, Bureau of Reclamation (Reclamation) has managed the Klamath Project (Project) to provide water for irrigation since its authorization in 1905 (Section 1.2). Reclamation is proposing to modify certain aspects of its water management for the Project under the Proposed Action Alternative (Section 2). The objective of this Environmental Assessment is to determine whether implementing the modified water operations for the Project as described in Section 2 (and in the updated 2024 Biological Assessment (Reclamation, 2024a)) would significantly affect the quality of the human environment.

1.1 Purpose and Need for Action

The purpose of the action considered is to continue the operation of the Project for authorized purposes, in a manner that:

- Meets requirements under federal Reclamation law and other federal and state laws and regulations;
- Satisfies Reclamation contractual obligations and agreements; and
- Meets federal trust responsibilities to Tribes.

Implementation of a new action for the continued operation of the Project is needed to improve the manner in which Reclamation satisfies this purpose by accounting for changing environmental conditions and updated scientific information and modeling.

1.2 Legal and Statutory Authorities

The Project was authorized by the Secretary of the Interior (Secretary) on May 15, 1905, in accordance with the Reclamation Act (Act) of 1902 (32 Stat. 388) and the Act of February 9, 1905 (33 Stat. 714), and approved by the President on January 5, 1911, in accordance with the Act of June 25, 1910 (36 Stat. 835). The Secretary, through Reclamation, must manage and operate the Project consistent with applicable local, state, and federal law and in accordance with the Secretary's Tribal Trust obligations.

In developing the Proposed Action Alternative, Reclamation considered legal requirements and obligations including but not limited to:

- Reclamation Act (32 Stat. 388) and all acts amendatory and supplemental thereto;
- National Environmental Policy Act (NEPA, 42 United States Code [U.S.C.] §4331 et seq.);
- Endangered Species Act (ESA, 16 U.S.C. §1531 et seq.);
- Clean Water Act (33 U.S.C. §1251 et seq.);
- Clear Air Act (42 U.S.C. §7401 et seq.);
- Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. §1801 et seq.);
- National Historic Preservation Act (NHPA, 16 U.S.C. §470 et seq.);

- Executive Orders;
- Federal Trust responsibility to Klamath Basin Tribes;
- Project water delivery and drainage contracts;
- Klamath Basin National Wildlife Refuges (NWRs);
- Related case law; and
- Reclamation policy and guidance.

1.3 Introduction to the Klamath Project

1.3.1 Geographic Scope of the Klamath Project and this Environmental Assessment

The Project provides water for irrigation, domestic, and related purposes (e.g., stock watering) to approximately 230,000 acres of farmland in southern Oregon and northern California (Hollenback *et al.*, 2023). The Project's service area encompasses lands in Klamath County, Oregon, and in Siskiyou and Modoc counties, California (Figure 1-1). Communities within the Project include Klamath Falls, Bonanza, Merrill, and Malin in Oregon and Tulelake and Newell in California.

Project facilities and affected surface waters fall within the Klamath River Basin (Figure 1-2). Affected surface waters include the Lost River, Tule Lake, Upper Klamath Lake (UKL), Clear Lake Reservoir, Gerber Reservoir, and the Klamath River, extending to its terminus in the Pacific Ocean. The study area also includes nearby feeding grounds for Southern Resident Killer Whales (SRKW; *Orcinus orca*, which forage on Chinook Salmon, *Oncorhynchus tshawytscha*, from the Klamath River, among other locations), and the Lower Klamath and Tule Lake NWRs, which may receive water from the Project, depending on annual water supply. Chapter 3 provides more details on the Environmental Assessment's scope, including the overall watershed setting, surface water features, and other information.

1.3.2 Project Facilities

The Project consists of a complex network of storage and conveyance features consisting of reservoirs, lakes, dams, diversion dams, canals, pumping facilities, and drains (Reclamation, undated). Water made available through these facilities is delivered to irrigated lands through approximately 675 miles of canals and laterals. Irrigation return flows and local runoff are collected from irrigated lands through approximately 545 miles of drains. Approximately 50 separate pumps are used to convey irrigation and drainage water to different portions of the Project.

In addition to Project facilities, in which title is vested in the United States, locally and privately owned irrigation works (such as Harpold Dam on the Lost River and North Canal in the Lower Klamath Lake area) are also used to divert and convey Project water to its place of use. In certain cases, Reclamation has agreements with the owners of these facilities concerning their construction and continued operations.

The waters of the Upper Klamath and Lost River watersheds are used for irrigation and related purposes within the Project and are considered "Project water" whether stored in UKL, Clear Lake Reservoir, Gerber Reservoir, or diverted from natural flow in both the Klamath and Lost rivers. The total active storage capacity of the Project's three reservoirs is approximately 1,066,000 acre-feet (AF).

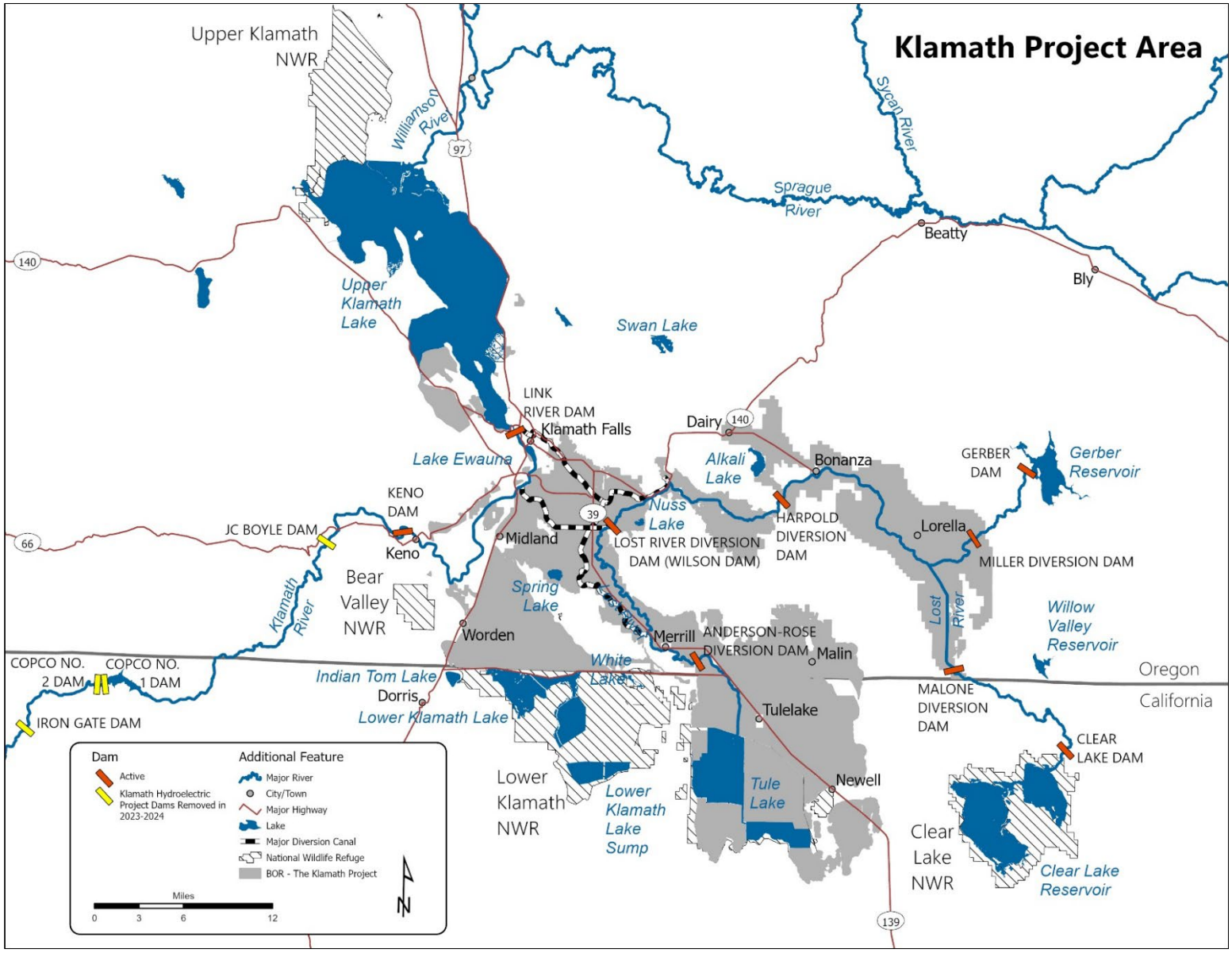


Figure 1-1. Klamath Project Area.

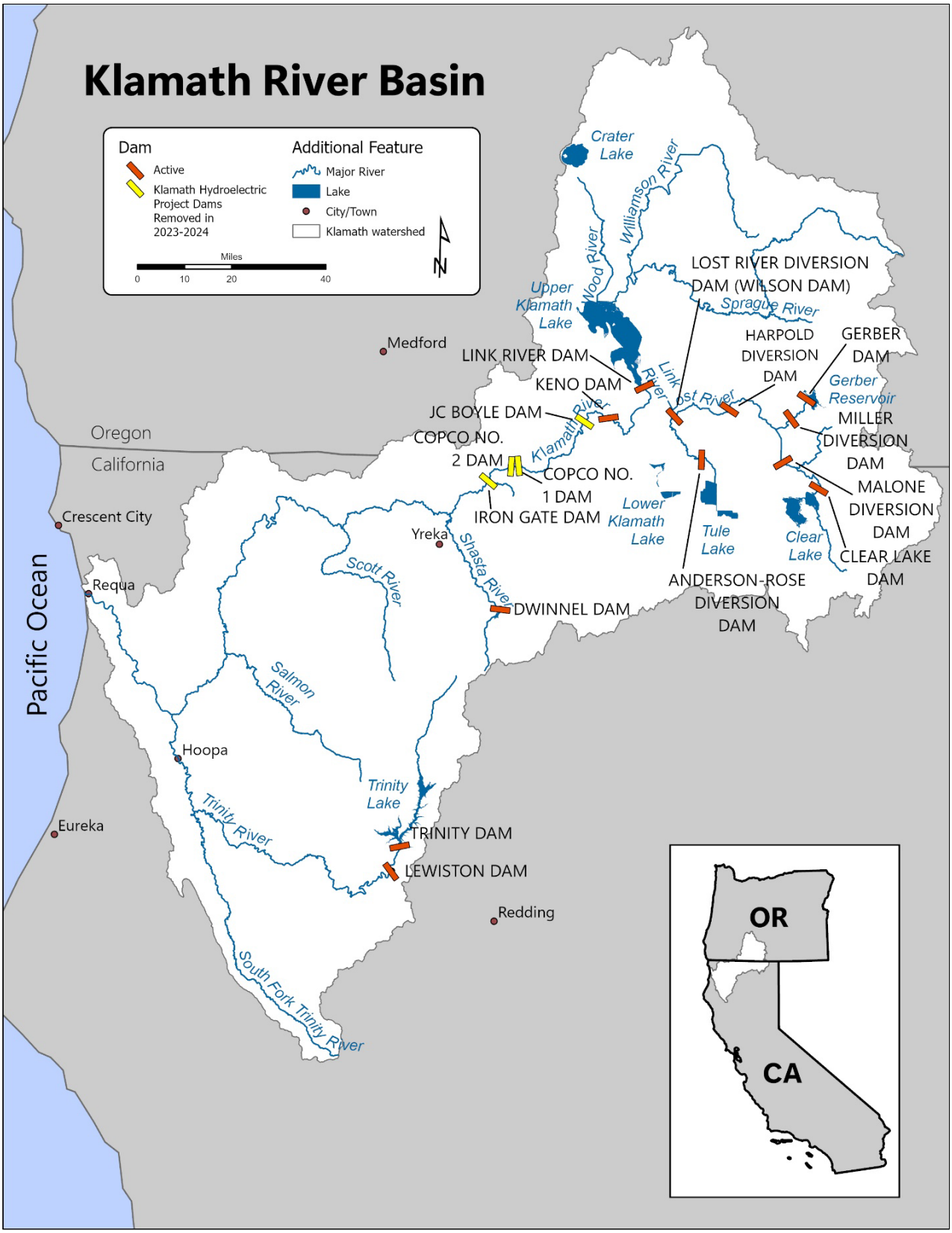


Figure 1-2. Overview of the Klamath River Basin.

Stored water in Clear Lake and Gerber reservoirs is generally used for irrigation purposes in Langell and Yonna valleys, although it can also be used for irrigation in the portion of the Project between Klamath Falls, Oregon, and Tulelake, California. Project water stored in UKL is used for irrigation on lands between Klamath Falls and Tulelake, Poe Valley, the Lower Klamath Lake area, and along the Klamath River between Lake Ewauna and the town of Keno, Oregon. Natural flows in the Lost River above Harpold Dam are primarily used in Langell and Yonna valleys, although all water in the Lost River below Harpold Dam is generally diverted and used within the Project during the irrigation season. Natural flows in the Klamath River resulting from natural runoff and other discharges into the river below Link River Dam is primarily used in the Lower Klamath Lake area. Section 2 of the 2024 Biological Assessment (Reclamation, 2024a) provides further information on the Project's service area.

1.3.3 Project Operations

Reclamation's operation of the Project consists of three primary elements:[3] storing waters of the Klamath and Lost Rivers; operating Project facilities; and performing operation, maintenance, and replacement (OM&R) activities necessary to maintain Project facilities.

Reclamation manages the Project to provide water for irrigation by storing water year-round in UKL, Clear Lake Reservoir, and Gerber Reservoir. Approximately 230,000 acres of the Project's service area are primarily served from UKL and the Klamath River (Hollenback *et al.*, 2023). Approximately 10,000 acres are served from the Lost River, and about 20,000 acres are served from Clear Lake and Gerber reservoirs, although stored water from these reservoirs can also be used under certain circumstances, as determined by Reclamation, to meet irrigation demands in portions of the Project Area typically served from UKL and the Klamath River.

In addition to irrigation deliveries, Reclamation makes flood control releases from UKL, Clear Lake Reservoir, and Gerber Reservoir based on flood control curves developed by water resource modelers through an iterative process to maximize water availability for fish and farms and were not developed using a flood frequency analysis or other formal engineering-based approach. The resulting flood control curves are roughly protective of a 50-year flood event.

Certain water levels in UKL, Gerber Reservoir, and Clear Lake Reservoir are required for ESA-listed Lost River and Shortnose suckers (*Deltistes luxatus* and *Chasmistes brevirostris*), and certain flow rates in the Klamath River are required for ESA-listed Coho Salmon (*Oncorhynchus kisutch*).

As part of its management responsibilities, Reclamation develops annual operations plans, each of which is specific to a particular time period. Reclamation's annual operations plans describe planned Project operations based upon then-current and projected hydrologic conditions, including seasonal water supply forecasts and hydrologic modeling that produces estimated Klamath River flows, Project diversion quantities, and UKL elevations. Reclamation may also issue annual drought plans that describe how Reclamation will allocate agricultural water supplies when they are inadequate to satisfy all contracted users.

1.3.4 Uses of Project Water

Reclamation operates the Project subject to competing demands. Protected aquatic species inhabit some of the Project Area's surface waters as well as the downstream Klamath River. Reclamation is

[3] These overarching elements and the general operations described in this section are shared by both the No Action and the Proposed Action alternatives. Chapter 2 presents these alternatives and describes their differences.

required to comply with the ESA by consulting with the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) (collectively, the Services)—the agencies with the legal authority to implement the ESA—to ensure that Project operations do not jeopardize federally listed species or adversely modify their designated critical habitat. In general, as a result of these consultations, Reclamation must retain an adequate quantity and quality of water *in situ* to support protected aquatic species that inhabit some of the Project Area's surface waters as well as the downstream Klamath River.

Local Tribes rely on the Basin's waters and the associated aquatic biota for subsistence, economic, and cultural purposes. Reclamation must protect Tribal Trust resources of federally recognized Tribes in the Klamath Basin. Some of these tribes, including the Yurok, Hoopa Valley, and Klamath tribes, hold reserved water rights to support the purposes of their respective reservations. These include instream water rights to support tribal fishing rights that are prior ("senior") to the water rights associated with the Project and which prohibit subsequent ("junior") appropriators from depleting certain waters, including UKL, its tributaries, and the Klamath River, below a protected level.

Reclamation has contractual obligations to provide water to Project users, subject to availability. Reclamation maintains over 160 perpetual contracts on the Project, covering approximately 230,000 acres, with district entities and individual landowners to provide water from the Project for irrigation in exchange for payment of Project costs and other conditions. In addition, approximately 2,900 acres are served by annual contracts for water that is surplus to the needs of the perpetual contractors (Reclamation, 2024a).

Reclamation is a primary source of water to the Lower Klamath and Tule Lake NWRs. Project water is used on the refuges to grow feed for migratory birds and to provide wetlands and open water that provides important habitat to waterfowl and migratory birds (among other species) and recreational and hunting opportunities to the public. The Klamath River itself provides additional opportunities for water-based recreation, including fishing, boating, and swimming. The Klamath River Basin's support of aquatic species, including the anadromous Chinook Salmon supports freshwater and ocean recreational fishing and ocean commercial fishing.

1.3.5 Endangered Species Act and National Environmental Policy Act Review of Operational Plans

When developing a new operational plan that may affect federally listed species, Reclamation also develops a Biological Assessment and initiates formal consultation with the Services pursuant to Section 7(a)(2) of the ESA. The purpose of these consultations is to evaluate the potential effects of the operational plan on species listed as threatened or endangered under the ESA and on their designated critical habitat. Upon completion of formal consultation, NMFS and USFWS separately or jointly issue biological opinion(s) on the proposed action. Each biological opinion evaluates the best available scientific and commercial data and concludes that the proposed action either is or is not likely to jeopardize the continued existence of the protected species, and that the proposed action either is or is not likely to result in the destruction or adverse modification of these species' designated critical habitat. If federally listed species would be jeopardized or designated critical habitat would likely be destroyed or adversely modified, then a biological opinion will identify a reasonable and

prudent alternative(s)[4] to the proposed action that avoid those outcomes. Effects determinations not reaching the level of "jeopardy" may nevertheless be accompanied by Terms and Conditions to avoid and/or minimize the anticipated incidental "take" of individuals of the listed species or adverse modification of designated critical habitat. Reclamation has prepared a Biological Assessment and has initiated formal consultation with the Services in connection with the Proposed Action Alternative described in Chapter 2.

Under NEPA, Reclamation is required to disclose to the public sufficient evidence information and analysis for determining whether or not the Proposed Action Alternative has the potential to cause significant impacts on the human environment. An Environmental Assessment may result in a Finding of No Significant Impact (FONSI) for the proposed action. If, however, an Environmental Assessment determines that the environmental impacts of a proposed action would be significant, then an Environmental Impact Statement is prepared.

[4] Reasonable and prudent alternative actions, identified during formal consultation, are those that: (1) can be implemented in a manner consistent with the intended purpose of the action; (2) can be implemented consistent with the scope of the action agency's legal authority and jurisdiction; (3) are economically and technologically feasible; and (4) NMFS or USFWS believes would avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat (50 Code of Federal Regulations [CFR] §402.02).

2 Proposed Action and No Action Alternatives

This Environmental Assessment analyzes two alternatives—the No Action and the Proposed Action alternatives—across a timeframe not to exceed 5 years, covering 2025-2029. The following sections describe the elements common to both alternatives and the differences between the alternatives.

2.1 Elements Common to Both Alternatives

2.1.1 Core Management Elements

Both alternatives include the following core elements: (1) store waters of the Klamath and Lost rivers; (2) operate the Project, or direct the operation of Project facilities, for the delivery of water for irrigation purposes and NWR needs (subject to water availability while maintaining conditions in UKL and the Klamath River that meet the legal requirements) or as necessary for flood control purposes, and (3) perform OM&R activities necessary to maintain Project facilities.

2.1.2 New Existing Conditions

Both the No Action and Proposed Action alternatives include actions taken by others that have changed the landscape, such as the 2023-2024 removal of four dams (J.C. Boyle, Copco 1, Copco 2, and Iron Gate dams) downstream of Keno Dam. Both alternatives also reflect the expected reconnection of the Agency-Barnes Unit of the Upper Klamath NWR to UKL by the USFWS, which is anticipated to occur within the year. This reconnection will change the relationship between lake level and the quantity of water stored, and it has implications for water modeling because, per unit of net inflow, UKL's elevation is anticipated to increase less when the lake is filling and decrease less when it is emptying. Both alternatives also reflect the availability of updated bathymetric data for UKL (Hollenback *et al.*, 2023), which was developed subsequent to the prior Interim Operating Procedures (Reclamation, 2019b). Altogether, these new existing conditions and updated datasets have resulted in the need to incorporate changes to the operational procedures to account for this new information and changed operational landscape, which are incorporated in this Environmental Assessment and the associated Biological Assessment (Reclamation, 2024a).

2.1.3 Service Area

Reclamation manages the Project to provide water to the Project's service area. The Project's service area, described in Section 1.3.1, remains the same under both the No Action and Proposed Action alternatives.

2.1.4 Clear Lake and Gerber Reservoir Operations

Operational procedures, resultant water deliveries and releases, and reservoir elevations at Clear Lake and Gerber reservoirs are generally described in Section 1.3.3 and are the same under both alternatives, consistent with the operations described in the 2020 Interim Operations Plan (IOP) (Reclamation, 2020a).

Under both alternatives, a minimum September 30 surface elevation at or above 4,520.60 ft for Clear Lake Reservoir and at or above 4,798.10 ft for Gerber Reservoir would be maintained. The Proposed Action Alternative extends these operations without changes through 2029. Because the Proposed Action Alternative would not differentially affect operations at these reservoirs compared to the No Action Alternative, and as potential impacts remain consistent with those analyzed in the 2020

Environmental Assessment for IOP operations, incorporated here by reference (Reclamation, 2020a), operations of these reservoirs and their potential impacts to resources are not discussed further in this Environmental Assessment.

2.1.5 Water Rights

In operating the Project to provide water for irrigation purposes, Reclamation must operate consistent with state law relating to the control, appropriation, use, or distribution of water used in irrigation, to the extent it does not conflict with federal law with respect to the diversion, control, and use of water. The laws of both the states of Oregon and California provide a means for a water user to establish a "right" to divert and apply available water for beneficial use, subject to certain requirements and conditions. Operating the Project consistent with such existing water rights of record is an element common to both alternatives.

Water rights associated with the Project, as established under state law, define the maximum volume and diversion rates and the permissible periods of use, timing, rate, total volume, and sources and locations from which water can be diverted, to the extent water is physically and legally available for appropriation and use under federal law.

Portions of the Lower Klamath and Tule Lake NWRs hold water rights for both irrigation and refuge purposes. Water within the refuges is commonly used for both purposes, being applied to a field to grow an agricultural crop, drained off, and then used for maintaining wetland areas elsewhere (or vice versa). The USFWS is responsible for managing water operations and use within the refuges, subject to compliance with state water law and federal law.

To the extent of Reclamation's direct control and oversight, the operations described under both alternatives will be carried out in a manner consistent with state water law, including existing water rights of record, and with applicable federal law. Districts and individuals are also responsible for ensuring that their water use is consistent with federal and state water laws, including existing water rights of record.

2.1.6 Water Deliveries and Releases from Upper Klamath Lake

Under both alternatives, UKL is used to store seasonal runoff to meet irrigation needs, with water released via Link River Dam to meet ESA requirements and to prevent flooding. Project water stored in UKL is used for irrigating lands within the Project's existing service area. Water available from UKL for irrigation purposes during the spring/summer period is diverted directly from UKL via the A Canal or after release from Link River Dam, directly from the Klamath River via Station 48, Miller Hill Pumping Plants, the North Canal, the Ady Canal, and smaller diversions in the Keno Impoundment to serve contracts along the Klamath River above Keno Dam. Project water stored in UKL is also used to provide the Lower Klamath NWR with water consistent with water rights held by the United States for the refuge and the contract priority within the Project. In addition to the above deliveries, under both alternatives Reclamation makes flood control releases from UKL as conditions warrant. Reclamation also releases water from UKL to meet designated stream flows in the Klamath River.

The Ceremonial Boat Dance is part of a traditional Yurok religious ceremony held every 2 years, generally in August or September, to restore and renew the balance of the world. To safely conduct the ceremony, it is necessary to have sufficient flows in the river to provide predictable flows and a water depth that allows for the canoes to pass over a riffle. Under both the No Action and Proposed Action alternatives,

Reclamation would temporarily increase water releases from Keno Dam to the Lower Klamath River to support the Ceremonial Boat Dance. Under both alternatives, Reclamation would determine the timing and quantity of Ceremonial Boat Dance flows in consultation with the Yurok Tribe.

2.1.7 Operational Periods and Period of Record

Both alternatives have a fall/winter period and a spring/summer period. The spring/summer period covers the irrigation season and the time of year that UKL elevations gradually decrease as the majority of Klamath River and irrigation releases occur, and the fall/winter period covers the rest of the year, during which most water is stored, UKL refill occurs, and irrigation diversions are minimal.

Both the No Action and Proposed Action alternatives were modeled using water years 1981 through 2022. For the purposes of evaluating the differential impacts of these two alternatives, this Environmental Assessment uses October 1991-November 2022, termed the Period of Record (POR). Model results for this POR are used in this Environmental Assessment to evaluate effects because the water years between 1981 and 1990 tended to be wetter than the subsequent decades, and the later time period is expected to better reflect likely future conditions.

2.1.8 Operation, Maintenance, and Replacements

To ensure functionality of the Project, various OM&R activities are carried out by Reclamation or through a contract to the appropriate irrigation district according to whether a specific facility is a reserved or transferred work, respectively. In general, OM&R activities include, but are not limited to: exercising dam gates; stilling well gage maintenance; repair, inspection, and clearing of canals, laterals, and drains; equipment (e.g., pump, headgate, valves) replacement; fish screen/ladder maintenance; and road, dike, and pumping facility upkeep. These actions have been ongoing throughout the history of the Project and would continue under both the No Action and Proposed Action alternatives.

As part of the removal of dams downstream of Keno Dam, ownership of Keno Dam was transferred to Reclamation in July 2024. Consequently, Reclamation will have OM&R responsibilities for Keno Dam under both alternatives. In addition, the removal of the downstream dams means Keno Dam may be re-designated as a "high hazard" dam—i.e., a dam the failure or mis-operation of which would likely cause loss of human life. If that redesignation occurs, under both the No Action and Proposed Action alternatives, Reclamation would maintain and operate Keno Dam accordingly.

Upon transfer of Keno Dam to Reclamation, PacifiCorp removed the automated equipment it was using to operate the dam. Until Reclamation is able to install equipment of its own, the dam will be operated manually. In the meantime, the access road to Keno Dam may experience increased vehicle traffic for dam operations.

Although not evaluated in this Environmental Assessment, the OM&R activities needed to operate the Project will be identified and evaluated on a case-by-case basis and undergo evaluation by Reclamation to determine if additional compliance with NEPA and the NHPA (and other applicable laws) is required prior to the activity(ies) being implemented.

2.1.9 Conservation Measures

Reclamation would undertake certain conservation measures under both alternatives. Such measures include, but are not necessarily limited to, salvage of Lost River and Shortnose suckers at Project canals (when canals are temporarily dewatered or are dewatered at the end of the irrigation season), and

continued support of a captive rearing effort by the USFWS for Lost River and Shortnose suckers. Reclamation (2024a) provides more information about these conservation measures.

Reclamation is also collaborating in a potential effort to evaluate fish screen needs (to reduce entrainment in Project canals) and fish passage improvements at Keno Dam. These activities are briefly described in the Biological Assessment but are not evaluated in this Environmental Assessment. Rather, they would first be assessed on a case-by-case basis and would undergo evaluation by Reclamation to determine the appropriate level of environmental compliance, as determined necessary.

2.1.10 Additional Common Elements

Under both alternatives, Reclamation will monitor daily flows at Link River Dam, Keno Dam, Clear Lake Reservoir, Gerber Reservoir, and all major diversion points (A Canal, Station 48, Miller Hill, North Canal, and Ady Canal). Reclamation will also continue monitoring at other locations necessary to effectively manage the Project. Section 3.6 of Reclamation (2024a) provides more information about Project monitoring.

Special studies address areas of scientific uncertainty on the reasonable balance among competing demands for water, including the requirements of fish, wildlife, and agriculture. Special studies anticipated under both alternatives include the Klamath River Basin natural flow study and an updated bathymetry inflow/storage study (Reclamation, 2024a). Under both alternatives, Reclamation would also continue to support research and monitoring projects that inform managers on the status of ESA-listed species populations as appropriated funds allow.

Reclamation's water shortage planning procedures are also identical under both alternatives, including coordination directly with Project contractors and the Services regarding Project water availability and demands. Section 3.9 of Reclamation (2024a) provides more information about water shortage planning.

2.2 Background About Project Inflows and Forecasts

Before describing the No Action and Proposed Action alternatives, it is useful to understand some key elements about Project inflows and seasonal forecasts, both of which are integral to describing differences between the No Action and Proposed Action alternatives.

2.2.1 Project Inflows

Sources of Project inflows considered in both the No Action and Proposed Action alternatives include the Lost River and UKL. Lost River inflows (measured at the headworks of the Lost River Diversion Channel [LRDC] at the Lost River Diversion Dam) are comprised primarily of surface runoff during wet periods, while during dry periods, Lost River inflows consist primarily of return flow from irrigation diversions originating in UKL.

UKL is the primary surface water source for managing downstream water uses along the Upper Klamath River between UKL and the former Iron Gate Dam (IGD); consequently, understanding and forecasting inflows to UKL is critical to Project management. Because there are many sources of inflow into UKL that are not measured (e.g., streams, springs), it is not possible to determine daily inflows accurately enough to use measured inflows as a basis for operational decisions. Instead, the net inflow into UKL is estimated each day as the change in UKL storage from the previous day plus the measured outflows from UKL over the Link River Dam. During the hottest, driest times of the

year when diversions from UKL and evapotranspiration from its surface are high and actual inflows are low, UKL net inflows commonly become negative.

2.2.2 Revised Upper Klamath Lake Bathymetry and Forecasts of Upper Klamath Lake Seasonal Total Net Inflows

Forecasts of seasonal total net inflow volume into UKL are used to make operations decisions in both the No Action and Proposed Action alternatives. As noted in Section 2.1.2, a recent bathymetric survey (Hollenback *et al.*, 2023) has been completed. This survey improved the accuracy of the UKL level-storage relationship, which necessitates the re-computation of daily UKL net inflow across the simulated period (i.e., water years 1981-2022), and the models used by the Natural Resource Conservation Service (NRCS) to forecast seasonal volumes of UKL net inflow must be recalibrated using the revised UKL net inflow dataset. NRCS has not yet completed this work, and as such, NRCS forecasts are not available for this Environmental Assessment.

The only currently available forecast models calibrated to the revised net inflow data are models based on the Normalized Wetness Index (NWI; see Section 2.4). Consequently, both the No Action and Proposed Action alternatives use these models for April, May, and June forecasts. Since there are no recalibrated forecast models available for the January, February, or March forecasts, these forecasts are generated in a manner that replicates the forecast error associated with the prior versions of the net inflow data and the corresponding NRCS forecast models. In the future, Reclamation intends to rely on a combined forecast based on forecasts from NRCS, the California Nevada River Forecast Center, and NWI models, once these forecasts are available.

The output of forecast models consists of multiple forecasts, each of which is associated with a different probability of occurring. For example, a 10th percentile forecast represents a net inflow volume that would be exceeded 90% of the time, while a 50th percentile forecast represents a net inflow volume that would be exceeded 50% of the time.[5]

Every net inflow forecast has a measurable error associated with it, which is calculated as the observed (actual) net inflow value minus the forecasted value. Large forecast errors can be problematic in water management. As an example, if water is allocated and used based on an overestimate of future net inflows, by the time the forecast error can be measured (at the end of September), the water has already been released from UKL. Substantial changes in water management between the No Action and Proposed Action alternatives (discussed below) are intended in part to better manage the consequences of forecast error. More detailed information can be found in the 2018, 2020, and 2024 Biological Assessments and their appendices (Reclamation, 2018b; 2020b; 2024a).

2.3 No Action Alternative

Under the No Action Alternative, Reclamation would continue to operate the Project in a manner that is generally consistent with the 2020 IOP (Reclamation, 2020a). Like the IOP, the No Action Alternative is based on the Klamath Basin Planning Model (KBPM) and its compliance point for measuring flows is the Iron Gate gage. The No Action Alternative does, however, include certain changes to the 2020 IOP. Some of these changes are necessary to reflect the new existing conditions

[5] Modelers typically use somewhat different terminology to describe these forecasts, using "percent exceedance" instead of percentiles. Using the more formal modeling nomenclature, a 10th percentile forecast is described as a 90% exceedance forecast. This Environmental Assessment uses percentile terminology to be more accessible to the general public.

(e.g., changes to bathymetry and forecasts discussed in Section 2.2.2), while others are intended to ensure use of the best available information. These modifications, and the general operation of the No Action Alternative, are described below.

Box 1. Key Terms

Environmental Water Account (EWA): volume of water allocated for Klamath River flows during March-September. Calculated based on the UKL Supply.

Project Supply: volume of water in UKL allocated for irrigation during the Spring and Summer. Calculated based on the UKL Supply and the EWA.

Project Diversions: volume of water used for irrigation from UKL and the Lost River.

UKL Central Tendency levels: a pattern of UKL end-of-month elevations interpolated to provide daily elevation values. These elevations increase in the fall and winter and decline in the spring and summer.

UKL Supply: the volume of water in UKL above a specified end-of-September target UKL elevation; based in part on the expected net inflow volume.

2.3.1 Changes from the 2020 Interim Operations Plan

2.3.1.1 Revised Lost River Operations

Recent changes in management of Lost River water involving more retention in the Tule Lake NWR sumps (especially in the winter) and less diversion into the Klamath River are not reflected in the 2020 IOP, which does not simulate water use in the Tule Lake NWR. In contrast, the Proposed Action Alternative model does simulate Tule Lake NWR sumps in a manner intended to reflect the current and likely ongoing management of Lost River water. To maximize comparability between the model results for the No Action and Proposed Action alternatives, the Lost River water used to maintain the Tule Lake NWR sumps in the Proposed Action Alternative simulation was subtracted from the Lost River inflow, and the result was used as the Lost River inflow into the No Action Alternative's model. In essence, this approach assumes that the water used in the Proposed Action Alternative for sump maintenance is not available for other uses in the No Action Alternative.

2.3.1.2 Historical Demand Cap on Simulated Irrigation Deliveries

Another change to the 2020 IOP involves deliveries to irrigation users. In wet years, the 2020 IOP simulated more irrigation water use than was observed in years when no other restrictions limited irrigation uses, often by relatively large amounts. In the No Action Alternative, simulated irrigation deliveries were capped by the historical demand, improving the realism of the No Action Alternative outcomes.

2.3.1.3 Revised Return Flows

Return flows from irrigation within the Klamath Drainage District (KDD) were simulated by a sub-model in the 2020 IOP that was based on a historical pattern that is increasingly unrealistic as KDD has implemented various approaches to minimize the use of F and FF pumps to return KSD water to the Klamath River. Over-estimates of KDD returns in simulations lead to over-estimation of either the agricultural reuse of the drain water or its contribution (instead of releases from UKL) to Klamath River flows. A more realistic estimate is used in the No Action Alternative, which is based on observed F/FF pumping, returns from Lower Klamath NWR, and irrigation diversions into KDD. Since this is the best available estimate of KDD returns, it is also used in the Proposed Action Alternative.

2.3.1.4 Flood Release Curve

The 2020 IOP used two flood release curves that determined UKL levels above which UKL storage would be spilled: one for drier conditions and another for wetter conditions. During the development of the Proposed Action Alternative, it was deemed acceptable to always use the flood release curve that was used for drier conditions in the 2020 IOP. The same flood release curve was used in the No Action Alternative.

2.3.1.5 Revised Accretions

Other input datasets used by the 2020 IOP were also modified recently to improve their stability and accuracy. A dataset of accretions (and decretions, which are the amount of water leaving a river between two indicated points) to the Keno Impoundment on the Klamath River between the Link River and Keno gages used in the IOP displayed very large, sudden changes caused by sub-daily operations of the Klamath Hydroelectric Project (KHP).[6] Similarly, the complex sub-daily power peaking operations within the KHP between the Keno and Iron Gate gages caused many large, unrealistic daily swings in accretions in the 2020 IOP. Both accretion data sets were revised as part of the Proposed Action Alternative development, and the resulting data sets are the best available expressions of daily accretions to those river reaches. Revisions focused on identifying and removing the KHP-related signatures, which significantly improved the realism of both datasets. Another change to the accretions dataset between the Keno and Iron Gate gages involves adding the evaporative losses from the KHP reservoirs to the accretion estimates, reflecting the removal of the KHP dams and their reservoirs. The No Action Alternative uses both datasets.

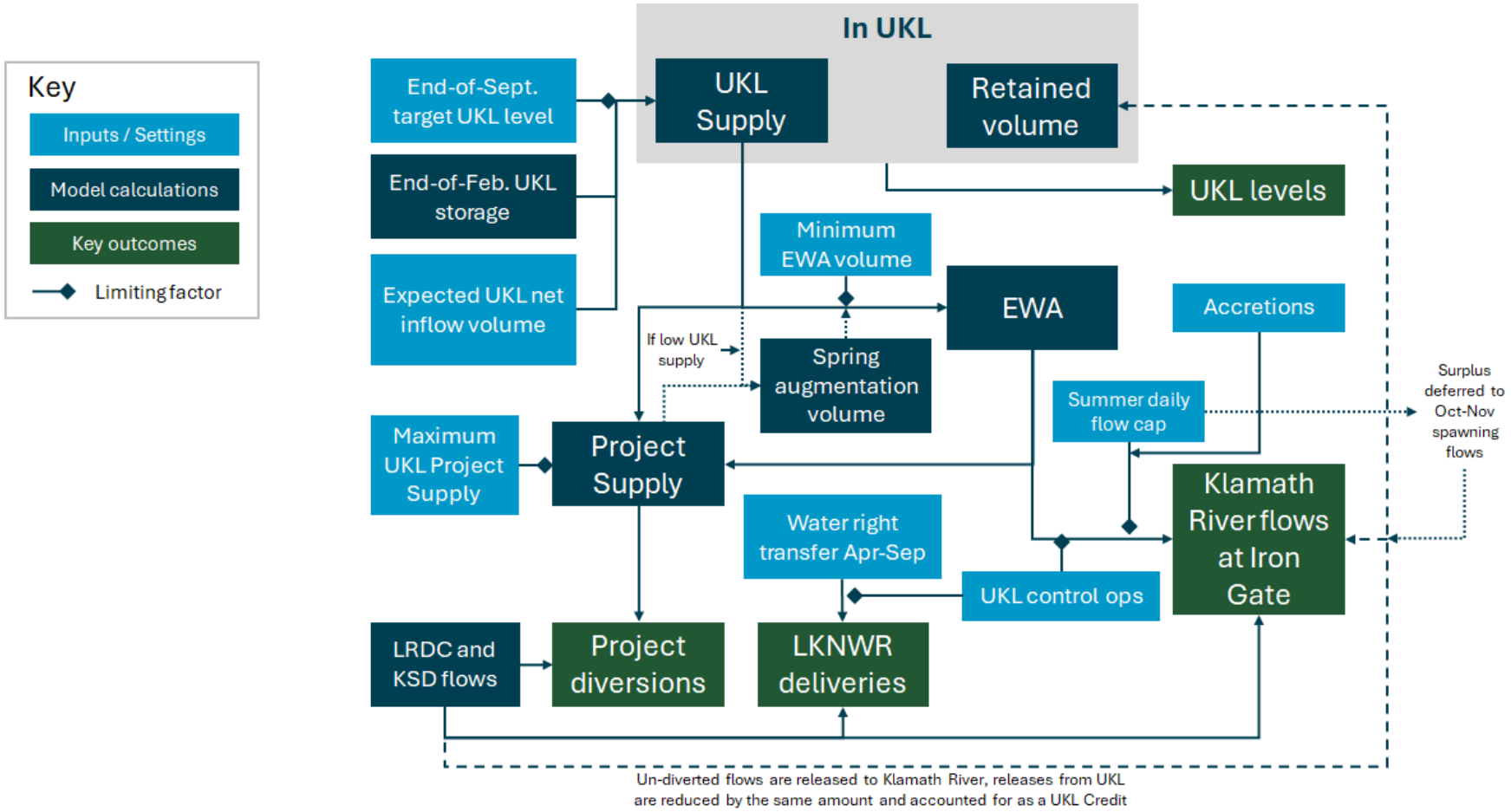
2.3.1.6 Model Rebalancing

After making these modifications to the KBPM, Reclamation then "rebalanced" the model so that the Klamath River flows and UKL elevations would be as similar as possible to those modeled under the 2020 IOP.

Approximately reproducing IOP outcomes for the Klamath River flows (specifically total volumes in a water year) required modifying the UKL Central Tendency levels (see Box 1) and the end-of-September target UKL elevations. Reproducing IOP outcomes for UKL elevations in spring (i.e., at the end of April) required increasing the UKL elevations at the end of the prior summer, which was achieved by decreasing modeled irrigation deliveries.

Operations under the No Action alternative would be roughly divided into three seasonal periods: spring (March-June), summer (July-October), and fall/winter (November-February). Different strategies would govern the distribution of water among various uses during these periods. Figure 2-1 provides a conceptual overview of the No Action Alternative's spring/summer operations (which are the most complex), and the following sections provide more detail on operations in each seasonal period.

[6] The PacifiCorp-owned KHP is different than the Reclamation-owned Project and currently includes East Side, West Side, and Fall Creek hydroelectric developments.



Notes:
UKL = Upper Klamath Lake
NRCS = National Resource Conservation Service
EWA = Environmental Water Account
NWI = Normalized Wetness Index
LRDC = Lost River Diversion Channel
KSD = Klamath Straits Drain

Figure 2-1. Overview of No Action Alternative spring/summer operations.

2.3.2 No Action Alternative Operations

2.3.2.1 Spring and Summer

Under the No Action Alternative, operations during spring would be focused on first establishing water allocation volumes for the Klamath River (called the Environmental Water Account, or EWA) and the Klamath Reclamation Project (Project Supply, used for irrigation), and then delivering water from these allocated volumes. The volume available for use from UKL would be determined on the first day of each month by first combining the divertible volume stored in UKL at the end of February with the expected net inflow volume into UKL over the March-September period. The UKL Supply is the anticipated volume above a specified end-of-September target UKL level.

The estimated net inflow volume into UKL over the March-September period is an important element of the UKL Supply calculation, and the one that ultimately incorporates forecast error into the allocations. On March 1, the estimated net inflow volume would be comprised solely of the 50th percentile forecast of March-September net inflow. Thereafter, the estimate would be comprised of the measured UKL net inflow volume that entered the lake on and after March 1 plus the 50th percentile forecast of the net inflow volume from the forecast date through September. For example, on June 1 the expected March-September net inflow volume into UKL would be the actual net inflow from March-May plus the 50th percentile forecast of the June-September net inflow volume.

The EWA allocation would be calculated based on the UKL Supply using an equation that yields increasing EWA volumes as the UKL Supply increases. Project Supply is the volume of UKL Supply that remains after allocating the EWA volume. Under the No Action Alternative, Project Supply from UKL would be capped at a maximum volume (350,000 AF), and Project deliveries would be capped at historical demand volumes. The EWA would not be allowed to drop below a minimum volume (400,000 AF). As the UKL Supply volume fluctuates on each first-of-month update, the EWA would fluctuate up or down. The Project Supply also would fluctuate in response to UKL Supply but would not be allowed to decrease below the volume calculated for the Project Supply on April 1 unless necessary to meet ESA requirements, consistent with federal law.

In addition, consistent with the 2019 Biological Opinion from NMFS (NMFS, 2019) and subsequent litigation, the No Action Alternative would provide an additional volume of up to 40,000 AF to supplement releases during May-June when conditions result in UKL Supply volumes within a range corresponding to dry conditions. To make these supplemental releases, 23,000 AF would be taken from Project Supply and another 17,000 AF from UKL.

These augmented flows are intended to avoid flow rates dropping below the minimums set forth in NMFS' Biological Opinion required for salmon. In addition, the No Action Alternative would provide for a surface flushing flow to reduce the incidence and severity of fish disease in the Klamath River. If needed, in the spring of each year, Reclamation would release enough water from UKL to produce flows of at least 6,030 cubic feet per second (cfs) at the Iron Gate gage for three consecutive days.

Under the No Action Alternative, there is no allocation volume dedicated to UKL; however, a process called UKL Control would regulate UKL releases under certain conditions to prevent UKL levels from dropping below modeled UKL Central Tendency elevations (Box 2).

Box 2. Central Tendency

Year-round UKL levels following a specified seasonal progression of filling in the fall/winter and declining in the spring and summer are called the UKL Central Tendency. When UKL levels are at or above the UKL Central Tendency levels, then the EWA volume under the No Action Alternative would be calculated as described in the main text. However, as UKL levels decline below the UKL Central Tendency levels, the No Action Alternative would reduce EWA volume, with the reductions growing larger (up to 80%) as the lake levels drop further. The same process would be applied to Project irrigation diversions from UKL during the fall/winter period (i.e., decreasing diversions with lower UKL levels); however, under the No Action Alternative, UKL levels below the Central Tendency would not reduce diversions during the spring or summer periods unless they additionally fell below levels prescribed by the applicable Biological Opinion.

Minimum flows below Iron Gate gage are specified for each month of the year, and whenever the calculated releases from UKL drop below them, the release needed to remain at the minimum flow is released instead. UKL Control operations cannot decrease releases below those necessary to maintain required minimum flows below Iron Gate gage.

Under the No Action Alternative, EWA release operations would change from spring to summer, in part because UKL net inflows are typically low (and negative at times) and so are not useful in shaping the EWA releases. Releases would instead be determined as a percentage of the EWA volume remaining at the end of June. Because this calculation can at times produce high flows, a maximum daily Iron Gate gage flow cap would be imposed. Calculated flows exceeding the cap would be accumulated and used to augment river flows during the October through mid-November salmon spawning period.

Under the No Action Alternative, Project irrigation releases from UKL during both spring and summer would be simulated by the KBPM using a sub-model that produces realistic seasonal patterns of irrigation deliveries (explained in detail in Appendix 4 of the 2018 Biological Assessment (Reclamation, 2018b)). However, the daily magnitudes and patterns of simulated irrigation diversions are not meant to be prescriptive. Operationally, the irrigators and Reclamation would co-manage the Project Supply volume available from UKL in a manner that would reflect real-time demand for water while ensuring that the irrigation allocation is not exceeded.

Under the No Action Alternative, during spring and summer, the return flows from the Lower Klamath Lake Basin (through the F/FF pumps on the KSD) and the inflows from the Lost River to the LRDC would be available for use by Project irrigators. If water from these sources exceeded what would be needed for irrigation, the unused water would be released to the Klamath River. UKL releases intended to meet calculated Iron Gate gage flows would then be reduced by the same amount, and the released volume would be accrued in UKL as a UKL Credit, which would remain in the lake thereafter.

Deliveries to the Lower Klamath NWR from April-September would consist of 11,000 AF from a transferred water right. The No Action Alternative includes provisions for the refuge to access to some portion of the Project Supply under certain conditions, but in past operations under the 2020 IOP, consistent deliveries were not implemented on that basis, and such deliveries would likely continue to be inconsistent under the No Action Alternative.

2.3.2.2 Fall/Winter

Operations under the No Action Alternative would change again in the fall/winter period. Releases to the Klamath River would be managed to provide specified flows at the Iron Gate gage during October through November 15 to support salmon spawning; thereafter, the focus would shift to refilling UKL. Under the No Action Alternative, the target refill level for the end of February would be 4,143.0 ft, and if the average daily refill rate necessary to reach it were exceeded, then releases to the Klamath River would increase. Releases to the Klamath River would decrease if the UKL refill rate is too low or if the UKL Control operation reduced releases. Irrigation Project diversions (up to 28,910 AF) consist of flooding lands in the KDD and lease lands associated with the Lower Klamath NWR, followed by draining these lands in the late winter and early spring. Deliveries to the Project during the fall/winter would be regulated by the UKL Control operation.

Deliveries to the Lower Klamath NWR from December-February include 11,000 AF from UKL.

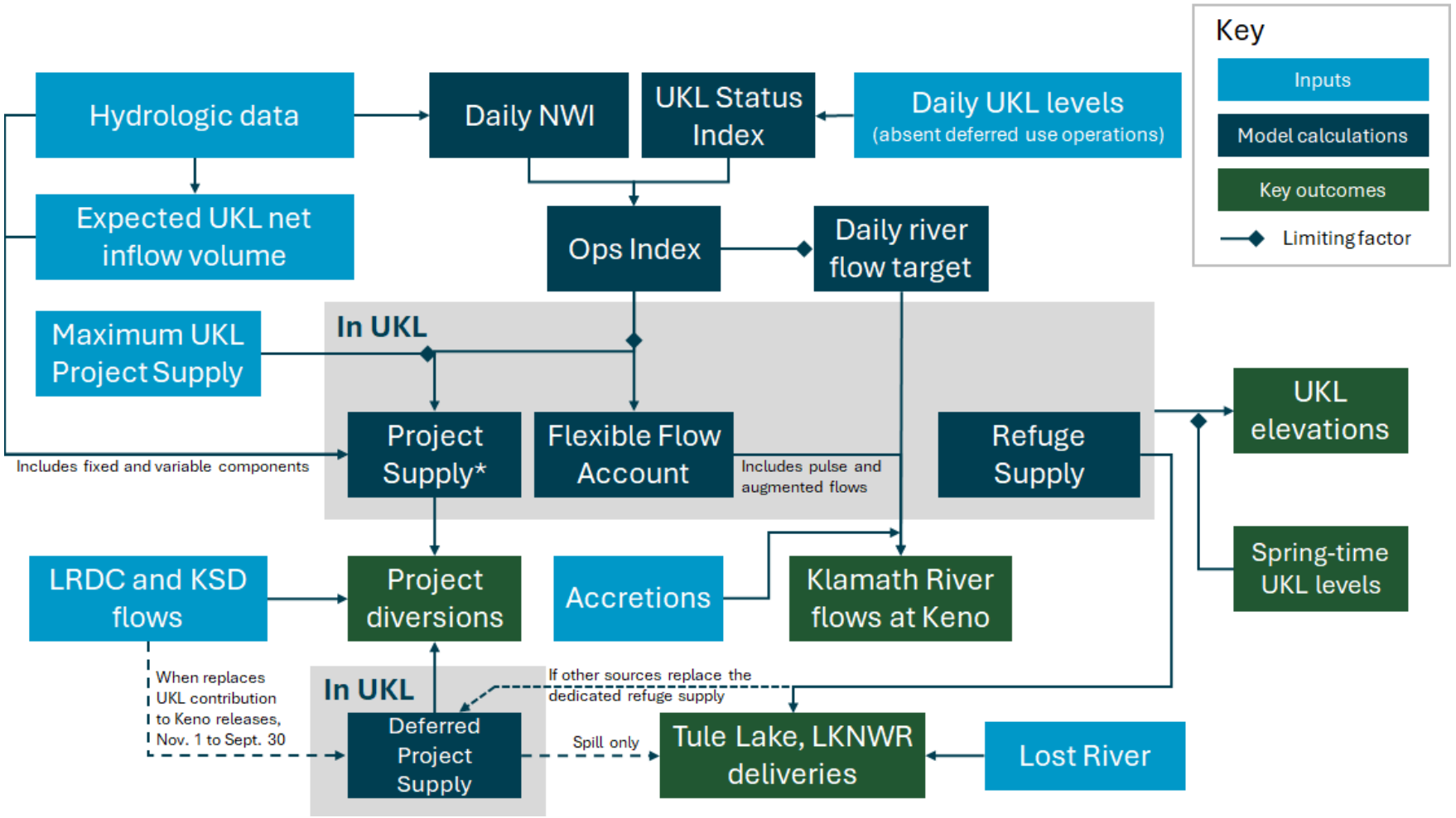
2.4 Proposed Action Alternative

The Proposed Action Alternative reflects a revised UKL operational approach. Figure 2-2 provides a conceptual overview of the Proposed Action Alternative, and the following sections provide more detail.

A Technical Team was convened in August 2023 to explore and evaluate the technical aspects of potential water management strategies that had been simulated using the KBPM. Two strategies had been simulated before the team was convened: the 2020 IOP and the Keno Release Model (KRM). Because the 2020 IOP had been the basis for operations for several years, the strengths and weaknesses of that water management strategy were well understood. In contrast, Reclamation had recently developed the KRM to improve the IOP approach to water management.

Over the next five months, the Technical team discussed many issues, modifying or confirming various KRM model settings, and making structural changes to the KRM's water management strategies to produce the Proposed Action Alternative. Some of these changes included:

- Use of the Flexible Flow Accounting (FFA) operations;
- Simulation of non-prescriptive pulse flow operations relying on the FFA volume;
- Use of the Deferred Project Supply operations;
- Operational changes that largely eliminate the reliance of targeted Klamath River flows on Lost River water, thereby retaining as much Lost River water as possible in the Upper Basin and providing flexibility to the interactions between Project irrigation and the refuges;
- Explicit simulation of the sumps in the Tule Lake NWR, the units within the Lower Klamath NWR, and D Plant operations that allow for water movement from the Tule Lake NWR to the Lower Klamath NWR;
- Water accounting changes for KDD diversions resulting in use of March-September as the spring/summer period in which diversions use Project Supply, and October-February as the fall/winter period when diversions are accounted towards their winter water right;
- Reducing estimated KDD returns from the KSD, better accounting for KDD tailwater reuse operations;
- Capping simulated Project irrigation diversions to prevent them from exceeding historical demand;



Notes:
*For more details on the Project Supply calculation, see Section 2.4.1.

CNRFC = California Nevada River Forecast Center
LKNWR = Lower Klamath National Wildlife Refuge
LRDC = Lost River Diversion Channel
NRCS = National Resource Conservation Service
NWI = Normalized Wetness Index
UKL = Upper Klamath Lake

Figure 2-2. Conceptual overview of Project management under the Proposed Action Alternative.

- Maintenance of Sump 1A in Tule Lake NWR and Unit 2 in Lower Klamath NWR to provide water for use by endangered suckers, using water from UKL when Lost River water is unavailable, and storing water for Project use under Deferred Project Supply operations when use of Lost River water offsets the need for UKL water; and
- Including reconnection of the Agency Lake and Barnes units of the Upper Klamath NWR (ALB) to UKL.

Because the four hydroelectric dams on the Klamath River downstream of Keno Dam were removed in 2024, the downstream-most point for measuring compliance of minimum flows required by NMFS in the Klamath River under the Proposed Action Alternative is at the streamflow gage downstream from Keno Dam. When a specific flow is to be provided at the Keno gage, operators calculate the releases from UKL that are necessary to provide that flow, considering the amount of water entering or leaving the river reach between the Link River and Keno gages.

In contrast to the No Action Alternative, the Proposed Action Alternative would use a consistent year-round operational strategy for making water management decisions. This strategy would continuously track the hydrologic conditions in the Upper Klamath Basin using the daily NWI and water storage conditions in UKL using the UKL Status Index. These two indices would be averaged to generate a single Operations Index, which would be used to distribute water among the various uses relative to conditions of basin hydrology and UKL storage. (See Box 3 for definitions of additional key terms.)

Box 3. Additional Key Terms

Normalized Wetness Index (NWI): a relative measure of water availability in the Upper Klamath Basin. This index ranges from zero (driest) to one (wettest).

UKL Status Index: a relative measure of the deliverable water volume in UKL absent deferred use operations. This index ranges from zero (least storage) to one (greatest storage).

Operations Index: average of the NWI and the UKL Status indices, used to distribute water among various uses. This index ranges from zero (driest, least storage) to one (wettest, greatest storage).

Flexible Flow Account (FFA): water volume accrued in UKL by deferring use during fall/winter for use in March-June as pulse or augmenting flows. The volume depends on the Operations Index.

The daily NWI would incorporate real-time information on recent UKL net inflows, the amount of water in the snowpack, recent precipitation, precipitation over the prior 3 years, and indices that track conditions in the Pacific Ocean affecting the local weather. It would do this in a way that tracks with the future UKL net inflow volume over the next 90 days. When hydrologic conditions are drying out, the daily NWI would approach a value of zero, and when conditions are getting very wet, the NWI would approach one. Because the daily NWI would be calibrated to the conditions experienced over the water years from 1991 through 2022, when the NWI is zero, conditions would be the same as the driest condition experienced from 1991-2022, and when it is one, conditions would be the same as the wettest condition experienced from 1991-2022.

The UKL Status Index would track the amount of the deliverable volume (i.e., above 4,136.0 ft, Reclamation datum) that would be in UKL if the deferred use operations (Box 4) for Klamath River flows and Project irrigation were not occurring. By using carefully crafted water accounting structures (both within the model and in real-time operations), the deferred use operations would track what

UKL levels would be in the absence of the deferred uses, while other portions of the model would continue to track UKL levels that include the effects of the deferred uses. The UKL Status Index would be calculated by normalizing the daily UKL levels simulated in the absence of the deferred uses using the highest and the near-lowest (fifth percentile) UKL levels from water years 1991-2022. Use of the fifth percentile UKL levels would cause the UKL Status Index to be zero when the UKL level declines to that level and would remain at zero if the levels drop even lower. When the daily UKL Status Index approaches zero, UKL storage in the absence of deferred uses would approach the near-lowest amount that was seen on that day of the year when simulating the outcomes of the Proposed Action Alternative, and when it approaches one, UKL storage would approach the largest volume simulated for that day of the year.

Box 4. About Deferred Use Operations

Deferred use operations are those in which water is retained in UKL for a specific future use. Deferred use operations include the FFA (for future releases to the Klamath River) and Deferred Project Supply (for future Project diversions).

Deferred use operations create more operational flexibility during the irrigation season and increase UKL levels during the biologically important spring months.

Because the Operations Index is the average of daily NWI and the daily UKL Status Index, dry, low storage conditions would be indicated as the Operations Index approaches zero, and wet, high storage conditions would be indicated as the Operations Index approaches one. Daily values of the Operations Index would drive many of the water management decisions year-round in the Proposed Action Alternative.

Because the UKL Status Index, and by extension the Operations Index, would be determined after removing the effects of the deferred use operations, the Operations Index would be unaffected by either the accrual or the use of the deferred water volumes. As a result, none of the decisions based on values of the Operations Index would change in response to how the deferred use volumes are accrued or used. In other words, the deferred use operations for the Klamath River would not affect water availability for Project irrigation, and water availability for Project irrigation would not affect deferred use operations for the Klamath River. As deferred use volumes are accrued, UKL levels increase above what they would otherwise have been, a difference that begins to decrease as the deferred volumes are used and ultimately disappears when the full deferred volumes are used up.

Under the Proposed Action Alternative, throughout the year, consistent logic would be used to set targeted flows for the Klamath River at the Keno gage compliance point (contrasting with the No Action Alternative, which would use three distinctly different seasonal strategies to determine targeted river flows). First, river base flows would be set for each day of the year. These base flows range from 650 to 1,000 cfs depending on the day (see Appendix C in Reclamation (2024a)), and targeted flows would not fall below these base flows. A multiple of the daily base flow would then be added to each daily base flow to determine the river flow target for each day. The multipliers would vary by month, and within each month they would generally increase as the Operations Index increases. If a multiplier is zero, then nothing would be added to the river base flow, which would then become the targeted flow. When conditions are wet with high storage (i.e., a high Operations Index), a multiplier may in some months be five (for example), which would mean that the targeted flow would be the river base flow plus five times the river base flow. In such a case, the targeted flow would be 6,000 cfs if the

river base flow were 1,000 cfs. Because the magnitude of the multiplier would be determined by the magnitude of the Operations Index, river flow targets on each day of the year would be simultaneously governed by the hydrologic condition of the upper basin and the storage status of UKL.

Under the Proposed Action Alternative, a FFA operation would defer use of some water during fall/winter, storing the accumulated volume in UKL during the October – March 1 accrual period, for release to the Klamath River in spring/summer. The volume accrued in the FFA would also be regulated by the Operations Index and could be spilled from UKL if lake levels reach the flood release threshold. During March 2 – June, the stored FFA water would be used in a manner that could vary each year, for example in the form of a pulse flow or to augment flows over an extended period. Because the FFA is by design intended to be non-prescriptive, the frequency, intensity, and duration of pulse flows are not specified in the Preferred Action Alternative and thus cannot be quantitatively compared to the prescribed flushing flows included in the No Action Alternative.

2.4.1 Upper Klamath Lake Project Supply Calculations

Under the Proposed Action Alternative, water available for irrigation use from UKL would be a combination of a fixed volume from UKL storage, fixed and variable volumes from UKL net inflows, and supply from deferred use operations. Sections 2.4.1.1 and 2.4.1.2 provide an overview of the UKL Project Supply calculations under the Proposed Action Alternative, including the dates when these values are generated.

2.4.1.1 Fixed and Variable Components

Under the Proposed Action Alternative, the allocation process would begin on March 1, when a proportion (the Project share, determined by the Operations Index) of the divertible volume above 4,138.8 ft in UKL[7] on the last day of February is added to the same Project share of the 50th percentile forecast of April-September UKL net inflows, producing a provisional Project allocation. Moving through the spring months, the proportion of different volumes that would be available to irrigators would fluctuate based on the value of the Operations Index. The first fixed component of the Project allocation would be established on April 1 as a proportion of the divertible volume above 4,138.8 ft in UKL on March 31.

Under the Proposed Action Alternative, determining the fixed and variable portions of the irrigation allocation from future net inflows into UKL would be complex, but this complexity would help manage the consequences of forecast error. This process (summarized in Table 2-1) would revolve around estimates of the expected net inflow (ENI) into UKL over the April through September period. The 5th percentile forecasts are conservative because it is very unlikely that actual inflow would be less than forecasted, and it is very likely that inflows would exceed the forecast (Section 2.2). On the other hand, the 50th percentile forecast has an equal chance that the actual inflow will be higher or lower than forecasted. The 50th percentile forecast will always be a larger volume of water than the 5th percentile forecast, but this larger forecast comes with a larger chance of being an over-forecast.

Because it is important that irrigators know as early as possible the volume that can be relied upon for irrigation, the Project share of the conservative 5th percentile forecast of April through September net

[7]The elevation of 4,138.8 ft represents the end-of-season minimum UKL elevation target in the Proposed Action Alternative. The elevation of 4,138.8 ft is set as a reasonable level that, in the event of a significant over-forecast of UKL net inflow (which is used to determine the Project allocation from inflow), is not likely to result in an end-of-season UKL level that is unacceptable for biological reasons or that would unacceptably reduce the likelihood of winter refill.

UKL inflows, as estimated on (ENI5) on April 1, would become the provisional Project allocation from net inflows. On April 15, the ENI5 would be updated to use the actual observed net inflow volume from April 1-14 plus the 5th percentile forecast of net inflows for the remainder of the season (i.e., from April 15 through September). The resulting ENI5 would represent the final, fixed allocation for irrigation from UKL net inflows. In other words, as of April 15, the irrigators would know that they could rely on the volume allocated to them on April 1 from UKL storage plus their share of the volume allocated to them on April 15 from future UKL net inflows during that water year.

Table 2-1. Calculation of the fixed and variable Upper Klamath Lake Project Supply elements under the Proposed Action Alternative

Forecast Date	Firm Supply from Storage	Firm Supply from Net Inflows	Variable Supply from Net Inflows
1-Mar	Provisional calculation: Project share of UKL storage above 4,138.8 ft on last day of February	Provisional calculation: • Project share of 50% exceedance net inflow forecast for April through September	
1-Apr	**Final calculation:** Project share of UKL storage above 4,138 ft on March 31	Provisional calculation: • Project share of April 1 ENI5	Provisional calculation: • Difference between Project share of April 1 ENI50 and Project share of April 1 ENI5. Adjusted up or down depending on whether April 1 net inflow is higher or lower than expected. Provisional calculation: • Difference between Project share of ENI50 on forecast date and Project share of April 15 ENI5. Adjusted up or down depending on whether net inflow volume since April 1 is higher or lower than expected.
15-Apr		**Final calculation:** • Project share of April 15 ENI5	[same as 1-Apr above]
1-May			[same as 1-Apr above]
15-May			[same as 1-Apr above]
1-Jun			**Final calculation**: • Difference between Project share of ENI50 on June 1 and Project share of April 15 ENI5. Adjusted up or down depending on whether net inflow volume since April 1 is higher or lower than expected.

Although the fixed supply available from net inflow is known on April 15, it is likely that more inflow will be available, and this is where the variable component of the irrigation supply plays a role. Under the Proposed Action Alternative, the 50th percentile forecast of UKL net inflows from the forecast date through September would be added to the observed UKL net inflow since April 1 to estimate the ENI50. The variable component of the irrigation supply would be calculated by taking the Project's share of the ENI50 volume, subtracting either the provisional allocation from the April 1 ENI5 or the fixed allocation from the April 15 ENI5, and adjusting the resulting volume up if net inflows since April 1 have been higher than expected, or down if the opposite is true. This component of irrigation supply is variable because it can go up or down each time the UKL net inflow forecast is updated. On June 1, the variable component of the irrigation supply would be calculated for the last time and added to the fixed allocation from storage and inflow from April 15.

On each forecast date (the first and fifteenth of each month from April through June 1) the Project Supply from UKL is the sum of the fixed and variable components, until all are fixed on June 1. Some volume may also be available on these dates from the Deferred Project Supply operation (Section 2.4.1.2).

2.4.1.2 Deferred Project Supply

To the extent that water from the Lost River (through the LRDC) or from Project returns (through the KSD) contribute to targeted releases from Keno Dam for the Klamath River, unless either Keno Dam or Link River Dam are spilling, there would be an equivalent decrease in releases from Link River Dam, and the volume would be stored in UKL as a Deferred Project Supply. In addition, when another water source can replace some of the volume dedicated from UKL for maintaining Tule Lake sumps and Unit 2 in the Lower Klamath NWR, the replaced volume would accrue to the Deferred Project Supply. Accruals to the Deferred Project Supply would be allowed from November 1 through September 30, and it would be used during the irrigation season.

2.4.2 Spills

When spills from UKL occur, the accrued volumes of the deferred use operations would be spilled: first the Deferred Project Supply and then the FFA. When UKL levels approach the flood release curve and spills are likely, operators would spill some or all of the Deferred Project Supply to the NWRs. Some of that water may subsequently be used for Project irrigation (Section 2.4.3). Spill from the FFA would be designated for the Klamath River.

2.4.3 National Wildlife Refuge Supplies

Under the Proposed Action Alternative, water for the Tule Lake and Lower Klamath NWRs would come from any or all of the following sources:

- A dedicated supply from UKL;
- Spill of Lost River water;
- Spill of Deferred Project Supply; and
- Spill from UKL.

In particular, under the Proposed Action Alternative, UKL would supply up to 43,000 AF to maintain the Tule Lake sumps and Unit 2 in the Lower Klamath NWR from April through October. When other sources replace some of this volume, the balance would accrue to the Deferred Project Supply. This additional supply was developed in coordination with the Services in order to provide benefits to habitats in these refuges and to support ESA-listed suckers occupying them.

In the event of spills, these refuges may receive water from other sources. Lost River water could be allowed to flow over Wilson Dam into the natural channel of the Lost River and from there to the Tule Lake NWR. If the Tule Lake sumps reach capacity, the D Plant could pump water into the Lower Klamath NWR. If the Tule Lake sumps are at capacity and UKL approaches flood release levels, Lost River water could be diverted into the LRDC and re-diverted to the Lower Klamath NWR via the Ady Canal.

If Deferred Project Supply spills, either refuge may divert the water. After all the volume has spilled from the Deferred Project Supply and the FFA, the refuges could divert water that spills from UKL.

2.4.4 Adaptive Management

Within the Adaptive Management activity of the Proposed Action Alternative, Reclamation intends to implement a structured decision making framework to establish a formal, transparent, and collaborative process to develop quantifiable and measurable objectives and determine the best alternatives to meet those objectives using quantitative models. Decision models represent how actions would improve populations and conditions for ESA-listed species in the Klamath Basin watershed. Reclamation intends to establish a science-based, collaborative team to recommend Reclamation consider actions and expected effects. KBAO will use structured decision making as the process to transparently and collaboratively gather and analyze data associated with Project operations described in the 2024 Biological Assessment (Reclamation, 2024a). Further, Reclamation intends to adaptively manage those actions through a combination of evaluating current and future data and external expertise to support structured decision making. The process has been historically successful in developing a clear understanding of complex interactions of Reclamation's water management action on rivers, waterbodies, and the fish and wildlife that depend on them, and in providing guidance for investment in management actions and restoration efforts.

2.5 Alternatives Considered but Eliminated from Further Consideration

In developing the Proposed Action Alternative, Reclamation assessed other alternatives, which included a range of potential alternative flow regimes, modeling adjustments, alternative operational methods, and timeframes. Through implementation of this screening effort, Reclamation retained components to establish a reasonable range. Each criterion was considered consecutively, so if a component was screened out after an earlier criterion, it was not compared to the subsequent criteria.

2.5.1 Screening Criterion # 1, Purpose and Need

If an alternative was inconsistent with Section 1.1, Purpose and Need for Action, then it was not considered further. These include meeting legal requirements, satisfying Reclamation contractual obligations, and meeting Tribal Trust responsibilities.

2.5.2 Screening Criterion # 2, Completeness

This screening criterion focuses on whether the recommend suggestion for an alternative or component is sufficiently complete, or sufficient information is available and can be analyzed through quantitative or qualitative means. If a suggested alternative or component is determined to be substantially incomplete, then it was not considered further.

2.5.3 Screening Criterion # 3, Technically and Economically Feasible

Technically and economically feasible components or alternatives are capable of being provided: (1) through technology that is readily available and has been demonstrated in actual operating conditions (not simply through tests or experiments) to operate in a workable manner; and (2) in a manner that does not require relatively large financial investments for relatively minor or unproven benefits. If an alternative is determined to be technically and economically infeasible to implement, then the alternative would not meet this screening criterion and was not considered further.

2.5.4 Screening Criterion # 4, Value Added

This criterion refers to suggested alternatives or components that may be considered unnecessary because similar or better performance in terms of resulting impacts is likely from a different or simpler configuration. Comments that suggest alternative actions that result in greater complexity in implementation with same or greater potential impacts on resources analyzed, would be removed from further consideration.

2.5.5 Screened Alternatives

2.5.5.1 Resource Agency Alternative

A joint request from the Services that was initially focused on providing adequate Klamath River flows, including pulse flows and specified River Base Flows, reconnecting ALB to UKL, and evaluating FFA operations and deferred Project Supply operations was considered. This alternative was eliminated from further consideration based on Screening Criterion #4, Value Added. This alternative resulted in greater complexity in implementation with same or greater potential impacts on resources analyzed. However, this effort did lead to additional changes incorporating Tule Lake NWR, Lower Klamath NWR, and D Plant into the KRM, making maintenance of Sump 1A and Unit 2 in the refuges part of the Deferred Project Supply operations with some supply coming from UKL being incorporated into the modeled Proposed and No Action alternatives. Many of the changes listed above were incorporated into the Proposed Action Alternative.

2.5.5.2 Tribal Alternative A

A series of exploratory runs were requested by a Yurok Tribe representative that included a range of flushing flows for the Klamath River varying with hydrology (smaller when dry, larger when wet), spring/summer and fall/winter Project irrigation uses also variable depending on hydrology (sized to produce specific end-of-September UKL levels), 6 thousand acre-feet (TAF) minimum delivery to Lower Klamath NWR, maximizing retention of Lost River water within the Project footprint, and ALB reconnected to UKL. These runs required structural changes to the KRM as well as extensive rebalancing. This alternative was eliminated from further consideration based on screening criterion Screening Criterion # 2, Completeness. While progress was made, the alternative description did not incorporate sufficient information to complete an environmental analysis. Ultimately, many elements of this alternative came to be integrated into the Proposed Action Alternative as part of the Collaborative Process, rendering this alternative moot.

2.5.5.3 Tribal Alternative B

A run was requested by a representative of the Karuk Tribe in which retention of Lost River water within the Project footprint would be maximized, no Project deliveries would be made, ALB would be reconnected to UKL, and Link River Dam gates would be wide open with the natural reef that once controlled UKL levels restored. This run was simple to simulate, so it was done and presented to the Technical Team. This alternative was eliminated from further consideration based on Screening Criterion # 1, Purpose and Need. The alternative did not meet the Purpose and Need, in this case, no Project deliveries.

2.5.5.4 Irrigator Alternative A

A run was requested by a representative of the Project irrigators in which river base flows would be reduced by 150 cfs across all months, Project shares would be manipulated to result in water

availability for Project irrigation from all sources of 220-370 TAF (as low as 200 TAF in the driest years), and Klamath River and UKL level outcomes would be rebalanced to accommodate the changes in availability of water for irrigation. This run, designed to prioritize consistency with state water law, required extensive rebalancing but was finished and presented to the Technical Team. This alternative was eliminated from further consideration based on screening criterion Screening Criterion # 1, Purpose and Need. While progress was made, the alternative description did not meet the legal requirements as stated, such as consistency with federal requirements and the needs of listed species.

2.5.5.5 Alternative 5

A run was requested by a representative of the Project irrigators that was extremely detailed. Its stated purpose was "to evaluate KID's[8] ALT KID FLOW THROUGH MODEL % of NET INFLOW proposed action … to fulfill non-discretionary obligations, Oregon water law and comply not to create jeopardy for the endangered C'waam [Lost River Sucker], Koptu [Shortnose Sucker], or threatened Coho Salmon while they traverse the Klamath River." This alternative included a focus on the preeminence of water rights, no specific flow requirements for the Klamath River, consideration of UKL water levels needed for shoreline spawning of suckers, a fall/winter flow through operation from UKL to Tule Lake NWR to Lower Klamath NWR to the Klamath River (for refuge and water quality benefits), setting Keno Dam gates to a specified elevation approximating that of the natural reef, assumed 80% of historical daily average rates of consumptive use at Project diversions, ALB reconnection to UKL, storage in UKL of specified percentages of cumulative net inflow into UKL for the water year, and potential availability of water for ecosystem purposes conditioned by federal requests for water either granted by the Klamath Irrigation District or the purchase of stored water from Project irrigators. Simulation would require extensive structural and operational modifications to the KRM, which could not be completed within the time available to complete environmental compliance within a timeframe that would allow the continued legal operation of the Project. This alternative was eliminated from further consideration based on Screening Criterion # 1, Purpose and Need. The alternative did not meet the legal requirements as stated, such as preeminence of water rights, the requirements of the Environmental Assessment, and conditioning availability of water on Klamath Irrigation District approval or purchases.

2.5.5.6 Other Exploratory Alternatives

In addition to the recent alternatives discussed above, a series of meetings in 2020 and 2021 led by the Yurok Tribe solicited feedback on potential planning model improvements and suggested potential scenarios for modeling. Three distinct exploratory scenarios were modeled, one for each of the major factions involved: the downstream Klamath River interests, the UKL interests, and the irrigation community. These were labelled as "bookends." The intention behind them was not to pursue any of these further but rather to demonstrate the effects if each of the three groups got their ideal situation for the river, the lake, and agriculture. These alternatives were eliminated from further consideration based on Screening Criterion # 1, Purpose and Need (either because of no Project deliveries or failure to meet legal requirements and Tribal Trust responsibilities).

[8] Klamath Irrigation District

3 Affected Environment

3.1 Watershed Setting

This Environmental Assessment evaluates natural resources within the Project Area and downstream of Project operations (Figure 1-1). The Project Area falls within the Klamath River Basin (Figure 1-2). The Basin's climate varies by location. In Oregon, it falls principally within the Eastern Cascades Slopes and Foothills ecoregion and is characterized by warm, dry summers and cold winters, with annual precipitation averaging 649 mm (25.5 inches). In California, the Klamath River Basin falls mainly in the Klamath Mountains ecoregion, which features a mid-latitude Mediterranean climate and annual average precipitation of about 1,438 mm (56.6 inches). Like the western United States overall, between the mid- and late-20th century, the Klamath River Basin has experienced a general decline in spring snowpack, reduced precipitation falling as snow, and increases in temperatures (KRBSTWG, 2016).

3.2 Water Resources

Surface waters within the geographic scope of this Environmental Assessment include UKL, the Link River, the Klamath River, Clear Lake Reservoir, the Lost River, Gerber Reservoir, Tule Lake, and three NWRs that are highly dependent on Project operations for surface water inputs.

3.2.1 Upper Klamath Lake

UKL is the largest lake in Oregon by surface area and receives the majority of its water from the Williamson, Wood, and Sprague rivers. Inflows to UKL have been declining. Between 1981 and 1990, the mean annual net inflow to UKL was approximately 1,400,000 AF; however, annual net inflows between 2011 and 2020 averaged about 1,000,000 AF and decreased further in 2021 and 2022 (Reclamation, 2024b).

The Oregon Department of Environmental Quality (ODEQ) has completed Total Maximum Daily Loads (TMDLs) for UKL due to impairments in pH, dissolved oxygen (DO), and chlorophyll-a (nuisance phytoplankton growth) (ODEQ, 2002). ODEQ has identified total phosphorus as the target pollutant to address these impairments and has set a goal of 40% reduction in external loading. UKL elevations and outflows are controlled by the Link River Dam, which regulates water releases into the Link River. The Link River flows from the UKL into the Klamath River. Due to its short length and the limited travel time, water quality in the Link River generally follows conditions in UKL (Reclamation, 2019b).

3.2.2 Klamath River

The Klamath River begins at the outlet of the Link River and flows approximately 253 miles through southern Oregon and northern California to the Pacific Ocean. The river has a natural drainage area of approximately 12,700 square miles (excluding the Lost River watershed). The first 2 miles of the river form a broad, flat body of water known as Lake Ewauna. Water levels remain relatively constant from Lake Ewauna downstream through the Keno Impoundment approximately 18 miles to Keno Dam, which had been owned and operated by PacifiCorp; transfer of ownership and operational responsibilities to Reclamation occurred in July 2024. Downstream of Keno Dam, the Klamath River

enters a narrow canyon where it descends approximately 1,550 ft over the next 40 miles (Reclamation, 2019b). Four hydroelectric dams (J.C. Boyle, Copco No. 1, Copco No. 2, and the IGD) previously operated by PacifiCorp were located along this reach between river miles 224 and 190. In November 2022, the Federal Energy Regulatory Commission allowed the license for these dams to be transferred to the states of California and Oregon and to the nonprofit Klamath River Renewal Corporation (KRRC) as co-licensees to carry out removal of the dams (FERC, 2022b). The Copco No. 2 Dam was removed in 2023. Removal of the three remaining dams is occurring in 2024 (California Natural Resources Agency, 2022).

ODEQ has completed TMDLs for the Klamath River and its tributaries due to impairments in temperature, ammonia toxicity, pH, DO, and chlorophyll-a (ODEQ, 2002). ODEQ has identified total phosphorus, total nitrogen, biological oxygen demand, and external thermal loading as the target pollutants to address these impairments. Releases from the hypereutrophic UKL are the primary cause of impaired water quality in the Upper Klamath River, and nutrient loads from the Upper Klamath River have also contributed materially to elevated nutrient levels in lower reaches of the river. The effect of upstream temperatures is also estimated to be leading to significant temperature increases downstream of Keno Dam.

3.2.3 Lost River

The Lost River System—including Clear Lake, Gerber Reservoir, and Tule Lake—historically functioned as a largely closed basin. However, human intervention in the early 1900s connected the Lost River System to the Klamath River system through the LRDC, regulated by the Lost River Diversion Dam. In addition to the Lost River Diversion Dam, three dams also operate on the mainstem of the Lost River: Malone Diversion Dam, located 12 miles downstream of Clear Lake, diverts water for irrigation purposes in Langell Valley. Harpold Dam, located approximately 3 miles west of the town of Bonanza, regulates upstream water levels to facilitate pumping from the river for irrigation purposes in Yonna Valley. Anderson-Rose Dam, 4 miles upstream from the terminus of the Lost River at Tule Lake, also diverts water from the Lost River (Reclamation, 2019b).

Gerber Reservoir provides storage for irrigation and reduces flow into the reclaimed portions of Tule Lake. Miller Creek, a tributary of the Lost River, extends from the Gerber Reservoir to the Lost River. The Miller Creek Diversion Dam is located on Miller Creek 8 miles below Gerber Dam and diverts water to serve lands in Langell Valley. Clear Lake Reservoir provides irrigation water for the Langell Valley (Reclamation, undated).

Water quality in portions of the Lost River and some of its tributaries is impaired. ODEQ and the U.S. Environmental Protection Agency have completed TMDLs to address impairments in pH, DO, ammonia toxicity, temperature, and chlorophyll-a (ODEQ, 2002; USEPA, 2008). Pollutants identified as causing impairments to these river systems are total phosphorus, total nitrogen, biological oxygen demand, and external thermal loads.

Clear Lake's water quality is generally better than that of UKL, with higher DO levels and no detectable microcystin toxin[9] (Burdick *et al.*, 2015). Gerber Reservoir, which provides storage for irrigation, is impaired by temperature and harmful algal blooms (ODEQ, 2022). Tule Lake, located within the Tule Lake NWR in California, has been hydrologically connected to the Klamath River via

[9] These toxins are released by some types of algae when they are present in large quantities (blooms) and can be harmful to aquatic and human life.

the P Canal and the KSD through the Lower Klamath NWR. Tule Lake and the Lower Klamath NWRs are on California's 303(d) list of impaired waters for pH (SWRCB, 2021).

3.2.4 Groundwater

Groundwater plays a significant role in the Upper Klamath Basin's hydrology. The Basin's volcanic bedrock contains an extensive groundwater system that is replenished by tributary runoff and recharge from surrounding uplands (Gannett *et al.*, 2012). Groundwater, used to supplement surface water supplies for the Project, has seen a marked increase in pumping between 2000 and 2014, increasing from about 28,600 AF per year before 2001 to rates as high as 128,740 AF per year in 2010 (Gannett *et al.*, 2012; Gannett and Breen, 2015). During this period, groundwater levels in and around the Project have declined by about 10 to 25 ft, due in part to the increased pumping (Gannett and Breen, 2015).

Regulation of groundwater use differs between Oregon and California. In Oregon, the Oregon Water Resources Department (OWRD) monitors and regulates impacts to groundwater,[10] enforcing limits to protect groundwater resources. In California, the Sustainable Groundwater Management Act aims for sustainable groundwater use, requiring the establishment of Groundwater Sustainability Agencies and Groundwater Sustainability Plans. The Tule Lake Subbasin, subject to Sustainable Groundwater Management Act regulations, has developed a Groundwater Sustainability Plan to manage groundwater sustainably (MBK Engineers, 2021).

Management of water resources in the Upper Klamath Basin requires collaborative efforts among various stakeholders, including federal, state, and Tribal agencies; water users; and conservation groups. Sustainable management practices, coupled with effective regulations and monitoring, are essential to ensure the long-term health and viability of the region's water systems. Ongoing research and adaptation to changing environmental conditions (Section 3.7) are crucial for mitigating future challenges and preserving the Upper Klamath Basin's water resources for future generations.

3.3 Biological Resources

The water resources described in Section 3.2 provide habitat for multiple aquatically linked species, not only within the identified surface waters but also in adjacent in aquatically linked areas (e.g., hydrologically linked wetlands and riparian areas). Multiple species in these areas have high cultural, recreational, commercial, and/or conservation importance. Because an adequate and timely quantity and quality of surface water is essential for these species' survival, this Environmental Assessment carefully considers the potential impacts of the Proposed Action and No Action alternatives on these resources. The following sections focus on federally listed aquatic species, migratory birds, and wetland/riparian areas. Terrestrial species, including the Monarch Butterfly (*Danaus plexippus*, a candidate species for ESA listing) and the endangered Applegate's Milk-Vetch (*Astragalus applegatei*), are not discussed because Reclamation has determined that the Proposed Action and No Action alternatives would not differentially affect such species.

[10] Reclamation funds OWRD to monitor groundwater levels within the Project boundary (Fish and Ahlquist, 2024).

3.3.1 Federally Listed Aquatic Species

The Klamath River Basin provides habitat for a number of federally listed aquatic species. Both the Upper and Lower Klamath Basin provide habitat for the threatened Coho Salmon (of the Southern Oregon/Northern California Coast [SONCC] Evolutionary Significant Unit [ESU]), and threatened Bull Trout (*Salvelinus confluentus*). In the Upper Basin, species include endangered Lost River and Shortnose suckers. The Oregon Spotted Frog (*Rana pretiosa*) also has critical habitat designated in the Upper Klamath Basin. The Lower Klamath Basin supports additional federally listed aquatic species that may be affected by Project water management practices. These include: the endangered Eulachon (*Thaleichthys pacificus*, Southern District Population Segment [DPS]) and threatened Green Sturgeon (*Acipenser medirostris,* Southern DPS). Endangered killer whales (*Orcinus orca*, Southern Resident DPS [SRKW]) make use of the ocean waters offshore and rely on Chinook Salmon for their diets and are therefore considered in this Environmental Assessment. All of these species are affected by Project water management practices (KRBSTWG, 2016).

3.3.1.1 Lost River Suckers

Endemic to the Klamath River Basin, Lost River Suckers are long-lived obligate lake dwellers. At present, the Upper Klamath Basin contains three spawning subpopulations of these fish. One subpopulation spawns upstream of the UKL in the Williamson and Sprague rivers, and a second subpopulation spawns in areas of groundwater upwelling along the eastern shore of UKL (Hewitt *et al.*, 2018). The third spawning subpopulation resides in Clear Lake Reservoir and is extremely small (Hewitt *et al.*, 2021).

Gilbert (1898) identified the Lost River Sucker as "the most important food-fish of the Klamath Lake region… running up the rivers in incredible numbers." Populations have declined greatly in the intervening years, and in 1988 the species was listed as endangered under the ESA (53 FR 27130). Lost River Suckers have been aged up to 52 years of age, and while annual survival is generally high (70-90%) for adult suckers in their prime, meaningful recruitment for Lost River Suckers in UKL has not occurred since the early 1990s, such that between 2001 and 2020, the abundance of Lost River Suckers declined by 75-80% (Krause *et al.*, 2023). Preliminary data on current population trends indicate extremely rapid declines for both populations of Lost River Suckers in UKL; ~60% fewer Lost River Suckers made spawning migrations into tributaries or to shoreline spawning grounds in 2024 than in 2023, indicating a sharp decline in both populations (*pers. com.*, USGS Klamath Falls Field Station, May 23, 2024 Reclamation Hydro Update). These data suggest that senescence is occurring at a rapid rate in UKL (pers.com., USGS KFFS, Reclamation, 2024c). Almost none of the fish hatching in cohorts after the early 1990s have survived to adulthood (Hewitt *et al.*, 2018) due to very high mortality within the first year or two of life. Causes of juvenile sucker mortality in UKL include disease, parasites, poor water quality, and predation from fish and birds (Burdick *et al.*, 2020).

The dwindling populations of these fish represent a huge loss to the Klamath Tribes, who describe C'waam (Lost River Sucker) and Koptu (Shortnose Sucker), especially the populations in UKL, as essential Tribal treaty resources. Historically, these fish provided the Tribes with subsistence, and both sucker species remain central to the Tribes' ability to maintain and exercise their cultural and spiritual practices, which in turn are critical to the physical and social health of Tribal families and community (Gentry, 2018).

3.3.1.2 Shortnose Suckers

Endemic to the Klamath River Basin, Shortnose Suckers are obligate lake dwellers. Three known breeding populations remain, inhabiting UKL, Clear Lake Reservoir, and Gerber Reservoir, of which the largest remaining population is in UKL. Shortnose Suckers in Clear Lake and Gerber reservoirs are genetically distinct from Shortnose Suckers in UKL (Smith *et al.*, 2020), and Shortnose Suckers in the Lost River Basin are morphologically and genetically similar to the Klamath Largescale Sucker (*Catostomus snyderi*), or a hybrid of the Shortnose Sucker and Klamath Largescale Sucker. Small, probably non-breeding populations have also been identified in other basin waters (National Research Council, 2004; Childress *et al.*, 2019). Evidence of decline in the population led to the 1988 listing of the species under the ESA (53 FR 27130). Shortnose Suckers have been aged up to 30 years of age, and while annual survival is generally high (70-90%) for adult suckers in their prime, meaningful recruitment for Shortnose Suckers in UKL has not occurred since the early 1990s, such that between 2001 and 2020, the abundance of Shortnose Suckers declined by 80-85% (Hewitt *et al.*, 2018; Krause *et al.*, 2023). Preliminary data on current population trends indicate extremely rapid declines for Shortnose Suckers in UKL; ~35% fewer Shortnose Suckers made spawning migrations into tributaries in 2024 than in 2023, indicating a sharp population decline within the last year (*pers. comm.*, USGS Klamath Falls Field Station, May 23, 2024 Reclamation Hydro Update). Clear Lake and Gerber reservoirs are experiencing small amounts of consistent recruitment though species genetic identities are unclear (Hewitt *et al.*, 2021).

3.3.1.3 Coho Salmon Southern Oregon/Northern California Coast Evolutionary Significant Unit

An anadromous species, Coho Salmon use the mainstem of the Klamath River for migration, spawning, and rearing, although most spawning occurs in tributaries (National Research Council, 2004). Adult migration and spawning occur from September through January, and juveniles are present year-round (National Research Council, 2004; FERC, 2022a). Once abundant and widely distributed in the study area, the Coho Salmon SONCC ESU was listed as threatened in 1997 (62 FR 24588), and in 2005, the State of California listed Coho Salmon in the Klamath River Basin as threatened under the California ESA (CNDDB, 2023).

Coho Salmon populations in the Klamath River Basin have been severely reduced from historical levels. In the most recent 5-year review, NMFS identified both the Lower and Upper Klamath River populations as having a high risk of extinction and identified the Middle Klamath River population as having a moderate risk of extinction (NMFS, 2016). The species recovery plan (NMFS, 2014) identifies a number of stresses[11] and threats[12] to the different populations within the SONCC ESU. Although these differ by location (i.e., among the Lower, Middle, or Upper Klamath River), stresses include lack of floodplain/channel structure, altered sediment supply, impaired water quality, altered hydrologic function, and fish-passage barriers. Key limiting threats include, but are not limited to, dams/diversions, channelization/diking, agricultural practices, high-severity fire, and disease.

Coho Salmon have been a relatively minor component of the Tribal fishery in the past century but traditionally were smoked and stored for the late winter months (Trihey & Associates Inc., 1996).

[11] Stresses are defined as the physical, biological, or chemical conditions and associated ecological processes that that may impede recovery.
[12] Threats are defined as the activities or processes that have caused, are causing, or may cause the stresses and thus the destruction, degradation, and/or impairment of the species and its habitat.

3.3.1.4 Bull Trout

Bull Trout populations within the coterminous United States were listed under the ESA as threatened in 1999 (64 FR 58910). Critical habitat has been designated for several locations including the Klamath River (75 FR 63898). The Klamath Recovery Unit Implementation Plan for Bull Trout (USFWS, 2015) identifies three core population areas in the Klamath Basin including UKL, Sycan River (a tributary of the Sprague River), and Upper Sprague River (a tributary of the Williamson River, which terminates in UKL). Factors contributing to reduced distribution within this recovery unit are habitat degradation and fragmentation, poor past and present land use practices, water diversions, and past fisheries management practices (USFWS, 2015). In addition, the Bootleg Fire in 2021 is believed to have extirpated Bull Trout from several creeks in the Upper Sprague and Sycan River core areas (USFWS, 2021).

3.3.1.5 Oregon Spotted Frog

The Oregon Spotted Frog was listed under the ESA as threatened in 2014 (79 FR 51658). Critical habitat was designated in 2016 (81 FR 29336) and includes three occupied critical habitat units in the Upper Klamath Basin: The Williamson River unit, the UKL unit (which includes multiple areas north of UKL), and the Upper Klamath unit, which includes a various lakes and creeks in Jackson and Klamath counties. None of these units are within Project boundaries, although the UKL unit could potentially be impacted by the Proposed Action Alternative given its proximity to Agency Lake. The UKL unit has been impacted by invasive plants, woody vegetation plantings and succession, hydrological changes, and non-native predators (81 FR 29336).

3.3.1.6 Chinook Salmon Upper Klamath-Trinity River Basin and Southern Oregon/Northern California Coast Evolutionary Significant Units

An anadromous fish, Chinook Salmon are a species of high importance to Tribes and sport anglers and are the principal prey of the endangered SRKW. Chinook Salmon are commercially fished in the ocean. Chinook are presently protected under the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (MSA; P.L. 109-479), and their identified essential fish habitat includes the Klamath River and other areas. Although some life stages use different parts of the Klamath River system for specific parts of the year, juveniles are present year-round (National Research Council, 2004; PFMC, 2019). Two ESUs that include the Klamath River Chinook—the Upper Klamath-Trinity River Basin ESU and the SONCC ESU—are candidates for ESA listing.

Chinook Salmon population runs are defined by the seasonality of their migration to spawning grounds. Historically (pre-development), the spring-run was the dominant life-history type in the Klamath system; however, for a number of decades, fall-run Chinook Salmon have constituted the vast majority of returning fish (National Research Council, 2004; FERC, 2022a). The Klamath winter-run of Chinook Salmon is considered to be extinct (Nehlsen *et al.*, 1991). Evidence for the declining abundance of Chinook Salmon spans many decades. The reasons for this decline are multiple and have varied over time.

3.3.1.7 Pacific Eulachon Southern Distinct Population Segment

In the Klamath River, Eulachon—an anadromous smelt—were once abundant but have declined to the point that the Southern DPS was listed as endangered in 2010 (75 FR 13012) and was determined to be at a moderate risk of extinction throughout its range. Although the Eulachon spend over 95% of their lives in the ocean (Gustafson *et al.*, 2010), they spawn in freshwater, and critical habitat for the

Eulachon includes the 10.7 river miles of the Klamath River upstream of the Pacific Ocean (76 FR 65324). Eulachon is a Tribal Trust species for the Yurok Tribe (Trihey & Associates Inc., 1996).

The species recovery plan and the latest 5-year review (NMFS, 2017; 2022) performed a threat assessment for subpopulations of the Southern DPS. Those documents identified climate change impacts on ocean conditions as posing the highest threat to the Klamath subpopulation. Dams/water diversions were identified as the second highest-ranked threat, posing a moderate severity level risk overall.

3.3.1.8 Green Sturgeon

Green Sturgeon are a long-lived, anadromous species. NMFS divides this species into Northern and Southern DPSs; fish spawning in the Klamath River Basin are part of the Northern DPS. Although this DPS has not been federally listed, NMFS has identified this DPS as a Species of Concern.

Green Sturgeon in the Klamath River have been documented migrating over 60 miles upstream to spawn (McCovey, 2011), and juvenile Green Sturgeon use the Klamath year-round, remaining in the river until they are 1 to 3 years old (National Research Council, 2004). The Southern DPS, listed as threatened in 2006 (71 FR 17757), does not make direct use of the Klamath River Basin, but its designated critical habitat includes coastal marine areas around the Klamath River estuary, near Klamath, California (74 FR 52300). The greatest threats to the Southern DPS are not associated with the Klamath River but rather include threats to its spawning and rearing habitat elsewhere in California (NMFS, 2018).

Green Sturgeon has cultural importance to Tribes in the Basin: a Tribal fishery for Green Sturgeon continues on the Klamath River in California (CDFG, 2010).

3.3.1.9 Killer Whale Southern Resident Distinct Population Segment

The SRKW was identified as endangered in 2005 under the ESA (70 FR 69903). During part of the year, these whales may travel as far south as central California and as far north as southeast Alaska (Carretta *et al.*, 2023). SRKWs are ecologically linked to inland waterways via their dependence on Chinook Salmon. Overall, Chinook Salmon may be of such importance to SRKWs that the salmon's overall availability plays a role in the whales' population dynamics, including their mortality and reproduction rates (Ford *et al.*, 2010). If Project actions affect Chinook availability—particularly the larger fish that are targeted by killer whales—the Project may have the potential to affect SRKWs.

3.3.1.10 Northwestern Pond Turtle

The Northwestern Pond Turtle (*Actinemys marmorata*) is a candidate species that has been proposed for listing as threatened. Its historical range included portions of Oregon and northern California (88 FR No.190 P. 68370-68399); however, critical habitat has not been proposed at this time. Northwestern Pond Turtles have been observed in the Project from spring to fall, primarily at apparent basking sites in or near aquatic environments. However, knowledge of their distribution, population numbers, terrestrial habitat use, and population dynamics within the Project's boundaries is very limited (Reclamation, 2024a).

3.3.2 Other Aquatic Species

The Klamath Basin contains at least 83 species of fish, 45 of which are native to the Klamath drainage and 38 of which have been introduced (Carter and Kirk, 2008). Upstream of the former IGD, the

Klamath River Basin hosts an estimated 18 native and 19 non-native fish species including several lamprey species, which are of particular importance to Tribes, and also the recreationally important Redband/Rainbow Trout (*Oncorhynchus mykiss newberrii*) (Carter and Kirk, 2008). Downstream of the former IGD, the Klamath River Basin supports 27 native and 19 non-native fish species. Native fish here include several lamprey species, Steelhead/Rainbow Trout (*Oncorhynchus mykiss*), Coastal Cutthroat Trout (*Oncorhynchus clarkii clarkii*), White Sturgeon (*Acipenser transmontanus*), and a number of others (Carter and Kirk, 2008). The following paragraphs provide general life history information on several native fish species of cultural and/or recreational importance.

3.3.2.1 Pacific Lamprey

The Pacific Lamprey (*Entosphenus tridentatus*)'s distribution along the Pacific Coast extends from Alaska to Baja, California. Pacific Lamprey are found throughout the mainstem Klamath River and its major tributaries immediately downstream of the former IGD. Their historical distribution above the IGD site is uncertain. Pacific Lamprey are anadromous, can migrate long distances, and generally show a similar distribution as anadromous salmon and Steelhead (Hamilton *et al.*, 2005). Pacific Lamprey migrate upstream into the Klamath River throughout the year, cease feeding during migration, and die shortly after spawning. They spawn in sandy gravel at the upstream edge of riffles. Lamprey eggs hatch in approximately 2 to 4 weeks, and then the larvae (ammocoetes) drift downstream and burrow into the substrate in backwater areas and feed on algae and detritus. Juveniles remain in fresh water for 5 to 7 years before they migrate to the sea and mature into adults (Moyle, 2002) . They spend 1 to 3 years in the ocean, where they parasitize a wide variety of marine fishes. Their degree of fidelity to their natal streams is low (Goodman *et al.*, 2008; Spice *et al.*, 2012)and can thus use other streams throughout their range.

The Yurok Tribe has strong cultural ties to the Pacific Lamprey and historically has harvested it; and it is a Tribal Trust species (Trihey & Associates Inc., 1996). A 1998 status review (Larson and Belchik, 1998) points to the paucity of quantitative data on Pacific Lamprey populations in the Klamath and other nearby drainages, while qualitative data from interviews with Tribal members document a dramatic decline of the species in the Klamath River. Interviewed Tribal members described this decline as having been gradual and occurring around the late 1980s or earlier (Larson and Belchik, 1998) with a decrease in per person daily catch from 300 to 1,500 to 20 to <100.

3.3.2.2 Redband Rainbow Trout

Redband Trout are an important game fish (Carter and Kirk, 2008) and are widely distributed throughout the Upper Klamath Basin watershed. Resident and/or migratory Redband Trout are present in Klamath River, the major tributaries of Upper Klamath and Agency lakes, and headwater streams of the Gearhart and Cascade mountains. The Klamath River populations were impacted by large dams on the Lower Klamath River (i.e., J.C. Boyle, Copco No.1, Copco No.2, and IGD) and associated impoundments. Very few fish have been documented volitionally moving through fish ladders at these dams. These impacts are expected to abate following dam removal in 2023 and 2024. However, given the observed lack of fish ladder use, Keno Dam and Link River Dam, along with numerous other smaller diversion dams and impoundments in the Basin, will likely continue to impact Redband Trout movement. Redband Trout in the Upper Klamath Basin display both resident and adfluvial life histories, meaning they can use both Upper Klamath Lake and its tributaries to spawn, rear, and migrate.

3.3.2.3 Steelhead Trout

Nearly all Steelhead entering the Klamath River spawn in tributaries located downstream from Seiad Valley (National Research Council, 2004). Adult summer-run Steelhead enter and migrate up the Klamath River from March through June. Adult winter-run Steelhead enter the Klamath River in late summer and fall, migrating and remaining in the mainstem Klamath River through fall and winter. Most Steelhead spawn in tributaries downstream from Seiad Valley. Post-spawning adult Steelhead migrate downstream in the spring to return to the sea, typically from April through May. Steelhead fry emerge from the gravel in the spring, and most spend 2 years in fresh water before going to sea. Juvenile Steelhead rear in the mainstem Klamath River, tributaries to the Klamath, and the estuary. Peak outmigration of Steelhead smolts occurs from early April through mid-June in the Klamath and Trinity rivers, although small numbers of smolts continue to migrate through September in the Trinity River.

In response to precipitous decline of Steelhead, NMFS delineated six DPSs of which the Klamath Mountains Province DPS is the only California DPS not presently listed under the ESA (CDFW, 2016a). The Klamath Mountains Province Steelhead have a high recreational value: California Department of Fish and Wildlife's (CDFW's) Report Card program gathers data on the numbers of Steelhead anglers within California, where they fish, and how successful they are. Data from 2007 through 2014 show that about 178,000 Steelhead were reported caught within the province during this period (CDFW, 2016a). More recently, CDFW found that statewide, Steelhead remain depressed with populations generally faring worse from north to south (Kurth, 2021). Historically, the Yurok Tribe relied on Steelhead, among other fish (Pierce, 1991). The species remains important to the Tribe and is a Tribal Trust species (Trihey & Associates Inc., 1996; The Yurok Tribe, 2020, undated).

3.3.2.4 Coastal Cutthroat Trout

Coastal Cutthroat Trout occur mainly within about 22 miles of the estuary in the smaller tributaries of the mainstem Klamath River as well as further upstream in tributaries to the Trinity River (Moyle *et al.*, 1995). Adults migrate into the Klamath River for spawning in September and October, and juveniles rear in fresh water for 1 to 3 years before out-migrating to the ocean during April through June.

3.3.3 Migratory Birds

Migratory birds are federally protected under the Migratory Bird Treaty Act of 1918, which prohibits the take (killing, capturing, selling, trading, and transport) of protected migratory bird species without prior authorization by the USFWS.

As described in the *Lower Klamath, Clear Lake, Tule Lake, Upper Klamath, and Bear Valley National Wildlife Refuges Final Comprehensive Conservation Plan/Environmental Impact Statement* (USFWS and KBNWRC, 2016), the NWRs within the study area have provided hugely valuable habitat to migratory birds. These refuges are on the Pacific Flyway, a major north-south migration corridor. Migratory birds that pass through these NWRs include waterfowl, shorebirds, gulls, terns, cranes, rails, herons, grebes, egrets, songbirds, and raptors. About 80% of migrating waterfowl on the Pacific Flyway pass through the Klamath Basin during the spring and fall migrations.

Historically, the Upper Klamath Basin supported some of the greatest autumn and spring concentrations of migrating waterfowl in North America (USFWS and KBNWRC, 2016); however, only a fraction of the historical shallow wetlands remain, and waterfowl numbers have declined. In the

past, the number of birds present per day in the Klamath Basin Refuge complex averaged about one million in the fall and 360,000 in the spring (USFWS and KBNWRC, 2016). However, waterfowl numbers have not exceeded one million in the past 50 years (or 500,000 in the past 20 years), and in 2022, the peak estimate was about 93,000 (Trail, 2022).

3.3.4 Wetland and Riparian Areas

Historically, the Klamath Basin contained the largest wetland areas west of the Mississippi River (USFWS, undated). Today, the area's wetlands are greatly diminished. Spatial imaging analysis indicates that close to 95% of the Basin's wetlands have been lost (Trail, 2022). Many of the remaining wetlands occur in NWRs, three of which are considered in this Environmental Assessment: Lower Klamath NWR, Tule Lake NWR, and the Upper Klamath NWR.[13]

Excluding direct rainfall and runoff, most water no longer flows naturally into these wetland areas; rather, water inputs are either directly managed or indirectly influenced by Reclamation. For example, the Upper Klamath NWR has several units that are hydrologically connected to UKL and are therefore affected by Reclamation-managed UKL water elevations.

The Lower Klamath NWR is located on the border between Oregon and California. It is the largest refuge in the complex and was the first federal refuge created to protect waterfowl. Historically, the refuge area supported a large, shallow lake and wetlands flooded naturally by the Klamath River. Today, the Lower Klamath NWR is isolated from the river by a railroad bed, and it receives most of its water from Project deliveries from the Klamath River through a combination of the Ady Canal on the west and Project return flows from Tule Lake sumps via the D plant to the east (USFWS and KBNWRC, 2016).

With sufficient water, Lower Klamath NWR has provided habitat of high ecological value; however, water availability has been an increasingly critical concern. In the 1980s and most of the 1990s, the Lower Klamath NWR received over 100,000 AF annually. Since 2006, the amount of water delivered has dropped precipitously due primarily to a twenty-fold increase in the cost of pumping water. In addition, 2010 was an extremely dry year, and Reclamation's 2010 Operations Plan (Reclamation, 2010) stated for the first time that there would be little or no water supply for the refuge, rendering it "essentially dry, a condition not observed since the 1930s" (USFWS and KBNWRC, 2016). The dire water situation continued in 2021 and 2022, with no wetlands in either the Lower Klamath NWR or the adjacent Tule Lake NWR receiving any water (Swearingen and Rash, 2023). The most recent Reclamation Operations Plans (Reclamation, 2022; 2023a) point to "extreme drought conditions" and note, with specific reference to the Lower Klamath NWR, that water is only available for delivery when consistent with Reclamations' contractual and other legal obligations.

Tule Lake NWR is located in Siskiyou and Modoc counties, California, and encompasses lands reclaimed from the historical Tule Lake. The refuge consists of two open water sumps (1A and 1B), plus leased croplands and other uplands. Tule Lake NWR's primary source of water is winter flows from the Lost River, augmented in the spring/summer period by return flows from adjacent private agricultural lands. Sumps 1A and 1B act as collecting basins during the spring/summer irrigation season as well as from precipitation runoff during winter and spring. The sumps also receive water from the

[13] The refuges not included in this Environmental Assessment are: Clear Lake NWR (which does not include appreciable areas of wetlands), Bear Valley NWR (which is terrestrial with only a few intermittent streams), and Klamath Marsh NWR (which is upstream of the Project Area) (USFWS and KBNWRC, 2016).

Lost River via Anderson Rose Dam spills and from N canal spills. Excess water (if any) is pumped from the sumps into the Lower Klamath NWR. Water surface elevations in the sumps are managed by the Tulelake Irrigation District, consistent with operating criteria established by Reclamation.

Insufficient water resources has adversely affected Tule Lake NWR. Return flows are not guaranteed, and shortages can prevent the USFWS from managing the refuge to fully achieve its purpose as a refuge and breeding ground for wild birds and animals (USFWS and KBNWRC, 2016). In the summer of 2021, the former open water area of Sump 1A had almost no water left (Herald and News, 2021), and USFWS (2022) indicated that the summer and fall of 2022 would mark the first time in the refuge's history that both Sumps 1A and 1B would be dry. Altogether, in recent years, drought conditions have greatly impacted the area's refuges, and habitat conditions are "the worst they have ever been" (USFWS, 2022).

In addition to wetlands in the NWRs, the study area includes a more limited quantity of riparian wetlands, including some along the Link River and associated with reservoirs created by Klamath River dams (PacifiCorp, 2004). In 2018 and 2019, KRRC biologists developed an updated delineation of riparian and wetland habitat within a quarter mile of the dams and structures to be removed (KRRC, 2019; 2020). That survey effort identified about 74 acres of wetlands and 73 acres of riparian habitat in the study area. Currently, revegetation efforts are occurring (KRRC, 2021).

3.3.5 Land Use

The Project is located in Klamath County, Oregon, and in Siskiyou and Modoc counties in California (Figure 3-1). This largely rural three-county area encompasses approximately 16,686 square miles or 10.7 million acres (U.S. Census Bureau, 2018), approximately 76% of which is managed by federal agencies and includes parts of national parks, monuments, and NWRs (USGS, 2023). The remainder is managed or owned by state and local agencies, private entities, and several Tribes (USGS, 2023). Land cover in these counties is dominated by forests, shrubs, and grasslands (collectively over 85%). Lands for pasture and cultivated crops make up approximately 6% of this total area. Within the Project Area itself, over 81% of the lands are used for cultivated crops and pasture, which may potentially be affected by the Project.

Section 3.4.3 discusses the current status of, and recent trends in, agricultural land use in the study area. Excluding agricultural areas, the Proposed Action and No Action alternatives are not expected to differentially affect land use. Consequently, land use is excluded from further analysis.

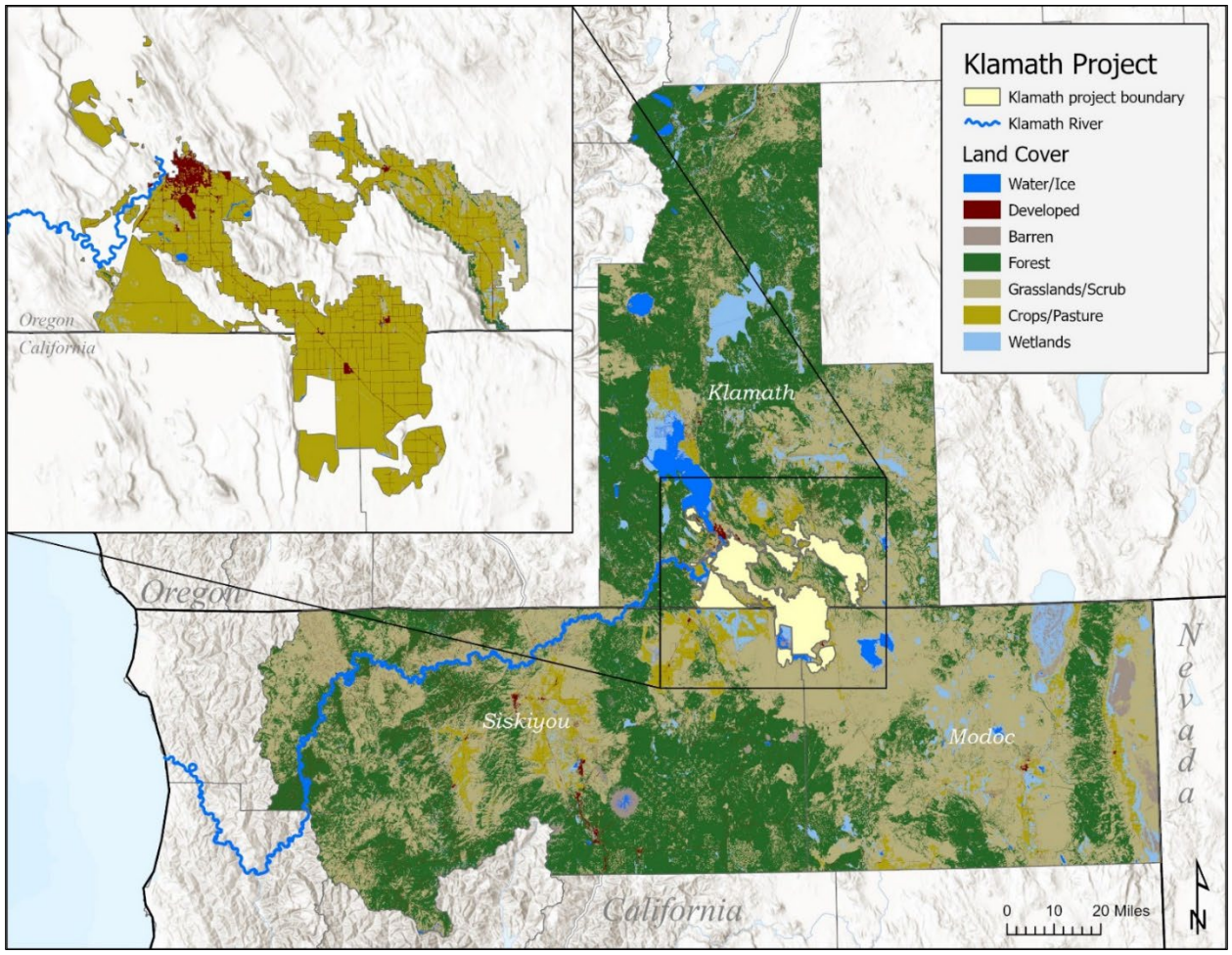


Figure 3-1. Land use in the primary Project Area and the broader impact area.

3.4 Socioeconomic Resources

This section provides an overview of regional socioeconomic conditions and identifies the specific economic sectors most likely to be differentially affected by implementation of either the Proposed Action or No Action alternatives (i.e., irrigated agriculture and fisheries). The study area considered for purposes of this socioeconomic analysis generally focuses on Klamath County, Oregon, and Siskiyou and Modoc counties in California (Figure 3-1). However, additional downstream areas are discussed for purposes of the commercial, recreational, and Tribal fisheries section.

3.4.1 Population

The study area is sparsely populated, with a mean population density of 7.6 people per square mile and a total population of approximately 122,000 as of 2018-2022 (Figure 3-1). The largest communities are Klamath Falls and Altamont in Oregon and Yreka in California. The study area's population has grown at a slower rate than average: between the time periods of 2006-2010 and 2018-2022, the population in these counties increased by 1.1%, which is much less than the corresponding

statewide increases of 12.4% in Oregon and 7.4% in California. Section 3.6 provides additional demographic details on the study area's population.

3.4.2 Income, Employment, Business, and Industrial Activity

In 2022, nearly 4,600 establishments employed roughly 40,000 employees in the study area (BLS (2022).[14] The Bureau of Labor Statistics classifies the largest number of establishments as providing education and health services. The industries employing the largest number of people in the region fall in the trade, transportation, and utilities sectors. The average annual wages in each of the three counties were approximately $50,000 (in 2023 dollars). The combined gross domestic product generated by these counties in 2022 was approximately $5.47 billion in 2023 dollars (BEA, 2023).

In 2022, 6.3% of jobs in the three-county area were natural resource and mining jobs (compared to 2.8% across Oregon and 2.4% across California). Section 3.5 discusses Tribal Nations and Tribal economies.

3.4.3 Irrigated Agriculture

Farmers in the Klamath Basin rely on water from the Project for irrigation and also make use of pumped groundwater. Irrigated agricultural activities contribute economic output, jobs, and labor income to the regional economy. Of approximately 230,000 acres of irrigable land in the Project, Reclamation reported that 190,208 acres of cropland and pasture were irrigated with Project water in 2019 (Reclamation, 2019a). Reclamation reported a similar number of irrigated acres in 2017 (189,163) (Reclamation, 2017), which represented nearly half (about 45%) of the irrigated acres in the three-county study area reported by U.S. Department of Agriculture in the 2017 Census of Agriculture (USDA, 2017b).

Table 3-1 shows the acreage and distribution of the main irrigated crops in the Klamath Project from 2016 to 2019 (Reclamation, 2016a; 2017; 2018a; 2019a). Crop areas are grouped by major crop categories. The principal irrigated cropland and pasture groups in the Project, presented using the 2016 to 2019 average acres, are alfalfa/hay (41%), irrigated pasture (23%), wheat (14%), small grain (12%), and potatoes (7%).

Table 3-1. Irrigated crop production in the Klamath Project Area by crop group, 2016-2019.

Crop	2016	2017	2018	2019	2016-2019 Average
Acres					
Alfalfa and Hay	78,532	76,082	75,879	75,327	76,455
Irrigated Pasture	38,298	44,167	41,623	44,783	42,218
Wheat	25,011	28,789	23,534	25,878	25,803
Small Grain	25,286	19,800	22,735	20,001	21,955
Potatoes	13,254	12,562	11,698	16,420	13,483
Other	7,065	7,764	7,073	7,798	7,425
TOTAL	187,446	189,163	182,541	190,208	187,339
Percent share of total					
Alfalfa and Hay	42%	40%	42%	40%	41%
Irrigated Pasture	20%	23%	23%	24%	23%

[14] Because BLS (2022) does not include data for unincorporated self-employed individuals, this data source underestimates annual average employment, particularly in industries such as commercial fishing.

Crop	2016	2017	2018	2019	2016-2019 Average
Wheat	13%	15%	13%	14%	14%
Small Grain	13%	10%	12%	11%	12%
Potatoes	7%	7%	6%	9%	7%
Other	4%	4%	4%	4%	4%

Note: Data from Reclamation (2016a; 2017; 2018a; 2019a).

The 2017 Census of Agriculture reported 2,173 farms in the three-county study area, which brought in an average of approximately $50,000 (2023 dollars) in net cash income per farm and whose products had a total market value of approximately $610 million (2023 dollars) (USDA, 2017b). Current available information is insufficient to specify how much of this total is associated with irrigated agriculture in particular. Table 3-2 shows farm characteristics, and Table 3-3 shows farmland uses, by county and state.

Table 3-2. Farm characteristics and land use in Klamath study area, 2017.

Geography	Number of Farms	Land in Farms (1,000 acres)	Average Size of Farms (acres)
Klamath	1,005	483	481
Siskiyou	745	687	923
Modoc	423	571	1,350
Study Area	2,173	1,742	801
Oregon	37,616	15,962	424
California	70,521	24,523	348

Note: Data from USDA (2017b).

Table 3-3. Land use on farms in Klamath study area, 2017.

Geography	Pastureland	Cropland	Woodland	Other Uses
Klamath	53%	31%	13%	3%
Siskiyou	52%	21%	18%	10%
Modoc	61%	28%	3%	9%
Study Area	55%	26%	12%	8%
Oregon	57%	30%	10%	3%
California	47%	39%	8%	6%

Note: Data from USDA (2017b).

Table 3-4 shows the market value and net cash farm income of all agriculture products sold and includes the total as well as per-farm values at the county and state level in 2017. Table 3-5 shows the market value of agricultural products at the county and state level from the 2012, 2017, and 2022 agricultural censuses (USDA, 2017b; 2022). Between 2012 and 2022, total market value of agricultural products decreased by 3% in the study area, driven by Klamath County, compared to 10% and 9% increases in in Oregon and California, respectively.

Table 3-4. Farm product value and net incomes within study area in Klamath study area, 2017 (2023 Dollars).

Geography	Market Value of Products Sold ($)	Net Cash Farm Income ($)	Market Value of Products Sold Per Farm ($)	Net Cash Farm Income Per Farm ($)
Klamath	$235 million	$33 million	$233,721	$32,493
Siskiyou	$235 million	$49 million	$315,021	$65,516

Geography	Market Value of Products Sold ($)	Net Cash Farm Income ($)	Market Value of Products Sold Per Farm ($)	Net Cash Farm Income Per Farm ($)
Modoc	$140 million	$28 million	$330,943	$65,036
Study Area	$610 million	$109 million	$280,520	$50,150
Oregon	$6.1 billion	$906 million	$162,332	$24,095
California	$55.1 billion	$10.9 billion	$780,896	$154,096

Note: Data from USDA (2017b).

Table 3-5. Market value of products in Klamath study area, in 2012, 2017, and 2022 (2023 Dollars).

Geography	2012 Market Value of Products	2017 Market Value of Products	2022 Market Value of Products	10-Year Change (2012 to 2022)
Klamath	$176 million	$235 million	$238 million	-26%
Siskiyou	$306 million	$235 million	$292 million	+5%
Modoc	$170 million	$140 million	$140 million	+21%
Study Area	$652 million	$610 million	$669 million	-3%
Oregon	$7.0 billion	$6.1 billion	6,391	+10%
California	$61.0 billion	$55.1 billion	$55.8 billion	+9%

Note: Data from USDA (2017a); (2022).

Table 3-6 describes the total jobs, natural resource and mining jobs, and distribution within those jobs by category for the three counties, in the study area, and across two states.

Table 3-6 Natural resources and mining jobs by category in Klamath study area, 2022.

Geography	Total Jobs	Natural Resources and Mining	Percent Crop Production	Percent Animal Production and Aquaculture	Percent Forestry and Logging	Percent Support Activities for Agriculture and Forestry	Percent Other
Klamath	23,411	1,013	53%	17%	7.7%	17%	4.9%
Siskiyou	13,914	1,163	52%	6.4%	22%	18%	1.5%
Modoc	2,652	352	48%	0%	0%	33%	19%
Study Area	39,977	2,528	52%	9.8%	13%	20%	5.3%
Oregon	1,950,774	54,423	51%	6.8%	9.3%	29%	3.5%
California	17,903,539	436,965	36%	6.5%	0.5%	53%	4.0%

Note: Data from BLS (2023b).

3.4.4 Recreation

The Klamath Basin is a popular area for nature-based recreation. Land adjacent to the Klamath River provides opportunities for hiking, camping, hunting, birdwatching, wildlife viewing, and photography, among other recreational activities. Motorized and non-motorized boating, swimming, and fishing are popular water-based activities.

The Upper Klamath, Lower Klamath, and Tule Lake NWRs each receive water from the Project. Wildlife viewing, photography (especially during periods of bird migration), and hunting are common activities on these refuges. The USFWS estimates that NWRs across the Pacific Region (including

Oregon) and the Pacific Southwest Region (including California) together received approximately 12.4 million visitors in fiscal year 2017, generating local economic output of $720,000 (Claudill, 2019).[15] A visitor survey report from 2010-2011 reported 135,000 annual visitors to Lower Klamath NWR.[16]

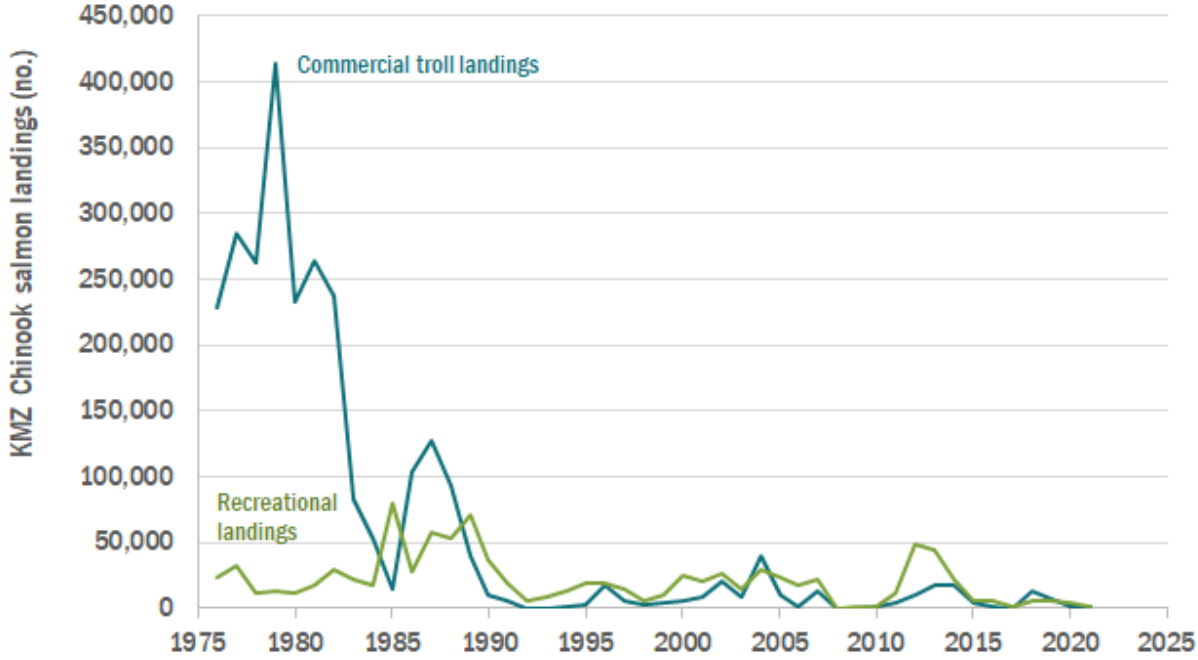
Changes in water supply to the Klamath River from the Project have the potential to affect whitewater rafting. The Upper Klamath River has been recognized as an outstanding whitewater rafting river with rapids classified to be of Class IV to V level difficulty. Whitewater rafting in the Hell's Corner Reach, a 16.4-mile stretch starting from below J.C. Boyle Reservoir, is managed by the Bureau of Land Management. The eight commercial boating permits issued in 2018 are estimated to have produced 2,001 user-days, and with a similar number in 2019 (CSWRCB, 2020). There are also extensive whitewater boating opportunities downstream from IGD with a rapid difficulty level of Class II-IV (CSWRCB, 2020).

Notably, the J.C. Boyle Dam along with the downstream Copco dams and the IGD were removed in 2024 as part of the hydropower license surrender by PacifiCorp and decommissioning of the Lower Klamath Project by the KRRC. The dam removals will reduce existing whitewater rafting opportunities in the Klamath Basin (such as in Hell's Corner Reach) but are expected to create new opportunities along other reaches and to increase whitewater rafting safety (FERC, 2022a).

3.4.5 Commercial, Recreational, and Tribal Fishing

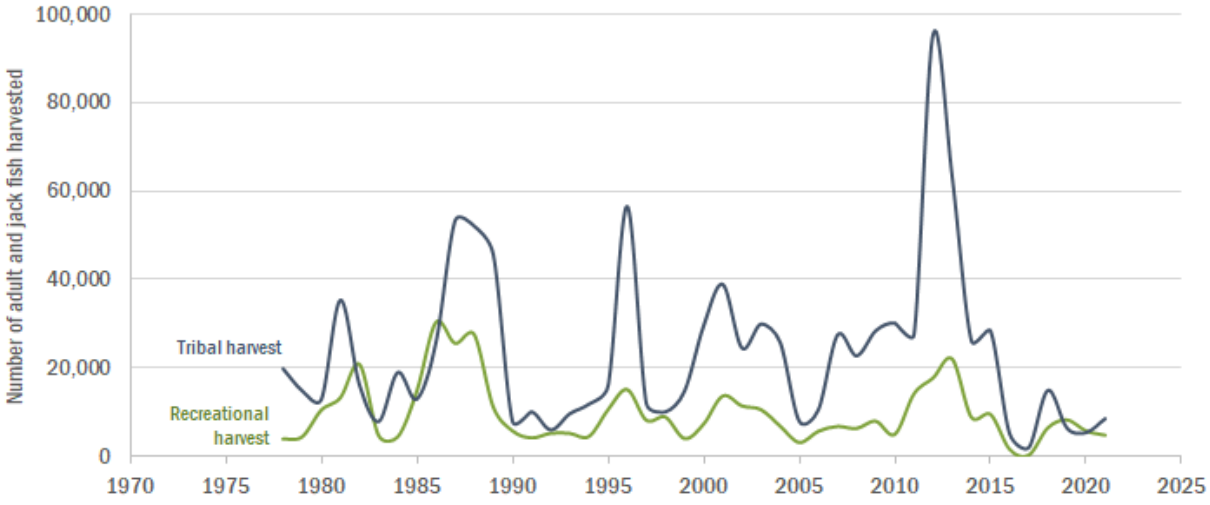
The study area has supported important recreational, Tribal, and commercial fisheries, although a number of these fisheries are in decline or have been discontinued to preserve the remaining fish populations. For example, Chinook Salmon is the dominant local species fished. The Pacific Fishery Management Council[17] annually determines the maximum total harvest and allocates this harvest among three groups: ocean harvest (including commercial harvest), Tribal harvest by the Yurok and Hoopa Valley tribes, and non-tribal recreational harvests (Prager and Mohr, 2001). Low abundance of Chinook Salmon over the past 30+ years has resulted in fishing curtailments and/or season length reductions that have substantially reduced the total harvest. Since 1990, commercial landings of Chinook Salmon have been a small fraction of what they were in the 1970s and 1980s (Figure 3-2). Recreational ocean landings have been variable, although since around 2015 these landings have been low and similar in order of magnitude to commercial landings (Figure 3-3). In-river Chinook landings have been variable for both Tribal and recreational catch (Figure 3-4).

[15] USFWS defines the "Pacific Region" as including the states of Washington, Oregon, Idaho, Hawaii, and the Pacific Islands; the "Pacific Southwest Region" includes the states of California and Nevada. There are 67 and 45 NWRs in the Pacific and Pacific Southwest regions, respectively.
[16] Similar attendance data for the Upper Klamath and Tule Lake NWRs are not available for the public at this time.
[17] The Pacific Fishery Management Council is one of eight regional fishery management councils established by the MSA. It manages fisheries in federal waters and coordinates with federally recognized west coast Tribes. Washington, Oregon, and California manage fisheries in their own waters, which include the coastal waters between 1 to 3 nautical miles offshore and inland waters within the states' boundaries.



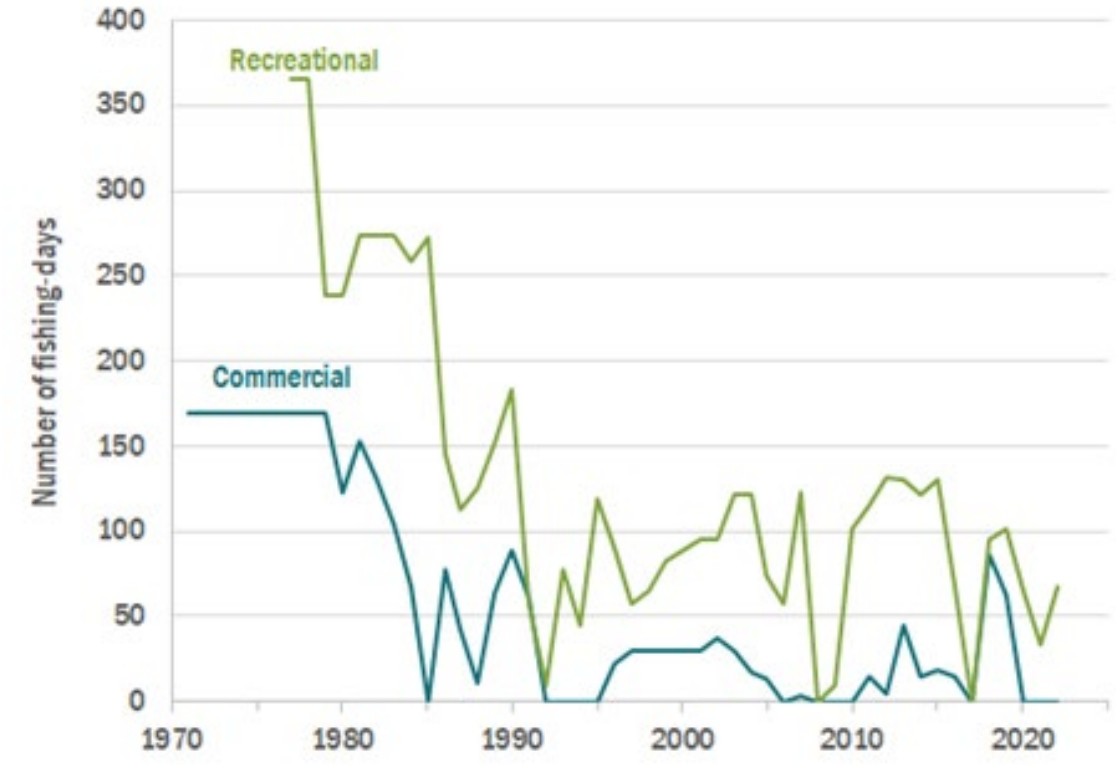
Note: Data from PFMC (2023a).

Figure 3-2. Ocean Chinook Salmon landings from the Klamath Management Zone.



Note: Data from PFMC (2023a).

Figure 3-3. Klamath River Tribal and recreational Chinook Salmon landings.



Note: Data from PFMC (2005; 2011; 2023b). The presented data reflect the numbers of fishing days in the Klamath Management Zone or geographically similar area, as defined in the applicable year.

Figure 3-4. Number of commercial and recreational ocean fishing-days in or near the Klamath Management Zone.

Steelhead are another popular sport fish in the Klamath River, and the Klamath Mountains Province DPS is the only California DPS not presently listed under the ESA (CDFW, 2016). The CDFW's Report Card program found that between 2007 and 2014 about 178,000 Steelhead were caught within the province (CDFW, 2016). Historically, the Yurok Tribe relied on Steelhead, among other fish (Pierce, 1991). The species remains important to the Tribe and is a Tribal Trust species (Trihey & Associates Inc., 1996; The Yurok Tribe, 2020, undated). The Eulachon, Green Sturgeon, and Pacific Lamprey are additional species of Tribal importance (Trihey & Associates Inc., 1996; CDFG, 2010), although their abundance has also steeply declined from historical levels.

Some formerly targeted species are now federally listed under the ESA, and fishing is no longer permitted. For example, commercial and recreational harvesting of the Lost River and Shortnose suckers is prohibited. The loss of this fishery has impacted the Klamath Tribes, for whom these suckers have been essential for subsistence and are essential culturally and spiritually (Donnelly, 2003; Gentry, 2018). Coho Salmon populations have also declined, leading to ongoing closures of commercial and recreational Coho fisheries in California starting in 1994 (Olswang, undated), with only limited sanctioned Tribal harvests for subsistence and ceremonial purposes remaining.

3.5 Tribal Nations and Tribal Economies

The United States "has charged itself with moral obligations of the highest responsibility and trust" toward Indian Tribes.[18] Federal trust responsibilities require agencies to protect trust resources including rights, property, assets, or interests protected by treaties, statutes, and executive orders. [19]

There are six federally recognized Tribes in the Klamath Basin, including the Klamath Tribes (which include the Klamath, Modoc, and Yahooskin tribes) in Oregon and the Hoopa Valley Tribe, the Yurok Tribe, the Karuk Tribe, the Quartz Valley Tribe, and the Pulikla Tribe of Yurok People (formerly Resighini Rancheria) in California. The Modoc Nation, the members of which are descendants of Modoc people forcibly removed to Oklahoma and which has reacquired land in its former homeland within the Project's boundaries, has also been independently involved in stakeholder outreach concerning Project operations. As discussed in Appendix D, the Klamath, Yurok, and Hoopa Valley tribes have federal reserved water and fishing rights. Reclamation must operate the Project consistent with these rights.[20] Some additional information about these Tribal Nations and Tribal economies in the Klamath Basin are described in Appendix D.

Described by Reclamation in 1998, "the significance of the Tribes' reliance on, and veneration for nature is evident in all facets of their culture, their traditions, their religions, and their resource use and management. Consequently, increasing resource scarcity over the last century has had a profound negative effect on the Tribes of the Klamath Basin. Tribal cultures are no longer able to fully embrace their traditional ways of life; the declining availability of resources critical to their traditional and spiritual practices has made some of those resources even more precious as a means of sustaining their culture" (Reclamation, 1998).

3.6 Environmental Justice

Consistent with Executive Orders 12898 of 1994, 14008 of 2021, and 14096 of 2023, this section discusses potential environmental justice concerns within the study area. More specifically, in accordance with the Council of Environmental Quality's (CEQ's) guidance on conducting an environmental justice analysis under NEPA (CEQ, 1997), this Environmental Assessment considers demographic and socioeconomic data along with "the interrelated cultural, social, occupational, historical, or economic factors that may amplify the natural and physical environmental effects of the proposed agency action."

3.6.1 Population Characteristics in the Study Area

Socioeconomic indicators suggest several potential environmental justice concerns in the study area. As Table 3-7 shows, on average the study area population has lower incomes, a higher unemployment rate, a higher poverty rate (both adults and children),[21] more households receiving food

[18] Seminole Nation v. United States, 316 U.S. 310 (1942).
[19] An Indian Trust Asset is a legal interest in property held in trust by the federal government for Indian Tribes or individuals.
[20] Baley v. United States, 942 F.3d 1312 (Fed. Cir. 2019); Klamath Water Users Ass'n v. Patterson, 204 F.3d 1206 (9th Cir. 2000).
[21] The 2022 poverty thresholds for the United States range from $14,040 for single individuals 65 years and over to $23,556 and upwards for households of three or more with at least one related child under 18 years (U.S. Census Bureau, 2022).

stamps/supplemental nutrition assistance program (SNAP) benefits, lower educational attainment, and more elderly residents compared overall in Oregon and California as well as in the United States. The population in the study area is, therefore, likely to be more vulnerable to economic and environmental changes than typical populations in these states or the United States overall. Appendix A includes information on these indicators for each county in the study area. The Appendix A tables demonstrate similar environmental justice concerns across the three counties.

Table 3-7. Study Area population characteristics compared to state-wide and national values 2018-2022.

Characteristic	Study Area	Oregon	California	Nation
Race and ethnicity				
Percent minority*	**25**	27	65	41
Percent American Indian and Alaska Native, alone or in combination with one or more other races	**7**	3	3	2
Income and economics				
Median household income (2023 dollars, rounded)	**$56,000 - $59,000**	$79,000	$95,000	$78,000
Percent below poverty level	**17**	12	12	12
Percent low income**	**39**	28	28	29
Percent of SNAP-dependent households	**19**	15	10	11
Percent unemployed	**7**	5	6	5
Percent of children living below the poverty level	**22**	13	16	17
Additional population characteristics				
Percent of 18-24 year olds with less than a high school education	**15**	13	10	12
Percent above 65 years old	**24**	18	15	16
Percent limited English proficient (LEP)	**2**	2	8	4

Notes: Data from U.S. Census Bureau (2023).
* Using U.S. census data, the minority population is determined by subtracting the population identified as White alone, not Hispanic or Latino from the total population.
** The U.S. Environmental Protection Agency defines "low-income" as a household whose income is less than or equal to twice the federal poverty level (i.e., 200% or less than the federal level) (USEPA, 2023).

3.6.2 City of Klamath Falls and Altamont

The largest population centers in the study area are in Klamath County, Oregon, and include the City of Klamath Falls (population >21,000) and the Census Designated Place of Altamont (population >20,000) (U.S. Census Bureau, 2023). Klamath Falls and Altamont have lower incomes and higher values for poverty-related indicators than Klamath County, the study area, and Oregon as a whole (Appendix A). The Klamath Falls and Altamont populations are, therefore, more vulnerable than both Klamath County or the study area as a whole and are considered to be communities with environmental justice concerns.

3.6.3 Additional Environmental Justice Considerations

The NEPA Committee and Federal Interagency Working Group on Environmental Justice states that agencies should identify and describe any unique conditions of the potentially affected minority and low-income populations that may be affected by the proposed action, including human health vulnerabilities, socioeconomic vulnerabilities (for example, reliance on a particular resource that may be affected by the proposed action), and cultural vulnerabilities (EJ IWG, 2016). Guidance from the

CEQ for analysis of environmental justice impacts recommends that analysts consider how impacts in minority or low-income populations may be different from impacts on the general population due to distinct cultural practices, such as subsistence fishing, hunting, or gathering (CEQ, 1997). Sections 3.5 and 3.4.5 discuss cultural practices and values that may result in differential impacts to Tribal populations than non-tribal populations.

3.7 Climate Change

Climate change has affected and will continue to affect the Klamath River Basin in multiple ways, including increasing air and water temperatures, changing precipitation patterns, and changing the amount and timing of snowpack runoff. More specifically, as summarized in the Klamath River Basin Study (Reclamation, 2016b), temperatures in the Pacific Northwest have increased by 1.0°C since 1900. By the 2050s, annual temperatures are projected to be outside the range of historical variability. Projections for the next 30 to 50 years also indicate that the Klamath Basin will continue to experience climate-change-related increases in winter precipitation as rain and decreases in summer precipitation (Reclamation, 2016b).

By the 2030s, the amount of water in the snowpack is projected to decrease by 34% to 40%, and by the 2070s, this decrease is projected to be about 60% (Reclamation, 2016b). The timing and volume of runoff from the snowpack is also expected to change. The *Final Environmental Impact Statement for Hydropower License Surrender and Decommissioning of the Lower Klamath Project* (FERC, 2022a) states, "irrigation season runoff (April to September) [is] projected to decrease about 40% by the 2070s, with slightly more rainfall-runoff during the winter (December through March) and a more apparent declining trend of less runoff during the late spring and summer (April through July)."

Changes in runoff quantities and timing—particularly, changes in the timing of low flows—are of interest to water managers since there are often numerous competing needs during low-flow periods (KRBSTWG, 2016). The timing and extent of low flows are also important to biological resource managers, as low-flow periods typically occur when some anadromous fish species, including salmon, begin their upstream spawning migration. Low flows during the summer may increase water temperatures and reduce the availability of temperature refugia, which is concerning as summer water temperatures already exceed criteria for the protection of salmonids. Low flows can increase disease transmission, as aquatic biota are forced into closer congregation. This situation occurred in September 2002 and resulted in a salmon kill in the Lower Klamath River (CDFG, 2004). Altogether, ongoing and future climate change poses a significant challenge to the Project.

4 Environmental Consequences

4.1 Introduction

This chapter presents the evaluation of the potential environmental consequences to the affected resources that may occur due to the implementation of the No Action Alternative and the Proposed Action Alternative, as described in Chapter 2. Under NEPA, federal agencies must consider the potential environmental effects, or impacts, of their proposed actions. These effects may include, among others, effects to social, cultural, and economic resources, as well as natural resources. CEQ regulatory definitions of effects to be evaluated are presented in Appendix E.

This Environmental Assessment describes and evaluates both adverse and beneficial impacts on the natural and human environments. To determine whether an action has the potential to result in significant impacts under NEPA, the magnitude of the impact, with respect to context and intensity of the action, must be considered. CEQ describes criteria for determination of significance, which are provided in Appendix E.

The qualitative assessment of impacts in this Environmental Assessment is based on a review of available and relevant reference material and professional judgment, using standards that include consideration of the permanence of an impact, the uniqueness of or ability to replace the resource, and the abundance or scarcity of the resource. A single act might result in adverse impacts on one resource and beneficial impacts on another resource. An adverse impact is one having unfavorable or undesirable outcomes for the human environment. Adverse impacts are generally described by one of the following terms:

- **Minor**. Minor impacts are generally those that might be detectable but, in their context, may nonetheless not be measurable because any changes they cause are so slight as to be impossible to define.
- **Moderate**. Moderate impacts are those that are more detectable and, typically, more quantifiable or measurable than minor impacts.
- **Major**. Major impacts are those that, in their context and due to their severity, have the potential to meet the thresholds for significance set forth in CEQ regulations as described in Appendix E (40 CFR § 1501.3) and, thus, warrant heightened attention and examination for potential benefit of mitigation.

A beneficial impact is one that creates a positive outcome to the manmade or natural environment. For resource areas where there is no expected effect from project activities, a "no-impact" conclusion is made.

4.2 Resources Considered but Eliminated from Further Evaluation

After analyzing the Proposed Action Alternative within the affected environment, the potential impacts to the following resource areas are considered to be negligible or nonexistent and have therefore been eliminated from further consideration in this Environmental Assessment.

- **Land Use**. The Proposed Action and No Action alternatives would not produce any terrestrial disturbances, would not result in the construction of new facilities or the modification of existing land-based facilities, and would not result in land use changes. Potential impacts on agricultural practices are described in Section 4.5.1.
- **Cultural Resources**. The Proposed Action Alternative would not produce any ground disturbances, would not result in the construction of new facilities or the modifications to existing facilities, and would not result in land use changes. Neither the Proposed Action Alternative nor the No Action Alternative have the potential to case effects to historical properties pursuant to 36 CFR § 800.3(a)(1) of the NHPA (see Appendix E).
- **Indian Sacred Sites**. No impacts to Indian Sacred Sites are anticipated under either the Proposed Action Alternative or No Action Alternative. Neither alternative would inhibit access to, or ceremonial use of, an Indian Sacred Site nor would alternatives adversely affect the physical integrity of such sacred sites. Potential impacts on Tribal Nations and Tribal economies are described in Section 4.6.
- **Climate Change and Greenhouse Gases**. Climate Change and greenhouse gases refers to change in measures of climate (e.g., temperature, precipitation, or wind) lasting for decades or longer. Greenhouse gas emissions, regardless of where they are generated, combine in the Earth's atmosphere, ultimately affecting global climate systems. The Project itself would not contribute to measurable increases in greenhouse gas emissions or other contributions to climate change. Impacts of climate change on the study area are described in Section 3.7.
- **Air Quality**. Air pollutants affect ambient air quality relatively close to their sources where they may more directly affect human and ecological health. Reclamation's actions under both alternatives would generally not be expected to increase air emissions such as fine particulate matter (PM2.5). Though, fallowing of agricultural lands associated with changes in water deliveries under both alternatives has some potential to lead to temporary increases in airborne dust. The Proposed Action Alternative would not increase the amount of fallowed lands as compared to the No Action Alternative and, as such, would not adversely affect air quality, including dust levels.
- **Gerber Reservoir, Clear Lake, and the Lost River above Harpold Dam**. The Proposed Action Alternative would not affect Reclamation's operations on these surface water resources. Future Clear Lake and Gerber Reservoir elevations are expected to be similar to those seen in the past for storage and release of water for irrigation, under both alternatives.
- **Terrestrial Species**. Both the Proposed Action and No Action alternatives address surface water management and supporting OM&R activities. As such, neither alternative is expected to result in more than negligible impacts to terrestrial species. Moreover, any such effects, should they occur, are expected to be identical in both alternatives.

The remainder of this chapter compares the effects of the Proposed Action Alternative with the effects of the No Action Alternative on potentially affected resources.

4.3 Water Resources

This section evaluates how and to what degree the No Action Alternative and Proposed Action Alternative could impact water resources in the study area.

4.3.1 No Action Alternative

Under the No Action Alternative, Reclamation would continue the current management direction and implementation of the 2020 IOP. Surface water management of the Project would largely continue as it has been to date, although as described in Chapter 2, adaptations would need to be made in response to other ongoing cumulative actions, including the reconnection of the ALB to UKL, updated bathymetry for UKL, as well as adjustments related to the removal of the dams below Keno Dam, which were located downstream of the Project Area.

As described in Chapter 3, surface water availability in the Klamath Basin has been insufficient, particularly in recent years, to satisfy all demands for both consumptive uses and for the provision of in-river non-consumptive ecological and other services (e.g., support of fish). These challenges have increased throughout the Project's history, as water supply has become increasingly limited in part due to climate change and regulations adopted to protect federally listed species. Reclamation anticipates these challenges will persist or even increase into the future.

Groundwater levels also in and around the Project have declined (see Section 3.2.4), which would be expected to continue under the No Action Alternative. The groundwater system in the Klamath Basin is most directly affected by basin-wide, decadal-scale climatic cycles, including climate change. Irrigation pumping has increased throughout the Basin over the last half-century, and particularly over the last two decades within the Project service area (Gannett *et al.*, 2012). To the extent that the No Action Alternative does not meet the demand for consumptive use, pressure to supplement surface water supplies through increased groundwater pumping would be expected to increase, and groundwater storage would be expected to continue to decrease. The KRRC dam removal—one of the new existing conditions discussed in Section 2.1.2—is also expected to affect groundwater levels in the aquifer adjacent to the reservoirs under the No Action Alternative (FERC, 2022a). However, these new conditions are not part of Reclamation's Proposed Alternatives and were discussed in detail in the Federal Energy Regulatory Commission Environmental Impact Statement (FERC, 2022a).

Existing water quality impairments at UKL are anticipated to continue under the No Action Alternative. Poor quality water emanating from UKL is the primary source for impaired water quality to the Upper Klamath River and contributes materially to nutrient loads in the lower reaches. Elevated temperatures within UKL would also continue to contribute to elevated temperatures downstream of Keno Dam reducing water quality under the No Action Alternative.

4.3.2 Proposed Action Alternative

The Proposed Action Alternative would be based on a revised water management strategy that would entail continuous tracking of the hydrologic conditions in the Upper Klamath Basin to generate a daily index that reflects both wetness and UKL storage conditions. This daily index would be used to determine the distribution of water among the various uses, including Project diversions, distribution to the Lower Klamath and Tule Lake NWRs, retention in UKL, and supporting Klamath River flows, Chapter 2 presents more information about the Proposed Action Alternative's operational strategy.

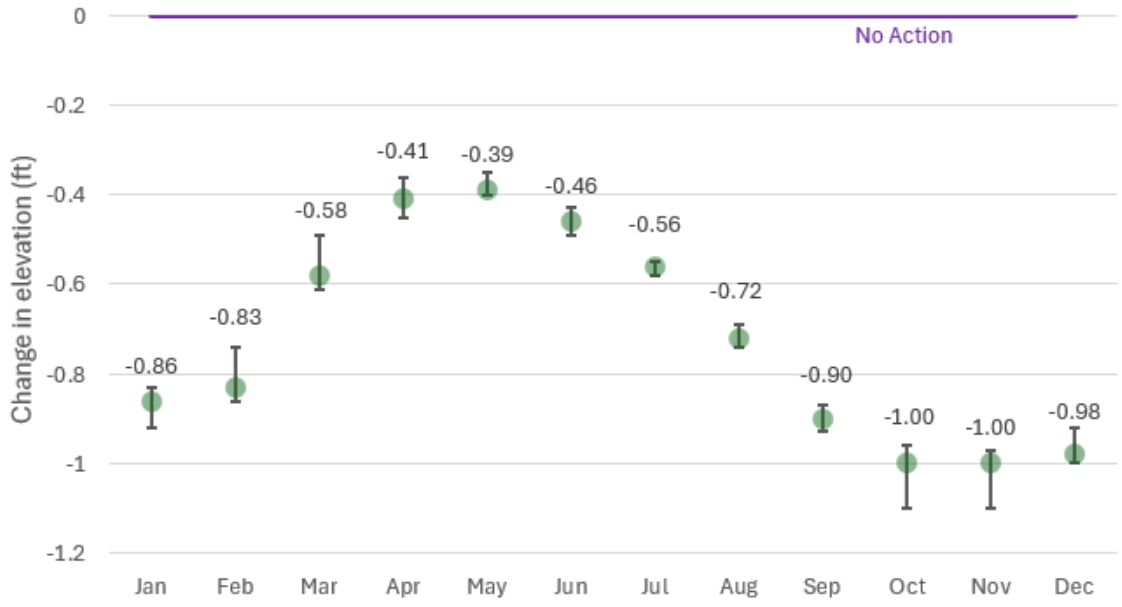
The Proposed Action Alternative operational strategies were used to simulate UKL elevations, Klamath River flows, Project diversions, and refuge deliveries over the October 1981 through November 2022 timeframe. The following sections describe the differential effects of the Proposed Action Alternative compared with the No Action Alternative for the (shorter) POR of October 1991 to November 2022.

4.3.2.1 Surface Water

The surface water discussion includes consideration of water levels at UKL, Klamath River flows, and Project diversions.

Upper Klamath Lake. As described in Chapter 3, UKL's elevation is critical to management of Project operations and, as such, is monitored closely. All else equal, higher elevations in UKL may allow for more water for Project deliveries later in the season and for more fish habitat in UKL, particularly for the endangered Lost River and Shortnose suckers. Higher elevations also allow for higher flows into the Klamath River throughout the year and thus provide more habitat for downstream fish including Coho Salmon.

Across all months within the POR, modeling suggests that median UKL elevations under the Proposed Action Alternative would be approximately 0.4 to 1.0 ft lower than under the No Action Alternative (Figure 4-1). These decreases in elevation would be less during wetter years, particularly in March through June (Figure 4-2).



Notes: Whiskers represent the 95% confidence intervals of the median. Data are based on Reclamation's modeling of the No Action and Proposed Action alternatives for the POR.

Figure 4-1. Simulated change in median Upper Klamath Lake elevations under the Proposed Action Alternative relative to the No Action Alternative for the period of record (October 1991-November 2022).

	Elevation percentile	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Wetter years	95%	-0.4	-0.1	-0.1	0.0	0.0	0.0	-0.4	-0.7	-1.1	-1.2	-1.3	-1.1
	90%	-0.7	-0.2	-0.1	-0.1	-0.1	-0.2	-0.5	-0.8	-1.0	-1.4	-1.5	-1.2
	85%	-0.8	-0.4	-0.2	-0.1	-0.1	-0.2	-0.4	-0.7	-1.1	-1.2	-1.3	-1.2
	80%	-1.0	-0.6	-0.3	-0.3	-0.2	-0.3	-0.5	-0.8	-1.1	-1.2	-1.3	-1.3
	75%	-1.0	-0.8	-0.3	-0.3	-0.4	-0.5	-0.7	-0.9	-1.1	-1.2	-1.3	-1.3
	70%	-1.1	-0.9	-0.4	-0.4	-0.2	-0.5	-0.7	-0.9	-1.0	-1.1	-1.3	-1.3
	65%	-1.1	-1.0	-0.7	-0.4	-0.2	-0.4	-0.7	-0.7	-0.8	-1.1	-1.3	-1.3
	60%	-1.1	-1.1	-0.8	-0.5	-0.3	-0.3	-0.4	-0.8	-1.0	-1.1	-1.1	-1.0
	55%	-1.0	-1.0	-0.9	-0.5	-0.6	-0.3	-0.5	-0.7	-0.9	-0.8	-0.9	-0.9
	50%	-1.0	-1.0	-0.9	-0.5	-0.6	-0.7	-0.9	-1.0	-1.0	-0.9	-0.9	-1.0
	45%	-1.0	-1.0	-0.9	-0.5	-0.5	-0.6	-0.7	-0.8	-0.9	-0.9	-0.9	-0.9
	40%	-1.0	-1.0	-0.9	-0.5	-0.5	-0.5	-0.7	-0.8	-0.8	-1.0	-0.9	-1.1
	35%	-1.0	-0.9	-0.8	-0.6	-0.5	-0.6	-0.6	-0.8	-0.9	-1.1	-1.0	-0.9
	30%	-0.9	-0.8	-0.6	-0.8	-0.6	-0.6	-0.6	-0.7	-0.9	-1.0	-1.0	-0.8
	25%	-0.8	-0.7	-0.7	-0.6	-0.6	-0.5	-0.5	-0.6	-0.8	-0.8	-0.8	-0.7
	20%	-0.6	-0.9	-0.6	-0.5	-0.6	-0.5	-0.6	-0.6	-0.6	-0.7	-0.7	-0.6
Drier years	15%	-0.7	-0.7	-1.0	-0.4	-0.3	-0.5	-0.7	-0.7	-0.8	-0.8	-0.8	-0.6
	10%	-0.9	-0.8	-0.7	-0.6	-0.7	-1.0	-0.8	-1.0	-1.0	-0.9	-1.0	-0.9
	5%	-1.1	-1.1	-0.9	-0.8	-0.8	-0.8	-0.9	-1.0	-1.0	-1.0	-1.1	-1.1
Median elevation difference within the simulated study period:		**-0.9**	**-0.8**	**-0.6**	**-0.4**	**-0.4**	**-0.5**	**-0.6**	**-0.7**	**-0.9**	**-1.0**	**-1.0**	**-1.0**

Notes: Data are based on Reclamation's modeling of the No Action and Proposed Action alternatives for the POR.

Figure 4-2. Simulated change in Upper Klamath Lake elevation (feet) under the Proposed Action Alternative relative to the No Action Alternative by month and elevation percentile for the period of record (October 1991-November 2022).

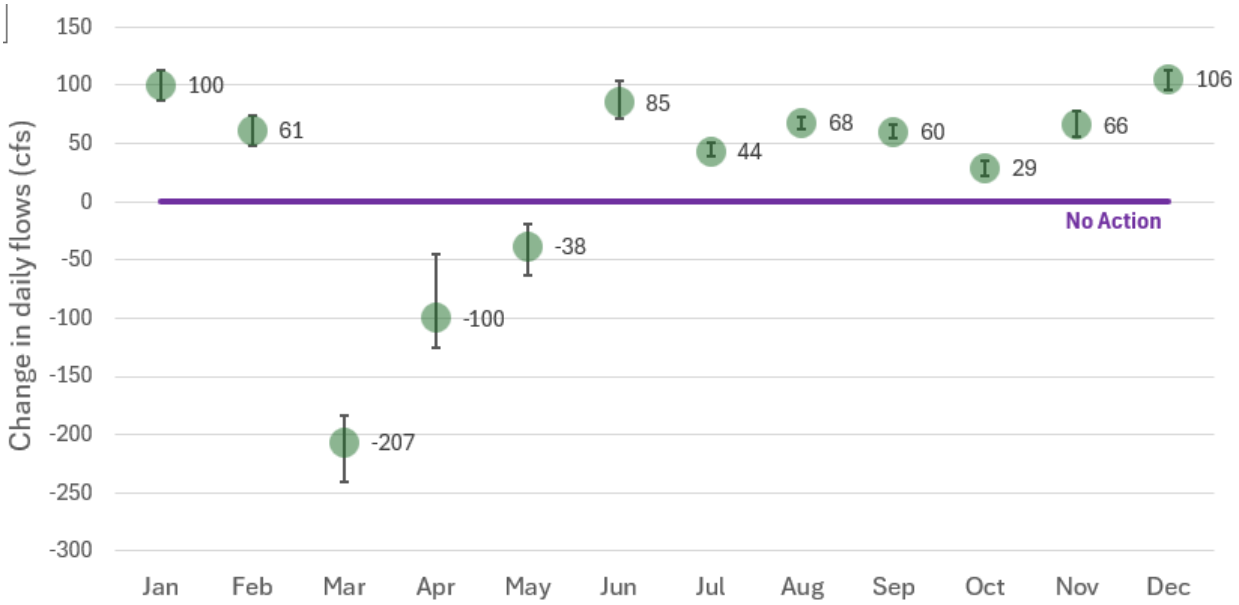
Figure 4-3 shows that, similar to the No Action Alternative, release rates at Keno Dam would continue to vary based upon water year and month, with releases lowest in summer and early fall (July through October), then increasing to higher levels in March through May. Figure 4-3 also shows that in some water years, UKL elevations would be below the targeted minimum value for sucker habitat as prescribed by prior biological opinions (USFWS, 2020; 2023), between August and December. Figure 4-3 also includes flow thresholds relevant to Lost River and Shortnose suckers, which are discussed in Section 4.4.1.

Notes: Data are based on Reclamation's modeling of the No Action and Proposed Action alternatives for the POR. USBRKB refers to Reclamation's Klamath Basin Area Office.

Figure 4-3. Simulated Upper Klamath Lake elevations under the No Action and Proposed Action alternatives for the period of record (October 1991-November 2022).

Klamath River. The 2024 removal of IGD and the three other hydropower dams moved the point of water flow control (also referred to as the "compliance point") upstream to Keno Dam. The timing and quantity of river flows is critical to the support of fish, including endangered Coho Salmon, Chinook Salmon, and other species. Reclamation manages flows in the Klamath River to minimize or avoid effects to federally listed fish species from Project operations.

Water modeling of expected flow conditions suggests that median daily flows at Keno Dam during the POR would be approximately 30 to 110 cfs higher under the Proposed Action Alternative than under the No Action Alternative in most months (Figure 4-4). From March through May, however, water modeling of expected flow conditions suggests that median daily flows would be lower under the Proposed Action Alternative than under the No Action Alternative, by about 40 to 210 cfs. The increases in flow under the Proposed Action Alternative relative to the No Action Alternative would be more pronounced in drier years, while the decreases in flow would occur during wetter years (Figure 4-5).



Notes: Whiskers represent the 95% confidence intervals of the median. Data are based on Reclamation's modeling of the No Action and Proposed Action alternatives for the POR.

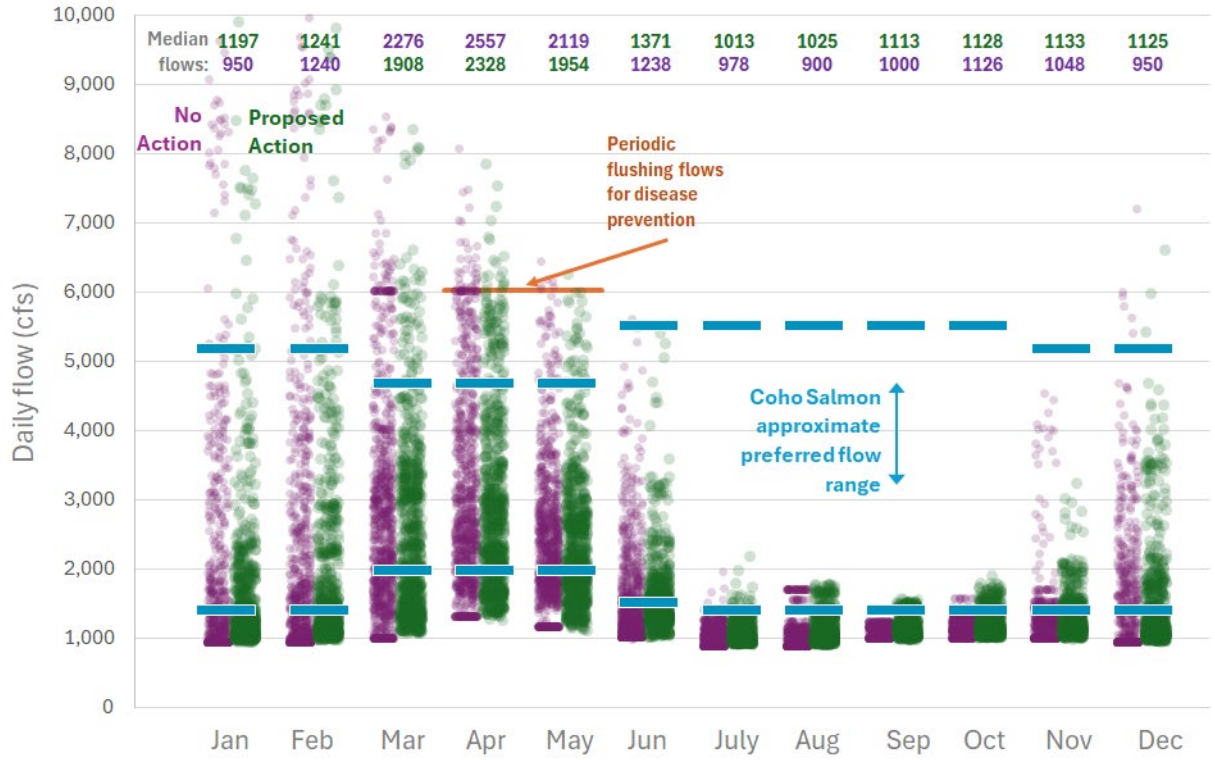
Figure 4-4. Simulated median change in daily Klamath River flows at Keno Dam under the Proposed Alternative compared to No Action in the period of record (October 1991-November 2022).

	Flow Percentile	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Wetter years	95%	17%	23%	-6%	-40%	-25%	-21%	-12%	-11%	-21%	7%	-5%	23%
	90%	4%	0%	-18%	-37%	-27%	-32%	-14%	-13%	-27%	6%	19%	7%
	85%	5%	0%	-11%	-32%	-32%	-17%	-20%	-11%	-15%	3%	19%	6%
	80%	7%	-7%	-17%	-13%	-34%	-9%	-15%	-7%	-8%	1%	15%	5%
	75%	1%	-8%	-7%	-14%	-28%	-9%	-19%	-4%	-3%	1%	13%	4%
	70%	0%	-10%	13%	8%	-24%	-23%	-16%	-2%	2%	1%	15%	6%
	65%	-4%	-8%	15%	13%	-25%	-29%	-14%	-5%	6%	2%	15%	8%
	60%	-5%	-5%	16%	15%	-16%	-28%	-10%	-9%	8%	0%	14%	7%
	55%	-4%	4%	17%	17%	3%	-29%	-7%	-10%	12%	0%	13%	5%
	50%	-2%	7%	18%	20%	10%	-27%	-13%	-8%	14%	4%	11%	6%
	45%	0%	9%	19%	20%	13%	-25%	-13%	-6%	17%	6%	10%	7%
	40%	1%	12%	20%	22%	16%	-25%	-12%	-4%	22%	6%	9%	6%
	35%	3%	15%	21%	24%	19%	-24%	-8%	-4%	26%	7%	9%	7%
	30%	4%	16%	22%	27%	21%	-22%	-3%	-3%	27%	8%	10%	9%
	25%	6%	18%	24%	30%	24%	-18%	-1%	-6%	26%	9%	11%	10%
	20%	8%	20%	27%	38%	28%	-7%	2%	-4%	25%	11%	12%	12%
	15%	9%	22%	32%	50%	30%	7%	12%	12%	24%	13%	15%	15%
Drier years	10%	12%	26%	39%	63%	35%	25%	15%	19%	22%	16%	17%	17%
	5%	18%	30%	55%	88%	42%	23%	11%	16%	23%	19%	21%	17%
Median daily flow change within the simulated study period (cfs):		**29**	**66**	**105**	**103**	**64**	**-207**	**-89**	**-46**	**78**	**44**	**69**	**62**

Notes: Data are based on Reclamation's modeling of the No Action and Proposed Action alternatives for the POR.

Figure 4-5. Simulated change in Klamath River flows at Keno Dam under the Proposed Alternative compared to No Action in the period of record (October 1991-November 2022).

Figure 4-6 shows that under the No Action and Proposed Action alternatives, daily flows at the Iron Gate gage[22] would continue to vary based upon water year and month, with flows lowest in summer and early fall (July through October), then increasing to higher levels in March through May. This general pattern would continue to mimic a natural hydrograph with peak flows in the spring and base flows in late summer.



Notes: Data are based on Reclamation's modeling of the No Action and Proposed Action alternatives for the POR. The Coho Salmon preferred flow range depicted here is based on the literature summary in Reclamation (2024a). Because preferred flow range depends on the life history stage, and because multiple life history stages are present at some times of the year, the preferred flow range is defined narrowly here as the range best suited for all life stages. Specifically, it reflects the highest minimum preferred flow and the lowest maximum preferred flow of the life stages present. Note that a small number of days with flow rates above 10,000 cfs in January and February are not depicted here, for clarity.

Figure 4-6. Simulated daily flows at the Iron Gate gage under the No Action and Proposed Action alternatives during the period of record (October 1991-November 2022).

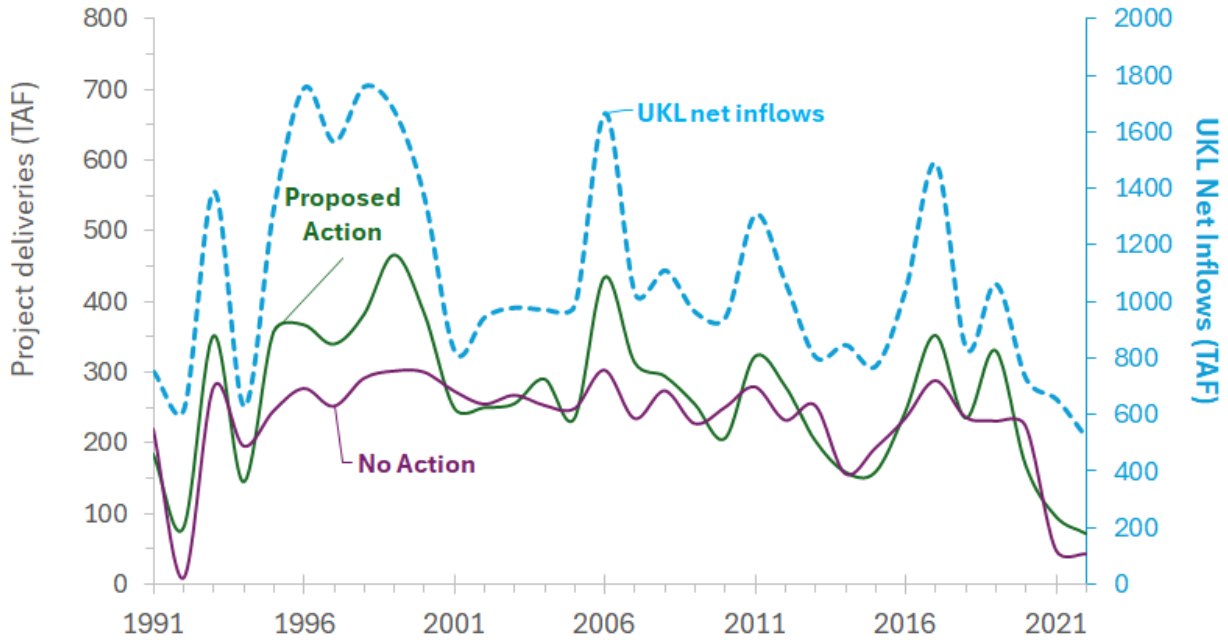
As shown in Figure 4-6, within a given month, minimum flows would be consistently higher under the Proposed Action Alternative relative to the No Action Alternative, while maximum flows would be lower under the Proposed Action Alternative than under No Action Alternative, except for September and October (Figure 4-6 also includes flow thresholds relevant to Coho Salmon, which are discussed in Section 4.4.1).

Pulse flows under the Proposed Action Alternative are non-prescriptive—i.e., their frequency, intensity, and duration of pulse flows are not specified in the Preferred Action Alternative—and thus cannot be quantitatively compared to the prescribed flushing flows included in the No Action

[22] Although the compliance point is being moved to the Keno Dam under the Proposed Action Alternative, this figure uses flows as modeled at the Iron Gate gage for purposes of comparisons with the general Coho Salmon preferred flow range values, which were based on flows at this gage.

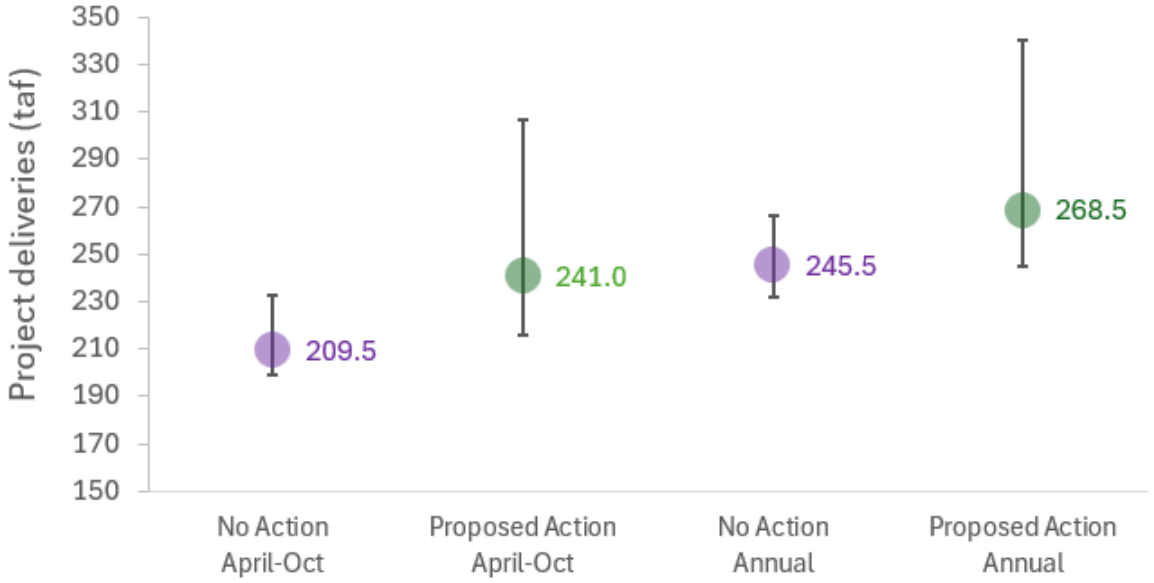
Alternative. Under the Proposed Action Alternative, the FFA accumulates over the winter and can be used at the discretion of downstream interests to meet flow augmentation or pulse flow objectives, which will generally be for the perceived benefit of anadromous fish. There are differences between the surface flushing flows prescribed under the No Action Alternative and the pulse flows that are provided for in the Proposed Action Alternative. The simulation of pulse flows (a.k.a. flushing flows) in the Proposed Action Alternative is intended only to demonstrate the flexibility and approximate magnitude that could be achieved by using the FFA volume to implement a single day peak release followed by downramping. The intent behind the FFA operation is that some amount of targeted winter flows would be deferred, and the volume accumulated in UKL for flexible use, either for pulse flows, augmented flows, or both. Thus, the pulse flow frequency, intensity, and duration is intentionally not specified, because these elements are not prescribed by the action. The FFA is to be available for use as directed by hydrologic conditions and downstream interests.

Project Diversions. Project diversions were simulated for each calendar year from 1991 through 2022 under both the No Action and Proposed Action alternatives. Figure 4-7 presents the results for both total annual diversions and for the spring/summer principal irrigation season (i.e., April through October) of each year. Particularly under the Proposed Action Alternative, Project deliveries would be higher in wetter years (as indicated by higher net inflows to UKL) and are similar to No Action deliveries in other years. Across all years, therefore, the Proposed Action Alternative would result in a higher volume of diversions than under the No Action Alternative (Figure 4-8).



Notes: UKL net inflows source: Reclamation (2024b). Project diversions data are from Reclamation's modeling of the No Action and Proposed Action alternatives for the POR.

Figure 4-7. Simulated total annual Project diversions from 1991-2022 under the No Action and Proposed Action alternatives.



Notes: Whiskers represent the 95% confidence intervals of the median. Data are based on Reclamation's modeling of the No Action and Proposed Action alternatives for the POR.

Figure 4-8. Simulated median Project diversions for the period 1991-2022 under the No Action and Proposed Action alternatives.

4.3.2.2 Water Quality

The Proposed Action Alternative is not expected to affect UKL water quality. Surface elevation is one of many factors that influences water quality parameters in UKL (Wherry and Schenk, 2024). Kann and Walker (2020) suggest an increased probability of suboptimal water quality in UKL outside a certain range of water surface elevations. Kann and Walker (2020) suggest water surface elevations near the long-term median have generally provided the lowest risk for poor water quality, through the avoidance of elevations at which the highest and lowest DO concentrations occur. Although the Proposed Action Alternative could result in generally lower surface water levels within UKL, it is unlikely that the difference in elevations would have noticeable impacts on water quality.

The Proposed Action Alternative is also not expected to materially impact water quality in the Upper Klamath River for the following reasons. The driving force for water quality in the Upper Klamath River is the water released from UKL. To the extent that Project diversions for irrigation purposes increase under the Proposed Action Alternative, return flows from Project lands into the Klamath and Lost rivers would also increase. However, the quality of water entering, within, and leaving the Keno Impoundment is largely related to the export of algal biomass from UKL and its subsequent decomposition within this reach (ODEQ, 2019). Because the water quality from UKL is not expected to change under the Proposed Action Alternative, water quality in the Upper Klamath River should not be impacted under the Proposed Action Alternative relative to the No Action Alternative.

4.3.2.3 Groundwater

As described in Section 3.2.4, groundwater, used to supplement surface water supplies for the Project, has seen a marked increase in pumping between 2000 and 2014, increasing from about 28,600 AF per year before 2001 to rates as high as 128,740 AF per year in 2010 (Gannett and Breen, 2015). During

this period, groundwater levels in and around the Project have declined by about 10 to 25 ft, due in part to the increased pumping (Gannett and Breen, 2015).

Under the Proposed Action Alternative, it is likely that groundwater pumping would continue to occur as under the No Action Alternative for the purpose of supplementing available Project surface water supplies in years when they are inadequate to meet the full demand of irrigated agriculture.

The U.S. Geological Survey (USGS), in coordination with Reclamation, OWRD, and other local entities, has conducted investigations attempting to quantify, through hydrologic models, the sustainable level of groundwater pumping within the Upper Klamath Basin and more specifically the Project (Gannett *et al.*, 2012; Wagner and Gannett, 2014). The models show differing amounts of supplemental groundwater that can be sustainably pumped within the Project depending on the constraints placed on pumping impacts (e.g., acceptable drawdown levels, reductions in groundwater discharge to surface water, or reductions in agricultural return flows).

These investigations indicate that to be sustainable, supplemental groundwater pumping within the Project should not exceed 54,000 AF of water (Gannett *et al.*, 2012; Wagner and Gannett, 2014). Reclamation will continue to rely on the state agencies with jurisdiction over groundwater to ensure that it is used in a sustainable manner.

Moreover, because Project diversions are generally expected to be higher under the Proposed Action Alternative than under the No Action Alternative, groundwater pumping is generally expected to be lower under the Proposed Action Alternative than under the No Action Alternative. This may result in reduced adverse impacts to groundwater resources under the Proposed Action Alternative relative to the No Action Alternative.

4.3.3 Summary of Impacts to Water Resources

The Proposed Action Alternative would not affect the total quantity of water in the Klamath River Basin relative to the No Action Alternative but would affect the distribution of water among the UKL, Klamath River flows, and Project diversions. In particular, the Proposed Action Alternative would result in moderate adverse effects on UKL in that UKL elevations would fall below the targeted minimums for habitat for listed species that have been established under the No Action Alternative at certain times of the year. This situation is not projected to occur under the No Action Alternative. The Proposed Action Alternative would increase median diversions during the primary irrigation season (April-October) by over 10% compared to the No Action Alternative, producing beneficial effects on Project diversions. Because large shortages exist under both alternatives compared to total water demand for the Project, the difference in demand for groundwater pumping would be negligible, resulting in continued adverse impacts to groundwater levels under the Proposed Action Alternative. Compared to the No Action Alternative, the Proposed Action Alternative would also result in slightly higher *minimum* Klamath River flow levels across all months, slightly higher *median* Klamath River flow levels in 9 months, and lower *median* Klamath River flow levels in 3 months (March through May), altogether resulting in negligible to minor adverse effects to the Klamath River. The Proposed Action Alternative is not expected to substantially affect water quality in the Klamath River.

4.3.4 Cumulative Effects

Other past, ongoing, and reasonably foreseeable future actions that may affect water resources in the study area are summarized in Appendix C, and include downstream dam removals, the reconnection

of ALB, non-project competing demands for groundwater, and changing climatic conditions that affect water availability and water temperature, among other factors. As described above, the Proposed Action Alternative impacts are anticipated to range from moderately adverse to beneficial on water resources relative to the No Action Alternative. Based on information available for this analysis, the Proposed Action Alternative is not expected to contribute substantially to short-term or long-term cumulative adverse impacts to water resources when analyzed in combination with other past, present, and reasonably foreseeable future actions.

4.4 Biological Resources

This section evaluates how and to what degree the No Action and Proposed Action alternatives could impact biological resources in the study area. Because the Proposed Action Alternative primarily affects the timing and distribution of water in the Project Area, this section is focused on potential impacts to fish, wetlands, and other riparian and aquatic organisms.

4.4.1 No Action Alternative

Under the No Action Alternative, Reclamation would not implement the Proposed Action Alternative. As described in Section 4.3.1, surface water management of the UKL by the Project would continue as it has been to date under the No Action Alternative, although adaptations would need to be made in response to other cumulative ongoing actions, including the reconnection of ALB, updated bathymetry for the UKL, as well as adjustments related to the removal of the dams below Keno Dam (see Section 2.1.2).

A variety of factors, including Project structures, natural mortality, and predation, would affect migration and survival of anadromous fish species as well as endangered suckers under the No Action Alternative. Adult fish migration would continue to be affected by dam passage, predation, and temperature and flow conditions. The nature of the effects of dam passage on migratory fish, however, are different than they were prior to the removal of the dams downstream of Keno Dam. Keno Dam is now the principal barrier to further migration of anadromous species. The KRRC Environmental Impact Statement found that dam removal would likely substantially increase the number of fall-run Chinook and Coho Salmon spawners over a 50-year period in the Klamath Basin (FERC, 2022a).

As noted above, Keno Dam currently is a barrier to fish passage. The dam has a fish ladder, but to operate optimally, it requires repairs, upgrades, and maintenance. Reclamation is collaborating in a potential effort to improve fish passage at Keno Dam and to evaluate fish screen needs (to reduce entrainment in Project canals). These activities, if pursued, will be assessed on a case-by-case basis and therefore are not evaluated in this Environmental Assessment.

Simulations of the No Action Alternative suggest that UKL elevations would generally meet targeted elevation levels for Lost River and Shortnose suckers, consistently exceeding the minimum target condition of 4,138 ft year-round and exceeding the spawning target condition of 4,142 ft in most years. The No Action Alternative is expected to provide a sufficient quantity and quality of habitat for adult Lost River and Shortnose suckers in UKL, including wetland habitat surrounding UKL. The No Action Alternative would likely result in the continued poor survival of juvenile suckers in UKL and lack of recruitment into the adult sucker population. Many factors contribute to poor juvenile sucker

survival in UKL including parasites, disease, poor water quality, fish and bird predation, and interactions with non-native species.

Simulations of the No Action Alternative suggest that Klamath River flows at the Iron Gate gage would frequently fall below the approximate preferred flow range for Coho Salmon, particularly from July through October (Figure 4-6). Across the POR, simulations suggest that Klamath River flows at Iron Gate gage would not be within the approximate preferred flow range for Coho Salmon for about 75% of days. Lower flows generally are associated with lower amounts of habitat available for salmon and are also associated with higher water temperatures and a higher probability of disease transmission.

Under the No Action Alternative, impacts of flow on water temperature, DO, and suspended sediments would likely result in short-term seasonal adverse impacts to non-federally listed aquatic species, such as Pacific Lamprey, Redband Rainbow Trout, Steelhead, and Coastal Cutthroat Trout. Fish passage at Keno Dam would continue to limit upstream and downstream movement of fish impacting their range, distribution, and genetic diversity. However, managed pulse flows to limit disease would be more predictable following dam removal, providing benefit to Steelhead and Redband Rainbow Trout.

Under the No Action Alternative, spring/summer deliveries to Lower Klamath NWR would be made from UKL only if elevation targets were met, and consistent water deliveries would not be expected to occur. In fall/winter, Lower Klamath NWR would receive an allocation of 11,000 AF from UKL. Tule Lake NWR would not have a dedicated Project Supply under the No Action Alternative.

In the last decade or so, the amount of water provided by the Project has been far below what these NWRs historically received, a situation that has been exacerbated by drought such that at times, the NWRs' wetlands have essentially gone dry (USFWS and KBNWRC, 2016; Swearingen and Rash, 2023). These conditions would be expected to continue under the No Action Alternative. Birds at these refuges often experience disease outbreaks, which have resulted in bird die-offs during the summer(Audubon California, 2020), a circumstance that is potentially aggravated by insufficient water. Overall, insufficient wetland habitat in these NWRs would continue to adversely affect aquatic biota and birds that depend on aquatic habitat under the No Action Alternative.

4.4.2 Proposed Action Alternative

The effects of the Proposed Action Alternative on biological resources would be a function of the quantity, quality, and timing of water that would be available to aquatic species and riparian and aquatic habitats. As such, the differential effects of the Proposed Action Alternative on simulated UKL elevations, Klamath River flows, and refuge diversions, are the basis for evaluating the differential effects of the Proposed Action Alternative compared with the No Action Alternative over the POR.

4.4.2.1 Federally Listed Aquatic Species

Lost River and Shortnose Suckers. With respect to Lost River and Shortnose suckers, this Environmental Assessment focuses on UKL, which supports the largest remaining populations of these species.[23] Generally speaking, higher UKL elevations would benefit Lost River and Shortnose

[23] Endangered suckers have inhabited other surface waters in the Project Area, including Clear Lake, Gerber Reservoir, the Keno Impoundment, and Tule Lake sumps. Because the Proposed Action would not affect Reclamation's operations of Clear Lake or Gerber reservoirs, the sucker status in these waterways is expected to be similar to those seen in the past

suckers as higher elevations result in more deepwater habitat (which is preferred by adult suckers in late summer) and more lakeshore spawning and rearing habitat. As described in Section 4.3.2, however, the Proposed Action Alternative is projected to result in generally lower UKL elevations throughout the year than would occur under the No Action Alternative.

Suckers spawn at shoreline springs in UKL and in tributaries. In UKL, an elevation of 4,142 ft is considered adequate to provide sufficient depth for spawning (Burdick *et al.*, 2015; Reclamation, 2024a). Most sucker spawning occurs from March through June, although there is some early spawning in February. Table 4-1 shows that an elevation of 4,142 ft would be reached in a lower proportion of years under the Proposed Action Alternative than under the No Action Alternative. Despite these decreases, most years provide spring lake elevations of 4,142 ft or greater and would be expected to provide sufficient depths for lakeshore spawning sucker populations (Reclamation, 2024a) during the majority of the critical embryo and larval development period.

Table 4-1. Percentage of years in the period of record (October 1991-November 2022) where Upper Klamath Lake elevation is simulated to exceed 4,142 feet at the end of the indicated month.

Month	No Action Alternative	Proposed Action Alternative
February	74%	32%
March	84%	68%
April	81%	71%
May	77%	61%
June	61%	42%

While reaching the specified surface elevations in UKL is critical to preserve shoreline spawning habitat for Lost River Suckers (Burdick *et al.*, 2015), current data suggests that adult sucker survival does not vary with environmental factors such as lake surface elevations or water quality (Krause *et al.*, 2022).

Shallow, near-shore areas, particularly with emergent vegetation, provide habitat for larval suckers, especially Shortnose Suckers (USFWS, 2008). The amount of emergent vegetation inundated at least 1-foot decreases with lake elevations such that at 4,140.8 ft, about half of emergent wetland habitat is available. In other words, the amount of nursery habitat available for larval suckers is affected by lake elevations (Dunsmoor *et al.*, 2000; Terwilliger, 2006; Markle and Dunsmoor, 2011). Larval suckers begin to appear in UKL in March, with peak abundance occurring from mid-May to mid-June. By mid-July, larvae transform to juveniles (Buchanan *et al.*, 2011). Table 4-2 shows that an elevation of 4,140.8 ft would be reached in a lower proportion of years under the Proposed Action Alternative than under the No Action Alternative. However, wetland availability for developing sucker larvae in the Proposed Action Alternative would still be adequate (Reclamation, 2024a).

Table 4-2. Percentage of years in the period of record (October 1991-November 2022) where Upper Klamath Lake elevation is simulated to exceed 4,140.8 feet at the end of the indicated month.

Month	No Action Alternative	Proposed Action Alternative
March	100%	90%
April	94%	90%
May	94%	90%

under both alternatives. The Tule Lake sumps dried out in 2020-2022, and under both alternatives, it is unclear when the sumps will have enough water to support suckers again (Reclamation, 2024a). Data on sucker populations in the Keno Impoundment are limited but suggest low numbers of individuals (Reclamation, 2024a).

Month	No Action Alternative	Proposed Action Alternative
June	90%	77%
July	90%	77%

While adequate for larval survival and development, the lower surface elevations in UKL under the Proposed Action Alternative would lead to a decrease in suitable habitat for sucker larvae in the spring and may increase the risk of desiccation and reduced habitat. [24] Both lethal and sub-lethal impacts related to habitat reduction on sucker larvae would therefore be anticipated within UKL as a result of the Proposed Action Alternative.

In addition to reducing habitat quantity, lower surface elevations in UKL as a result of the Proposed Action Alternative would be expected to result in additional adverse effects on suckers. For adults, these effects include increased risk of disease and parasites, increased risk of entrainment, and increased risk of avian predation. For eggs and larvae, reduced UKL elevations would be expected to increase entrainment under the Proposed Action Alternative. For juveniles, the effects of lower UKL surface elevations would include increased risk of avian predation, increased risk of disease, and increased entrainment (Reclamation, 2024a). If redundant sucker populations are established by USFWS in Tule Lake sumps and Lower Klamath Lake, there could be a net species-level benefit for suckers. However, this would not specifically address the UKL sucker essential Tribal Treaty resources concerns of the Klamath Tribes.

Coho Salmon. Coho Salmon make use of the Klamath River and its tributaries for parts of their life cycle, including spawning, incubation, and juvenile rearing. Certain minimum flow levels are essential to provide adequate habitat. Although habitat use and flow needs are a function of life stage, as discussed in Chapter 6 of the Biological Assessment (Reclamation, 2024a), in general, higher flow levels tend to result in higher amounts of salmon habitat and improved water quality (e.g., reduced temperatures and higher DO levels). Notably, for some life stages, flows can be too high: embryos may be washed away if flows exceed approximately 5,000 cfs in the reaches immediately downstream of IGD (depending on sediment composition and other factors) (Reclamation, 2024a).

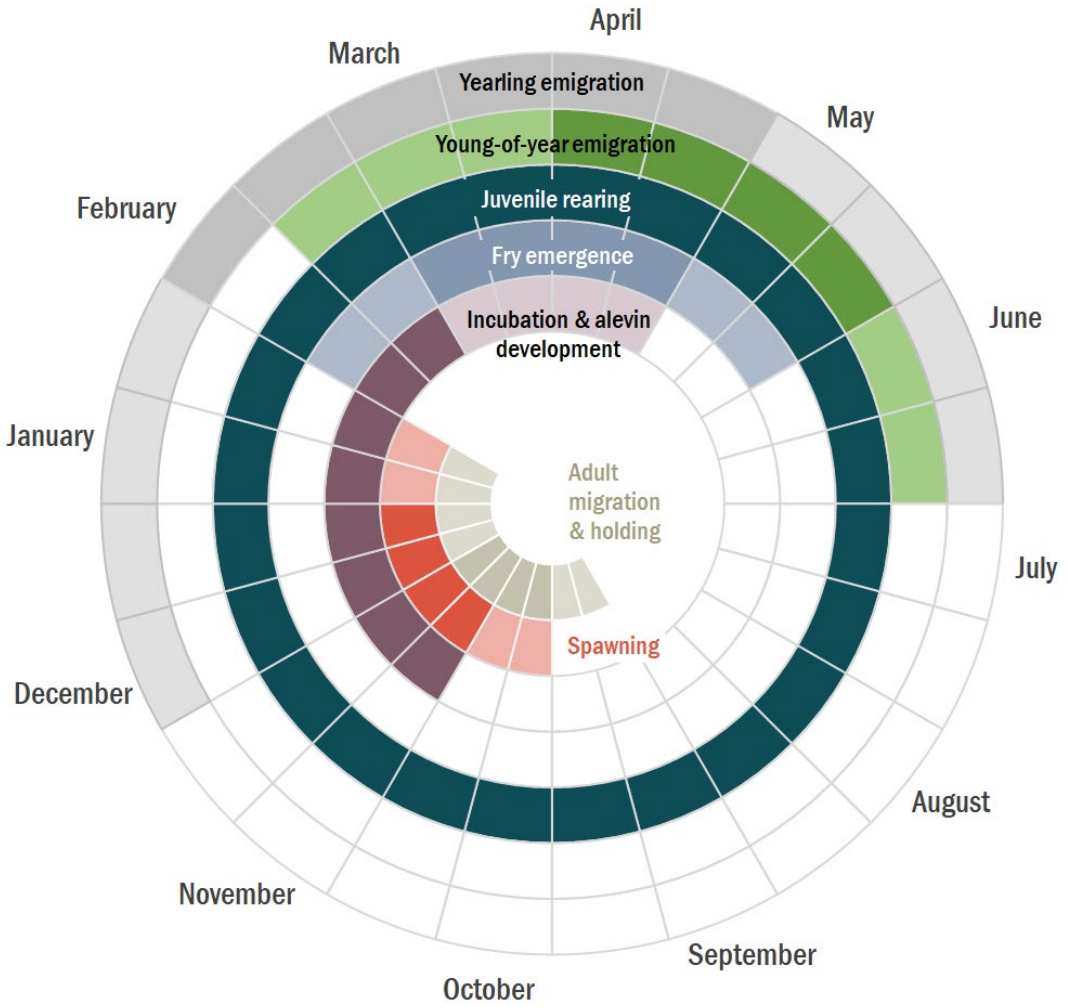
Under both the Proposed Action and No Action alternatives, short-term high flows (above 6,000 cfs) may be discretionarily implemented to curtail the risk of disease. As discussed in Section 2.4, the No Action Alternative would prescribe the parameters for such flows, while the Proposed Action Alternative would allow for such flows but in a more flexible manner that would not specify their frequency, intensity, or duration. The extent to which the use of short-term high flows under the Proposed Action Alternative might differentially affect Coho Salmon compared to the prescribed flushing flows that would occur under the No Action Alternative, is uncertain.

As described in Section 4.3.2, relative to the No Action Alternative, the Proposed Action Alternative is projected to produce slightly higher (30-110 cfs) median daily flow rates at Keno Dam in most months and lower median daily flow rates (40 to 210 cfs) in March through May (Figure 4-4 and

[24] Super-imposition refers to spawning that occurs on top of a previous spawner's redd. This can occur with nest-digging spawners where, if spawning habitat is insufficient for the population (i.e., density dependence), later spawning fish will dig up and/or spawn over the top of previous spawners.

Figure 4-5). Across the POR, simulations suggest that Klamath River flows would not be within the (approximate) preferred flow range for Coho Salmon for about 73% of days.[25]

The small increases in flows are likely to result in seasonal impacts on Coho Salmon that may range from negligible to beneficial. The reduction in flows in March through May could result in adverse effects to Coho Salmon in the future to the extent that it affects spawning. Specifically, during a median water year as shown in Figure 4-5, these flow rates would translate to a decrease in flows at Keno of about 27% (March), 13% (April), and 8% (May) relative to the No Action Alternative. These months coincide with peak periods of juvenile outmigration in Coho Salmon (Figure 4-9). Although the 2021 Biological Opinion (NMFS, 2021) reported that only a small number (fewer than 10) Coho Salmon had been spawning in the mainstem and future spawning in the mainstem downstream of the former IGD may be limited due to its removal. If spawning were to occur in the mainstem following dam removal, lower flows during these months could reduce embryo survival in redds and alevin emergence. *C. shasta* disease prevalence may also be increased by lower flows.



Notes: data from National Research Council (2004) and FERC (2022a). Within a ring, darker colors indicate peak periods for a life stage.

Figure 4-9. Summary of temporal life stage domains for Klamath River Coho Salmon.

[25] This finding is based on comparing estimated flows at the Iron Gate gage to flow thresholds that are based on this same location. Flow thresholds specific to Keno Dam are not available.

Differences in daily flow rates can also be translated into estimated effects on the availability of Coho Salmon fry and parr habitat (termed weighted usable area, or WUA).

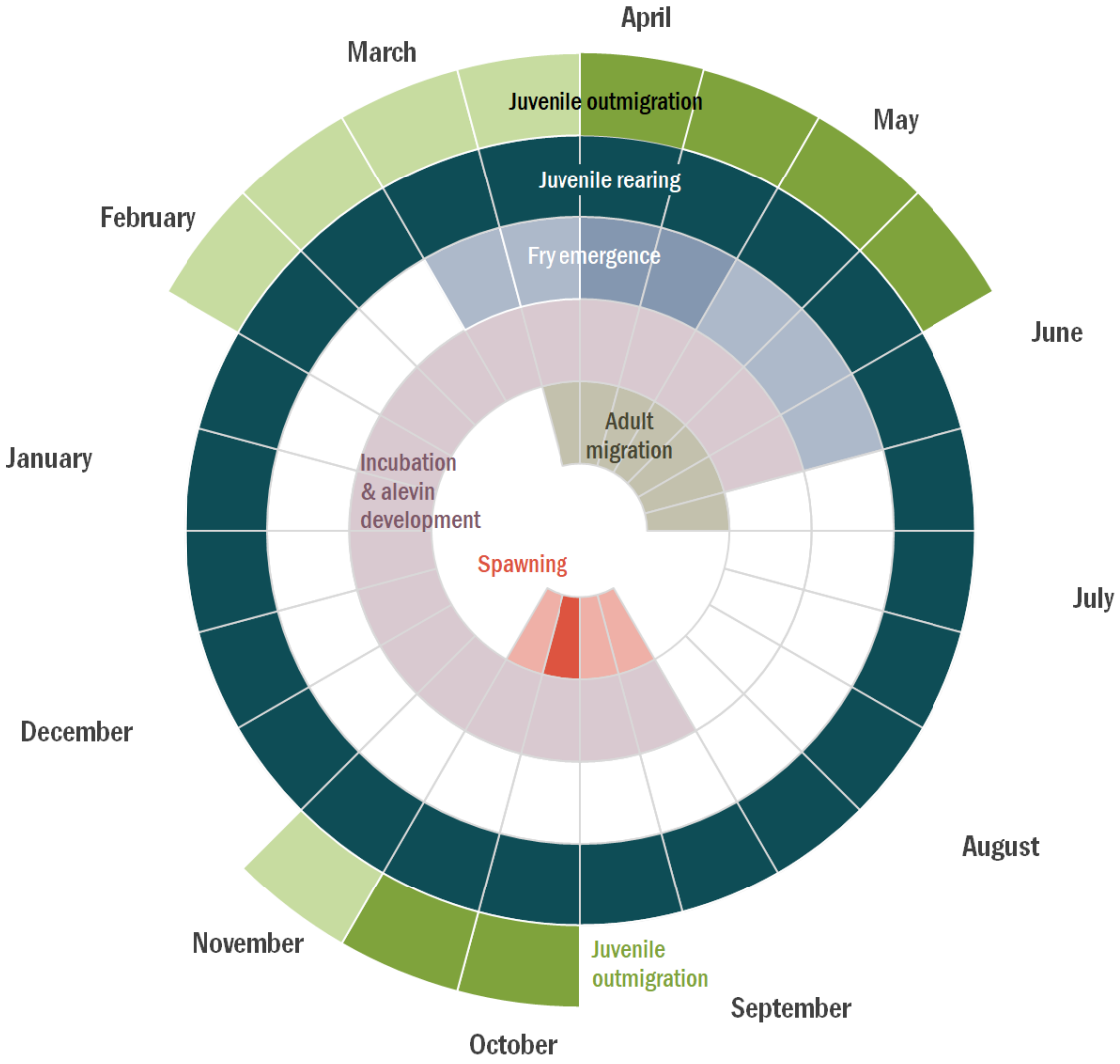
The 2024 Biological Assessment (Reclamation, 2024a) presents Coho Salmon habitat availability curves as a function of mainstem flow rate for three locations downstream of the location of the former IGD: Tree of Heaven Campground, Beaver Creek, and Klamath Community Center. Under the Proposed Action Alternative, the Tree of Heaven Campground and Klamath Community Center locations are anticipated to reach 80% of the maximum WUA on 90% and 81% of days, respectively, over the POR. Beaver Creek would be anticipated to fare less well, reaching the 80% threshold on only 9% of days over the POR (Reclamation, 2024a).

Finally, ramping rates in the Klamath River below Keno Dam would largely remain consistent under the Proposed Action Alternative relative to what would be observed under the No Action Alternative. As such, changes in ramping rates are not expected to differentially impact Coho Salmon or other biological resources under the Proposed Action Alternative compared to the No Action Alternative.

Southern Resident Distinct Population Segment of Killer Whales. Potential effects of the Proposed Action Alternative on the SRKW would occur by affecting the availability of Chinook Salmon, which are a major component of SRKW diet. As stated in the NMFS 2021 biological opinion (NMFS, 2021 Page 254):

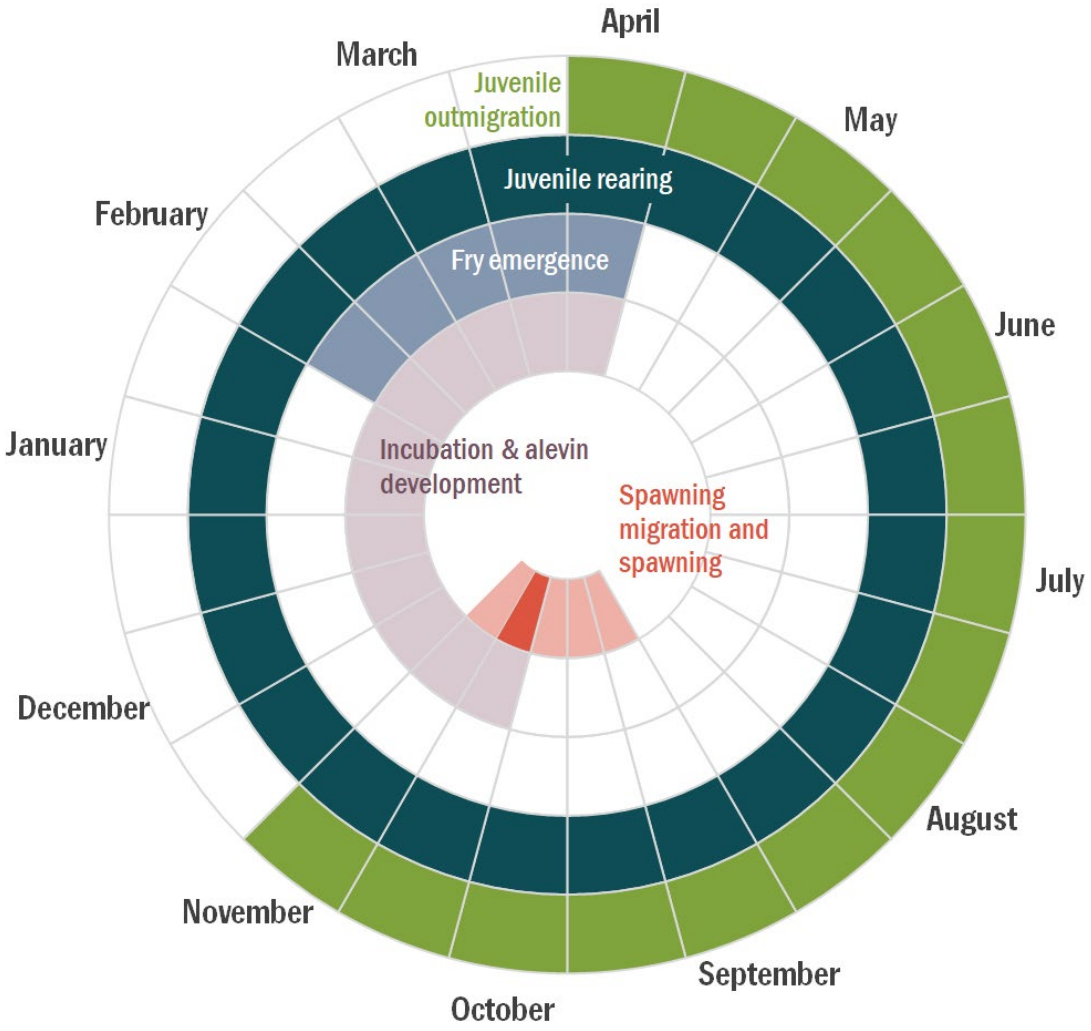
> *Cumulative effects on Klamath River basin Chinook Salmon in the freshwater environment are likely to be similar to those described for SONCC Coho Salmon because…Chinook and coho share similar life histories and are thus likely to be affected by cumulative effects in similar ways. In turn, these result in effects to prey resources of SRKWs in the action area …While many of the cumulative effects expected to affect Coho Salmon will also be relevant to Chinook Salmon, there are some important differences between the species that need to be considered. First, Chinook Salmon and Coho Salmon exhibit some differences in life history…The impact of these life history differences between Chinook and Coho Salmon is minor, as they have similar freshwater habitat requirements for spawning, egg incubation, and rearing, so threats for one species are generally likely to be threats for the other. However, one important difference between the two species that is relevant to the effects of the proposed action is that Chinook Salmon are expected to migrate significantly farther upstream once the dams are removed than are Coho Salmon. [Following dam removal] Chinook Salmon are expected to repopulate over 303 miles of habitat upstream of Iron Gate Dam…, while Coho Salmon are expected to repopulate up to 76 miles of habitat upstream of Iron Gate Dam…. NMFS coordinated with USFWS regarding activities that were reasonably certain to occur in the areas above Spencer Creek that would impact Chinook Salmon future habitat, but not Coho Salmon, and did not identify activities that were likely to have an impact on Chinook Salmon.*

That said, Chinook Salmon, which are not a listed species in the Klamath Basin, may be more vulnerable to actions that affect flows in the mainstem Klamath River than Coho Salmon due to differences in their life history. For one, unlike Coho Salmon, Chinook Salmon typically spawn in larger waterways including the Klamath River mainstem. The spring run of Chinook has its peak spawning migration period between April and mid-June (Figure 4-10), a timeframe that coincides with the period when flows are most reduced under the Proposed Action Alternative relative to the No Action Alternative. The life stages present during the March-through-May period for fall-run Chinook include incubating eggs/alevins, emerging fry, rearing juveniles, and outmigrating juveniles (Figure 4-11). Reclamation has determined that SRKW may experience minor adverse effects as a result of decreased Chinook Salmon availability as a prey species.



Notes: Data from Stillwater Sciences (2009). Within a ring, darker colors indicate peak periods for a life stage.

Figure 4-10. Summary of temporal life stage domains for Klamath River spring-run Chinook Salmon.



Notes: data from Leidy and Leidy (1984), National Research Council (2004), and Stillwater Sciences (2009). Within a ring, darker colors indicate peak periods for a life stage.

Figure 4-11. Summary of temporal life stage domains for Klamath River fall-run Chinook Salmon.

Differences in daily flow rates may affect WUA (habitat) availability for Chinook Salmon. The Biological Assessment notes that the WUA analysis for Coho Salmon can inform effects of the Proposed Action Alternative on Chinook and POR.

Other Federally Listed Aquatic Species. Due to the relatively small contribution of the upper basin to the overall flow in the Lower Klamath River, no impacts to southern DPS of Green Sturgeon or the southern DPS of Pacific Eulachon are expected to be meaningfully measured, detected, or evaluated. Reclamation has also found that the Proposed Action Alternative may have minor to moderate effects Bull Trout, and that there would be no impact on individuals or populations of Oregon Spotted Frog (Reclamation, 2024a). As for the candidate species, Northwestern Pond Turtle, little is known about its habitat use within the Project's boundaries. The impacts of Project water operations on individual turtles are unclear. Routine maintenance operations could potentially harm

an unknown number of hatchings dispersing from nests and on females going on land to nest (Reclamation, 2024a). Reclamation concludes that the Proposed Action Alternative may adversely impact candidate species Northwestern Pond Turtle.

4.4.2.2 Other Aquatic Species

The following paragraphs consider the potential effects of the Proposed Action Alternative on several native fish species of cultural and/or recreational importance.

Pacific Lamprey. The Proposed Action may result in short-term, seasonal increases in suspended sediment, which could have a short-term adverse effect on Pacific Lamprey in the Klamath River due to increased stress and impaired homing ability. The Proposed Action's slightly higher flows, except in March through May, are likely to result in slightly lower temperatures and higher DO, which may bring marginal, seasonal benefit to Pacific Lamprey.

Redband Rainbow Trout. Lower UKL lake elevations may result in minor adverse effects to Redband Trout, limiting access to spawning and rearing habitat as well as thermal refugia as summer temperatures and DO levels exceed Redband optima.

Steelhead. The Proposed Action's slightly higher flows, except in March through May, are likely to result in slightly lower temperatures and higher DO, which may bring marginal, seasonal benefit to Steelhead. However, slightly lower spring flows may have negative effects on parr outmigration cues and timing. Also, short-term, seasonal increases in suspended sediment could have a short-term adverse effect on Steelhead, particularly eggs through parr life stages, due to deposition on redds and rearing habitat As with other salmonid species (i.e., Coho and Chinook Salmon), the relative disease-mitigation efficacy of the flexible high flow pulses under the Proposed Action Alternative, compared to the prescribed pulses under the No Action Alternative, is uncertain.

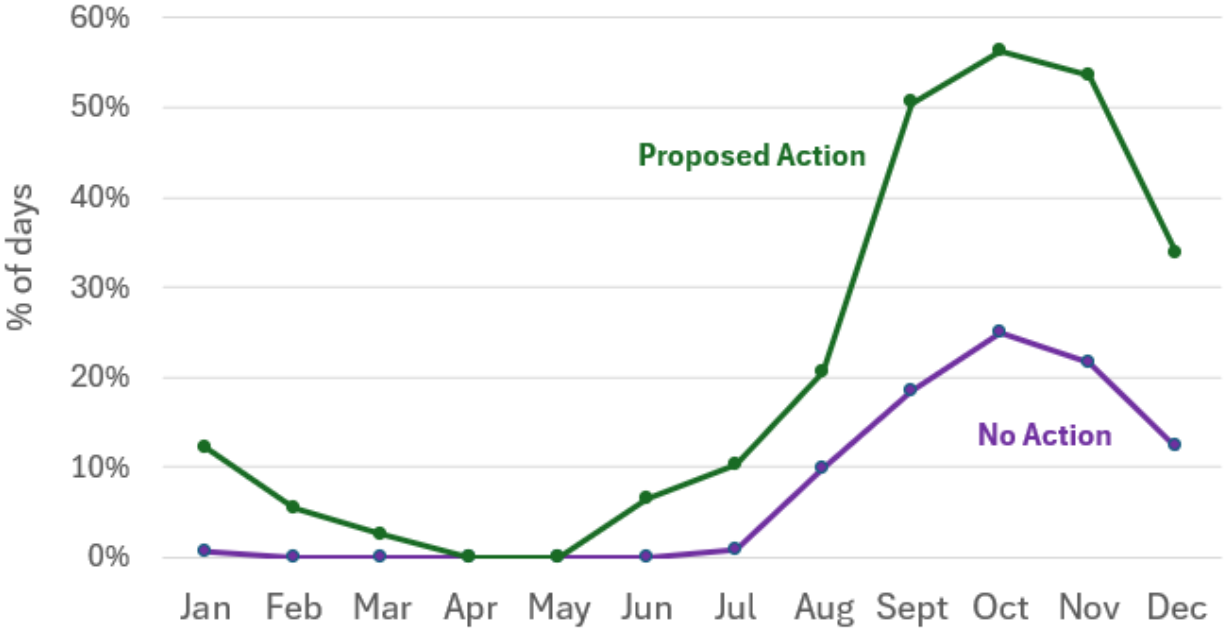
Coastal Cutthroat Trout. Information on Coastal Cutthroat Trout in the Klamath River is limited. As a result, there is no direct documented evidence of the Project's effect on Cutthroat Trout populations in the Klamath River. However, higher flows, and their effect on temperature and DO, are likely to impact Coastal Cutthroat Trout similarly to other salmonids (i.e., Redband Trout, Steelhead, Coho, and Chinook Salmon). They are also likely to have a similar minor adverse effect on juvenile outmigration in the spring.

4.4.2.3 Wetlands and Riparian Habitats

Upper Klamath Lake. As shown in Figure 4-12, under both the No Action and Proposed Action alternatives, wetland areas around UKL would periodically be without standing water, i.e., dry (due to the UKL elevation being below 4,139.5 ft), often for an extended period. Under the No Action Alternative, wetland areas around UKL are projected to be without standing water at the end of September in 33% of all years, while under the Proposed Action Alternative, this figure would increase to 51% of all years (and would be higher in October).

Specifically, when UKL elevation falls below 4,139.5 ft, the Hanks Marsh and Upper Klamath Marsh units of Upper Klamath NWR (comprising approximately 15,000 acres) would receive less water and may have no standing water. Wet meadow habitat within the ALB (9,796 acres), which is located north of the Upper Klamath Unit of the Upper Klamath NWR, is also likely to be affected by UKL

water levels once the dikes separating it from UKL are removed and it becomes hydrologically reconnected to the lake, which is anticipated to occur by the end of 2024.



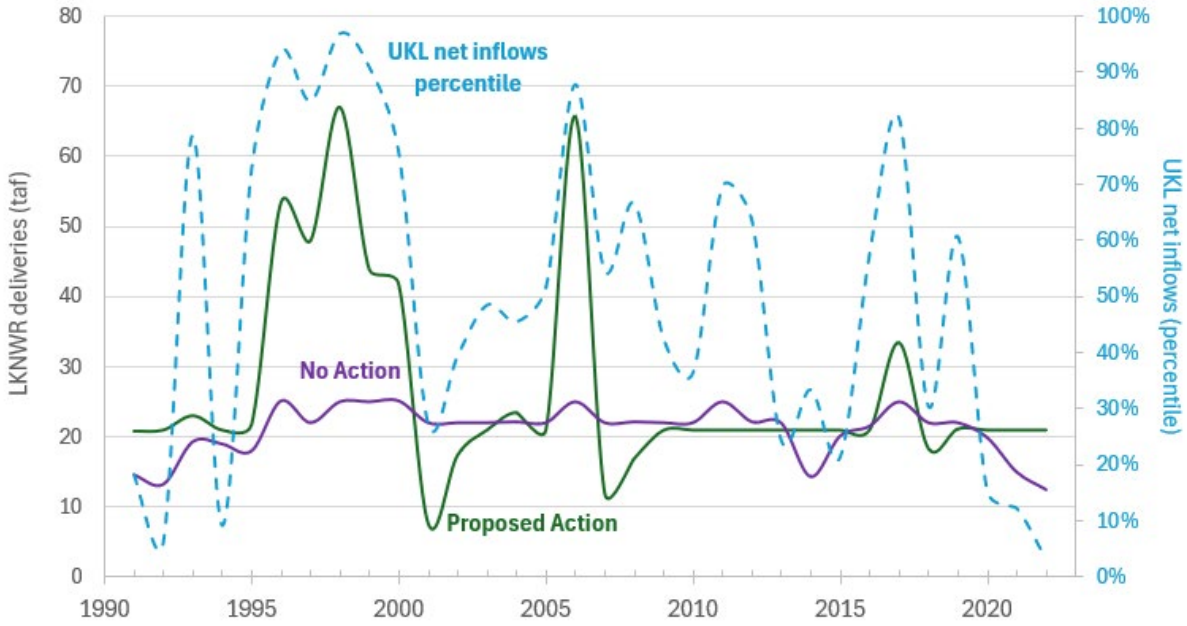
Notes: Data are based on Reclamation's modeling of the No Action and Proposed Action alternatives for the POR.

Figure 4-12. The proportion of days, by month, that Upper Klamath Lake elevation under the No Action and Proposed Action alternatives would fall below 4,139.5 feet.

Tule Lake and Lower Klamath Lake National Wildlife Refuges. As described in Chapter 3, the method of calculating deliveries to Lower Klamath and Tule Lake NWRs would differ between the No Action and Proposed Action alternatives. Under No Action, spring/summer deliveries to Lower Klamath NWR would be made from UKL only if elevation targets were met, and consistent water deliveries were not expected to occur. In fall/winter, Lower Klamath NWR would receive an allocation of 11,000 AF from UKL. Tule Lake NWR would not have a dedicated project supply under the No Action Alternative. Under the Proposed Action Alternative, the NWRs would jointly receive up to 43,000 AF from UKL each year, plus Lost River water in the event of flood control spilling.

In most years, water deliveries to Lower Klamath NWR under the Proposed Action Alternative would be similar to, or higher than, under the No Action Alternative (Figure 4-13). This comparison, however, is imprecise because of differences in the modeling approach: under the No Action Alternative, Lower Klamath NWR deliveries were considered to be only what was delivered through the Ady Canal. The Proposed Action Alternative, however, simulates deliveries to Lower Klamath NWR that include both Ady Canal inputs as well as inputs to Lower Klamath NWR from Tule Lake if its sumps are at capacity.

Differences in total water deliveries to the NWRs would be most marked between the No Action and Proposed Action alternatives in years of particularly high net inflows to UKL. In some of these wetter years, the Proposed Action Alternative could provide materially more water to Lower Klamath NWR than would occur under No Action (Figure 4-13).



Notes: UKL net inflows source: Reclamation (2024b). Data are based on Reclamation's modeling of the No Action and Proposed Action alternatives for the POR.

Figure 4-13. Simulated annual total deliveries to the Lower Klamath National Wildlife Refuge under the No Action and Proposed Action alternatives.

The model uses two sources of water for the refuges: UKL and Lost River. Lower Klamath NWR is guaranteed approximately 20 TAF of UKL Supply if needed to maintain Unit 2 at a certain elevation. If it is not needed in a wet year, like 2001, then the volume that is not needed for the refuge can be converted to Project Supply. The model's first priority is to use winter Lost River water to fill the Tule Lake sumps. Once the sumps are full, then the Lost River water can go to Lower Klamath NWR through Ady Canal by way of the LRDC or through D Plant. If Tule Lake sump elevations begin the year on the low side, as in 2019, 2011, and 2012, they can absorb a larger volume of the Lost River water than in other years. However, Lost River is a much more intermittent supply for Lower Klamath NWR than UKL, thus causing some of the variability.

Another way that Lower Klamath NWR is dependent on UKL is flood control spills. These can be diverted to Lower Klamath NWR. So, there are a few different ways that deliveries to Lower Klamath NWR can vary widely in wet years.

Across all years in the POR, median deliveries to Lower Klamath NWR would be similar: about 21,000 AF under the Proposed Action Alternative, and 22,000 AF under the No Action Alternative. Average deliveries, however, would be higher under the Proposed Action Alternative (27,000 AF) compared with 21,000 AF under the No Action Alternative. Total annual deliveries under the Proposed Action Alternative range from 8,000 AF to 67,000 AF, while total annual deliveries range from 12,000 AF to 25,000 AF under the No Action Alternative.

It is not possible to compare deliveries to Tule Lake NWR under the No Action and Proposed Action alternatives because the model structure for the No Action Alternative does not encompass Tule

Lake. Under the Proposed Action Alternative, however, median deliveries to Tule Lake sumps over the POR are estimated at 62,000 AF, with a range of 15,000 AF to 129,000 AF per calendar year.

Because wetlands (permanent or seasonal) generally require at least 2.5 AF per acre per year to maintain wetland vegetation (Stannard *et al.*, 2013), the above quantities of water translate, very roughly, into the numbers of acres indicated in Table 4-3.[26]

Table 4-3. Estimated number of wetland acres supported by Project deliveries within the period of record (October 1991-November 2022).

Value	Lower Klamath NWR No Action[(b)]	Lower Klamath NWR Proposed Action[(c)]	Tule Lake NWR[(a)] Proposed Action
10th percentile	5,771	6,828	11,796
Median	8,820	8,400	24,796[(d)]
90th percentile	10,064	20,732	38,197[(d)]
Estimated total wetland area in Refuge (assuming adequate water)	24,000	24,000	13,240

Notes:
a. No data are available to calculate deliveries to this refuge under the No Action Alternative.
b. Based on refuge deliveries through the Ady Canal.
c. Based on deliveries including those through the Ady Canal plus inputs from Tule Lake if its sumps are at capacity.
d. These numbers exceed the estimated total wetland area and therefore overestimate the number of acres supported by the water deliveries.

The Proposed Action Alternative would generally provide a similar amount or somewhat more water to Lower Klamath NWR than the No Action Alternative, but like the No Action Alternative, the volume of water delivered to Lower Klamath NWR under the Proposed Action Alternative would be inadequate to meet the refuge's needs under most hydrologic conditions. For instance, the Proposed Action Alternative provides a median volume of 21,000 AF to this refuge, while in the 1980s and most of the 1990s, the Lower Klamath NWR received over 100,000 AF annually. In these more recent years, constraints on the average annual volume of water available to the Project have limited USFWS' ability to manage the NWR to provide a variety of vegetative communities, particularly for wetland-dependent species. Across all years of the POR, the Proposed Action Alternative would provide an estimated median increase of 481 acres of wetland when compared to the No Action Alternative, although across all years in the POR, the 10th percentile represents a *decrease* of 2,033 acres, and the 90th percentile represents an *increase* of 11,030 acres.

Under the Proposed Action Alternative, Tule Lake NWR would receive the water it needs to support all its wetlands in the majority of years. Overall, the Proposed Action Alternative is expected to provide a higher quantity and a more reliable amount of wetland habitat in these NWRs than would be the case under the No Action Alternative.

4.4.2.4 Migratory Birds

The effects of the No Action and Proposed Action alternatives on migratory birds are directly related to the effects of these alternatives on wetland areas. When dry, wetland areas do not support the submergent vegetation, invertebrates, and fish populations that serve as an important food source for wetland-dependent species, particularly waterfowl and other migratory birds. Wetland areas that lack

[26] Translating volumes of inflows into acres of wetland with greater accuracy is requires knowledge of the wetlands' bathymetry and is beyond the scope of this document.

standing surface water also cannot serve as a refuge for molting for migrating waterfowl, or temperature-stressed aquatic life.

With respect to UKL, when wetland areas are dry, the open water areas would still provide food and habitat for waterfowl, particularly diving ducks such as canvasback, redheads, and ringnecks; however, wetland-dependent waterfowl (mallards, pintails widgeons, Canada geese) would be without access to suitable habitat. During such times, migratory birds would also lose access to emergent vegetation that is crucial during periods of inclement weather when conditions on the open lake are inhospitable (USFWS and KBNWRC, 2016).

The Proposed Action Alternative would affect the availability of wetland habitat in Tule Lake and Lower Klamath NWRs as described above. In most years, excluding the driest, Lower Klamath NWR is expected to receive similar or more water than it would under the No Action Alternative (although as noted above, precise comparisons are not possible due to differences in the No Action and Proposed Action Alternative models). Under the Proposed Action Alternative, Tule Lake NWR would be included as part of the overall dedicated NWR supply.

As stated above, the Proposed Action Alternative is expected to provide a higher quantity and reliability of wetland habitat in these refuges than would be the case under the No Action Alternative. More water to the refuges would result in a corresponding increase in food and habitat for wetland-dependent migratory birds in the refuges. More water would also reduce the risk of potential waterfowl diseases, particularly avian botulism.

4.4.3 Summary of Impacts to Biological Resources

The effects of the Proposed Action Alternative on biological resources are connected with the effects on surface water resources. Relative to the No Action Alternative, adult suckers inhabiting UKL will experience minor to moderate adverse effects with respect to habitat availability during the spawning season. Substantial population-level declines are anticipated for suckers in UKL due to senescence and will likely occur regardless of surface elevations. Additional minor effects of lower surface elevations in UKL to eggs and juveniles will occur with an increased risk of desiccation, disease, entrainment, and/or avian predation, depending on the life stage. An increase in available wetland habitat in Barnes-Agency is expected to provide additional habitat for juvenile suckers (USFWS, 2023). If redundant populations are successfully established in the Tule Lake and Lower Klamath NWRs, the cost of lower surface elevations in UKL in exchange for water in Tule Lake sumps and Lower Klamath may be a net benefit to the species. Alternatively, lower surface elevations in UKL could result in fewer suckers showing up to spawn at east side springs and spending less time at spawning grounds (Burdick *et al.*, 2015). Further, additional wetland habitat in ALB will also provide habitat for piscivorous fish and birds, and ideal conditions for parasites and disease. For Coho Salmon, the expected effects of the Proposed Action Alternative are expected to be minor adverse compared to the No Action Alternative, while impacts to the unlisted Chinook would be moderate and adverse. Reclamation has determined that SRKW may experience minor adverse effects as a result of decreased prey availability (Chinook Salmon). Reclamation has determined that the Proposed Action Alternative may affect, but is not likely to adversely affect, other federally listed aquatic species or their designated critical habitats with the exception of the candidate species Western Pond Turtle, which may experience adverse effects but about which little is known of abundance and distribution within the Project's boundaries. For other non-listed aquatic species, effects are generally anticipated to be minor, with some effects being beneficial effects and others adverse.

Relative to the No Action Alternative, the Proposed Action Alternative would result in beneficial effects to Lower Klamath NWR wetlands in most, but not all, years. Structural differences between the No Action and Proposed Action Alternative models prevent a direct comparison of deliveries to Tule Lake NWR. Under the Proposed Action Alternative, however, the Tule Lake NWR would receive sufficient water to support all its wetlands. The wetlands surrounding UKL would experience minor adverse effects due to the increase in the proportion of years where those wetlands are projected to be without standing water in fall months.

Migratory birds and non-migratory waterbirds making use of wetlands around UKL would likely experience minor adverse effects due to the increased number of years in which these wetlands would lack water in the fall. Migratory birds and non-migratory waterbirds at Tule Lake and Lower Klamath NWRs will benefit from the availability of more wetland habitat at these refuges.

4.4.4 Cumulative Effects

Other past, ongoing, and reasonably foreseeable future actions that may affect the biological resources in the study area are summarized in Appendix C and include downstream dam removals, the reconnection of ALB, non-project competing demands for groundwater, off-project water withdrawals, and changing climatic conditions that affect water availability and water temperatures, among other factors. Some beneficial effects are also anticipated associated with various efforts to restore and improve habitat and biological conditions in the basin.

As described above, compared to the No Action Alternative, the Proposed Action Alternative's impacts on biological resources are anticipated to be adverse with an intensity ranging from negligible to moderate. In particular, minor adverse effects are anticipated for endangered UKL suckers, and given the recent trends and extremely perilous status of suckers in UKL, it is likely that both alternatives would result in significant and meaningful reductions in all populations of these fish in UKL. If redundant sucker populations are established by USFWS in Tule Lake sumps and Lower Klamath Lake, there could be a net species-level benefit for suckers. However, this would not specifically address the UKL sucker Tribal Treaty resources concerns of the Klamath Tribes. For salmonids, Proposed Action Alternative impacts are anticipated to include negligible to moderate adverse impacts and may contribute to short-term and long-term cumulative adverse impacts to these species when analyzed in combination with other past, present, and reasonably foreseeable future actions. For other non-listed species, effects are generally anticipated to be minor, with some effects being beneficial effects and others adverse; as such, based on information available for this analysis, the Proposed Action Alternative is not expected to contribute substantially to short-term or long-term cumulative adverse impacts to aquatic species when analyzed in combination with other past, present, and reasonably foreseeable future actions.

Effects on wetland habitat should be considered in the broader context of recent droughts, water shortages, and climate change. The Proposed Action Alternative is expected to produce mixed effects on wetland habitat, with minor adverse effects anticipated for UKL wetlands, benefits anticipated for Lower Klamath NWR wetlands, and benefits of uncertain magnitude for Tule Lake NWR. Altogether, based on information available for this analysis, the Proposed Action Alternative is not expected to contribute substantially to short-term or long-term cumulative adverse impacts to wetlands when analyzed in combination with other past, present, and reasonably foreseeable future actions.

4.5 Socioeconomic Resources

This section evaluates how and to what degree the No Action Alternative and Proposed Action Alternative could impact socioeconomic resources in the study area.

4.5.1 Irrigated Agriculture

This section evaluates impacts to irrigated agriculture in the Klamath Basin. The analysis is derived from a simulation of the impacts of the No Action and Proposed Action alternatives across the POR, which are used to simulate likely future water conditions under the alternatives.

Briefly, the modeling approach compares alternative water management scenarios under the No Action and Proposed Action alternatives to historical water demand and historical water conditions during the POR. If a water supply shortage is anticipated, farmers are assumed to reduce irrigated land acres, also called "involuntary land idling." The acreage of involuntary land idling is used to estimate lost farm revenue in each simulated year for the POR. The model takes into account the typical cropping patterns on the Project, the market value of crops, and priority of access to Project water supply per Reclamation's contractual obligations. Finally, the analysis assumes that reductions in farm revenues would affect regional spending, and regional economic effects of lost farm revenues are estimated.

This analysis primarily focuses on a scenario where groundwater pumping is assumed not to occur. Groundwater pumping decisions are made by individual irrigators and are regulated by state water laws and, as such, are not easily forecasted. However, two scenarios that assume varying levels of groundwater supplementation occur are also briefly described to illustrate the impacts of supplemental groundwater pumping on agricultural revenues. The modeling approach used for estimating impacts to agriculture is presented in more detail in Appendix B.

4.5.1.1 No Action Alternative

Under the No Action Alternative, Reclamation would not implement the Proposed Action Alternative. As described in Section 4.3.1, surface water management of the Project would largely continue as it has been under the IOP, though adaptations would need to be made in response to other ongoing actions, including the reconnection of ALB, updated bathymetry for the UKL, as well as adjustments related to the removal of the dams below Keno Dam (Chapter 2).

As described in Chapter 3 and Section 4.3.1, surface water availability in the Klamath Basin has been insufficient, particularly in recent drier years, to satisfy all demands for both consumptive uses and for the provision of in-river non-consumptive ecological and other services. These challenges have increased throughout the Project's history, as water supply has become increasingly limited in part due to increasing ESA commitments and climate change. Reclamation has the challenge of operating the Project in the context of these past and ongoing constraints, which are expected to continue for the foreseeable future and which may worsen over time.

Having adjusted the water model to reflect anticipated changes to the existing physical conditions from actions anticipated under the Proposed Action Alternative, model simulations of the No Action Alternative show that surface Project diversions in the future would be lower than historical irrigation demand in all of the study years (i.e., median Project deliveries would be 206,769 AF, compared to a median demand of 397,912 AF).

Modeling suggests that, on average, approximately 56% of the Project's cropland would be idled due to water shortages annually under the No Action Alternative. As a result of involuntary land idling due to water shortages, average annual agricultural crop revenues would be $111.8 million less than these revenues would have been with sufficient water to meet full irrigation demand under the No Action Alterative. These direct revenue reductions would lead to reductions in regional economic output of $164.7 million, $58.2 million less in labor income, and a reduction in employment demand of 844 jobs. This would represent a 48% reduction in economic activity associated with agricultural activities than under a scenario where all irrigation demands were met. The average and maximum impacts associated with irrigated agriculture under the No Action Alternative are presented in Table 4-4 and Table 4-5.

Table 4-4. Economic impacts of water shortages associated with changes in agricultural practices under the No Action and Proposed Action alternatives

Measure	No Action Alternative	Proposed Action Alternative	Proposed Action Relative to No Action
Estimated average agricultural revenues in Project Area, annual	$120.2 million	$151.0 million	+$30.8 million
Agriculture revenues in Project Area relative to full irrigation demands, average annual (range)	-$111.8 million (-$18.4 to -$213.1 million)	-$81.1 million ($0 to -$182.7million)	+$30.8 million (-$89.9 to +$123.6 million)
Regional economic output relative to full irrigation demands, average annual (range)	-$164.7 million (-$27.2 to -$313.9 million)	-$119.4 million ($0 to -$269.1 million)	+45.3 million (-$132.4 to +$182.0 million)
Regional income relative to full irrigation demands, average annual (range)	-$58.2 million (-$9.6 to -$110.9 million)	-$42.2 million ($0 to -$95.1 million)	+$16.0 million (-$46.8 to +$64.3 million)
Employment demand relative to full irrigation demands, average annual jobs (range)	-844 (-139 to -1,608)	-612 (0 to -1,378)	+232 (-678 to +932)

Table 4-5. Involuntary land idling under No Action and Proposed Action alternatives

Measure	No Action Alternative	Proposed Action Alternative	Proposed Action Relative to No Action
Agriculture lands idled, average annual acres (range)	88,268 (37,888 to 149,837)	67,700 (0 to 135,176)	-20,568 (-66,644 to +49,810)
Agriculture lands idled, average annual % of total Project cropland area (range)	56% (24% to 94%)	43% (0% to 85%)	-13% (-42% to +31%)

The Klamath Project Drought Response Agency typically provides financial assistance to agricultural producers for reducing the demand and use of Project water. Reclamation has provided between $9.1 and $20 million per year between 2021 to 2023, with assistance per acre ranging from $310 to $450 for a full season. Additionally, the U.S. Department of Agriculture CARES program provided $15 million in assistance in 2021. Funding for the assistance program is not guaranteed each year but would likely reduce the economic impacts of water supply shortages on irrigated agriculture when available. This assistance is not guaranteed to occur in all years but would be anticipated to continue under the No Action Alternative.

4.5.1.2 Proposed Action Alternative

Under the Proposed Action Alternative, similar to the No Action Alternative, water modeling results suggest that Project diversions would continue to be lower than historical irrigation demand in most future years (as modeled using the POR, median irrigation demand is 397,912 AF). However, under

the Proposed Action Alternative, median Project diversions are 230,227 AF which are 23,458 AF higher than would be expected under than under the No Action Alternative (where median diversions are 206,769 AF).

As such, although Project diversions would continue to be below historical demand in 94% of the study years (30 of 32 years), impacts on agriculture would be somewhat positive relative to the No Action Alternative, where water diversions would be below historical demand in all years.

As described above, modeling results presented in Table 4-4 and Table 4-5 assume that no supplemental groundwater pumping is likely to occur. This scenario is likely to overstate the actual amount of land that would be idled when water from the Project is reduced, because at least some supplemental groundwater is typically pumped in all years. As noted above, supplemental groundwater pumping in response to water shortages is an action taken by individual irrigators and regulated by state water laws and, therefore, exists outside of Reclamation's mandate and control. Because groundwater pumping is not regulated by Reclamation and is not recorded for all well sites by state regulators, past volumes of groundwater pumping are estimated. Further, the level of groundwater pumping for a given year may not be sustainable and instead result in depletion of groundwater resources. For these reasons, the primary modeling excludes groundwater pumping.

To provide some context for understanding the effects of different assumptions about groundwater availability and supplemental pumping, the analysis in this Environmental Assessment evaluated the following two additional scenarios:

- **Sustainable Yield –** This scenario assumes that supplemental groundwater would be available in all years at a level that is considered sustainable. USGS investigations (Section 4.3.2.3) indicate that to be sustainable, supplemental groundwater pumping within the Project should not exceed 54,000 AF of water (Gannett *et al.*, 2012; Wagner and Gannett, 2014). Therefore, this scenario assumes that groundwater is pumped to a maximum of 54,000 AF each year.
- **Maximum Groundwater Pumping** – The second scenario with supplemental groundwater is based on historical groundwater pumping data from the Project in Oregon and California from 2010 to 2022. A 2024 OWRD report indicates the maximum groundwater pumping on the Oregon side of the Project was 78,920 AF, which occurred in 2010 and represents a conservative estimate given limited metering (OWRD, 2024). A 2023 Tulelake Subbasin Groundwater Sustainability Agency report indicates the maximum groundwater pumping on the California side of the Project was 62,319 AF, which also occurred in 2010 (Tulelake Subbasin GSA, 2024). Together, the maximum pumping level for the Project is 141,239 AF. Therefore, this scenario assumes that groundwater is pumped to a maximum of 141,239 AF each year.

Considering the two scenarios where groundwater pumping would occur, the average losses of agricultural revenues (presented in Table 4-4 and Table 4-5) would be reduced by between 51% and 81% under the No Action Alternative and by between 33% and 82% under the Proposed Action Alternative. The estimated average costs of groundwater pumping would range from $716,900 to $1,831,600 under the No Action Alternative and from $627,100 to $1,426,700 under the Proposed Action Alternative, which represents a small increase in costs relative to the level of avoided crop

losses.[27] These scenarios illustrate uncertainties in the evaluation of likely crop losses due to varying groundwater assumptions.

4.5.1.3 Summary of Impacts to Irrigated Agriculture

Reductions in surface water reduce farm production value and farm income and farm spending. Reductions in farm spending ripple through the local economy to reduce demand for goods and services, as well as jobs, in other sectors. On average, approximately 43% of all historical Project cropland would be involuntarily idled in an average year due to water shortages under the Proposed Action Alternative, which would be 13% less than under the No Action Alternative. That is, the Proposed Action would represent a benefit relative to the No Action Alternative because there would be less cropland involuntarily idled.

Under both Alternatives, agricultural revenues and associated economic activity will be lower than if irrigation demand were fully met. Compared to the No Action Alternative, the Proposed Action Alterative would result in $30.8 million higher average annual revenues, corresponding to $45.3 million higher total economic output, $16.0 million higher labor income, and additional demand for 232 jobs in the regional economy. This would represent a 28% decrease in economic losses compared to the No Action Alternative. The average and maximum impacts under the Proposed Action Alternative are presented in Table 4-4 and Table 4-5.

In conclusion, implementation of the Proposed Action Alternative would result in less frequent and less severe reductions in agricultural production and associated regional impacts than would be expected under the No Action Alternative. As such, the Proposed Action Alternative is anticipated to be beneficial for irrigated agriculture.

4.5.1.4 Cumulative Effects

Other past and ongoing actions that may affect irrigated agriculture in the study area are summarized in Appendix C and include off-project agricultural practices and off-project water withdrawals.

As described above, the Proposed Action Alternative impacts are anticipated to be beneficial for irrigated agriculture relative to the No Action Alternative. Based on information available for this analysis, the Proposed Action Alternative is not expected to contribute substantially to short-term or long-term cumulative adverse impacts to irrigated agriculture when analyzed in combination with other past, present, and reasonably foreseeable future actions.

4.5.2 Recreation

As described in Chapter 3, The Klamath Basin is a popular area for nature-based recreation. Land adjacent to the Klamath River provides opportunities for hiking, camping, hunting, birdwatching, wildlife viewing, and photography, among other recreational activities. Motorized and non-motorized boating, swimming, and fishing are popular water-based activities. Changes in water supply to the Klamath River from the Project have the potential to affect water-based activities. In addition, the Upper Klamath, Lower Klamath, and Tule Lake NWRs each receive water from the Project. Wildlife viewing, photography (especially during periods of bird migration), and hunting are common activities

[27] Assumes $13.28 per acre-foot for groundwater pumping.

on these refuges, which could be affected by changes in conditions at theses reservoirs. Impacts related to recreational fishing are described under Section 4.5.3.

4.5.2.1 No Action Alternative

Under the No Action Alternative, Reclamation would not implement the Proposed Action Alternative. As described in other resource sections, surface water management of the Project would largely continue as it has been to date absent the Proposed Action Alternative, though adaptations would need to be made in response to other ongoing actions, including the reconnection of ALB, updated bathymetry for the UKL, as well as adjustments related to the removal of the dams below Keno Dam (Chapter 2). The removal of J.C. Boyle, Copco No. 1, and Iron Gate reservoirs under the No Action Alternative would eliminate existing opportunities for reservoir-based recreation activities, such as power boating, water skiing, lake swimming, and flatwater boat angling on 11 sites, as described in the Federal Energy Regulatory Commission Environmental Impact Statement (FERC, 2022a). The removal of the reservoirs and the elimination of power production at those sites would change the existing flatwater areas to free-flowing reaches and would change the flow regime in the bypassed and power peaking reaches to a more normative flow regime. The KRRC Environmental Impact Statement found that dam removals would increase the number of days with acceptable to whitewater boaters in the bypassed reaches of J.C. Boyle and Copco No. 2, but adversely affect opportunities in the Hell's Corner reach. Some new recreation sites would be established as well (FERC, 2022a).

As described in Section 4.4.1, the No Action Alternative would provide limited water to the Lower Klamath NWR (up to 11,000 AF) and would not have any dedicated Project surface water supply for Tule Lake NWR.

4.5.2.2 Proposed Action Alternative

Under the Proposed Action Alternative, the refuges would jointly receive up to 43,000 AF from UKL each year, in addition to Lost River water in the event of spills, which is more than would be anticipated under the No Action Alternative. To the extent that increases in flows would improve conditions for wildlife such that visitor experiences at the refuges would be improved, the Proposed Action Alternative would be beneficial to recreation, wildlife viewing in particular, in these areas.

As described in Section 4.3.2, relative to the No Action Alternative, the Proposed Action Alternative is projected to produce slightly higher median daily flow rates in the Klamath River in most months and lower median rates in March through May, which could result in negligible to minor adverse effects to salmonid species. To the extent that fish populations are smaller, these flow changes could marginally adversely affect opportunities for recreational fishing (Section 4.5.3), but could provide marginal benefits to some recreational boating activities that would experience increased flow conditions during some periods. Because flow rates, including ramping rates, at Keno Dam would be similar to the No Action Alternative, impacts on whitewater rafting under the Proposed Action Alternative are anticipated to be negligible relative to the No Action Alternative.

4.5.2.3 Cumulative Effects

Other past and ongoing actions that may affect recreation in the study area are summarized in Appendix C and include, in particular, the ongoing removal of the J.C. Boyle Dam, Copco No. 1 and 2 dams, and IGD and off-project water withdrawals. While the removal of the dams could affect some Project operations, those changes would not result from implementation of this action. As

described above, the Proposed Action Alternative impacts are anticipated to include beneficial impacts to recreation at NWRs and would have no effects on recreational activities relative to the No Action Alternative. As such, the Proposed Action Alternative is not expected to contribute substantially to short-term or long-term cumulative adverse impacts to recreation when analyzed in combination with other past, present, and reasonably foreseeable future actions.

4.5.3 Commercial, Recreational, and Tribal Fishing

4.5.3.1 No Action Alternative

Under the No Action Alternative, Reclamation would not implement the Proposed Action Alternative. As stated in Chapter 3, the study area has supported important recreational, Tribal, and commercial fisheries, although a number of these fisheries are in decline or have been discontinued to preserve the remaining fish populations (Trihey & Associates Inc., 1996). Low abundance of Chinook Salmon over the past 30+ years, for example, has resulted in fishing curtailments and/or season length reductions that have substantially reduced the total harvest. A lack of commercial fishing activity in the Klamath River would likely continue under the No Action Alternative. Recreational and Tribal fishing activities would likely continue to occur downstream of the Project Area at current levels.

4.5.3.2 Proposed Action Alternative

The Proposed Action is expected to result in adverse impacts to sucker species in UKL. At present, due to their precarious status, suckers are minimally harvested by Tribes (and, as a federally listed species, are not available for recreational or commercial harvest). Despite the minimal current harvest, the potential for adverse effects to suckers suggests that adverse cultural impacts for Tribes could occur, as described further in Section 4.6.2.

The Proposed Action Alternative is expected to result in negligible to moderate adverse impacts to salmon species in the Klamath River relative to the No Action Alternative. Consequently, there could also be adverse impacts to recreational and Tribal fishing opportunities along the Klamath River. The Proposed Action Alternative's impact on commercial fishing is likely to be smaller in magnitude than on recreational or Tribal fishing because commercial harvest is based on Chinook Salmon from other rivers in addition to the Klamath River. To the extent that fish populations are substantially affected, fishing for salmon along the southern Oregon and northern California coastline in the range of the SONCC ESU of Coho and Chinook Salmon could also be affected.

4.5.3.3 Cumulative Effects

Agricultural water diversions, timber harvesting, man-made barriers such as the hydroelectric dams, mining, road building, livestock grazing, and streambed alteration have contributed to habitat degradation for aquatic species. Ongoing water quality and habitat restoration programs are being implemented to address habitat degradation associated with these activities.

Actions expected to benefit fish in the study area include the removal of downstream dams; operation of the Fall Creek Hatchery; implementation of recovery plans for the SONCC ESU of Coho Salmon; and implementation of the Oregon and California Anadromous Fish Reintroduction plans. While KRRC does not propose specific measures to address commercial, recreational, or Tribal fisheries in California, the dam removals aim to facilitate large-scale fisheries restoration in the Klamath River Basin by addressing system-wide limiting factors including a lack of fish passage, high summer and fall water temperatures, blue-green algae blooms, disease incidence, impaired sediment supply and

transport, and other factors. KRRC also states that the proposed dam removal (now completed) is expected to increase the abundance of naturally spawned salmon in the Klamath River Basin. Additional actions and circumstances that may adversely affect fish that are targeted recreationally include off-project water withdrawals and climate change. As described above, the Proposed Action Alternative impacts are anticipated to include negligible to moderate adverse impacts to recreational fishing opportunities and may contribute to short-term and long-term cumulative adverse impacts to recreational fishing, Tribal fishing, and commercial Chinook Salmon fishing when analyzed in combination with other past, present, and reasonably foreseeable future actions.

4.5.4 Population

4.5.4.1 No Action Alternative

Under the No Action Alternative, Reclamation would not implement the Proposed Action Alternative. As described in Section 4.3.1, surface water management of the Project would largely continue as it has been to date under this alternative. As described in Chapter 3 and Section 4.3.1, surface water availability in the Klamath Basin has been insufficient, particularly in recent years, to satisfy all demands for both consumptive uses and for the provision of in-river non-consumptive ecological and other services. These challenges have increased throughout the Project's history, as water supply has become increasingly limited in part due to increasing ESA commitments and climate change. Reclamation has the challenge of operating the Project in the context of these past and ongoing constraints, which are expected to continue for the foreseeable future and which may worsen over time.

As described in Section 3.4.1, population in the study area has grown at a slower rate in the study area compared to Oregon and California at large. Under the No Action Alternative, limited water availability for irrigation and involuntary land idling is expected to create outward migration pressure on populations that directly and indirectly depend on the agriculture industry in the region. As described in Chapter 3, 6.3% of jobs in the three-county area were natural resource and mining jobs (compared to 2.8% across Oregon and 2.4% across California). Over half of these jobs were in crop production.

4.5.4.2 Proposed Action Alternative

As described above, implementation of the Proposed Action Alternative would result in less frequent and less severe reductions in agricultural production and associated regional impacts than under the No Action Alternative. As such, the Proposed Action Alternative is anticipated to provide beneficial impacts to irrigated agriculture. Thus, impacts on population growth associated with the Proposed Action Alternative are anticipated to be beneficial.

4.5.4.3 Cumulative Effects

Population has grown at a slower rate in the study area compared to Oregon and California at large. Other past and ongoing actions that may affect population in the study area include many economic and demographic factors, including population age and broader economic trends. Appendix C summarizes some specific foreseeable cumulative actions, including off-project agricultural practices, off-project water withdrawals, and recreation. As described above, impacts on population growth associated with the Proposed Action Alternative are anticipated to be negligible. As such, the Proposed Action Alternative is not expected to contribute substantially to short-term or long-term cumulative adverse impacts to population when analyzed in combination with other past, present, and reasonably foreseeable future actions.

4.5.5 Income, Employment, Business, and Industrial Activity

4.5.5.1 No Action Alternative

Under the No Action Alternative, Reclamation would not implement the Proposed Action Alternative. Agriculture would continue to play a meaningful role in the region's economy under the No Action Alternative. As described in Section 4.5.1, approximately 42% of all Project cropland would be idled due to water shortages annually under the No Action Alternative. This would represent a 33% reduction in economic activity associated with agricultural activities than under a scenario where all irrigation demands were met. Under the No Action Alternative, limited water availability for irrigation is expected to create outward migration pressure on populations that directly and indirectly depend on the agriculture industry in the region. There were 307 businesses classified as natural resources industries in the study area as of 2022 (BLS, 2022; 2023a).

4.5.5.2 Proposed Action Alternative

As described above, implementation of the Proposed Action Alternative would result in less frequent and less severe reductions in agricultural production and associated regional impacts than under the No Action Alternative. As such, the Proposed Action Alternative is anticipated to have beneficial impacts to irrigated agriculture. Thus, impacts on regional economic activity associated with the Proposed Action Alternative are anticipated to be beneficial.

4.5.5.3 Cumulative Effects

Broad economic trends as well as specific localized conditions can affect income, employment, business, and industrial activities in the study area. Appendix C summarizes some specific foreseeable localized cumulative actions, including off-project agricultural practices, off-project water withdrawals, and recreation. As described above, impacts on regional economic activity associated with the Proposed Action Alternative are anticipated to be beneficial. As such, the Proposed Action Alternative is not expected to contribute substantially to short-term or long-term cumulative adverse impacts to income, employment, business, and industrial activity when analyzed in combination with other past, present, and reasonably foreseeable future actions.

4.6 Tribal Nations and Tribal Economies

Because the Proposed Action Alternative is a water management action, the discussion of potential impacts to Tribal Nations and Tribal economies in this Environmental Assessment focuses on the impacts of these management actions on water availability as well as potential impacts to sucker and salmon populations, which are economically, culturally, and spiritually important to Tribes of the Klamath Basin (The Klamath Tribes, Karuk Tribe, Yurok Tribe, and Hoopa Valley Tribes, in particular).

Under both alternatives, operation of the Project would continue to be managed consistent with federal law, Oregon water law, the Amended and Corrected Findings of Fact and Order of Determination (ACFFOD), and the stipulated agreement between the United States, The Klamath Tribes, and Project water users that provides that the water right for minimum water surface levels in UKL would not be exercised against any water rights prior to August 9, 1908. The stipulated agreement is valid until the judicial review of the Klamath Basin General Stream Adjudication within

the Klamath County Circuit Court is complete. The ACFFOD is subject to ongoing judicial review but is still currently enforceable. The Klamath Tribes, through the Bureau of Indian Affairs, have made a call to enforce some or all of the water rights for instream flows in tributaries to UKL, at varying levels, every year since issuance of the ACFFOD in 2013, which would continue to occur under the No Action Alternative. There would be no change to The Klamath Tribes' federal reserved water rights under either alternative.

Also, under both alternatives, 7,000 AF of water for the Yurok Tribe's Ceremonial Boat Dance would continue to be allocated in even years, with the actual expenditure varying depending on hydrologic conditions. Ceremonial events dependent on water resources for the Hoopa Valley Tribe would not be impacted by implementation of the No Action Alternative as Klamath River flows for those purposes are supported by releases from the Trinity River in those years.

Also, under both alternatives, as stated in Chapter 3 and described by Reclamation in 1998, "the significance of the Tribes' reliance on, and veneration for nature is evident in all facets of their culture, their traditions, their religions, and their resource use and management. Consequently, increasing resource scarcity over the last century has had a profound effect on the Tribes of the Klamath Basin. Tribal cultures are no longer able to fully embrace their traditional ways of life; the declining availability of resources critical to their traditional and spiritual practices has made some of those resources even more precious as a means of sustaining their culture" (Reclamation, 1998).

4.6.1 No Action Alternative

Under the No Action Alternative, Reclamation would not implement the Proposed Action Alternative. Data available regarding economic conditions of Tribal reservations in the Klamath Basin suggest that populations residing on Tribal reservations (which is not equivalent to Tribal enrollment) have lower incomes, and higher unemployment and poverty rates relative to surrounding counties as well as to Oregon and California overall.

Surface water management of the Project would largely continue as it has been to date, though adaptations would need to be made in response to other ongoing cumulative actions, including the reconnection of ALB, updated bathymetry for the UKL, as well as adjustments related to the removal of the dams below Keno, which are located downstream of the Project Area (Chapter 2).

Simulations of the No Action Alternative suggest that UKL elevations would generally meet targeted elevation levels and provide a sufficient quantity and quality of habitat for adult Lost River and Shortnose suckers in UKL, including wetland habitat surrounding UKL. The No Action Alternative would, however, likely result in the continued low survival of juvenile suckers in UKL and limited recruitment into the adult sucker population, particularly as the reasons for low recruitment and juvenile survival in UKL are not well understood. This resource would likely continue to be insufficient for economic, cultural, and spiritual needs of the Klamath Basin Tribes.

Simulations of the No Action Alternative suggest that Klamath River flows at Iron Gate gage would not be within the preferred flow range for Coho or Chinook Salmon for about 75% of days. Continued pressure on species under the No Action Alternative could impact the Tribal Trust fishery in the Klamath River by reducing the opportunities for the Karuk, Hoopa Valley, and the Yurok tribes to harvest salmon for subsistence, ceremonial, and commercial needs. Under the No Action

Alternative, fish in the Klamath River would likely provide for only very limited subsistence fishing opportunities for the Karuk, Hoopa Valley, and the Yurok tribes, in particular.

4.6.2 Proposed Action Alternative

Because suckers inhabiting UKL may experience adverse effects from the Proposed Action Alternative relative to the No Action Alternative, and because these fish are an important traditional food source as well as components of cultural, spiritual, and economic health for the Klamath Tribes, adverse effects to Klamath Tribes and Tribal economies could result from implementation of the Proposed Action Alternative. As noted above, if USFWS is able to establish redundant populations in Tule Lake sumps and Lower Klamath Lake, there could be a species population-level net benefit, which would provide benefits for Klamath Tribes and Tribal economies. When compared to the No Action Alternative, the adverse effects would be minor because conditions under both alternatives related to recovery of the species to harvestable levels would be similar.

Adverse effects to the Karuk, Hoopa Valley, and/or the Yurok tribes and Tribal economies could result from implementation of the Proposed Action Alternative because negligible to moderate adverse effects on Klamath River salmon populations relative to the No Action Alternative may further limit the likelihood of recovery of listed species populations.

4.6.3 Cumulative Effects

As stated above, increasing resource scarcity over the last century has had a profound effect on the Tribes of the Klamath Basin. Tribal cultures are no longer able to fully embrace their traditional ways of life; the declining availability of resources critical to their traditional and spiritual practices has made some of those resources even more precious as a means of sustaining their culture (Reclamation, 1998). Other past and ongoing actions that may also affect Tribal Nations and Tribal economies in the study area are summarized in Appendix C, including those that impact biological resources, some of which should result in beneficial effects to salmon and sucker populations in the study area.

The Proposed Action Alternative may result in adverse impacts on sucker populations in UKL, which could adversely affect the Klamath Tribes. As noted above, there could be a species population-level net benefit, which would provide benefits for Klamath Tribes and Tribal economies. The Proposed Action Alternative is expected to result in negligible to moderate adverse impacts to salmon species in the Klamath River relative to the No Action Alternative. Implementation of the Proposed Action Alternative appears unlikely to be large enough to substantially impact the economies of the Karuk, Hoopa Valley, or the Yurok tribes relative to the No Action Alternative.

Potential impacts of the Proposed Action Alternative on salmon in the Klamath River would be negligible to moderate adverse. As such, the Proposed Action Alternative may contribute to short-term or long-term cumulative adverse impacts to Tribal Nations or Tribal economies when analyzed in combination with other past, present, and reasonably foreseeable future actions.

4.7 Environmental Justice

This section evaluates how and to what degree the No Action and Proposed Action alternatives could impact environmental justice in the study area.

4.7.1 No Action Alternative

Under the No Action Alternative, Reclamation would not implement the Proposed Action Alternative. As described in Section 3.6, on average the study area population has lower incomes, a higher unemployment rate, a higher poverty rate (adults and children), more households receiving food stamps/SNAP benefits, lower educational attainment, and more elderly residents compared to Oregon and California as well as to the United States. The Klamath Falls and Altamont populations would continue to be more vulnerable than either Klamath County or the study area as a whole. These conditions would continue under the No Action Alternative.

Agriculture would continue to play a meaningful role in the region's economy under the No Action Alternative. As described in Section 4.5.1, approximately 42% of all Project cropland would be idled due to water shortages annually under the No Action Alternative. This would represent a 33% reduction in economic activity associated with agricultural activities than under a scenario where all irrigation demands were met. Adverse impacts to the agriculture industry have the potential to adversely affect already at-risk populations by reducing employment opportunities in this area.

Section 4.6 specifically addresses potential impacts of the No Action alternative on Tribal Nations and Tribal economies. As stated in that section, data available regarding economic conditions of Tribal reservations in the Klamath Basin suggest that populations residing on Tribal reservations (which are not equivalent to Tribal enrollment) have lower incomes, and higher unemployment and poverty rates relative to surrounding counties as well as to Oregon and California overall. These conditions would continue under the No Action Alternative.

4.7.2 Proposed Action Alternative

As described above, implementation of the Proposed Action Alternative would result in less frequent and less severe reductions in agricultural production and associated regional impacts than under the No Action Alternative. As such, the Proposed Action Alternative is anticipated to have beneficial impacts to irrigated agriculture and impacts on regional economic activity associated with the Proposed Action Alternative are anticipated to be beneficial. Benefits to the agricultural economy should result in benefits to communities with environmental justice concerns.

The Proposed Action Alternative is expected to result in negligible to moderate adverse impacts to salmon species in the Klamath River relative to the No Action Alternative. However, implementation of the Proposed Action Alternative is unlikely to be large enough to substantially impact communities with environmental justice concerns.

Because suckers inhabiting UKL may experience adverse effects from the Proposed Action Alternative relative to the No Action Alternative, and because these fish are an important traditional food source as well as components of cultural, spiritual, and economic health for the Klamath Tribes, adverse effects to Klamath Tribes and Tribal economies could result from implementation of the Proposed Action Alternative. As noted above, if USFWS is able to establish redundant populations in Tule Lake sumps and Lower Klamath Lake, there could be a population-level net benefit, which would provide benefits for the Klamath Tribes.

4.7.3 Cumulative Effects

Other past and ongoing actions that may affect communities with environmental justice concerns in the study area are summarized in Appendix C, including all those that impact biological resources,

irrigated agriculture, recreation, and Tribal Nations and Tribal economies. The Proposed Action Alternative would reduce impacts to agriculture compared to the No Action Alternative and not have a significant impact on fish species. It is therefore not expected to contribute substantially to short-term or long-term cumulative adverse impacts to communities with environmental justice concerns when analyzed in combination with other past, present, and reasonably foreseeable future actions.

4.8 Comparison of Impacts of the Alternatives

Table 4-6 presents a comparison of the effects of the Proposed Action and No Action alternatives.

Table 4-6. Comparison of the impacts of the alternatives

Resource	No Action Alternative	Proposed Action Alternative*
Water Resources (surface water, water quality, groundwater)	**Surface Water.** Under the No Action Alternative, Reclamation would not implement the Proposed Action Alternative. Surface water management of the Project would largely continue as it has been to date, though adaptations would need to be made in response to other ongoing actions, including the reconnection of ALB, updated bathymetry for the UKL, as well as adjustments related to the removal of the dams below Keno, which are located downstream of the Project Area. Surface water availability in the Klamath Basin has been insufficient, particularly in recent years, to satisfy all demands for both consumptive uses and for the provision of in-river non-consumptive ecological and other services (e.g., support of fish). These challenges have increased throughout the Project's history, as water supply has become increasingly limited in part due to climate change. These constraints are expected to continue for the foreseeable future and may worsen over time.	**Surface Water.** The Proposed Action Alternative would affect the distribution of water among the UKL, Klamath River flows, and Project diversions. Some UKL elevations would fall below the targeted minimums at certain times of the year more often than under the No Action Alternative, which would result in moderate adverse effects on UKL water resources. Compared to the No Action Alternative, the Proposed Action Alternative would also result in slightly higher median Klamath River flow levels across most months but lower median flows in spring, resulting in negligible to minor adverse effects to Klamath River surface flows. The Proposed Action Alternative would increase median diversions during the primary irrigation season (April-October) by over 10% compared to the No Action Alternative, resulting in beneficial effects on Project diversions.
Water Resources (surface water, water quality, groundwater)	**Water Quality.** Existing water quality impairments at UKL are anticipated to continue under the No Action Alternative. Releases from the UKL are the primary cause of impaired water quality in the Upper Klamath River, and nutrient loads from the Upper Klamath River have also contributed materially to elevated nutrient levels in the lowest reach of the river. Elevated temperatures at UKL would also continue to contribute to elevated temperatures downstream of Keno Dam under the No Action Alternative.	**Water Quality.** The Proposed Action Alternative is not expected to substantially affect water quality in the Upper Klamath River.
Water Resources (surface water, water quality, groundwater)	**Groundwater**. Groundwater levels are also declining in the Tule Lake subbasin, which would be expected to continue under the No Action Alternative. The groundwater system in this basin is most directly affected by basin-wide, decadal-scale climatic cycles, including climate change. Irrigation pumping has increased throughout the basin over the last half-century, and particularly over the last two decades within the Project service area (Gannett *et al.*, 2012). To the extent that the No Action Alternative does not meet the demand for consumptive use, pressure to supplement surface water supplies through increased groundwater pumping would be expected to increase and groundwater storage would be expected to continue to decrease.	**Groundwater**. Because large shortages exist under both alternatives, the difference in demand for groundwater pumping would be negligible, resulting in negligible differential impacts to groundwater under the Proposed Action Alternative compared to the No Action Alternative.

Resource	No Action Alternative	Proposed Action Alternative*
Biological Resources (federally listed aquatic species, wetlands and riparian areas, migratory birds)	**Lost River and Shortnose Suckers.** Simulations of the No Action Alternative suggest that UKL elevations would generally meet targeted elevation levels for Lost River and Shortnose suckers and would provide a sufficient quantity and quality of habitat for UKL adult suckers; however, the low survival of juvenile suckers would likely continue.	**Lost River and Shortnose Suckers.** The Proposed Action Alternative's effects on biological resources are connected with the alternative's effects on surface water resources. UKL Lost River and Shortnose suckers may experience adverse effects with respect to habitat availability with a modest increase in risk of mortality and morbidity from stressors such as desiccation, disease risk, and predation due to water management. Populations of suckers in UKL will likely experience high mortality due to senescence regardless of water management. If USFWS is able to establish redundant populations in Tule Lake sumps and Lower Klamath Lake, there could be a population-level net benefit.
Biological Resources (federally listed aquatic species, wetlands and riparian areas, migratory birds)	**Salmon, SRKW, and Other Aquatic Species in the Klamath River.** Klamath River flows at the Iron Gate gage would frequently fall below the approximate preferred flow range for Coho Salmon, particularly from July through October.	**Salmon, SRKW, and Other Aquatic Species in the Klamath River.** For Coho Salmon, the effects of the Proposed Action Alternative compared to the No Action Alternative are expected to be generally adverse but minor. Reclamation has determined that SRKW may experience minor adverse effects as a result of decreased prey availability in the form of moderate adverse effects on Chinook Salmon. Reclamation has determined that the Proposed Action Alternative may affect, but is not likely to adversely affect, other federally listed aquatic species or their designated critical habitats with the exception of the candidate species Western Pond Turtle, which may experience adverse effects but about which little is known of abundance and distribution within the Project's boundaries.
Biological Resources (federally listed aquatic species, wetlands and riparian areas, migratory birds)	**Wetlands and Riparian Habitats**. Tule Lake NWR would not have a dedicated Project Supply of water, and deliveries to Lower Klamath NWR from UKL would be made only in fall/winter for up to 11,000 AF and only if UKL elevation targets were met. This quantity of water is far below what the NWRs require, resulting in loss of habitat for migratory and aquatically linked birds as well as other aquatic biota. These conditions would be expected to continue under the No Action Alternative.	**Wetlands and Riparian Habitats**. Compared to No Action, the Proposed Action Alternative is expected to benefit Tule Lake NWR, as it would receive sufficient water to support its wetlands, and Lower Klamath NWR is expected receive benefits in most, but not all, years, compared to the No Action Alternative. Compared to the No Action Alternative, the Proposed Action Alternative would result in minor adverse effects to UKL wetlands, as these wetlands would dry out more frequently in the fall. The direction of effects on migratory birds and on non-migratory waterbirds would parallel the effects on wetlands, with beneficial effects to Tule Lake and Lower Klamath NWR birds but adverse effects for UKL wetland birds. Overall, relative to the No Action Alternative, the Proposed Action Alternative's impacts on biological

Resource	No Action Alternative	Proposed Action Alternative*
		resources are anticipated to range from minor adverse in UKL to potentially beneficial in Tule Lake sumps and Lower Klamath Lake.
Socioeconomic Resources (irrigated agriculture, recreation, commercial, recreational, Tribal fisheries, population, income, employment, business and industrial activity)	**Irrigated Agriculture**. Under the No Action Alternative, Project diversions would be lower than historical irrigation demand in all of the study years.	**Irrigated Agriculture**. Implementation of the Proposed Action Alternative would result in less frequent and less severe reductions in agricultural production and associated regional impacts than would be expected under the No Action Alternative. While agricultural revenues and associated economic activity would still be lower than if irrigation demand was fully met, average annual revenues would be $30.8 million higher under the Proposed Action Alternative than under the No Action Alternative, corresponding to $45.3 million higher total economic output, $16.0 million higher labor income, and additional demand for 232 jobs in the regional economy. As such, the Proposed Action Alternative is anticipated to have beneficial impacts to irrigated agriculture.
Socioeconomic Resources (irrigated agriculture, recreation, commercial, recreational, Tribal fisheries, population, income, employment, business and industrial activity)	**Recreation.** Under the No Action Alternative, Klamath River flows at Keno would not be within the preferred flow range for Coho Salmon for the majority of the year, which could limit recreational fishing opportunities. The No Action Alternative would provide limited water to the Lower Klamath NWR and would not have any dedicated Project surface water supply for Tule Lake NWR.	**Recreation.** Under the Proposed Action Alternative, the NWRs would jointly receive up to 43,000 AF from UKL each year, plus Lost River water in the event of spills. To the extent that these increases in flows would improve conditions for wildlife such that visitor experiences at the refuges would be improved, the Proposed Action Alternative would be beneficial to recreation in these areas. Impacts on whitewater boating associated with the Proposed Action Alternative are anticipated to be negligible.
Socioeconomic Resources (irrigated agriculture, recreation, commercial, recreational, Tribal fisheries, population, income, employment, business and industrial activity)	**Commercial, Recreational, and Tribal Fishing.** Under the No Action Alternative, there is no commercial fishing activity in the Klamath River. Recreational and Tribal fishing activities are occurring downstream of the Project Area.	**Commercial, Recreational, and Tribal Fishing.** The Proposed Action Alternative is expected to result in negligible to moderate adverse impacts to salmon species in the Klamath River relative to the No Action Alternative. Consequently, there could also be adverse impacts to recreational and Tribal fishing opportunities along the Klamath River.
Socioeconomic Resources (irrigated agriculture, recreation, commercial, recreational, Tribal fisheries, population, income, employment, business and industrial activity)	**Population, Income, Employment, Business, and Industrial Activities:** Under the No Action Alternative, agriculture would continue to play a meaningful role in the region's economy. Limited water availability for irrigation is expected to create outward migration pressure on populations that directly and indirectly depend on the agriculture industry in the region.	**Population**. Impacts on populations and migration associated with the Action Alternative would primarily be associated with changes in the agriculture industry and are anticipated to be beneficial. **Income, Employment, Business, and Industrial Activities**. Impacts on regional economic activity associated with the Proposed Action Alternative are anticipated to be beneficial.

Resource	No Action Alternative	Proposed Action Alternative*
Tribal Nations and Tribal Economies	Continued pressure on species under the No Action Alternative could impact the Tribal Trust fishery in the Klamath River by reducing the opportunities for the Karuk, Hoopa Valley, and the Yurok tribes to harvest salmon for subsistence, ceremonial, and commercial needs. Under the No Action Alternative Tribes including the Yurok Tribe would likely provide for only very limited subsistence fishing opportunities.	Adverse effects to the Karuk, Hoopa Valley, and/or the Yurok tribes and Tribal economies could result from implementation of the Proposed Action Alternative because negligible to moderate adverse effects on Klamath River salmon populations relative to the No Action Alternative may further limit the likelihood of recovery of listed species populations. Because suckers inhabiting UKL may experience adverse effects from the Proposed Action Alternative relative to the No Action Alternative, and because these fish are an important traditional food source as well as components of cultural, spiritual and economic health for the Klamath Tribes, adverse effects to Klamath Tribes and Tribal economies could result from implementation of the Proposed Action Alternative. As noted above, if USFWS is able to establish redundant populations in Tule Lake sumps and Lower Klamath Lake, there could be a population-level net benefit, which would provide benefits for Klamath Tribes and Tribal economies. When compared to the No Action Alternative, the adverse effects would be minor because conditions under both alternatives related to recovery of the species to harvestable levels would be similar.
Environmental Justice	Under the No Action Alternative, irrigated agriculture would be less viable compared to a case where full irrigation demand is met, resulting in a variety of regional economic impacts. Agriculture plays a meaningful role in the region's economy, meaning impacts to the industry are likely to adversely affect already at-risk populations. On average the study area population has lower incomes, a higher unemployment rate, a higher poverty rate (adults and children), more households receiving food stamps/SNAP benefits, lower educational attainment, and more elderly residents compared to Oregon and California as well as to the United States.	Under the Proposed Action Alternative, irrigated agriculture would be less viable compared to a case where full irrigation demand is met, resulting in a variety of regional economic impacts. However, these impacts are expected to be less severe compared to the No Action Alternative, making the incremental effects of the Proposed Action Alternative beneficial. However, adverse impacts to Tribal communities are expected related to negligible to moderate adverse impacts to salmon populations, which would result in adverse impacts to the Karuk, Hoopa Valley, and Yurok tribes. Adverse impacts to sucker populations could adversely impact the Klamath Tribes.

Notes:
*As recommended by CEQ NEPA regulations, the impacts of the Proposed Action Alternative are described relative to the No Action Alternative.

5 Consultation and Coordination

5.1 Agencies and Groups Consulted

Reclamation coordinated with multiple interested parties preparing this Environmental Assessment. Specifically, five primary teams met to discuss the development of the Proposed Action Alternative in a set of at least 35 meetings, as summarized in Table 5-1. The teams were identified as follows:

- **The Technical Team** was formed to provide technical advice to the management team. Meetings included invitations for the Hoopa Valley Tribe, Karuk Tribe, Klamath Tribes, Modoc Nation, Pulikla Tribe of Yurok People, Yurok Tribe, CDFW, Modoc County, NMFS, Oregon Department of Fish and Wildlife (ODFW), Siskiyou County, OWRD, USFWS, USGS, KDD, Klamath Irrigation District, Klamath Water Users Association, and Tulelake Irrigation District.

- **The Flow Account Scheduling Technical Advisory (FASTA)Team** was formed in 2013 to provide input to Reclamation on use of available water. Since, it has also become a forum to share information on upcoming actions. Meetings included invitations for the Hoopa Valley Tribe, Karuk Tribe, Klamath Tribes, Modoc Nation, Pulikla Tribe of Yurok People, Yurok Tribe, Quartz Valley, CDFW, California State Water Resources Control Board, Oregon State University, NMFS, ODFW, OWRD, USFWS, USGS, and Klamath Water Users Association.

- **The Klamath Project Operations Team** was formed to address questions about forecasting methods. Meetings included invitations for the Hoopa Valley Tribe, Karuk Tribe, Klamath Tribes, Pulikla Tribe of Yurok People, Yurok Tribe, Quartz Valley, CDFW, California State Water Resources Control Board, California Nevada River Forecast Center, Oregon State University, NMFS, ODFW, OWRD, USFWS, USGS, Klamath Irrigation District, Klamath Water Users Association, and Tulelake Irrigation District.

- **The Management Team** was formed to make management or policy decisions as related to the Proposed Action Alternative. Meetings included invitations for the Hoopa Valley Tribe, Karuk Tribe, Klamath Tribes, Modoc Nation, Pulikla Tribe of Yurok People, Yurok Tribe, Quartz Valley, Klamath County, Modoc County, Siskiyou County, CDFW, Bureau of Indian Affairs, NMFS, ODFW, OWRD, USFWS, USGS, KDD, Klamath Irrigation District, Klamath Water Users Association, Tulelake Irrigation District.

- **The Adaptive Management Subteam** was formed in 2024 to inform structured decision-making. Their first meeting included the Karuk Tribe, Yurok Tribe, CDFW, NMFS, USFWS, KDD, and Tulelake Irrigation District.

Table 5-1. Summary of Klamath interested party planning team meetings

Team	2023 Meeting Dates	2024 Meeting Dates
Adaptive Management		1/8/2024
Flow Account Scheduling Technical Advisory		2/22/2024 3/14/2024 3/28/2024 4/4/2024 4/25/2024 5/23/2024 5/30/2024 6/27/2024 7/11/2024
Klamath Project Operations		2/9/2024 3/8/2024 5/10/2024 6/7/2024
Management Team	8/24/2023 9/8/2023 10/10/2023 11/13/2023 12/7/2023	2/7/2024 3/20/2024 4/17/2024 5/15/2024
Technical Team	8/18/2023 8/25/2023 9/1/2023 9/8/2023 9/15/2023 9/29/2023 10/26/2023 11/9/2023 11/30/2023 12/14/2023	1/4/2024 2/1/2024 2/29/2024

5.2 Endangered Species Act

Section 7(a)(2) of the ESA requires federal agencies to ensure that any action they authorize, fund, or carry out "is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification" of designated critical habitat (16 U.S.C. § 1536(a)(2)). Thus, Reclamation is prohibited from operating the Project in any way that would be likely to jeopardize the continued existence of an endangered or threatened species or result in destruction or adverse modification of designated critical habitat. On June 14, 2024, Reclamation transmitted to the Services, its Biological Assessment of its proposed Project operations from October 1, 2024 through September 30, 2029, which may be revised and clarified by subsequent letters and addenda.

Reclamation concluded in the Biological Assessment that implementing the Proposed Action Alternative may affect and is likely to adversely affect the SONCC Coho Salmon ESU survival, growth, and reproduction as well as designated SONCC Coho Salmon critical habitat. However, more natural flow regimes, through use of the FFA under the Proposed Action Alternative, paired with previously authorized Klamath Coho Restoration Program projects, would help address habitat and disease issues in the Klamath River. More natural flow regimes and flexibility to address quantity of habitat in the Klamath River through FFA is anticipated to provide additional habitat in dry and

critically dry years. These, combined with restoration, are expected to improve conditions for adult and juvenile SONCC Coho Salmon and minimize the effects of implementation of the Proposed Action Alternative.

Reclamation further concluded that the Proposed Action Alternative may affect and is likely to adversely affect the SRKW DPS. The Proposed Action Alternative may decrease salmon abundance (i.e., may affect and is likely to adversely affect) within the SRKW range thereby impacting the prey availability and abundance for SRKW DPS. Reclamation's Proposed Action Alternative is not likely to impact SRKW DPS designated critical habitat, defined as Pacific coastal waters from Washington through Central California, with exclusions for military exercises off the Washington Coast.

Reclamation concluded in the Biological Assessment that implementing the Proposed Action Alternative, including the beneficial measures intended to offset adverse impacts, may affect, and is likely to adversely affect the Lost River and Shortnose suckers and their critical habitat. Periodic, though infrequent and temporary, low surface elevations as a result of low inflows may impact suckers and critical habitat through limiting sucker access to spawning and rearing habitat. Reclamation anticipates habitat impacts from the Proposed Action Alternative to be seasonal and temporary.

5.3 Essential Fish Habitat

Essential Fish Habitat (EFH) is designated for commercially fished species under the MSA. The MSA requires federal fishery management plans, developed by NMFS and the Pacific Southwest Fisheries Management Council, to describe the habitat essential to the fish being managed and to describe threats to that habitat from both fishing and non-fishing activities. Pursuant to section 305(b) of the MSA (16 U.S.C. 1855(b)), federal agencies are also required to consult with NMFS on actions that may adversely affect EFH for species managed under the Pacific Coast Salmon Fishery Management Plan. This section also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

Reclamation conducted an EFH analysis that covered Chinook Salmon and SONCC Coho Salmon and submitted the EFH Assessment to NMFS on August 26, 2024. Reclamation concluded that the Proposed Action Alternative is likely to adversely affect Chinook Salmon and SONCC Coho Salmon EFH (Appendix D in Reclamation, 2024a).

Reclamation will review NMFS's EFH assessment response document and associated conservation recommendations once they are delivered. Consistent with the MSA, Reclamation will provide a detailed written response to NMFS's EFH conservation recommendations within 30 days of their receipt (50 CFR S 600.920(k)(l)).

6 References

Audubon California. 2020. Avian Botulism Kills 40,000 Birds at Lower Klamath National Wildlife Refuge. Retrieved from https://ca.audubon.org/news/avian-botulism-kills-40000-birds-lower-klamath-national-wildlife-refuge.

BEA (U.S. Bureau of Economic Analysis). 2023. Table 1. Real Gross Domestic Product, by County, 2019–2022. Retrieved from https://www.bea.gov/data/gdp/gdp-county-metro-and-other-areas.

BLS (U.S. Bureau of Labor Statistics). 2022. Quarterly Census of Employment and Wages. Retrieved from https://www.bls.gov/cew/downloadable-data-files.htm.

BLS (U.S. Bureau of Labor Statistics). 2023a. Local Area Unemployment Statistics (Laus). Retrieved from https://beta.bls.gov/dataQuery/find?st=0&r=20&more=0.

BLS (U.S. Bureau of Labor Statistics). 2023b. Quarterly Census of Employment and Wages. Retrieved from https://www.bls.gov/cew/downloadable-data-files.htm.

Braunworth, W. S., T. Welch and R. L. Hathaway. 2002. Water Allocation in the Klamath Reclamation Project, 2001: An Assessment of Natural Resource, Economic, Social, and Institutional Issues with a Focus on the Upper Klamath Basin.

Buchanan, D., M. Buettner, T. Dunne and G. Ruggerone. 2011. Klamath River Expert Panel Final Report Scientific Assessment of Two Dam Removal Alternatives on Resident Fish.

Burdick, S. M., D. G. Elliott, C. O. Ostberg, C. M. Conway, A. Dolan-Caret, M. S. Hoy, . . . K. R. Echols. 2015. Health and Condition of Endangered Juvenile Lost River and Shortnose Suckers Relative to Water Quality and Fish Assemblages in Upper Klamath Lake, Oregon, and Clear Lake Reservoir, California. U.S. Geological Survey. doi: 10.3133/ofr20151217.

Burdick, S. M., D. A. Hewitt, B. A. Martin, L. Schenk and S. A. Rounds. 2020. Effects of Harmful Algal Blooms and Associated Water-Quality on Endangered Lost River and Shortnose Suckers. Harmful Algae 97: 101847. doi: 10.1016/j.hal.2020.101847.

Burke, S. M., R. M. Adams and W. W. Wallender. 2004. Water Banks and Environmental Water Demands: Case of the Klamath Project. Water Resources Research. 40. 9/28/2004. Retrieved from https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2003WR002832.

California Natural Resources Agency. 2022. Federal Energy Regulator Gives Final Go-Ahead for Historic Klamath Dam Removal Plan. Retrieved from https://resources.ca.gov/Newsroom/Page-Content/News-List/Federal-Energy-regulator-gives-final-go-ahead-for-historic-Klamath-Dam-removal-plan.

Carretta, J. V., E. M. Oleson, K. A. Forney, D. W. Weller, A. R. Lang, J. Baker, . . . R. L. B. Jr. 2023. U.S. Pacific Marine Mammal Stock Assessments: 2022. National Marine Fisheries Service. July. doi: 10.25923/5ysf-gt95.

Carter, K. and S. Kirk. 2008. Fish and Fishery Resources of the Klamath River Basin. July.

CDFG (California Department of Fish and Game). 2004. September 2002 Klamath River Fish-Kill: Final Analysis of Contributing Factors and Impacts. July.

CDFG (California Department of Fish and Game). 2010. Status of the Fisheries Report. An Update Through 2008. August.

CDFW (California Department of Fish and Wildlife). 2016. Steelhead Report and Restoration Card Program. Report to the Legislature 2007-2014. October.

CEQ (Council on Environmental Quality). 1997. Environmental Justice Guidance under the National Environmental Policy Act. December. Retrieved from https://www.epa.gov/sites/default/files/2015-02/documents/ej_guidance_nepa_ceq1297.pdf.

Childress, E., J. Rasmussen, D. Blake, S. Doose, B. Erickson, R. Fogerty, . . . E. Willy. 2019. Species Status Assessment for the Endangered Lost River Sucker and Shortnose Sucker. Final Report, Version 1. U.S. Fish and Wildlife Service, Pacific Southwest Region, Klamath Falls Fish and Wildlife Office. March.

Claudill, J., Carver, E. 2019. Banking on Nature 2017. U.S. Fish and Wildlife Service (USFWS).

CNDDB (California Natural Diversity Database). 2023. State and Federally Listed Endangered and Threatened Animals of California. State of California Natural Resources Agency, Department of Fish and Wildlife BIogeographic Data Branch. October.

CSWRCB (California State Water Resources Control Board). 2020. Lower Klamath Project – Final Environmental Impact Report (Final EIR). Retrieved from https://www.waterboards.ca.gov/waterrights/water_issues/programs/water_quality_cert/lower_klamath_ferc14803_eir.html.

Daley, T. T., N. R. Glaser, S. A. Adams and N. A. Som. 2022. Klamath Basin Water Temperature Summary, Water Year 2019. U.S. Fish and Wildlife Service. September.

Donnelly, R. 2003. Sucker Harvest. Oregon Historical Society. Retrieved from https://www.oregonhistoryproject.org/articles/historical-records/sucker-harvest/.

Dunsmoor, L., L. Basdekas, B. Wood and B. Peck. 2000. Quantity, Composition, and Distribution of Emergent Vegetation Along the Lower River and Upper Klamath Lake Shorelines of the Williamson River Delta, Oregon. 1-27.

EJ IWG (Federal Interagency Working Group on Environmental Justice). 2016. Promising Practices for Ej Methodologies in Nepa Reviews. Report of the Federal Interagency Working Group on Environmental Justice & NEPA Committee. March. Retrieved from https://www.epa.gov/sites/default/files/2016-08/documents/nepa_promising_practices_document_2016.pdf.

FERC (Federal Energy Regulatory Commission). 2022a. Final Environmental Impact Statement for Hydropower License Surrender and Decommissioning. Lower Klamath Project—FERC Project No. 14803-001 Klamath Hydroelectric Project—FERC Project No. 2082-063 Oregon and California. FERC/EIS-0313F. August.

FERC (Federal Energy Regulatory Commission). 2022b. Order Modifying and Approving Surrender of License and Removal of Project Facilities. Project Nos. 2082-063, 14803-001. November.

Fish, G. and S. Ahlquist. 2024. Annual Report Regarding Owrd Groundwater Monitoring for U.S. Bureau of Reclamation Project Area in the Upper Klamath Basin. Oregon Water Resources Department. March.

Ford, J. K. B., B. M. Wright, G. M. Ellis and J. R. Candy. 2010. Chinook Salmon Predation by Resident Killer Whales: Seasonal and Regional Selectivity, Stock Identity of Prey, and Consumption Rates. DFO Canadian Science Advisory Secretariat.

Gannett, M. W. and K. H. Breen. 2015. Groundwater Levels, Trends, and Relations to Pumping in the Bureau of Reclamation Klamath Project, Oregon and California. U.S. Geological Survey. doi: 10.3133/ofr20151145.

Gannett, M. W., B. J. Wagner and J. Kenneth E. Lite. 2012. Groundwater Simulation and Management Models for the Upper Klamath Basin, Oregon and California. U.S. Geological Survey.

Gentry, D. 2018. Endangered Sucker Release- a Small Step toward a Great Need. The Klamath Tribes. Retrieved from https://klamathtribes.org/endangered-sucker-release-a-small-step-toward-a-great-need/.

Gilbert, C. H. 1898. The Fishes of the Klamath River Basin. U.S. Fish Commission Bulletin for 1897 Article 1: 1-13.

Goodman, D. H., S. B. Reid, M. F. Docker, G. R. Haas and A. P. Kinziger. 2008. Mitochondrial DNA Evidence for High Levels of Gene Flow among Populations of a Widely Distributed Anadromous Lamprey *Entosphenus tridentatus* (Petromyzontidae). Journal of Fish Biology 72(2): 400-417. doi: 10.1111/j.1095-8649.2007.01731.x.

Gustafson, R. G., M. J. Ford, D. Teel and J. S. Drake. 2010. Status Review of Eulachon (*Thaleichthys pacificus*) in Washington, Oregon, and California. March.

Hamilton, J. B., G. L. Curtis, S. M. Snedaker and D. K. White. 2005. Distribution of Anadromous Fishes in the Upper Klamath River Watershed Prior to Hydropower Dams—a Synthesis of the Historical Evidence. Fisheries 30(4): 10-20. doi: 10.1577/1548-8446(2005)30[10:Doafit]2.0.Co;2.

Herald and News. 2021. Tule Lake Emptied to Improve Habitat, Fight Disease. The Oregonian. Retrieved from https://www.oregonlive.com/environment/2021/06/tule-lake-emptied-to-improve-habitat-fight-disease.html.

Hewitt, D. A., B. S. Hayes, A. C. Harris, E. C. Janney, C. M. Kelsey, R. W. Perry and S. M. Burdick. 2021. Dynamics of Endangered Sucker Populations in Clear Lake Reservoir, California. U.S. Geological Survey. doi: 10.3133/ofr20211043.

Hewitt, D. A., E. C. Janney, B. S. Hayes and A. C. Harris. 2018. Reclamation Status and Trends of Adult Lost River (*Deltistes luxatus*) and Shortnose (*Chasmistes brevirostris*) Sucker Populations in Upper Klamath Lake, Oregon, 2017. doi: 10.3133/ofr20181064.

Hollenback, S. M., N. Bradley, D. Varyu and P. Wright. 2023. 2020-2022 Sedimentation Survey Upper Klamath Lake. Klamath Project, Oregon Interior Region 10 California Great Basin. Bureau of Reclamation. Technical Memorandum No. ENV-2023-036. February.

Hoopa Valley Tribe. 2023. Hoopa Valley Tribe. Retrieved from https://www.kimaw.org/hvt.

Houston Jr, J. E. and N. K. Whittlesey. 1986. Modeling Agricultural Water Markets for Hydropower Production in the Pacific Northwest. Western Journal of Agricultural Economics: 221-231.

Howitt, R. E. 1995. Positive Mathematical Programming. American journal of agricultural economics 77(2): 329-342.

Kann, J. and J. D. Walker. 2020. Detecting the Effect of Water Level Fluctuations on Water Quality Impacting Endangered Fish in a Shallow, Hypereutrophic Lake Using Long-Term Monitoring Data. Hydrobiologia 847(8): 1851-1872. doi: 10.1007/s10750-020-04215-z.

Krause, J. R., E. C. Janney, S. M. Burdick, A. C. Harris and B. S. Hayes. 2022. Water and Endangered Fish in the Klamath River Basin: Do Upper Klamath Lake Surface Elevation and Water Quality Affect Adult Lost River and Shortnose Sucker Survival? North American Journal of Fisheries Management 42(6): 1414-1432. doi: 10.1002/nafm.10850.

Krause, J. R., R. K. Paul-Wilson and A. C. Harris. 2023. Status and Trends of Adult Lost River (*Deltistes luxatus*) and Shortnose (*Chasmistes brevirostris*) Sucker Populations in Upper Klamath Lake, Oregon, 2023: U.S. Geological Survey Data Release.

KRBSTWG (Klamath River Basin Study Technical Working Group (U.S. Department of the Interior Bureau of Reclamation, State of California Department of Water Resources, State of Oregon Water Resources Department)). 2016. Final Report Klamath River Basin Study. Technical Memorandum 86-68210-2016-06. March.

KRRC (Klamath River Renewal Corporation). 2019. Klamath River Renewal Project 2018 Annual Terrestrial Resources Survey Report. April.

KRRC (Klamath River Renewal Corporation). 2020. Klamath River Renewal Project 2019 Annual Terrestrial Resources Survey Report. March.

KRRC (Klamath River Renewal Corporation). 2021. Lower Klamath Project Biological Assessment. Appendix G - Species Accounts. March.

Kurth, R. 2021. California Steelhead: Managment and Stock Status Update. Presented at the 2021 Pacific Coast Steelhead Management Meeting, March 16-18, 2021. Presented.California Department of Fish and Wildlife. Retrieved from https://www.psmfc.org/steelhead/2021/CALIFORNIA_KURTH_StockStatus_2021.pdf.

Larson, Z. S. and M. R. Belchik. 1998. A Preliminary Status Review of Eulachon and Pacific Lamprey in the Klamath River Basin. Y. T. F. Program. April.

Leidy, R. A. and G. R. Leidy. 1984. Life Stage Periodicities of Anadromous Salmonids in the Klamath River Basin, Northwestern California. U.S. Fish and Wildlife Service. April.

Markle, D. F. and L. K. Dunsmoor. 2011. Effects of Habitat Volume and Fathead Minnow Introduction on Larval Survival of Two Endangered Sucker Species in Upper Klamath Lake, Oregon. Transactions of the American Fisheries Society 136(3): 567-579. doi: 10.1577/t06-063.1.

MBK Engineers. 2021. Tule Lake Subbasin Groundwater Sustainability Plan. December.

McCovey, B. W. 2011. Klamath River Green Sturgeon Acoustic Tagging and Biotelemetry Monitoring 2010. Final Technical Report. Yurok Tribal Fisheries Program, Klamath River Division.

Moyle, P. B. 2002. Inland Fishes of California. Berkeley and Los Angeles, CA: University of California Press.

Moyle, P. B., R. M. Yoshiyama, J. E. Williams and E. D. Wikramanayake. 1995. Fish Species of Special Concern of California. 2 ed.: California Department of Fish and Game.

National Fish and Wildlife Foundation. undated. Klamath Coho Habitat Restoration Program (Bureau of Reclamation). Retrieved from https://www.nfwf.org/programs/klamath-basin-restoration-program/klamath-coho-habitat-restoration-program-bureau-reclamation#:~:text=The%20U.S.%20Bureau%20of%20Reclamation's,Endangered%20Species%20Act%20and%20its.

National Research Council. 2004. Endangered and Threatened Fishes in the Klamath River Basin: Causes of Decline and Strategies for Recovery. Washington, DC: The National Academies Press.

NCWQCB (North Coast Water Quality Control Board). 2010. Final Staff Report for the Klamath River Total Maximum Daily Loads (TMDLs) Addressing Temperature, Dissolved Oxygen, Nutrient, and Microcystin Impairments in California, the Proposed Site Specific Dissolved Oxygen Objectives for the Klamath River in California, and the Klamath River and Lost River Implementation Plans. March.

Nehlsen, W., J. E. Williams and J. A. Lichatowich. 1991. Pacific Salmon at the Crossroads: Stocks at Risk from California, Oregon, Idaho, and Washington. Fisheries 16(2): 4-21. doi: 10.1577/1548-8446(1991)016<0004:Psatcs>2.0.Co;2.

NMFS (National Marine Fisheries Service). 2014. Final Recovery Plan for the Southern Oregon/ Northern California Coast Evolutionarily Significant Unit of Coho Salmon (*Oncorhynchus kisutch*).

NMFS (National Marine Fisheries Service). 2016. 2016 5-Year Review: Summary & Evaluation of Southern Oregon/Northern California Coast Coho Salmon.

NMFS (National Marine Fisheries Service). 2017. Endangered Species Act Recovery Plan for the Southern Distinct Population Segment of Eulachon (*Thaleichthys pacificus*). September.

NMFS (National Marine Fisheries Service). 2018. Recovery Plan for the Southern Distinct Population Segment of North American Green Sturgeon (*Acipenser medirostris*). August.

NMFS (National Marine Fisheries Service). 2019. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response Klamath Project Operations from April 1, 2019 through March 31, 2024. NMFS Consultation Number : WCR -2019-11512 , WCRO-2019-00113. March.

NMFS (National Marine Fisheries Service). 2021. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response. Surrender and Decommissioning of the Lower Klamath Hydroelectric Project No. 14803-001, Klamath County, Oregon and Siskiyou County, California. Volume NMFS No: WCRO-2021-01946. December.

NMFS (National Marine Fisheries Service). 2022. 2022 5-Year Review: Summary & Evaluation of Eulachon, Southern DPS.

ODEQ (Oregon Department of Environmental Quality). 2002. Upper Klamath Lake Drainage Total Maximum Daily Load (TMDL) and Water Quality Management Plan (WQMP). May. Retrieved from https://www.oregon.gov/deq/FilterDocs/UKtmdlwqmp.pdf.

ODEQ (Oregon Department of Environmental Quality). 2019. Upper Klamath and Lost River Subbasins Nutrient TMDL and Water Quality Management Plan. January.

ODEQ (Oregon Department of Environmental Quality). 2022. 2022 Integrated Report. September. Retrieved from https://www.oregon.gov/deq/wq/Pages/epaApprovedIR.aspx.

ODFW and The Klamath Tribes. 2021. Implementation Plan for the Reintroduction of Anadromous Fishes into the Oregon Portion of the Upper Klamath Basin. December. Retrieved from https://www.dfw.state.or.us/fish/CRP/docs/klamath_reintroduction_plan/ODFW%20and%20The%20Klamath%20Tribes_Upper%20Klamath%20Basin%20anadromous%20reintroduction%20implementation%20plan_Final%202021.pdf.

Olswang, M. undated. Coho Salmon. California Department of Fish and Wildlife. Retrieved from https://wildlife.ca.gov/Conservation/Fishes/Coho-Salmon.

OWRD. 2024. Annual Report Regarding Owrd Groundwater Monitoring for U.S. Bureau of Reclamation Project Area in the Upper Klamath Basin: Calendar Year 2023.

PacifiCorp. 2004. Final Technical Report Klamath Hydroelectric Project (Ferc Project No. 2082) Terrestrial Resources. February.

PFMC (Pacific Fishery Management Council). 2005. Review of 2004 Ocean Salmon Fisheries. Stock Assessment and Fishery Evaluation Document for the Pacific Coast Salmon Fishery Management Plan. February.

PFMC (Pacific Fishery Management Council). 2011. Review of 2010 Ocean Salmon Fisheries. Stock Assessment and Fishery Evaluation Document for the Pacific Coast Salmon Fishery Management Plan. February.

PFMC (Pacific Fishery Management Council). 2019. Salmon Rebuilding Plan for Klamath River Fall Chinook. July.

PFMC (Pacific Fishery Management Council). 2023a. Ocean Salmon Fishery Effort and Landings. Salmon Review Appendix A. Retrieved from https://www.pcouncil.org/documents/2020/06/ocean-salmon-fishery-effort-and-landings-salmon-review-appendix-a-excel-file-format.xlsm.

PFMC (Pacific Fishery Management Council). 2023b. Review of 2022 Ocean Salmon Fisheries. Stock Assessment and Fishery Evaluation Document for the Pacific Coast Salmon Fishery Management Plan. February.

Pierce, R. 1991. The Klamath River Fishery: Early History. In: A. Lufkin (Ed.), California's Salmon and Steelhead: The Struggle to Restore an Imperiled Resource. Berkeley, CA. University of California Press.

Prager, M. H. and M. S. Mohr. 2001. The Harvest Rate Model for Klamath River Fall Chinook Salmon, with Management Applications and Comments on Model Development and Documentation. North American Journal of Fisheries Management 21(3): 533-547. doi: 10.1577/1548-8675(2001)021<0533:Thrmfk>2.0.Co;2.

Pulikla Tribe of Yurok People. undated. Who We Are. Retrieved from https://resighinirancheria.com/who-we-are/.

QVIR (Quartz Valley Indian Reservation). undated. History of Qvir. Retrieved from https://qvir.com/history-of-qvir/.

Reclamation (Bureau of Reclamation). 1998. Klamath Project 1998 Annual Operations Plan and Environmental Assessment.

Reclamation (Bureau of Reclamation). 2010. Klamath Project 2010 Operations Plan. May.

Reclamation (Bureau of Reclamation). 2016a. 2016 Crop Report, Klamath Project, Oregon-California. February.

Reclamation (Bureau of Reclamation). 2016b. Final Report: Klamath River Basin Study. Technical Memorandum 86-68210-2016-06. March.

Reclamation (Bureau of Reclamation). 2017. 2017 Crop Report, Klamath Project, Oregon-California. February.

Reclamation (Bureau of Reclamation). 2018a. 2018 Crop Report, Klamath Project, Oregon-California. February.

Reclamation (Bureau of Reclamation). 2018b. The Effects of the Proposed Action to Operate the Klamath Project from April 1, 2019 through March 31, 2029 on Federally-Listed Threatened and Endangered Species. Final Biological Assessment. December.

Reclamation (Bureau of Reclamation). 2019a. 2019 Crop Report, Klamath Project, Oregon-California. July.

Reclamation (Bureau of Reclamation). 2019b. Environmental Assessment - Implementation of Klamath Project Interim Operating Procedures 2019 – 2024. Oregon and California. 2019-EA-009. April.

Reclamation (Bureau of Reclamation). 2020a. Environmental Assessment Implementation of Klamath Project Operating Procedures 2020-2023. Klamath Project, Oregon/California Interior Region 10 California Great Basin. CGB-EA-2020-018. April.

Reclamation (Bureau of Reclamation). 2020b. Final Biological Assessment on the Effects of the Proposed Action to Operation the Klamath Project from April 1, 2020 through March 31, 2024 on Federally Listed, Threatened, and Endangered Species. Klamath Project, Oregon/California. February.

Reclamation (Bureau of Reclamation). 2022. 2022 Annual Operations Plan Klamath Project, Oregon-California Interior Region 10 - California-Great Basin. April.

Reclamation (Bureau of Reclamation). 2023a. 2023 Annual Operations Plan Klamath Project, Oregon-California Interior Region 10 - California-Great Basin. April.

Reclamation (Bureau of Reclamation). 2023b. Hydrologic Database. SDI 200893 and 200894, Upper Klamath Lake Net Inflow Raw and Smoothed. Retrieved from https://www.usbr.gov/pn-bin/hdb/hdb.pl?svr=kbohdb&sdi=200893,200894&tstp=DY&t1=9-1-1980&t2=10-31-2022&table=R&mrid=0&format=2.

Reclamation (Bureau of Reclamation). 2024a. Draft Biological Assessment: The Effects of the Proposed Action to Operate the Klamath Project from October 1, 2024, through September 30, 2029 on Federally-Listed Threatened and Endangered Species. Klamath Project, Oregon/California. June.

Reclamation (Bureau of Reclamation). 2024b. Hydrologic Database Online Data Query. SDI 200893, Upper Klamath Lake net inflow (raw) - volume of computed inflow in acre-feet. Retrieved from https://www.usbr.gov/lc/region/g4000/riverops/_HdbWebQuery.html.

Reclamation (Bureau of Reclamation). 2024c. Klamath River Basin Hydrologic Update, May 23, 2024 (Presentation). May.

Reclamation. undated. Facilities. Bureau of Reclamation. Retrieved from https://www.usbr.gov/mp/kbao/facilities.html.

Smith, M., J. Von Bargen, C. Smith, M. Miller, J. Rasmussen and D. A. Hewitt. 2020. Characterization of the Genetic Structure of Four Sucker Species in the Klamath River Basin Characterization of the Genetic Structure of Four Sucker Species in the Klamath River Basin Final Report.

Spice, E. K., D. H. Goodman, S. B. Reid and M. F. Docker. 2012. Neither Philopatric nor Panmictic: Microsatellite and Mtdna Evidence Suggests Lack of Natal Homing but Limits to Dispersal in Pacific Lamprey. Mol Ecol 21(12): 2916-2930. doi: 10.1111/j.1365-294X.2012.05585.x.

Stannard, D. I., M. W. Gannett, D. J. Polette, J. M. Cameron, M. S. Waibel and J. M. Spears. 2013. Evapotranspiration from Marsh and Open-Water Sites at Upper Klamath Lake, Oregon, 2008-2010. U.S. Geological Survey. Scientific Investigations Report 2013-5014.

Stillwater Sciences. 2009. Effects of Sediment Release Following Dam Removal on the

Aquatic Biota of the Klamath River. Prepared for State Coastal Conservancy, Oakland, California. January.

Swearingen, S. and J. Rash. 2023. A Plea for Water & Habitat in the Klamath Basin. Retrieved from https://www.mossyoak.com/our-obsession/blogs/conservation/a-plea-for-water-habitat-in-the-klamath-basin.

SWRCB (State Water Resources Control Board). 2021. 2018 Integrated Report for Clean Water Act Sections 305(B) and 303(D). January.

Terwilliger, M. 2006. . Physical Habitat Requirements for Lost River and Shortnose Suckers in the Klamath Basin of Oregon and California: Literature Review. Oregon State University. Prepared for United States Department of the Interior, Bureau of Reclamation and Fish and Wildlife Service (Klamath Falls, OR).

The Klamath Tribes. 2019. Restoring Fish and a Dying Lake.

The Yurok Tribe. 2020. Written Testimony Regarding H.R. 5548, Fishery Failures: Urgently Needed Disaster Declarations Act. January 14, 2020. Retrieved from https://www.congress.gov/116/meeting/house/110359/witnesses/HHRG-116-II13-Wstate-MyersF-20200114.pdf.

The Yurok Tribe. undated. Fisheries. Retrieved from https://www.yuroktribe.org/fisheries.

Trail, P. 2022. The Klamath Basin's Water Crisis Is a Growing Disaster for Waterfowl. Audubon. Retrieved from https://www.audubon.org/news/the-klamath-basins-water-crisis-growing-disaster-waterfowl.

Tribe, K. undated. Karuk Department of Tribal Lands Management. Retrieved from https://www.karuk.us/index.php/departments/land-management.

Trihey & Associates Inc. 1996. Instream Flow Requirements for Tribal Trust Species in the Klamath River. Prepared for The Yurok Tribe. March.

Tulelake Subbasin GSA. 2024. Tule Lake Subbasin: Groundwater Sustainability Plan Annual Report Water Year 2022.

U.S. Census Bureau. 2018. Maf/Tiger Geographic Database, 2018 Cartographic Boundary File. Retrieved from https://www.census.gov/geographies/mapping-files/time-series/geo/carto-boundary-file.html.

U.S. Census Bureau. 2022. Poverty Thresholds by Size of Family and Number of Children 2022. Retrieved from https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-poverty-thresholds.html.

U.S. Census Bureau. 2023. 2018-2022 American Community Survey 5-Year Estimates. Retrieved from https://data.census.gov/.

USDA (United States Department of Agriculture National Agricultural Statistics Service). 2017a. 2017 Census Volume 1, Chapter 2: County Level Data. Retrieved from https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_2_County_Level/California/.

USDA (United States Department of Agriculture National Agricultural Statistics Service). 2017b. Census of Agriculture 2017 State and County Profiles. Retrieved from https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/County_Profiles/index.php.

USDA. 2022. 2022 Census Volume 1, Chapter 2: County Level Data. Retrieved from https://www.nass.usda.gov/Publications/AgCensus/2022/Full_Report/Volume_1,_Chapter_2_County_Level/California/.

USEPA (U.S. Environmental Ppotection Agency). 2003. EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards. EPA 910-B-03-002. April.

USEPA (U.S. Environmental Protection Agency). 2008. Reconsideration of California's 2006 Section 303(D) List Omission of Microcystin Toxin Listings for Three Klamath River Segments and Determination to Add Microcystin Toxins Listing for Klamath River Hydrologic Unit (Hu), Middle Ha Hydrologic Area (Ha), Oregon to Iron Gate. March. Retrieved from https://www.epa.gov/sites/default/files/2015-09/documents/klamath-swrcb303d-final.pdf.

USEPA (U.S. Environmental Protection Agency). 2023. Ejscreen Technical Documentation. Retrieved from https://www.epa.gov/system/files/documents/2023-06/ejscreen-tech-doc-version-2-2.pdf.

USFWS (U.S. Fish and Wildlife Service). 2008. Biological/Conference Opinion Regarding the Effects of the U.S. Bureau of Reclamation's Proposed 10-Year Operation Plan (April 1, 2008 – March 31, 2018) for the Klamath Project and Its Effects on the Endangered Lost River and Shortnose Suckers. April.

USFWS (U.S. Fish and Wildlife Service). 2013. Revised Recovery Plan for the Lost River Sucker and Shortnose Sucker *(Deltistes luxatus and Chasmistes brevirostris)*. January.

USFWS (U.S. Fish and Wildlife Service). 2015. Klamath Recovery Unit Implementation Plan for Bull Trout (*Salvelinus Confluentus*). September. Retrieved from https://www.seattle.gov/light/skagit/relicensing/cs/groups/secure/@scl.skagit.team/documents/document/cm9k/ndy1/~edisp/prod465583.pdf.

USFWS (U.S. Fish and Wildlife Service). 2019. Shortnose Sucker (*Chasmistes brevirostris*) 5-Year Review: Summary and Evaluation. September.

USFWS (U.S. Fish and Wildlife Service). 2020. Biological Opinion on the Effects of the Proposed Interim Klamath Project Operations Plan, Effective April 1, 2020, through September 30, 2022, on the Lost River Sucker and the Shortnose Sucker. TAILS # 08EKLA00-2020-F-0059. April.

USFWS (U.S. Fish and Wildlife Service). 2021. Biological Opinion for the Surrender and Decommissioning of the Lower Klamath Hydroelectric Project, Nos. 14803-001, 2082-063. December.

USFWS (U.S. Fish and Wildlife Service). 2022. Tule Lake and Lower Klamath Refuges Habitat Conditions 2022. July. Retrieved from https://www.fws.gov/media/kbnwr-2022-habitat-conditions-0.

USFWS (U.S. Fish and Wildlife Service). 2023. Biological Opinion on the Effects of the Proposed Interim Klamath Project Operations Plan, Effective January 13, 2023, through September 30, 2023, on the Lost River Sucker and the Shortnose Sucker. January.

USFWS (U.S. Fish and Wildlife Service). undated. Upper Klamath National Wildlife Refuge. Retrieved from https://www.fws.gov/refuge/upper-klamath.

USFWS and KBNWRC (U.S. Fish and Wildlife Service and Klamath Basin National Wildlife Refuge Complex). 2016. Lower Klamath, Clear Lake, Tule Lake, Upper Klamath, and Bear Valley National Wildlife Refuges Final Comprehensive Conservation Plan/ Environmental Impact Statement. December.

USGS (U.S. Geological Survey). 2023. Gap Analysis Project (Gap). Protected Areas Database of the United States (PAD-US) 3.0 (ver. 2.0, March 2023). Retrieved from https://doi.org/10.5066/P9Q9LQ4B.

USGS (U.S. Geological Survey). undated. National Water Information System. Site Inventory for the Nation. Retrieved from https://waterdata.usgs.gov/usa/nwis/inventory/.

Velarde-Tiller, V. 1996. Tiller's Guide to Indian Country: Economic Profiles of American Indian Reservations. Albuquerque, New Mexico: NM: BowArrow Publishing Company.

Wagner, B. J. and M. W. Gannett. 2014. Evaluation of Alternative Groundwater-Management Strategies for the Bureau of Reclamation Klamath Project, Oregon and California. U.S. Geological Survey. doi: 10.3133/sir20145054. Retrieved from https://pubs.usgs.gov/publication/sir20145054.

Wherry, S. A. and L. Schenk. 2024. Examining the Effect of Physicochemical and Meteorological Variables on Water Quality Indicators of Harmful Algal Blooms in a Shallow Hypereutrophic Lake Using Machine Learning Techniques. ACS ES&T Water 4(3): 1073-1082. doi: 10.1021/acsestwater.3c00299.

Wogan, C. F. 2021. Court's Opinion and Conclusions of Law on Phase 3, Part 1, Group C Motions. In the Matter of the Determination of the Relative Rights of the Waters of the Klamath River, a Tributary of the Pacific Ocean. In the Circuit Court of the State of Oregon for the County of Klamath, Case No. Wa1300001. In Re: Waters of the Klamath River Basin. February 24, 2021. February 24, 2021.

APPENDIX A Environmental Justice

Executive Order (E.O.) 12898 of 1994 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations), E.O. 14008 of 2021 (Tackling the Climate Crisis at Home and Abroad), and E.O. 14096 "EJ for All" of 2023 (Revitalizing Our Nation's Commitment to Environmental Justice for All) direct federal agencies to make achieving environmental justice part of their missions.

E.O. 14096 defines environmental justice as "the just treatment and meaningful involvement of all people, regardless of income, race, color, national origin, Tribal affiliation, or disability, in agency decision-making and other Federal activities that affect human health and the environment" (EJ for All, §2(b)).

Consistent with E.O. 12898, E.O. 14096 directs agencies to "identify, analyze, and address disproportionate and adverse human health and environmental effects (including risks) and hazards of Federal activities, including those related to climate change and cumulative impacts of environmental and other burdens on communities with environmental justice concerns." (EJ for All, §1§3(ix))§3(i)). It specifically instructs agencies to conduct reviews under the National Environmental Policy Act (NEPA) "in a manner that… analyzes direct, indirect, and cumulative effects of Federal actions on communities with environmental justice concerns; … considers best available science and information on any disparate health effects (including risks) arising from exposure to pollution and other environmental hazards, such as information related to the race, national origin, socioeconomic status, age, disability, and sex of the individuals exposed; and… provides opportunities for early and meaningful involvement in the environmental review process by communities with environmental justice concerns potentially affected by a proposed action" (EJ for All, §1§3(ix)). E.O. 14096 identifies communities with environmental justice concerns as those "found in geographic locations that have a significant proportion of people who have low incomes or are otherwise adversely affected by persistent poverty or inequality" and those "found in places with a significant proportion of people of color, including individuals who are Black, Latino, Indigenous and Native American, Asian American, Native Hawaiian, and Pacific Islander," as well as "geographically dispersed and mobile populations, such as migrant farmworkers."(EJ for All, §1).

Consistent with the above directives concerning environmental justice, this section discusses potential environmental justice concerns within the study area for the Klamath Project. In accordance with CEQ guidance on conducting environmental justice analysis under NEPA (CEQ, 1997), demographic and socioeconomic data are considered along with "the interrelated cultural, social, occupational, historical, or economic factors that may amplify the natural and physical environmental effects of the proposed agency action."

A.1 Klamath Primary Study Area

As shown in Appendix Table A-1, approximately 25% of the population in Klamath County identified as part of minority populations in 2018-2022, which was similar to the Oregon statewide average.[28] In Siskiyou and Modoc counties, minority populations comprised approximately 26% and 24%, respectively, in that same year, which were similar to Klamath County but lower than California statewide averages.

Appendix Table A-1. Minority populations in counties within Klamath Primary Study Area and Reference Areas in 2018-2022.

State	County	Total Population	White Alone, Not Hispanic or Latino Population	Minority Population*	Percent Minority
Oregon	Klamath	69,506	52,272	17,234	24.8%
California	Siskiyou	44,049	32,689	11,360	25.8%
California	Modoc	8,651	6,565	2,086	24.1%
Reference areas					
Oregon	-	4,229,374	3,100,790	1,128,584	26.7%
California	-	39,356,104	13,848,294	25,507,810	64.8%
U.S.A.	-	331,097,593	194,886,464	136,211,129	41.1%

Notes:
*The minority population is determined by subtracting the population identified as White alone, not Hispanic or Latino from the total population.
Data from U.S. Census Bureau (2023).

Appendix Table A-2 provides information for income and poverty rates for the counties in the study area. The 2022 poverty thresholds for the United States range from $14,040 for single individuals 65 years and over to $23,556 and upwards for households of three or more with at least one related child under 18 years (U.S. Census Bureau, 2022). These thresholds do not reflect differences in cost of living across the United States. To address cost-of-living variability and other factors, the U.S. Environmental Protection Agency defines "low-income" as a household whose income is less than or equal to twice the federal poverty level (i.e., 200% or less than the federal level) (USEPA, 2023). Using this metric, approximately 39% of the total population of Klamath County was identified as low-income, compared to 28% in Oregon and 28% in the United States in 2018-2022. Within Siskiyou and Modoc counties during the same period, 37% and 39% of the respective total populations were low-income, compared with 28% in California. Each of these study counties, therefore, have larger low-income populations relative to their total populations than the respective state averages, as well as the national average.

Appendix Table A-2. Economic indicators in counties within the Klamath Primary Study Area and Reference Areas in 2018-2022.

State	County	Percent of Low-Income Population	Median Household Income (2023 dollars)	Percent of Population Living Below Poverty Level
Oregon	Klamath	39.2%	$59,153	17.8%
California	Siskiyou	37.3%	$55,720	16.7%
California	Modoc	39.3%	$56,820	16.9%

[28] Using U.S. Census data, the minority population is determined by subtracting the population identified as White alone, not Hispanic or Latino from the total population.

State	County	Percent of Low-Income Population	Median Household Income (2023 dollars)	Percent of Population Living Below Poverty Level
Reference Areas				
Oregon	-	27.57%	$79,222	11.9%
California	-	27.51%	$95,011	12.1%
U.S.A.	-	28.12%	$77,689	12.5%

Note: Data from U.S. Census Bureau (2023).

Median household income in Klamath County was approximately $59,100 in 2018-2022, which was substantially lower than the statewide median household income in Oregon ($79,200). In Siskiyou and Modoc counties in 2018-2022, median household incomes were approximately $55,700 and $56,800, respectively in 2023 dollars, which were also lower than the statewide averages in California (over $95,000). In all three counties, median household incomes were lower than the national averages as well ($78,700).

Appendix Table A-3 provides information for other economic indicators for the study area, including unemployment rate, households receiving food stamps/supplemental nutrition assistance program (SNAP) benefits, and educational attainment.

Appendix Table A-3. Additional economic indicators in counties within the Klamath Primary Study Area and Reference Areas in 2018-2022.

State	County	Percent of Households with Food Stamp/SNAP Benefits in Past 12 Months	Unemployment Rate	Percent of Population with Less than High School Education
Oregon	Klamath	22.6%	7.6%	16.3%
California	Siskiyou	13.8%	7.4%	12.2%
California	Modoc	13.4%	7.6%	18.8%
Reference Areas				
Oregon	-	14.9%	5.5%	12.8%
California	-	10.3%	6.4%	9.7%
U.S.A.	-	11.5%	5.3%	11.8%

Note: Data from U.S. Census Bureau (2023).

In 2018-2022, Klamath County had a higher percentage of households relying on benefits such as food stamps/SNAP (23%) compared to average in Oregon (15%). In Siskiyou and Modoc counties, approximately 14% and 13% of the respective populations in the same period relied on SNAP benefits which were also higher than the percentage of California population (10%). In all these counties, population percentages dependent on SNAP benefits were higher than the national average (11%). All three counties in the study area had higher unemployment rates than their respective states and the national average in 2018-2022. Klamath County had an estimated unemployment rate of approximately 8% compared to the state and national percentages (both approximately 5%) in 2018-

2022. Siskiyou and Modoc counties both also have approximate unemployment rates of nearly 8% compared to the California state rate of 6%.[29]

In 2018-2022, Klamath County residents had relatively lower educational attainment levels (16% had less than a high school education), compared to average residents in Oregon (13% had less than a high school education). In that same period, 12% of the population in Siskiyou County and 19% of the population of Modoc County had less than a high school education, compared to 10% of the population in California. All three counties in the study area had percentages of population with less than high school education that were higher than or similar to the national level (12%).

In addition to low-income, minority, and Tribal populations as discussed in Section 3.5 other vulnerable populations—such as those with limited English proficiency, elderly populations, or others identified under E.O. 13985 as underserved—may also have vulnerabilities that could lead to environmental justice concerns. A higher proportion of elderly people (defined as 65 years of age and over) in a community may indicate greater vulnerability to adverse human health and environmental effects and hazards. As shown in Appendix Table A-4, the counties within the study area had larger elderly populations than state and national averages in 2018-2022. Approximately 21% of Klamath County's population was elderly, while Siskiyou and Modoc counties had elderly populations of approximately 26% and 30% in 2018-2022, compared with Oregon and California averages of 18% and 15%, respectively), and the national average (17%).

Appendix Table A-4. Population 65 years and over in counties within Klamath Primary Study Area and Reference Areas in 2018-2022.

State	County	Total Population	Population 65 Years and Over	Percent of Population 65 and Over
Oregon	Klamath	69,506	14,909	21.4%
California	Siskiyou	44,049	11,610	26.4%
California	Modoc	8,651	2,571	29.7%
Reference area				
Oregon	-	4,229,374	773,258	18.3%
California	-	39,356,104	5,865,300	14.9%
U.S.A.	-	331,097,593	54,737,648	16.5%

Note: Data from U.S. Census Bureau (2023).

In 1997, E.O. No. 13045, Protection of Children from Environmental Health Risks and Safety Risks, required that federal agencies identify and assess environmental health risks and safety risks that may disproportionately affect children. Further, the E.O. directs each federal agency to ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health and safety risks. A higher proportion of children living in poverty can also indicate a higher vulnerability in an area.

[29] Consistent with other data in this section, these estimates of unemployment rates are from the 2018-2022 American Community Survey 5-year estimates to keep discussion consistent in terms of data source and year. However, 2022 data from the Local Area Unemployment Statistics, the Bureau of Labor Statistics present slightly different estimates of these rates, as discussed in Section 3.4.2. Based on the Bureau of Labor Statistics estimates, Klamath County had a higher unemployment rate than the state average of Oregon. Siskiyou and Modoc counties had similar unemployment rates as California as a whole.

Appendix Table A-5 presents information about children living in poverty in the Klamath study area. As shown, the percentage of children living in poverty was higher in study area counties than the statewide or national averages. In 2018-2022, approximately 22% of children in Klamath County, 21% of children in Siskiyou County, and 24% of children in Modoc County were living below the poverty level, compared with Oregon and California statewide averages of 13% and 16%, respectively, and the national average of 17%.

Appendix Table A-5. Percentage of children in poverty in counties within Klamath Primary Study Area and Reference Areas in 2018-2022.

State	County	Percent of Children Under 5 years Below Poverty Level	Percent of Children 15 to 17 Years Below Poverty Level	Percent of Total Children Under 18 Years Below Poverty Level
Oregon	Klamath	24.7%	21.1%	22.1%
California	Siskiyou	18.3%	21.8%	21.0%
California	Modoc	29.4%	21.8%	23.8%
Reference Area				
Oregon	-	14.6%	13.1%	13.5%
California	-	15.6%	15.6%	15.6%
U.S.A.	-	18.1%	16.2%	16.7%

Note: Data from U.S. Census Bureau (2023).

Individuals who have a limited ability to read, speak, write, or understand English are considered limited English proficient (LEP). In general, LEP populations are present in the study area, but make up a relatively small percentage of the total population. As shown in Appendix Table A-6, Klamath County had a similar proportion of LEP households as the state of Oregon in 2018-2022 (approximately 2%). Siskiyou and Modoc counties had much smaller proportions of LEP households than the state of California (approximately 1% and 3% compared with 8%). All these counties had lower proportions of LEP households than the national level (4%) in 2018-2022.

Appendix Table A-6. Limited English-proficient households in counties within the Klamath Primary Study Area and Reference Areas in 2018-2022.

State	County	Total Households	Limited English-Speaking Households*	Percent Limited English-Speaking Households
Oregon	Klamath	28,186	487	1.7%
California	Siskiyou	18,768	237	1.3%
California	Modoc	3,403	73	2.1%
Reference Areas				
Oregon	-	1,680,800	37,452	2.2%
California	-	13,315,822	1,115,589	8.4%
U.S.A.	-	125,736,353	5,280,039	4.2%

Notes:
*A "limited English speaking household" is one in which no member 14 years old and over (1) speaks only English or (2) speaks a non-English language and speaks English "very well."
Source: U.S. Census Bureau (2023).

A.2 City of Klamath Falls and Altamont

In Klamath County, the City of Klamath Falls and the Census Designated Place Altamont are within the study area and have significant numbers of residents (over 21,000 and 20,000, respectively) (U.S. Census Bureau, 2023). The socioeconomic indicator variables discussed in Section A.1 are examined for Klamath Falls and Census Designated Place Altamont to analyze potential environmental justice concerns at this geographic level and are based on American Community Survey 2018-2022 5-year estimates.

The percentage of minority population in these two places in 2018-2022 were 26% and 29%, respectively, which were similar to the county-wide and statewide percentages. In the same period, median household income was approximately $48,000 in Klamath Falls in 2023 dollars, which was lower than the county-level ($59,000) and state-level ($77,000) median household incomes. In Census Designated Place Altamont, median household income was approximately $56,000, which, while similar to the county-level value, was still lower than the state-level value.

This was also reflected in percentages of low-income populations, percentages of populations living below poverty level, and percentages of households with food stamp/SNAP benefits in Klamath Falls and Altamont in 2018-2022, which were higher than county and statewide averages. The percentages of children living under poverty were also noticeably higher in Klamath Falls (35%) and in Altamont (28%) relative to Klamath County (22%) and the state of Oregon (13%) in 2018-2022.

Educational attainment in 2018-2022 was higher in Klamath Falls, with only 10% of its population having less than high school education, compared to 16% in Klamath County and 12% in Oregon. In Altamont, educational attainment was lower than both county and statewide levels, with 19% of its population having less than a high-school education. Percentage of population above 65 in Altamont (20%) was similar to the percentages across both Klamath County and Oregon in 2018-2022, but in Klamath Falls (16%) it was a little lower. The percentage of LEP households in Klamath Falls (1%) and in Altamont (3%) were similar to or slightly higher than the countywide or statewide percentage (both 2%).

A.3 Additional Environmental Justice Considerations

The NEPA Committee and Federal Interagency Working Group on Environmental Justice states that agencies should identify and describe any unique conditions of the potentially affected minority and low-income populations that may be affected by the Proposed Action Alternative, including human health vulnerabilities, socioeconomic vulnerabilities (for example, reliance on a particular resource that may be affected by the Proposed Action Alternative), and cultural vulnerabilities (EJ IWG, 2016). Guidance from the CEQ for analysis of environmental justice impacts recommends that analysts consider how impacts in minority or low-income populations may be different from impacts on the general population due to distinct cultural practices, such as subsistence fishing, hunting, or gathering (CEQ, 1997). Section 3.5 (Tribal Nations and Tribal Economies) and Section 3.4.5 (Commercial Recreational and Tribal Fisheries), discuss cultural practices and values that may result in differential impacts to tribal populations than non-tribal populations.

APPENDIX B Agriculture Modeling

B.1 Model Overview

Two models were used to estimate potential impacts. The first is a farm budget application called KB_HEM (Klamath Basin-Hydro Economic Model), developed by the U.S. Bureau of Reclamation (Reclamation), to measure net farm income under the No Action and Proposed Action alternatives. The second modeling package used to assess the regional economic impacts resulting from the potential change in the on-farm gross crop revenue was IMPLAN (IMpact analysis for PLANning). IMPLAN is a commonly used, industry accepted economic input-output modeling system that estimates the effects of economic changes in a defined analysis area. MIG, Inc., developed the IMPLAN modeling system. This analysis used 2022 IMPLAN data for the counties in the study area.

B.2 Klamath Basin-Hydro Economic Model Description

KB_HEM was developed in 1999 at Oregon State University (OSU) and University of California, Davis (UC Davis)[30] with funding from the U.S. Department of Agriculture and Reclamation. The original model was used to estimate the hydrologic and economic impacts of the 2001 court decision. Since then, the model has been updated, modified, and used, at Reclamation's request, to prepare multiple Environmental Assessments and Environmental Impact Statements. For example, the model was used in the writing of the economics section for the Secretarial Determination of the 2010 Klamath Basin Restoration Agreement.[31] Additionally, Reclamation allowed the model to be used in other collaborative efforts. For example, it was used to produce *Water Allocation in the Klamath Reclamation Project, 2001: An Assessment of Natural Resource, Economic, Social and Institutional Issues with a Focus on the Upper Klamath Basin, Special Report 1037,* from OSU and UC Davis Extension Services (Braunworth *et al.*, 2002). The model was also used in the doctoral dissertation of Susan Burke (2000), which was published in the peer reviewed publication *Water Resources Research* (Burke *et al.*, 2004).

The economic portion of the KB_HEM model uses positive mathematical programming theory developed by Richard Howitt, Ph.D., UC Davis (Howitt, 1995). The original non-linear model, written in general algebraic modeling system (GAMS), used a nested constant elasticity of substitution production function. The model maximizes on-farm profits of Klamath Project farmers subject to resource constraints. The model was formulated to estimate both the change in cropping patterns and the change in irrigation efficiency at a sub-project level that may occur if canal deliveries from the Klamath Project are reduced below estimated historical demand.

The economic model assumes that growers are profit maximizers subject to resource constraints. In addition to choosing applied water and irrigation technology, growers select crop mixes to maximize

[30] The original grant was written by Richard Adams, Ph.D. and Susan Burke, doctoral candidate both of OSU and Richard Howitt, Ph.D. and Wes Wallander, Ph.D. both of UC Davis. The effort was a collaboration between the Department of Land Air and Water Resources at UC Davis, the Department of Agricultural and Resource Economics from OSU and Reclamation's Klamath Basin Area Office and Technical Service Center. The work culminates in the model development and was documented in Dr. Burke's 1999 doctoral thesis.

[31] The Secretarial Determination was written in collaboration with Paula Engel and Nancy Parker both of Reclamation's Technical Service Center.

their profits given available water for 1 year. As such, the model is a short-run model, maximizing the on-farm profit for one period, assumed to be 1 year.

The economic model is calibrated to reproduce observed cropping patterns and crop-level evapotranspiration (ETc) given prices and input costs using positive mathematical programming following Howitt (1995). The model code is written in GAMS. The generalized model is shown in equation (1) and equation (2):

$$MAX\ Profit_{\square} = \sum_{ig} P_{ig}\ f_{ig}(x_{jgi}) - \sum_{j} c_{igj}\, x_{igj} \quad (1)$$

Subject to:

$$\sum_{i} x_{igj}\ \leq X_{gj}\ and\ x_{igj}\ \geq 0 \quad (2)$$

Where:

i = Crops (e.g., alfalfa hay, potatoes)
g = Regions (e.g., irrigation districts)
j = Inputs (e.g., land, applied water, irrigation technology)
P_{ig} = Price of crop i in region g
f_{ig} = Yield function of crops and ETc for crop i in region g
x_{igj} = Inputs of land, water, irrigation technology for crop i in region g
c_{igj} = Cost of land, water, irrigation technology for crop i in region g
X_{gj} = Total amount of j input available in region g

The KB_HEM model estimates revenue losses and land fallowing for different water availability levels.

B.3 Klamath Basin-Hydro Economic Model Inputs

Inputs to KB_HEM are described below. They include crop data from Reclamation, as well as other assumptions organized in tables "Modeling Unit" and "Resource Use."

B.3.1 Crop Data

Crop acres, yields, prices, and total values come from Reclamation's 2016, 2017, 2018, and 2019 crop reports. Horsefly and Langell Valley Irrigation districts are excluded from the analysis as they were not included in the water modeling or water analysis. Crops are aggregated into representative crop groups. Appendix Table B-1 shows the Klamath Project-level acres, yields, prices, and value, excluding Horsefly and Langell Valley Irrigation districts, by representative crop group. An additional 26,077 acres (14% of total) and $18.7 million in value (8% of total) are reported for Horsefly and Langell Valley Irrigation districts, most of which are alfalfa hay and irrigated pasture.

Appendix Table B-1. Crop acres, yields, prices, and values by representative crop groups (excluding Horsefly and Langell Valley Irrigation Districts).

Crop	Acres	Yield (ton/acre)	Price ($/ton)	Value
Alfalfa and Hay	65,724	6.7	$221.8	$97.4 million
Irrigated Pasture[1]	27,788	4.3	$29.5	$3.5 million
Small Grain	25,459	2.6	$223.8	$14.8 million
Wheat	21,474	3.4	$252.7	$18.5 million

Crop	Acres	Yield (ton/acre)	Price ($/ton)	Value
Potatoes	13,426	21.8	$229.1	$67.1 million
Other	7,391	13.3	$261.4	$25.6 million
Total	**161,263**			**$226.9 million**

Note::
1. Irrigated pasture yields are in Animal Unit-Months (AUM) /acre and irrigated pasture values are in $/AUM.

Surface water on the Klamath Project is allocated according to the relative priority of each user's water delivery contract. Contracts are categorized as either A, B, or C priority, where A-contracts are senior to B-contracts, which are senior to C-contracts. Under the A/B/C water type allocation, C-users are the first to experience a reduction in diversions. B-users are next in line to experience a reduction in diversions but only after all diversions to C-users have completely ceased. A-users are the last users to experience a reduction in diversions, and only after all diversions to B-users have ceased. The water rights priorities (A, B, or C) of each model unit also come from Reclamation's crop reports.

B.3.2 Modeling Unit Data Table

Appendix Table B-2 contains the data collected for each of the modeling units, e.g. irrigation districts. There are 41 unique modeling units and 53 rows of data. Some of the modeling units were disaggregated because the belonged to more than one hydrologic unit, which come from the original mass balance model developed at UC Davis. For example, Klamath Irrigation District was disaggregated into hydrologic unit A1-2, A1-2, and A1-3A.

Appendix Table B-2. Descriptions of modeling unit data table fields.

Field Name	Field Type	Field Description	Source	Note
Mdl_Unit	Short Text	A 3-5 alpha character abbreviation for the irrigation districts	Reclamation Klamath Basin Area Office	
Desc	Short Text	The description of the irrigation district that matches the crop reports	Reclamation Klamath Basin Area office	
Irrigation	Yes/No	Yes=summer irrigation No=no irrigation	Reclamation Klamath Basin Area office	This field was used in early versions of the model
State	Short Text	The state in which the irrigation district is found (CA or OR)	Reclamation Klamath Basin Area office	
Hydro_unit	Short Text	The modeling unit from the hydrology model	The original mass balance model developed at UC Davis	
County	Short Text	Klamath, Siskiyou, or Modoc	Reclamation Klamath Basin Area office	
Irr_acres	Number	The total number of irrigable acres	Reclamation Klamath Basin Area office	
Priority	Short Text	The water rights priority, A, B, or C	Reclamation Klamath Basin Area office	
Soil_type	Short Text	Organic or Mineral Soils	UC Davis Agriculture Extension Office	Used to determine yield changes for a mid-season cut off
A	Number	The percent of priority A water lands in the unit	Reclamation Klamath Basin Area office	
B	Number	The percent of priority B water lands in the unit	Reclamation Klamath Basin Area office	
C	Number	The percent of priority C water lands in the unit	Reclamation Klamath Basin Area office	
G	Number	The percent of groundwater available in the irrigation district	U.S. Geological Survey	This field is no longer used as the data is outdated

Field Name	Field Type	Field Description	Source	Note
Avg_kwh	Number	The average kilowatt per hour charge per contractual arrangement	Reclamation Klamath Basin Area office	Since the re-negotiation of power rates the rate is the same for each irrigation district
Pmp_eff	Number	The average pump efficiency in the unit	UC Davis Agriculture Extension	This data was based on professional experience of extension staff
Head	Number	Feet of hydraulic head by modeling unit and water category	Oregon Water Resources Department and California Department of Water Resources	This data was based on the depth to groundwater estimated in the early 1990s and is no longer used to calculate pumping cost

B.3.3 Resource Use Data Table

Appendix Table B-3 contains the costs and water requirements for each aggregated crop. There are seven records in the table, one for each crop.

Appendix Table B-3. Descriptions of "Resource Use" data table fields.

Field Name	Field Type	Field Description	Source	Note
Crop	Short Text	Agricultural crop	Professional judgment	7 unique crop types, for example alfalfa hay and other hay are aggregated into the ag_crop category "Hay"
Land	Number	The cost per acre of land	UC Davis and/or OSU Enterprise Budget	
Tech	Number	Per acre dollars of irrigation technology (labor plus amortized capital)	Derived from Houston Jr and Whittlesey (1986)	
Etc	Number	Evapotranspiration based on reference ET	UC Davis	
ET	Number	Evapotranspiration percent of applied water	UC Davis mass balance	
Etaw	Number	Applied water, based on 65% efficiency rate	UC Davis mass balance	
Src_cost	Long Text	Source of the cost data	UC Davis Cost and Return Studies[32]	
Yr_cost	Short Text	The year of the cost data report	The year UC Davis Cost and Return Studies was published	
Src_et	Long Text	Source of the ET and Etaw data	UC Davis mass balance	

B.4 Klamath Basin-Hydro Economic Model Outputs

The final spreadsheet combines the output of the estimated canal deliveries by alternative, provided by the hydrologic model, with the economics model output to estimate the annual economic impacts for each alternative.

The hydrologic model analyzes historical data on precipitation and temperature to calculate the surface water canal deliveries available under various operating alternatives. In the current analysis

[32] See Agricultural & Resource Economics, UC Davis, Cost and Return Studies, here https://coststudies.ucdavis.edu/

there are 32 years of data, ranging from 1991 to 2022. The baseline used to determine impacts is the historical full demand.

The following columns (i.e., variables) are included in the final spreadsheet:

- **Year**: the year for the hydrologic data used in the model, ranging from 1991 to 2022
- **Historical demand**: the volume of surface water that is demanded by irrigators; this column is used for the baseline to determine the reduction in surface water deliveries
- **Alternative diversions**: the volume of surface water available under the alternative
- **Difference in available surface water compared to demand**: the difference between the baseline surface water and the estimated amount of surface water available under the alternative
- **Assumed amount of groundwater pumped**: the volume of pumped groundwater estimated to replace the estimated surface water shortage; this analysis focuses on a scenario with no groundwater pumping
- **Total available water for Project use**: sum of canal deliveries and estimated groundwater pumping
- **Irrigation water supply available (surface and ground) (% hist)**: total available water for Klamath Project use as a percent of historical full demand
- **On-farm revenue losses**: the results of the GAMS file output of total on-farm revenue losses (compared to a full demand baseline) associated with the appropriate binned percent of irrigation water supply available
- **Pumping charges**: the product of the estimated volume of groundwater pumped times the cost per unit to pump
- **Land fallowed**: the results of the GAMS file output of total acres of land fallowed (compared to a full demand baseline) associated with the appropriate binned percent of irrigation water supply

B.5 IMPLAN

The Klamath Project has the potential to generate an estimated $232.0 million in on-farm gross revenue, assuming historical water demands are met, which is adjusted from actual revenues reported in Reclamation's 2016, 2017, 2018, and 2019 crop reports to account for current shortages from full demand. Using IMPLAN multipliers, this corresponds to $341.9 million in regional output, $120.8 million in labor income, and 1,751 jobs. The IMPLAN multipliers are used to calculate the regional output, labor income, and employment losses associated with the losses in on-farm revenue from water shortages calculated by KB_HEM.

IMPLAN is a standard input-output model commonly used to analyze the multiplier effects associated with changes in demand within one or more sectors of the economy. The underlying data for IMPLAN is derived from multiple federal sources, including the Bureau of Economic Analysis, the Bureau of Labor Statistics, and the U.S. Census Bureau. These data describe the interrelationships between industry producers and consumers. IMPLAN combines these data, which describe market monetary flows, with "social accounts" that describe non-market monetary flows, such as payments made between households, or between households and governments. The current model classifies all industries into 546 IMPLAN sectors, which represent aggregations of North American Industry Classification System (NAICS) codes. These sectors define the businesses and institutions that support the social and economic structure of a given region, providing needed goods and services and

employment opportunities. These relationships are location- and sector-specific. IMPLAN uses these data to translate initial changes in expenditures into economic impacts by sector and in the aggregate for a geographic region. The IMPLAN data describing the market monetary flows generate the multipliers in the analysis.

For each metric, IMPLAN estimates regional economic impacts for the following three primary categories of effects:

- **Direct Effects**: Direct effects represent the changes in production, expenditures, or employment that directly result from an activity or policy. These are specified initially by the modeler.
- **Indirect Effects**: Indirect effects are "ripple" effects that result from changes in the output of industries that supply goods and services to the industries that are directly affected.
- **Induced Effects**: Induced effects reflect changes in household consumption on goods and services resulting from changes in employment and associated income (which in turn are the result of direct and indirect effects). These effects occur when people who receive income from direct and indirect demand for goods and services spend money locally.

Direct, indirect, and induced effects are calculated for all industries and aggregated to determine the total regional economic impacts of the modeled expenditures.

APPENDIX C Cumulative Effects

Council on Environmental Quality (CEQ) regulations for implementing the National Environmental Policy Act (NEPA) require an assessment of cumulative effects. According to CEQ regulations for implementing the procedural provisions of NEPA, cumulative effects are "effects on the environment that result from the incremental effects of the action when added to the effects of other past, present, and reasonably foreseeable actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative effects can result from actions with individually minor but collectively significant effects taking place over a period of time" (40 CFR § 1508.1). As such, cumulative impacts are the combination of impacts from:

- The proposed action or alternatives;
- Other past or present actions; and
- Reasonably foreseeable future actions.

As stated in the CEQ handbook, Considering Cumulative Effects (CEQ, 1997), cumulative impacts need to be analyzed in terms of the specific resources, ecosystem, and human community being affected and should focus on effects that are truly meaningful. Consistent with CEQ regulations, the cumulative impacts analysis considers the environmental impacts of proposed alternatives when added to impacts of past, present, and reasonably foreseeable future actions throughout affected areas.

C.1 Analysis Approach

The cumulative action analysis methods are based on the policy guidance and methodology originally developed by (CEQ, 1997). This method includes identifying affected resources and associated direct/indirect effects; establishing the geographic and temporal boundaries of the analysis; identifying the cumulative action scenario; and analyzing the cumulative effects.

The Environmental Consequences sections of Chapter 4 present the direct and indirect effects of the Proposed Action and No Action alternatives on each resource's affected environment as presented in the Affected Environment sections of Chapter 3. The resource conditions described in those sections account for the effects to resources related to past and present actions. Cumulative effects sections in Chapter 4 further consider the cumulative effects of each alternative combined with reasonably foreseeable future actions and conditions for all resources. Climate change, for example, can be considered an effect of past, present, and reasonably foreseeable future actions that may have a cumulative effect on certain resources in the analysis area. The U.S. Bureau of Reclamation (Reclamation) considers those that have completed planning and any required compliance activities to be reasonably foreseeable.

C.2 Actions and Projects Considered in Cumulative Effects Analysis

Centuries of human interactions with the natural environment have profoundly affected the current conditions in the Klamath River Basin. This context includes, but is not limited to, the draining and conversion to agriculture of expansive wetland complexes in the upper part of the Basin, damming of the Klamath River and some of its tributaries, plus streamflow diversions and groundwater withdrawals for irrigation and other human uses. The Proposed Action Alternative occurs in this

context and also in the context of ongoing fossil fuel-related climate change (the general effects of which in the Klamath Basin are summarized in Section C-3).

The effects of past and ongoing actions are reflected under each resource in the Affected Environment sections of Chapter 3, which describes the existing condition for each resource as well as ongoing trends. Appendix Table C-1 summarizes important and reasonably foreseeable future actions in the Klamath River Basin that are relevant to potential effects described in Chapter 4.

An important ongoing and future action expected to affect the natural resources considered in this Environmental Assessment is the Klamath River Renewal Corporation's (KRRC's) 2023-2024 removal of the J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams (California Natural Resources Agency, 2022). KRRC dam removals are located downstream of Klamath Project facilities on the Klamath River. KRRC's dam removal encompass not only actual dam removal but also a number of related activities, including: (a) restoration of the areas formerly inundated by reservoirs; (b) reconnecting tributary streams to the mainstem; (c) stabilizing lands disturbed by the dam facilities; (d) closing the Iron Gate Hatchery, located at the base of the former Iron Gate Dam; and (e) upgrading and temporarily operating Fall Creek Hatchery for 8 years post dam-removal (NMFS, 2021). The anticipated environmental effects of KRRC dam removals and their associated actions are complex and have been evaluated in detail in an environmental impact statement (FERC 2022).

Additional actions considered here are those which may affect listed species and whose impacts are a central concern of the Environmental Assessment and associated Endangered Species Act Section 7 consultation. In particular, recovery plans established for the Lost River and Shortnose suckers (USFWS, 2013) and for the Southern Oregon/Northern California Coast (SONCC) Evolutionary Significant Unit (ESU) of Coho Salmon may provide some benefits to these species (NMFS, 2014). Recovery plans identify actions needed to help the species' recovery. Conservation efforts that have been undertaken and that were underway at the time to protect these species include a captive rearing program for the Shortnose Sucker (USFWS, 2019). In addition, since 2015 the National Fish and Wildlife Foundation and Reclamation have awarded millions of dollars to projects aimed at conserving SONCC Coho Salmon in the Klamath River Basin, including watershed habitat restoration, instream habitat structure installation, and opening nearby stream habitat (National Fish and Wildlife Foundation, undated).

Ongoing operations of the Trinity River Hatchery have also been considered. This hatchery is located at the base of Lewiston Dam on the Trinity River (a tributary of the Klamath River) and produces spring- and fall-run Chinook Salmon, Coho Salmon, and Steelhead (FERC, 2022a). Reclamation funds operation and maintenance of the Trinity River Hatchery, which is operated by the California Department of Fish and Wildlife.

Appendix Table C-1. Reasonably foreseeable future projects considered in the cumulative impacts analysis.

Action or Project	Institution	Description	Affected Resources	Effect on Resource
2023-2024 Removal of the J.C. Boyle, Copco No. 1, Copco No 2, and Iron Gate Dams	KRRC	KRRC dam removals are downstream of Klamath Project facilities on the Klamath River (California Natural Resources Agency, 2022). Related activities, include: (a) restoration of the areas formerly inundated by reservoirs; (b) reconnecting tributary streams to the mainstem; (c) stabilizing lands disturbed by the dam facilities; (d) closing the Iron Gate Hatchery; and (e) upgrading and temporarily operating Fall Creek Hatchery for 8 years post dam removal (NMFS, 2021). An environmental impact statement (EIS; FERC, 2022a) has evaluated the anticipated environmental effects.	Water Resources, Biological Resources, Socioeconomic Resources, Tribal Nations and Tribal Economies, Environmental Justice	Short-term adverse and long-term beneficial
Off-Project Water Withdrawals	Private Water Users	Landowners with water rights independent of the Klamath Project and who are able to exercise such rights without the use of Klamath Project facilities, would reasonably be expected to continue to divert available supplies. Such diversions include approximately 17,000 acres irrigated by direct diversions from Upper Klamath Lake, through private facilities over which Reclamation holds no discretionary control. There are also approximately 7,300 acres irrigated by direct diversions from the Keno Impoundment reach, again through private facilities that Reclamation has no control over. There are also landowners and entities along the Lost River with non-federal diversion works that would continue to operate. Among these are included Harpold Dam (owned and operated by Horsefly Irrigation District) and another dam at the Lost River Ranch (privately owned). Horsefly Irrigation District serves approximately 10,000 acres of irrigable land around Bonanza, through district- and individually owned pumps in the Lost River. Horsefly Irrigation District has water rights independent of the Klamath Project that are recognized by the state of Oregon and that the Horsefly Irrigation District would presumably continue to exercise.	Water Resources, Biological Resources, Socioeconomic Resources, Tribal Nations and Tribal Economies, Environmental Justice	Adverse
Off-Project Agricultural Practices	Private Entities	Off-Klamath Project agricultural operations on Klamath River tributaries, if unaltered, will continue to reduce the quantity, and alter the timing, of water availability and may negatively affect riparian and wetland habitats through upland modifications that lead to increased siltation or reductions in water flow in stream channels. Grazing activities from dairy and cattle operations can degrade or reduce suitable critical habitat for Endangered Species Act-listed Coho Salmon by increasing erosion and sedimentation, as well as introducing nitrogen, ammonia, and other nutrients into the watershed. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may negatively affect salmonid reproductive success and survival rates. Furthermore, agricultural practices can alter the hydrograph (e.g., timing of peak runoff, base flows, return flows and contamination) and therefore impact salmonid habitats. Also, with agricultural practices, the cultivation of marijuana, legal and illegal, can also impact salmonid habitats. Watersheds within the Action Area have been used to produce marijuana crops both legally and illegally. Illegal	Water Resources, Biological Resources, Socioeconomic Resources, Tribal Nations and Tribal Economies	Adverse

Action or Project	Institution	Description	Affected Resources	Effect on Resource
		marijuana production within the Action Area can result in grow operations of over 100,000 plants; often these illegal grow operations occur on federal lands. These grow operations can adversely affect Coho Salmon habitat by diversion of water for irrigation, resulting in the drying of streams or draining of pools that provide rearing habitat for Coho Salmon juveniles. The operations can also contaminate nearby streams by the discharge of pesticides, rodenticides, and fertilizers to nearby streams. Such influx of contaminants can be lethal to exposed Coho Salmon or result in the alteration of stream habitats via eutrophication.		
Recovery Plans for the Lost River and Shortnose Suckers (USFWS, 2013)	U.S. Fish and Wildlife Service	Recovery plans identify actions needed to help the species recover, including the implementation of a captive rearing program for the Shortnose Sucker (USFWS, 2019). Collection of eggs or fish for the rearing program could represent an adverse effect to suckers that is, however, outweighed by the beneficial effect of rearing eggs or fish in a captive environment prior to release into natural environments.	Biological Resources, Socioeconomic Resources, Tribal Nations and Tribal Economies	Beneficial
Recovery Plans for the SONCC ESU of Coho Salmon (NMFS, 2014)	National Fish and Wildlife Foundation and Reclamation	Since 2015 the National Fish and Wildlife Foundation and Reclamation have administered millions of dollars in projects aimed at conserving SONCC Coho Salmon in the Klamath River Basin, including watershed habitat restoration, instream habitat structure installation, and opening nearby stream habitat (National Fish and Wildlife Foundation, undated).	Biological Resources, Socioeconomic Resources, Tribal Nations and Tribal Economies	Beneficial
Water Quality – Total Maximum Daily Loads (TMDLs)	Oregon Department of Environmental Quality	The Oregon Department of Environmental Quality released the *Upper Klamath Lake Drainage Total Maximum Daily Load (TMDL) and Water Quality Management Plan* in 2002 (ODEQ, 2002) and the *Upper Klamath and Lost River Subbasins Nutrient TMDL and Water Quality Management Plan* in 2019 (ODEQ, 2019). Implementation of the resultant water quality management plans will aid in improving water quality in Upper Klamath Lake and its tributaries as well as the mainstem Klamath River in habitats occupied by listed suckers, which is beneficial to listed suckers and their habitats.	Water Resources, Biological Resources, Socioeconomic Resources, Tribal Nations and Tribal Economies	Beneficial
Non-Federal Ecosystem Restoration Actions	Various Non-Federal Agencies	Excerpt abridged from page 173 of the U.S. Fish and Wildlife 2023 Biological Opinion (USFWS, 2023): *The non-Federal actions that are expected in the action area include habitat restoration, water quality improvements, and other actions that are regularly funded by the Oregon Watershed Enhancement Board, National Fish and Wildlife Foundation, as well as through other entities. For example, past work has been done by the Klamath Basin Rangeland Trust, Klamath Watershed Partnership, The Klamath Tribes, The Nature Conservancy, Trout Unlimited, Sustainable Northwest, Klamath Soil and Water Conservation District, and Klamath Water Users Association.*	Water Resources, Biological Resources, Socioeconomic Resources, Tribal Nations and Tribal Economies	Beneficial
Klamath Tribes Rearing Programs	Klamath Tribes	Excerpt abridged from page 173 of the U.S. Fish and Wildlife 2023 Biological Opinion (USFWS, 2023): *The Klamath Tribes established a rearing program in 2018 for Lost River and Shortnose Suckers at a facility near Chiloquin, Oregon. The rearing program is expected to result in an additive effect towards recovery of the species.*	Biological Resources, Socioeconomic Resources, Tribal Nations and Tribal Economies	Beneficial

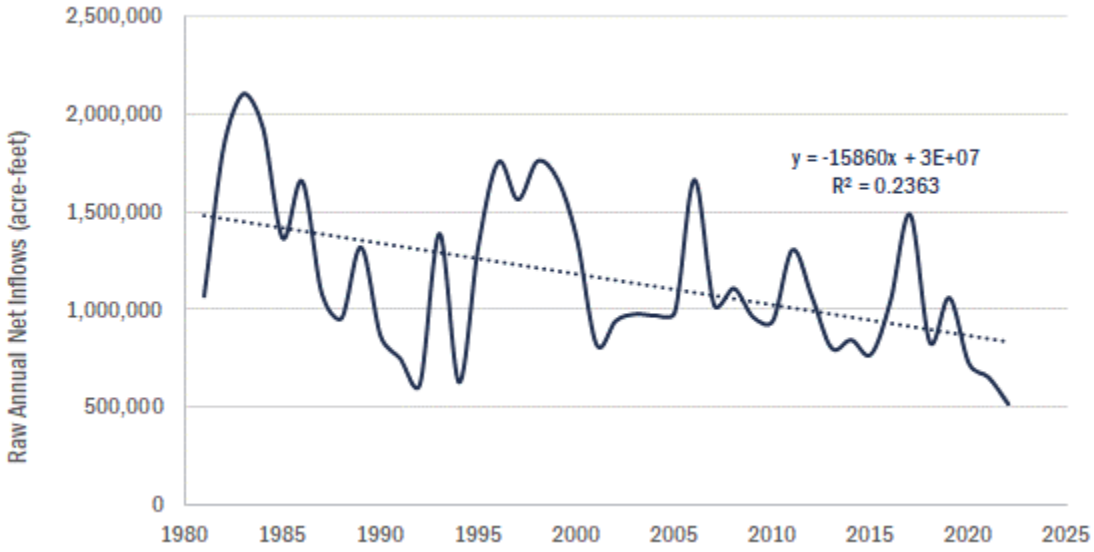
Action or Project	Institution	Description	Affected Resources	Effect on Resource
Oregon Anadromous Fish Reintroduction Plan	Oregon Department of Fish and Wildlife and Klamath Tribes	Oregon Department of Fish and Wildlife and the Klamath Tribes of Oregon have finalized an *Implementation Plan for the Reintroduction of Anadromous Fishes into the Oregon Portion of the Upper Klamath Basin* (ODFW and The Klamath Tribes, 2021). The plan provides for volitional reintroduction by anadromous species (fall-run Chinook and Coho Salmon, Steelhead, and Pacific Lamprey) and includes a recommended strategy for monitoring re-establishment of anadromous species following removal of the four Lower Klamath Hydroelectric dams.	Biological Resources, Socioeconomic Resources, Tribal Nations and Tribal Economies	Beneficial
California Anadromous Fish Reintroduction Plan	California Department of Fish and Wildlife and Partners	California Department of Fish and Wildlife, with support from Oregon Department of Fish and Wildlife and other key partners including several Klamath Basin tribes, National Marine Fisheries Service, and U.S. Fish and Wildlife have prepared a draft implementation plan for the reintroduction of anadromous fishes, including Coho and Chinook Salmon, into the California portion of the Upper Klamath Basin. Reclamation believes that the plan is reasonably likely to be implemented.	Biological Resources, Socioeconomic Resources, Tribal Nations and Tribal Economies	Beneficial
Timber Management on Private Lands	Private Entities	Excerpt abridged from page 252 of the National Marine Fisheries Service 2021 Biological Opinion (NMFS, 2021): *Timber management, along with associated activities such as harvest, yarding, loading, log hauling, site preparation, slash burning, tree planting, thinning, and road construction occurs in the action area. NMFS assumes that harvest levels on private lands within the action area in the foreseeable future will be similar to harvest levels that have occurred over the past 20 years.*	Water Resources, Biological Resources, Socioeconomic Resources, Tribal Nations and Tribal Economies, Environmental Justice	Adverse
Control of Wildland Fires on Non-Federal Lands	State, Federal, and Private Entities	Excerpt abridged from page 252 of the National Marine Fisheries Service 2021 Biological Opinion (NMFS, 2021): *Climate change is increasing the frequency and severity of wildfires not only in California* [and Oregon] *but also all over the world. Since 1950, the area burned by California wildfires each year has been increasing, as spring and summer temperatures have warmed and spring snowmelt has occurred earlier (CARB 2021). Control of wildland fires may include the removal or modification of vegetation due to the construction of firebreaks or setting of backfires to control the spread of fire. This removal of vegetation can trigger post-fire landslides as well as chronic sediment erosion that can negatively affect downstream Coho Salmon habitat. Also, the use of fire retardants may adversely affect salmonid habitat.*	Water Resources, Biological Resources, Socioeconomic Resources, Tribal Nations and Tribal Economies	Beneficial and adverse
Construction, Reconstruction, Maintenance, and Use of Roads	State, Federal, and Private Entities	Excerpt abridged from page 253 of the National Marine Fisheries Service 2021 Biological Opinion (NMFS, 2021): The Klamath Basin includes *"thousands of miles of surface roads used to provide access to timber or private residences. Erosion from unmaintained roads increases fine sediment concentrations to waterways and can suffocate redds, degrade pool quality, and decrease pool depth (Newcombe and Jensen 1996; Suttle et al. 2004).*	Water Resources, Biological Resources, Socioeconomic Resources, Tribal Nations and Tribal Economies	Adverse

Action or Project	Institution	Description	Affected Resources	Effect on Resource
Mining, Rock Quarrying, and Processing	Private Entities	Excerpt abridged from page 253 of the National Marine Fisheries Service 2021 Biological Opinion (NMFS, 2021): *NMFS anticipates that upland mining and quarrying will continue to be conducted by non-federal parties adjacent or upslope to and affecting the [Klamath Basin]. Mining can cause increased sedimentation, accelerated erosion, increased streambank and streambed instability, and changes to substrate.*	Water Resources, Biological Resources, Socioeconomic Resources, Tribal Nations and Tribal Economies	Adverse
Marine Policy and Conditions	State and Federal Agencies	Excerpt abridged from page 257 of the National Marine Fisheries Service 2021 Biological Opinion (NMFS, 2021): *Additional activities that may occur in the coastal waters off Oregon and California will likely consist of state or local government actions related to ocean use policy and management of public resources, such as changes to or additional fishing or energy development projects.*	Biological Resources, Socioeconomic Resources, Tribal Nations and Tribal Economies	Beneficial and adverse

C.3 Climate Change

Climate change involves long-term shifts in temperatures and weather patterns. In the Klamath River Basin, climate change affects the extent and timing of precipitation, the extent and timing of snowpack runoff, air and water temperatures, and the frequency and severity of storms. Climate change is a likely contributor to certain environmental trends that have been documented in the study area, such as declines in annual water inflows to Upper Klamath Lake.

Between 1981 and 1990, the mean annual net inflow to Upper Klamath Lake was approximately 1,400,000 acre-feet; however, annual net inflows have been declining, averaging about 1,000,000 acre-feet between 2011 and 2020 and decreasing further in 2021 and 2022 (Appendix Figure C-1).



Note: Data from Reclamation (2023b).

Appendix Figure C-1. Raw annual inflow (acre-feet) into Upper Klamath Lake, 1981-2022.

The *Final Environmental Impact Statement For Hydropower License Surrender and Decommissioning of the Lower Klamath Project* (FERC, 2022a) describes the effects of climate changes on the Klamath River Basin as follows.

> *Climate change is expected to result in a wide variety of effects in the Klamath River Basin (Karl et al., 2009; Barr et al., 2010; Hamilton et al., 2011; Woodson et al., 2011; Dalton et al., 2017; May et al., 2018; Mote et al., 2019; and Reclamation, 2011b, 2016a, 2016b). The Reclamation (2016b) Klamath River Basin Study provides an overview of the climate change impacts on the watershed with respect to historical and projected future water supply and demand. The following summary statements of future effects on water quantity in the Klamath River Basin are consistent with projected changes in temperature and precipitation as presented in the aforementioned reports:*
>
> – *Climate change models indicate temperatures throughout the Klamath River Basin may increase by approximately 5 to 6°F over the 21st century, with a projected increase of from 2.2 to 2.7 percent in precipitation by 2050.*

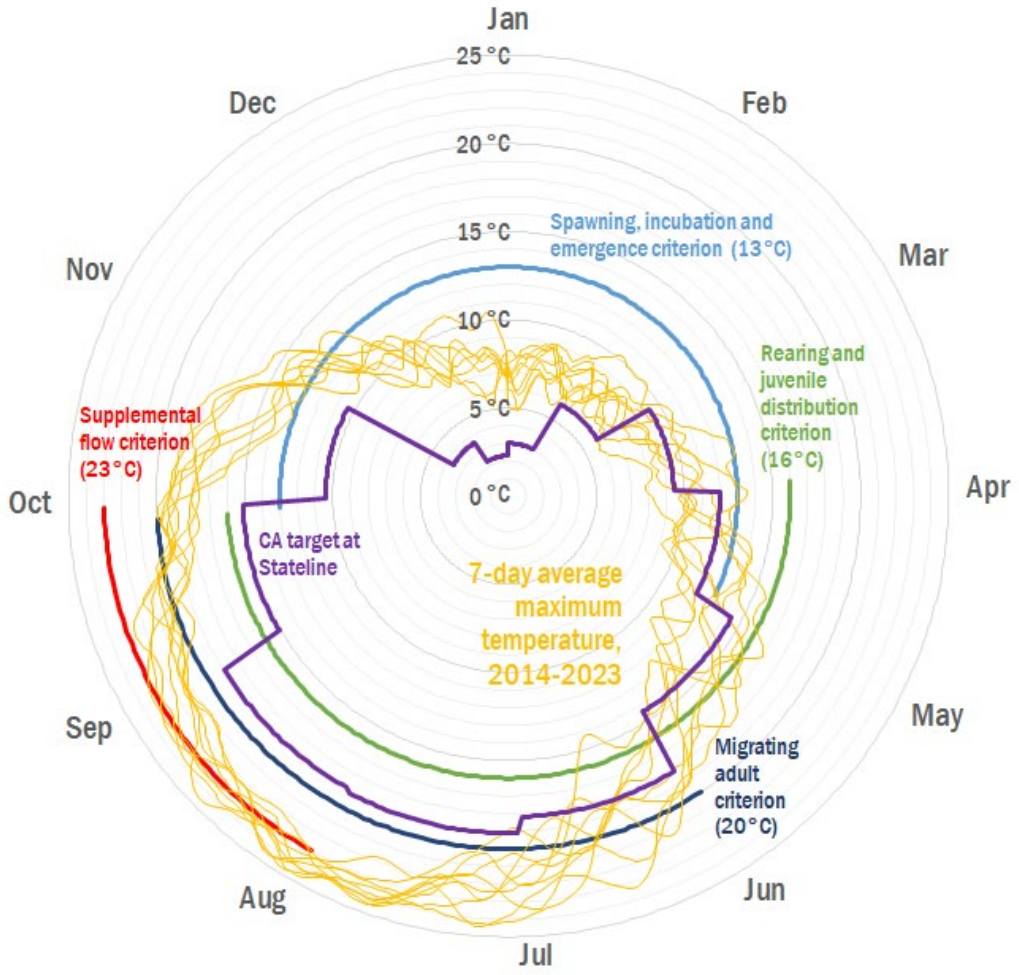
- *Increased warming is expected to reduce snowpack and snowmelt, resulting in less runoff during the late spring through early autumn. Snowpack decreases are projected to be more substantial in the warmer parts of the basin.*
- *Mean annual runoff is projected to increase by from 2.9 to 9.6 percent by 2050; it may increase by 15 percent by 2070, with a range from a decrease of 6 percent to an increase of 39 percent across all equally likely scenarios.*
- *Despite a possible increase in annual runoff, projected warming would change runoff timing, with irrigation season runoff (April to September) projected to decrease about 40 percent by the 2070s, with slightly more rainfall-runoff during the winter (December through March) and a more apparent declining trend of less runoff during the late spring and summer (April through July).*

Additionally, individual rain events are predicted to become more intense, and thus flooding flows will be more frequent. These hydrologic changes are expected to cause changes in groundwater levels and water quality….

The climate change vulnerability assessment for south-central Oregon (Halofsky et al., 2019) reports that the effects of climate change on hydrology will be significant. Effects include decreased snowpack and earlier snowmelt, which will shift the timing and magnitude of streamflow; peak flows will be higher, and summer low flows will be lower. Projected changes in climate and hydrology affect aquatic and terrestrial ecosystems via predicted increases in frequency of extreme climate events (drought, low snowpack) and ecological disturbances (flooding, wildfire, insect outbreaks).

The projected changes in the timing of runoff—in particular, the timing of low flow periods—is of interest to water managers since there is often limited supply for numerous competing resources during low flow periods (KRBSTWG, 2016). In addition, the timing and extent of low flows are of concern to biological resource managers, as low flow periods typically occur when some anadromous fish species, including salmon, begin their upstream spawning migration. Low flows during the summer may also increase water temperatures and reduce the availability of temperature refugia, which is of concern particularly as summer water temperatures already exceed criteria for the protection of salmonids (Appendix Figure C-2). Low flows can increase disease transmission as aquatic biota are forced into closer congregation: in September 2002, more than 33,000 adult salmon in the Lower Klamath River died of disease, and drought and warm temperatures contributed by creating ideal conditions for the pathogens to infect the fish (CDFG, 2004).

The Lower Klamath Project Biological Assessment (KRRC, 2021) identifies additional mechanisms whereby climate change can affect aquatic resources. For instance, the expected higher frequency of rain-on-snow events may increase late winter and early spring flooding, destroying salmonid redds and reducing salmonid survival. More generally, Klamath Basin Chinook Salmon, Coho Salmon, Steelhead, and Bull Trout populations may be particularly susceptible to the effects of climate change as the Klamath Basin falls within the southern portion of these species' ranges. As such, the increasing water temperatures in both freshwater and marine habitats may be particularly challenging for these populations to endure (KRRC, 2021).



Notes: Standards from USEPA (2003) and NCWQCB (2010); temperature data from USGS (undated). Applicable time periods for the U.S. Environmental Protection Agency criteria are from Daley *et al.* (2022).

Appendix Figure C-2. Summer water temperatures (ºC) at USGS Station 11530500 in the Lower Klamath River between 2014 and 2023, which have exceeded U.S. Environmental Protection Agency criteria to protect Pacific salmonids.

KRRC (2021) also summarizes the expected effects of climate change on the Klamath Basin's terrestrial environment. In addition to expected increases in pests, diseases, and invasive species, the frequency of forest fires is projected to rise across all forest types. Forest fires result in the loss of vegetation, which in turn can increase soil erosion and river sedimentation (thereby degrading water quality). The loss of shade along riparian zones further increases water temperatures. The intense, lasting heat produced by a major fire can cause plants to release a gas into the soil that cools and solidifies into a water-repelling substance, decreasing precipitation infiltration and that further increasing runoff and erosion into streams (KRRC, 2021). In short, climate change is expected to adversely affect Klamath Basin terrestrial and aquatic ecosystems in numerous complex and interconnected ways.

This page intentionally left blank

APPENDIX D Tribal Nations and Tribal Economies in the Klamath Basin

D.1 The Klamath Tribes (Klamath, Modoc, and Yahooskin)

In 1864, a Treaty with the United States reserved to the Klamath, Modoc, and Yahooskin peoples, known today as "the Klamath Tribes," fishing, hunting, and gathering rights on lands formerly part of the Klamath Indian Reservation.[33] Resources central to the exercise of these rights include fish, specifically the Lost River Sucker, or *C'waam* and the Shortnose Sucker, or *Koptu,* as well as wildlife species within or adjacent to the former Klamath Reservation. The *C'waam* and *Koptu* serve as important traditional food sources as well as components of cultural, spiritual, and economic health for the Klamath Tribes (The Klamath Tribes, 2019). *C'waam* and *Koptu* as well as other fish and plant species like wocus, an aquatic plant species native to the Upper Klamath Basin, are culturally important to The Klamath Tribes.

The 1864 Treaty also reserved to the Klamath Tribes federal reserved water rights to support their hunting, fishing, and gathering rights.[34] In 2014, the state of Oregon issued the Amended and Corrected Findings of Fact and Order of Determination (ACFFOD), which identifies specific instream flows in tributaries to Upper Klamath Lake within the boundaries of the former Klamath Indian Reservation. The ACFFOD also recognizes a water right in Upper Klamath Lake, to maintain water surface at various elevations during different times of the year. Under the ACFFOD, these water rights are held by the Bureau of Indian Affairs, on behalf of The Klamath Tribes, and have a priority date of "time immemorial," making them prior ("senior") to all other water rights recognized in the ACFFOD. The ACFFOD is now being judicially reviewed by the Klamath County Circuit Court.

Today, the Klamath Reservation includes 372 acres of reacquired land (Velarde-Tiller, 1996) and had approximately 41 residents in 2018-2022 (U.S. Census Bureau, 2023).

D.2 The Hoopa Valley Tribe

The Hupa people traditionally lived along the shores of the Trinity River, a major tributary to the Klamath River, which historically saw abundant Chinook Salmon, Steelhead, and Coho Salmon runs (Velarde-Tiller, 1996). The present-day Hoopa Valley Reservation is located on the Trinity River at its confluence with the Klamath River in Humbolt County and includes the most downstream reach of the Trinity River. Fish migrating to the Trinity River must pass through 42 miles of the Lower Klamath River.

The Yurok and Hoopa Valley tribes have Federal Indian reserved fishing rights secured to the Tribes by a series of 19th century executive orders and confirmed in the 1988 Hoopa-Yurok Settlement Act. The Yurok and Hoopa Valley tribes' fishing rights entitle them to take fish for ceremonial,

[33] In 1954, Congress passed the Klamath Indian Termination Act that terminated the reservation and the Klamath Tribe's government-recognized status (P.L. 99-398 [1986]). However, the Act provided that the fishing and water rights of the Tribes would be retained. The Klamath Indian Tribes were restored to federal recognition on August 27, 1986 (69 Stat 718 codified at 25 U.S.C. § § 564-564w [1976]).
[34] United States v. Adair, 723 F.2d 1394 (9th Cir. 1984); (Wogan, 2021).

subsistence, and commercial purposes. Theses Tribes also hold reserved water rights to an instream flow sufficient to 1) protect the right to take fish within their reservation; 2) prevent others from depleting the stream flow below a protected level; and 3) the right to water quality and flow to support all life stages of fish (Reclamation, 1998). These rights are senior to the water rights associated with the Project.[35]

The Hoopa Valley Reservation had approximately 2,503 residents as of 2018-2022 (U.S. Census Bureau, 2023) and includes 85,445 acres (Hoopa Valley Tribe, 2023).

D.3 Yurok Tribe

The Yurok people traditionally lived along the coast and Lower Klamath River in California. The present-day Yurok Reservation encompasses both banks of the Lower Klamath River from its terminus in the Pacific Ocean to slightly upstream of its confluence with the Trinity River. As noted above, the Yurok and Hoopa Valley tribes have Federal Indian reserved fishing rights secured to the Tribes by a series of 19th century executive orders and confirmed in the 1988 Hoopa-Yurok Settlement Act, as well as senior reserved water rights to support the tribal fishery (Reclamation, 1998)

The Yurok Reservation covers 56,585 acres (Velarde-Tiller, 1996) and approximately 763 members lived on the Reservation in 2018-2022 (U.S. Census Bureau, 2023).

D.4 Karuk Tribe

The Karuk people traditionally lived in the middle-course of the Klamath River. The Karuk Tribe has not had a reservation set aside for it by treaty or executive order, and most of Tribe's aboriginal lands along the Klamath River are part of the Klamath National Forest. Recently, the United States took additional lands into trust for the Tribe along the Klamath River in Siskiyou and Humboldt counties, California, and the Tribe's water and fishing rights to the river have not been established.

The Karuk Tribe has acquired 1,661 acres of land, 900 of which have been placed into trust status (Tribe, undated). There were 498 residents between the reservation and off-reservation trust lands in 2018-2022 (U.S. Census Bureau, 2023).

D.5 Quartz Valley Indian Community

The Quartz Valley Indian Community includes Klamath, Karuk, and Shasta Indians. The Quartz Valley Reservation is located in the Scott River Basin, a tributary to the Klamath River in California and covers 210 acres of land (QVIR, undated). In 2018-2022, there were 254 reservation residents (U.S. Census Bureau, 2023).

D.6 Pulikla Tribe of Yurok People (formerly Resighini Rancheria)

In 1938, the Secretary of the Interior purchased 228 acres of land on the Lower Klamath River under the Wheeler-Howard Act of 1934 as trust land for tribal residents without an allotment. Several Yurok families moved to the area, and in 1938, the Resighini Rancheria was proclaimed an Indian Reservation. When the 1988 Hoopa-Yurok Settlement Act designated the Yurok Reservation surrounding the Resighini Rancheria, citizens voted to remain a distinct tribe (Pulikla Tribe of Yurok People, undated). In May 2024, Tribal citizens voted to amend the Tribe's Constitution and change their name to

[35] Baley v. United States, 942 F.3d 1312 (Fed. Cir. 2019).

Pulikla Tribe of Yurok People. The Tribal reservation had 39 residents as of 2018-2022 (U.S. Census Bureau, 2023).

D.7 Tribal Economies

The following list briefly describes the economic activity for Tribes within the Klamath Basin:

- The Klamath Tribes have faced economic challenges since the Klamath Termination Act of 1954 left them with little land. Forestry remains a major factor in the economy, and there is potential for further economic activity from tourism and recreation (Velarde-Tiller, 1996).
- The primary economic activities conducted on Hoopa Valley Tribe reservation lands include timber, farming, and livestock (Hoopa Valley Tribe, 2023), though most of the land is designated as commercial timberland (Velarde-Tiller, 1996).
- The Yurok Tribe has proposed economic development ventures in recreation, aquaculture, aggregate extraction, and a fish processing facility. The timber industry is a major employer in the region and for tribal members, but has declined over time (Velarde-Tiller, 1996).
- The Karuk Tribe has engaged in a number of development projects, including a building-materials business, laundromat, U.S. Forest Service forestry contracts, and consulting and business-development projects. Private construction and timber companies are an important source of employment for tribal members (Velarde-Tiller, 1996).
- Quartz Valley Indian Community has had a number of development plans contingent on further land acquisition. The U.S. Forest Service has contracted the tribe for a number of forestry operations (Velarde-Tiller, 1996).
- The Pulikla Tribe of Yurok People (formerly Resighini Rancheria) has been successful in agricultural production. The Tribe currently operates a campground and RV park (Pulikla Tribe of Yurok People, undated).

Appendix Table D-1 provides a summary of income and poverty statistics for the six federally recognized Tribes in the Klamath Basin, compared to Oregon, California, and the United States. According to recent U.S. Census data (U.S. Census Bureau, 2023), median household income for Tribes in the Klamath Basin ranged from $11,630 (Klamath Reservation) to $57,436 (Hoopa Valley Reservation) in 2018-2022, which is substantially lower than average incomes in California ($95,011), Oregon ($79,222), or the United States ($77,689). Similarly, rates of poverty, low-income populations, and Supplemental Nutrition Assistance Program (SNAP) benefits were much higher among the Tribes, except the Pulikla Tribe of Yurok People, where poverty was high, but SNAP use was low.

Appendix Table D-2 describes the workforce and unemployment rates for the six federally recognized Tribes in the study area (U.S. Census Bureau, 2023). U.S. Census data reports data for populations on reservation lands. According to Census data, less of the population residing on reservations in the Klamath Basin over 16 years of age were in the labor force (ranging from 23 to 60%) relative to average populations of California (64%), Oregon (63%) or United States (64%) averages in 2018-2022. On the Hoopa Reservation, which comprises 61% of the total reservation population, just 47% of the population 16 years and over was in the labor force compared with 64% in Unites States overall. Except for the Klamath Reservation, which has very limited residents, unemployment rates within the labor force also far exceeded the California (6.4%), Oregon (5.5%), and United States (5.3%) averages. Unemployment rates on Tribal reservations in the Klamath Basin other than the Klamath Reservation ranged from 13% to 25% (U.S. Census Bureau, 2023).

Appendix Table D-1. Demographics of Tribal reservations in the Klamath River Basin, 2018-2022.

Geography[1]	Total Population[2]	Median Household Income (2023 dollars)	Percent of Population Living Below Poverty Level	Percent of Population Designated Low Income	Percent of Households with SNAP Benefits in Past 12 Months
Klamath Reservation	41	$11,630	68%	76%	77%
Hoopa Valley Reservation	2,503	$57,462	28%	53%	31%
Yurok Reservation	763	$45,487	30%	58%	31%
Karuk Reservation and Off-Reservation Trust Land	498	$35,941	26%	66%	23%
Quartz Valley Reservation and Off-Reservation Trust Land	254	$45,372	17%	48%	41%
Pulikla Tribe of Yurok People[3]	39	$16,984	69%	87%	7.1%
Oregon	**4,229,374**	**$79,222**	**12%**	**28%**	**15%**
California	**39,356,104**	**$95,011**	**12%**	**28%**	**10%**
United States	**331,097,593**	**$77,689**	**13%**	**28%**	**12%**

Notes:
1. Geographic distinctions reflect the groups and names provided by the U.S. Census Bureau.
2. Populations reflect people in the geographic range defined by the U.S. Census Bureau, not tribal members.
3. Listed as Resighini Rancheria in U.S. Census Bureau data.
Data from U.S. Census Bureau (2023)

Appendix Table D-2. Tribal unemployment rates, 2018-2022.

Geography[1]	Total Population[2]	Population 16 Years and Over	Percent of Population 16 Years and Over in Labor Force	Unemployment Rate (Within Labor Force)
Klamath Reservation	41	35	37%	0%
Hoopa Valley Reservation	2,503	1,914	47%	18%
Yurok Reservation	763	601	43%	16%
Karuk Reservation and Off-Reservation Trust Land	498	330	60%	13%
Quartz Valley Reservation and Off-Reservation Trust Land	254	201	46%	20%
Pulikla Tribe of Yurok People[3]	39	35	23%	25%
Oregon	**4,229,374**	**3,472,552**	**63%**	**5.5%**
California	**39,356,104**	**31,601,862**	**64%**	**6.4%**
United States	**331,097,593**	**266,411,973**	**64%**	**5.3%**

Notes:
1. Geographic distinctions reflect the groups and names provided by the U.S. Census Bureau.
2. Populations reflect people in the geographic range defined by the U.S. Census Bureau, not tribal members.
3. Listed as Resighini Rancheria in U.S. Census Bureau data.
Data from U.S. Census Bureau (2023)

APPENDIX E Council on Environmental Quality National Environmental Policy Act Definitions

The Council on Environmental Quality (CEQ) regulations (40 CFR § 1508.1(i)) define effects or impacts as changes to the human environment from the proposed action or alternatives that are reasonably foreseeable and include the following:

- Direct effects, which are caused by the action and occur at the same time and place.
- Indirect effects, which are caused by the action and are later in time or farther removed in distance but are still reasonably foreseeable. Indirect effects may include growth-inducing effects and other effects related to induced changes in the pattern of land use, population density, or growth rate, and related effects on air and water and other natural systems, including ecosystems.
- Cumulative effects, which are effects on the environment that result from the incremental effects of the action when added to the effects of other past, present, and reasonably foreseeable actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time. For example, this Environmental Assessment will evaluate the effects of the Proposed Action Alternative on fish species in combination with additional, foreseeable, actions that would affect fish species in the Klamath Basin in the future that are unrelated to the Proposed Action Alternative.

Effects include ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historical, cultural, economic, social, or health, such as disproportionate and adverse effects on communities with environmental justice concerns, whether direct, indirect, or cumulative. Effects also include effects on Tribal resources and climate change-related effects, including the contribution of a proposed action and its alternatives to climate change, and the reasonably foreseeable effects of climate change on the proposed action and its alternatives. Effects may also include those resulting from actions which may have both beneficial and detrimental adverse effects, even if on balance the agency believes that the effects will be beneficial. Both adverse and beneficial effects of the Proposed Action Alternative are described in this appendix of the Environmental Assessment.

CEQ regulations describe considerations for significance determinations as follows (40 CFR § 1501.3):

"In considering whether an adverse effect of the proposed action is significant, agencies shall examine both the context of the action and the intensity of the effect. In assessing context and intensity, agencies should consider the duration of the effect. Agencies may also consider the extent to which an effect is adverse at some points in time and beneficial in others (for example, in assessing the significance of a habitat restoration action's effect on a species, an agency may consider both any

short-term harm to the species during implementation of the action and any benefit to the same species once the action is complete). However, agencies shall not offset an action's adverse effects with other beneficial effects to determine significance (for example, an agency may not offset an action's adverse effect on one species with its beneficial effect on another species).

Agencies shall analyze the significance of an action in several contexts. Agencies should consider the characteristics of the geographic area, such as proximity to unique or sensitive resources or communities with environmental justice concerns. Depending on the scope of the action, agencies should consider the potential global, national, regional, and local contexts as well as the duration, including short-and long-term effects.

Agencies shall analyze the intensity of effects considering the following factors, as applicable to the Proposed Action and in relationship to one another:

- The degree to which the action may adversely affect public health and safety.
- The degree to which the action may adversely affect unique characteristics of the geographic area such as historic or cultural resources, parks, Tribal sacred sites, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas.
- Whether the action may violate relevant Federal, State, Tribal, or local laws or other requirements or be inconsistent with Federal, State, Tribal, or local policies designed for the protection of the environment.
- The degree to which the potential effects on the human environment are highly uncertain.
- The degree to which the action may adversely affect resources listed or eligible for listing in the National Register of Historic Places.
- The degree to which the action may adversely affect an endangered or threatened species or its habitat, including habitat that has been determined to be critical under the Endangered Species Act of 1973.
- The degree to which the action may adversely affect communities with environmental justice concerns.
- The degree to which the action may adversely affect rights of Tribal Nations that have been reserved through treaties, statutes, or Executive Orders."

APPENDIX F Cultural Resources Compliance

CULTURAL RESOURCES COMPLIANCE
Division of Environmental Affairs
Cultural Resources Branch (CGB-153)

CGB-153 Tracking Number: 24-KBAO-218

Project Name: Implementation of Klamath Project Operating Procedures 2024-2029

NEPA Document: - KBAO-EA-2024-004

NEPA Contact: Amanda Babcock, Natural Resource Specialist

CGB-153 Cultural Resources Reviewer: Mark Carper, Archaeologist MARK CARPER Digitally signed by MARK CARPER Date: 2024.08.05 08:00:23 -07'00'

Date: August 5, 2024

Reclamation is proposing to implement modified water operations for the Klamath Project from 2024 through 2029 consistent with Reclamation's responsibilities and obligations. Implementation of the Proposed Action addresses Project Supply availability, and also includes Reclamation's management of Upper Klamath Lake water level elevations and Klamath River flows. This is the type of undertaking that does not have the potential to cause effects to historic properties, should such properties be present, pursuant to the Title 54 U.S.C. § 306108, commonly known as Section 106 of the National Historic Preservation Act (NHPA) regulations codified at 36 CFR § 800.3(a)(1). Reclamation has no further obligations under NHPA Section 106, pursuant to 36 CFR § 800.3(a)(1).

Though the Proposed Action includes operation and maintenance tasks, the Proposed Action would not produce any ground disturbances, would not result in the construction of new facilities or the modification of existing facilities, and would not result in land use changes. Such actions would be analyzed independently from this Proposed Action.

This document is intended to convey the completion of the NHPA Section 106 process for this undertaking. As defined, this action would not have significant impacts on properties listed, or eligible for listing, on the National Register of Historic Places as determined by Reclamation (LND 02-01) (43 CFR 46.215 (g). Please retain a copy in the administrative record for this action. Should changes be made to this project, additional NHPA Section 106 review, possibly including consultation with the State Historic Preservation Officer (SHPO), may be necessary. Thank you for providing the opportunity to comment.