BUREAU OF RECLAMATION

The 2022 Annual Monitoring Report for the coordinated 2019 National Marine Fisheries Service and 2020 U.S. Fish and Wildlife Service Biological Opinions on Klamath Project Operations

Klamath Project, Oregon/California
Interior Region 10 California Great Basin

U.S. Department of the Interior **March 1, 2023**

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 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 Department of the Interior plays a central role in how the United States stewards its public lands, increases environmental protections, pursues environmental justice, and honors our nation-to-nation relation with Tribes.

Abbreviations and Acronyms

USFWS 2020 BiOp	*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*
NMFS 2019 BiOp	*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*
AF	acre-feet
AFA	Annual Funding Agreement
BA/Modified 2018 Operations Plan	*Final Biological Assessment on the Effects of the Proposed Action to Operations Plan Operate the Klamath Project from April 1, 2019, through March 31, 2024, that was transmitted to the Services on December 21, 2018, with associated addenda dated February 15, 2019, March 25, 2019, and October 11, 2019.*
C. shasta	*Ceratonova shasta*
CA-NV FHC	California-Nevada Fish Health Center
CDFW	California Department of Fish and Wildlife
cfs	cubic-feet-per-second
CPUE	Catch Per Unit Effort
DCP	Data Collection Platform
EWA	Environmental Water Account
ESA	Endangered Species Act
FASTA	Flow Account Scheduling Technical Advisory
FES	A Canal Fish Evaluation Station
FY	Fiscal Year
IGD	Iron Gate Dam
IOP	Interim Operating Plan (2020-2022)
KBAO	Klamath Basin Area Office
KBHDB	Klamath Basin Hydrologic Database
KBPM	Klamath Basin Planning Model
KID	Klamath Irrigation District
KLS	Klamath largescale sucker
KRCR	Klamath River Coho Restoration
KFNF	Klamath Falls National Fish Hatchery
KSD	Klamath Straits Drain
LKNWR	Lower Klamath National Wildlife Refuge
LKR	Lower Klamath River
LRS	Lost River sucker
LRD	Link River Dam

LRDC	Lost River Diversion Channel
LVID	Langell Valley Irrigation District
M&RR	Monitoring and Reporting Requirement
mm	millimeter
NFWF	National Fish and Wildlife Foundation
NMFS	National Marine Fisheries Service
OSU	Oregon State University
PIT	Passive Integrated Transponder
POM	Prevalence of mortality
POR	period of record
PORmax	period of record maximum
Project	Klamath Project
QA/QC	Quality Assurance/Quality Control
Reclamation	Bureau of Reclamation
RIT	Recovery Implementation Team
RR	Reporting Requirement
SCADA	Supervisory Control and Data Acquisition
SL	Standard length
SNS	shortnose sucker
SONCC	Southern Oregon Northern California Coast
T&Cs	Terms and Conditions
TID	Tulelake Irrigation District
TLS1A	Tule Lake Sump 1A
TOP	Temporary Operating Procedures
UKL	Upper Klamath Lake
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WY	Water Year

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Introduction and Background

The purpose of this Annual Monitoring Report is for the Bureau of Reclamation (Reclamation) to meet and report certain requirements outlined in the separate, but coordinated U.S. Fish and Wildlife Service's (USFWS) *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* (USFWS 2020 BiOp) issued on April 10, 2020, and the National Marine Fisheries Service's (NMFS) *Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for Klamath Project Operations from April 1, 2019 through March 31, 2024* (NMFS 2019 BiOp) issued on March 29, 2019 (collectively; "Services" and "BiOps"). Under both BiOps, Reclamation is required to provide the Services with an Annual Monitoring Report due March 1 every year, for the purpose of conveying information related to progress on implementing the conservation measures, Terms and Conditions (T&Cs), and associated monitoring requirements. To implement this requirement, Reclamation consulted with the Services to develop a format for the Annual Monitoring Report.

Annual reporting is required to address progress on: (1) implementation of the Environmental Water Account (EWA); (2) implementation of the T&Cs and associated monitoring; (3) budgeting for implementation of the T&Cs; and (4) implementing the conservation measures that were included in the Proposed Action described in Reclamation's *Final Biological Assessment on the Effects of the Proposed Action to Operate the Klamath Project from April 1, 2019, through March 31, 2024* that was transmitted to the Services on December 21, 2018, with associated addenda dated February 15, 2019, March 25, 2019, October 11, 2019 in addition to the 2020-2022 Interim Operations Plan (IOP; herein referred to as the Proposed Action or Modified 2018 Operations Plan/IOP) agreed to under a 2020 Stipulated Stay of Litigation between the Yurok Tribe, Pacific Coast Federation of Fishermen's Associations, Institute for Fisheries Resources, the Klamath Water Users Association, and the NMFS.

Table 1 indicates the T&Cs and associated monitoring and reporting requirements (M&RR; RR) required under the Services' BiOps.

Reclamation and the Services have determined that one annual meeting is sufficient to meet the intention of the RR under both BiOps and will work toward formal clarification in the near future.

Reclamation has worked diligently since receipt of both BiOps to ensure all T&Cs and associated monitoring requirements were met in a timely manner.

Implementation of Terms and Conditions and Associated Monitoring Requirements

Reclamation has made considerable progress implementing the T&Cs and conducting the associated M&RR for both BiOps (Table 1). Table 1 provides a summary of the T&Cs included in BiOps and the status of completion.

Progress on Implementation of Conservation Measures

Table 1. Summary of Terms and Conditions (T&C), Monitoring and Reporting Requirements (M&RR), and Reporting Requirements from 2019 and 2020 BiOps and Implementation Status.

	Title of Requirement	Page Number	Implemented
	USFWS Requirements		
T&C 1a	Ensure that No Unnecessary Actions are Taken that Increase Entrainment of Listed Suckers at Link River Dam (LRD)	212	Y
T&C 1b	Actions to Determine Klamath Project (Project) Supply and Take Corrective Actions to Avoid Going below Minimum Elevations in Clear Lake Reservoir, Gerber Reservoir, and Tule Lake Sump 1A	212	Y
T&C 1c	Take Corrective Actions to Ensure Upper Klamath Lake (UKL) Elevations are Managed within the Scope of the Proposed Action	213	Y
T&C 1d	Activate the A Canal Pumped-bypass System Annually by August 1	214	Y
T&C 1e[3]	Develop and Implement a Hydrologic Data Management Plan	214	Y
T&C 1f	Annual Identification and Installation of Needed Water-Level and Flow-Measurement Gages in the Project	214	Y
T&C 1g[1]	Monitor Keno Impoundment and UKL Project-Related Diversions	215	Y
T&C 1h[4]	Operation Updates	215	Y
T&C 1i[2]	Consultation with the Services on Release of Project Call Water	216	Y
T&C 1j	Ensure Project Impacts on Spawning access in Clear Lake are not Greater than Anticipated	216	Y
	Monitoring and Reporting Requirements		
M&RR 1.1a	Methods, results, and recommendations to improve monitoring related to A Canal Fish Evaluation Station monitoring efforts.	217	Y, Appendix B
M&RR 1.1b	Flow monitoring at the A Canal, and Link River, Clear Lake Reservoir, Gerber Dams as surrogate for larval sucker entrainment monitoring.	218	Y,

M&RR 1.1c	Canal Salvage Report	219	Y, Appendix C
M&RR 2	Adult Lost River Sucker and Shortnose Sucker Monitoring in Project Reservoirs	219	Y, Appendix D
M&RR 3.3a	Project Implementation and Hydrologic Monitoring using the Klamath Basin Planning Model	219	Y
M&RR 3.3b[5]	Project Implementation and Hydrologic Monitoring Monitor and Maintain Water-Level and Flow-Measurement Gages throughout the Project	220	Y
	NMFS Requirements		
T&C 1A	Take actions to Ensure Environmental Water Account (EWA) Distribution and Iron Gate Dam (IGD) Flows are Managed within the Scope of the Proposed Action	280	Y
T&C 1B[1]	Monitor Keno Impoundment and UKL Project-Related Diversions	281	Y
T&C 1C[2]	Consultation with the Services on Release of Project Call Water	281-282	Y
T&C 1D[3]	Develop and Implement a Hydrological and Biological Data Management Plan	282	Y
T&C 1E[4]	Operations Spreadsheet	282-283	Y
T&C 1F	Development of a Post-Facilities removal Operations plan	283	Y
T&C 1G	Abundance, prevalence of infection, and predicted mortality of emigrating juvenile salmon in the Klamath River	283-284	Y
T&C 1H	In the event of funding lapses, fund the monitoring and reporting requirements of DFW Shasta River Rotary Screw Trap	284	Y
T&C 1I	Fund Development and Refinement of Klamath River Decision Support Tools	284	Y
T&C 1J	Fund Fish Modeling to evaluate the effects of *Ceratonovashasta* spore concentrations on the survival of out-migrating coho salmon in the Klamath River	285	Y
T&C 2A*	Terms and Conditions Implementation Plan	285	Y
T&C 2B	**Reporting Requirements**	**285-286**	**Y**
T&C 2B RR 1	Report all measured accretion data (LRD to Keno Dam) and all measured and estimated accretion data (Keno Dam to IGD) in addition to all of the EWA, Project and Refuge information.	286	Y
T&C 2B RR 2	Assessment in coordination with the Services of EWA used and EWA remaining on May 1 of each calendar year.	286	Y
T&C 2B RR 3	Report of daily and monthly reductions of IGD releases due to UKL control logic on a monthly basis (particularly important in the March through June period).	286	Y

T&C 2B RR 4	Monthly update reports for the formulaic approach during the fall/winter operations including reductions to IGD flows due to UKL control logic, UKL net inflow, LRD to IGD accretions, UKL levels, winter Project deliveries, Refuge deliveries, and any other relevant data NMFS identifies during implementation of the Proposed Action.	286	Y
T&C 2B RR 5	Rolling monthly and annual graphs of the observed, smoothed UKL net inflow and observed IGD flows versus the one and two week forecasted IGD flow schedules for the entire water year.	286	Y
T&C 2B RR 6	Report on the type and location of each restoration project implemented. The monitoring report shall include the total number of coho salmon captured, relocated, injured, or killed for each restoration project, and will be submitted annually by March 1 to the NMFS Northern California office.	286	Y
T&C 2C[5]	Monitor and Maintain Water Level and Flow Management Gages Throughout the Project	286-287	Y

[1,2,3,4,5] Term and Condition similar in both BiOps.

*This requirement follows the T&C in USFWS's 2020 BiOp and is unnumbered whereas, it was listed as a T&C from NMFS.

Budgeting for Implementation of Terms and Conditions

As specified in the BiOps, Reclamation committed to fund actions related to species monitoring, research, and recovery. Table 2 provides a summary of funding actions Reclamation has taken to comply with the BiOps.

Table 2. Summary of Funding Actions for Terms and Conditions.

	USFWS Requirements			
Title		**Organization**	**Funding Amount**	**Funded in Fiscal Year (FY) 2022**
SARP telemetry in Upper Klamath Lake (UKL)		USFWS	$110,544	Y
Thiamine Deficiency Evaluation in SNS and LRS life stages (USFWS)		USFWS	$66,972	Y
Thiamine Deficiency Evaluation in SNS and LRS life stages (USGS)		USGS	$29,9964.00	Y
Semi-Natural Wetland		USFWS	$185,169.54	Y
UKL juvenile sucker cohort tracking		USGS	$143,285	Y
UKL Adult Sucker Monitoring		USGS	$654,445	Y
Clear Lake Adult Monitoring		USGS	$294,523	Y
Sucker Captive Propagation and database		USFWS	$376,531	Y
Willow Creek, UKL East Side Springs PIT Tag Arrays Upgrade		USGS-Biomark	$257,867	Y
Updated Sucker Spawning Behavior Report		USGS	$95,291	Y
Fish Evaluation Station (FES) and Juvenile Monitoring Comparison		USGS	$101,453	
	NMFS Requirements			
	Coho Salmon Disease	Oregon State	$950,152	Y
		USFWS CA- NV FHC[1]	$117,201	Y
	Outmigration and disease modeling (S3)	USFWS-Arcata and USGS	$81,666	Y

Ensure Key Monitoring	Outmigrant Screw Trapping	USFWS Arcata	$252,246	Y
		Yurok Tribe	$123,121	Y
		Karuk Tribe	$25,581	Y

	NMFS Requirements			
Title		**Organization**	**Funding Amount**	**Funded in Fiscal Year (FY) 2022**
	Yurok AFA	Yurok Tribe	$ 250,000	Y
	Hoopa Valley Tribe AFA	Hoopa Valley Tribe	$ 118,880.60	Y
Other Requirements	Klamath River Coho Restoration Grant Program	Competitive Grant	$500,000[2]	N
	Karuk Annual Funding Agreement (AFA)	Karuk Tribe	$250,000	Y

[1]California-Nevada Fish Health Center (CA-NV FHC).

[2]Fiscal year 2022 funding ($500,000) was combined with fiscal year 2020 ($700,000) and fiscal year 2021 ($500,000) funding for a total of $1.7 Million of funding for the 2022 grant cycle.

Reclamation successfully implemented Conservation Measures in 2021 as indicated in (Table 3).

Table 3. Summary of 2019 and 2020 BiOp Conservation Measures and Implementation Status.

Summary of Conservation Measures			
Title of Conservation Measure	**Requirement Reference**	**Page Number**	**Implemented**
U.S. Fish and Wildlife Service (USFWS) Conservation Measures			
Canal Salvage	4.6.1	60	Y, Appx. B
Sucker Assisted Rearing Program	4.6.2	60-61	Y, USFWS CM
Sucker Monitoring and Recovery Program Participation	4.6.3	61-62	Y, M&RR2
National Marine Fisheries Service Conservation Measures			
Coho Restoration Grant Program	1.3.5.1	54	Y, T&C 2B RR 6

Estimating Incidental Take of Lost River Suckers and Shortnose Suckers

Section 9 of the Endangered Species Act (ESA) makes it unlawful for any person to "take" any endangered species. The ESA defines "take" to mean to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." However, under ESA section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of an agency action is not considered to be prohibited under the ESA provided that such taking is in compliance with an Incidental Take Statement. The USFWS 2020 BiOp provided Reclamation with allowable annual take of ESA-listed suckers in the Incidental Take Statement. Appendix E contains estimates for the incidental take of federally endangered Lost River suckers (*Deltistes luxatus; LRS)* and shortnose suckers (*Chasmistes brevirostris; SNS)*, by life-stage and activity, resulting from Reclamation's Klamath Project (Project) operations analyzed in the USFWS 2020 BiOp.

Coordinated (U.S. Fish and Wildlife Service & National Marine Fisheries Service) Reporting Requirements and Terms and Conditions

T&C 2B-RR 2 (NMFS)- Progress of Implementation of Environmental Water Account

Requirement

The NMFS 2019 BiOp states:

"Reclamation shall complete an assessment in coordination with the Services of EWA used and EWA remaining on May 1 of each calendar year."

Results

On October 15, 2019, Reclamation requested clarification regarding the due date of the EWA assessment required under Reporting Requirement 2B.2 as the information necessary to complete the assessment is not available until after the due date included in the 2019 NMFS BiOp. Reclamation requested that the assessment be completed and transmitted to the Services as soon as practicable, but no later than May 15 of each year. On October 22, 2019, NMFS concurred with Reclamation's clarification thereby modifying the due date of the assessment.

Reclamation completed the assessment required under Reporting Requirement 2B.2 and transmitted it to NMFS on May 14, 2022. In the assessment, Reclamation indicated that 123,646 AF was used by May 1 and 283,354 AF was remaining through the September 30. For more details on actual EWA expenditures during the 2022 spring summer irrigation season, see T&C 1A results on page 46.

T&C Implementation Plan (USFWS) and T&C 2A (NMFS)

Requirement

The NMFS 2019 BiOp states:

> *"Reclamation shall develop an "Implementation Plan" in consultation with the Services describing how Reclamation intends to implement the Terms and Conditions in this opinion. The Implementation Plan shall describe the process Reclamation will follow to ensure necessary resources are allocated to implement the Terms and Conditions and to complete required monitoring and reporting by the due dates. Having this agreement will ensure that terms and conditions are reliably and fully implemented and will aid in identifying any problems as early as possible and help avoid any additional incidental take of listed species above those considered in this opinion.*
>
> *We understand that this Opinion contains multiple requirements for deliverables and that it might be infeasible for Reclamation to have all of them prepared by the stated due dates because of staffing and funding limitations; therefore, we will work with Reclamation to develop an acceptable implementation schedule. Reclamation shall develop the draft Implementation Plan in consultation with the Services, provide the Services a draft Implementation Plan for review and comment by October 1, 2019, provide the Services a final Implementation Plan that addresses the Services' comments by December 15, 2019, and implement the final Implementation Plan thereafter; these dates can be adjusted to ensure a high quality product if Reclamation, NMFS and USFWS agree that it is necessary."*

Results

Reclamation's Term and Condition Implementation Plan was developed, and the first draft was delivered to the Services on October 1, 2019. Reclamation's final draft was submitted to the Services on December 13, 2019, and is still in effect as of 2022.

T&C 1e (USFWS) and T&C 1D (NMFS) – Develop and Implement a Hydrological and Biological Data Management Plan

Requirement

The USFWS 2020 BiOp and NMFS 2019 BiOp state:

> *Effective management of hydrological and biological data is essential to ensure that take and other Project effects can be evaluated and to maintain a period of record for future consultations. Therefore, Reclamation shall develop a data management plan that will include the details of how data will be stored and shared with the Service and other agencies. Reclamation shall develop the plan in coordination with the Service, providing a draft plan by October 1, 2020, and a final plan by December 1, 2020; these dates can be adjusted to ensure a high-quality product if both Reclamation and the Service agree that it is necessary*
>
> *The plan shall include standard operating procedures for collecting, reviewing, finalizing, storing, and presenting Project reservoir elevation, flow, diversion, and pumping data as well as biological data collected during salvage, FES monitoring, and Gerber Reservoir monitoring. The plan shall include annual updates to hydrological data sets, including those described in Section 7.1, as well as plans for finalizing historical data sets such that official versions are available upon request or via web hosting. The plan shall also include an annual update of the KBPM, with output provided to the Service.*
>
> .

Results

Reclamation submitted the final *Hydrological and Biological Data Management Plan – Klamath Project Operations* to USFWS and NMFS on December 1, 2020. Consistent with T&C 1e (USFWS) and 1D (NMFS) Reclamation submitted a draft of the Plan to the Services on October 1, 2020, for review and comment such that a final Plan could be submitted on December 1, 2020, and implemented thereafter. Based on feedback received during that review, Reclamation revised the draft Plan.

While the Klamath Basin Hydrologic Database (KBHDB) is in continuous development, the database is in full production mode. Web-hosted KBHDB data query services are publicly accessible via the following link:
https://www.usbr.gov/lc/region/g4000/riverops/_HdbWebQuery.html.

KBAO Water Operations Division staff typically use KBHDB on a daily basis for daily operations tasks.

Reclamation has developed two biological databases in Microsoft Access for A Canal Fish Evaluation Station (FES) and Gerber Reservoir. These continue to be updated and they have been shared with USFWS. The most recent version of the Gerber database was sent to USFWS on January 20, 2022, and the most recent version of the FES database was sent on January 25, 2022. Reclamation continues to pursue the development of a more robust database in coordination with USFWS.

T&C 1g (USFWS) and T&C 1B (NMFS) – Monitor Keno Impoundment and Upper Klamath Lake Project-Related Diversions

Requirement

The USFWS 2020 BiOp and 2019 NMFS BiOp states:

> *"Reclamation shall monitor Project-related diversions in the Keno Impoundment and around UKL to reduce uncertainty associated with the unknown volumes of water delivered to these lands under operation of the Klamath Project. Monitoring and annual reporting of these Project-related diversions helps ensure that the diversion volumes are consistent with what was modeled in the KBPM for the POR and will provide NMFS with more certainty regarding KBPM output, specifically IGD flows, Project deliveries and UKL elevations. More certainty in water allocations will help improve the KBPM and reduce error through time, and aid in in-season management to address disease issues and minimize incidental take. Reclamation shall also compile monitoring data for these diversions on an annual basis for the duration of the proposed action and assemble the data into a complete data set to be reported in the Annual Monitoring Report and incorporated into the next proposed action."*

The USFWS 2020 BiOp T&C 1g and NMFS 2019 BiOp T&C 1B requires Reclamation to monitor Project-related ungaged diversions adjacent UKL and along the Keno Impoundment. This data collection effort will help minimize uncertainty in the unknown volume of water delivered to lands operating within the Project; these data will increase accuracy and overall skill in the Klamath Basin Planning Model (KBPM); and NMFS will be provided more certainty per KBPM outputs—specifically, Iron Gate Dam (IGD) flows, Project deliveries, and UKL elevations. Additionally, Reclamation is required to compile monitoring data for these diversions on an annual basis for the duration of the Proposed Action and assemble data into a complete data set to be reported in the

Annual Monitoring Report and incorporated into the next Proposed Action.

Results
Reclamation staff continued to engage Keno Impoundment and UKL Project-related contractors during the 2022 spring-summer irrigation season in order to obtain flow-measurement and/or delivery data. Due to the exceptionally dry water year and lack of adequate supply to fully support irrigation operations, Reclamation ordered Keno Impoundment contractors (who are all Warren Act contract holders) to cease all diversions along the Keno Impoundment prior to the start of the irrigation season.

T&C 1h (USFWS) and T&C 1E (NMFS)- Operation Updates and Operations Spreadsheet

Requirement
The USFWS 2020 BiOp and 2019 NMFS BiOp states:

> *As of early February 2019, Reclamation was developing one or more operations spreadsheets that will be used to implement the proposed action. The spreadsheet(s) translate the code in the KBPM and the detailed written description of the proposed action provided in Appendix 4 of Reclamation's biological assessment (USBR 2018a Appendix 4) into an operations spreadsheet(s). The operations spreadsheet(s) will bring together the input data (e.g., UKL net inflow, UKL elevations, NRCS forecasts), equations (e.g., seasonal water supply allocations, daily EWA releases), and relationships (e.g., EWA is calculated before Project Supply, methods by which the Lower Klamath Lake Refuge may be delivered water) that Reclamation will use on a daily basis to implement the proposed action. Reclamation shall provide the Services with the proposed action implementation and operation spreadsheet(s) by June 1, 2020, and at least annually thereafter. Reclamation shall provide updates to the Service within 2 weeks of Reclamation's acceptance and use of an updated operations spreadsheet(s). Reclamation shall provide the Services with a tutorial explaining how Reclamation uses the spreadsheet, which data may be updated, and which data should remain fixed and not be changed or updated. This tutorial will be offered, as Reclamation operations' staff are available, to new Service employees with relevant designations (e.g., hydrologist) as they join Services' staff throughout the life of this BiOp.*

Results
Reclamation provided operations updates to the Services throughout the 2022 season via weekly Flow Account Scheduling Technical Advisory (FASTA) coordination meetings, periodic phone calls, and other meeting platforms. A current copy of the operations spreadsheet (referred to as the "PA Calculator") is provided to the Services whenever they request it.

T&C 1i (USFWS) and T&C 1C (NMFS)- Consultation with the Services on Release of Project Call Water

Requirement
In USFWS T&C 1i, and NMFS T&C 1C, Reclamation is required to produce a robust water quantification tool or method by June 1, 2021, to quantify an amount of inflow that may result from a Project Call.

Specifically, the USFWS BiOp states:

> *"As of early February 2019, Reclamation was developing one or more operations spreadsheets that will be used to implement the proposed action. The spreadsheet(s) translate the code in the KBPM and the detailed written description of the proposed action provided in Appendix 4 of Reclamation's biological assessment (USBR 2018a Appendix 4) into an operations spreadsheet(s). The operations spreadsheet(s) will bring together the input data (e.g., UKL net inflow, UKL elevations, NRCS forecasts), equations (e.g., seasonal water supply allocations, daily EWA releases), and relationships (e.g., EWA is calculated before Project Supply, methods by which the Lower Klamath Lake Refuge may be delivered water) that Reclamation will use on a daily basis to implement the proposed action. Reclamation shall provide the Services with the proposed action implementation and operation spreadsheet(s) by June 1, 2020, and at least annually thereafter. Reclamation shall provide updates to the Service within 2 weeks of Reclamation's acceptance and use of an updated operations spreadsheet(s). Reclamation shall provide the Services with a tutorial explaining how Reclamation uses the spreadsheet, which data may be updated, and which data should remain fixed and not be changed or updated. This tutorial will be offered, as Reclamation operations' staff are available, to new Service employees with relevant designations (e.g., hydrologist) as they join Services' staff throughout the life of this BiOp."*

Results

Reclamation received a presentation from U.S. Geological Survey (USGS) in May 2019 on potential approaches for quantifying call water. The approaches did not completely satisfy the requirements and after internal discussions, development of a more suitable methodology was included in a proposed scope of work for a consulting contract to be obligated at the start of fiscal year (FY) 2021. The consultant identified several critical data areas (including crop mixtures and additional evaporation data) necessary for completing work on this task. Coordination with Reclamation's Technical Services Center indicated this information would become available as part of the Natural Flow Study and quantification needed to wait until then, including a revised bathymetry of Upper Klamath Lake (field work largely completed in 2021). In addition, a Project call was not made in 2022, thus, Reclamation did not consult with the Services on such an action in water year (WY) 2022.

Based on upcoming data collected by newly installed stream gauges and evaporation platforms, along with the new technical studies, and no recent calls from irrigators, Reclamation continues to develop a regulatory call tool that will incorporate new information and will be robust enough to withstand technical and legal scrutiny. Our earliest estimate for completion of such a tool is the end of 2023. In the meantime, Reclamation will provide the Services with quarterly progress reports during 2023.

M&RR 3.3b (USFWS) and T&C 2C (NMFS) - Monitor and Maintain Water Level and Flow-Measurement Gages throughout the Project

Requirements

M&RR 3.3b of the USFWS 2020 BiOp requires:

> *"Water level and flow measurement gages shall be maintained throughout the Project in accordance with the Hydrological and Biological Data Management Plan developed under T&C 1e. Water levels in Project reservoirs shall be monitored at frequent intervals, at least daily, and Reclamation shall make those data available to the Services via a secure website or other appropriate means. An annual summary of reservoir water level and flow-monitoring compliance shall be included in the Annual Monitoring Report due March 1*

every year.
Accurate hydrologic data are needed to calculate Project water use and effects on listed suckers and ensure compliance with this Incidental Take Statement. Monitoring shall be conducted at the following, and the list shall be evaluated annually and could include additional monitoring if needed.

1. A Canal
2. Lost River to Lost River Diversion Channel at Lost River Diversion
3. Ady Canal (at the point of common diversion for agriculture and the Lower Klamath Lake NWR, and at the point of entry into the Refuge)
4. North Canal
5. Straits Drain at State Line and at pumps F and FF
6. West Side Power Canal at Link River Dam
7. Station 48
8. Miller Hill Pumping Plant
9. Miller Hill spill
10. UKL, Clear Lake, Gerber Reservoir*, and Tule Lake Sump 1A**
11. Link River Dam
12. Keno Dam
13. Iron Gate Dam
*14. Reductions to IGD flow due to UKL control logic ***
*15. EWA spending ***
*16. Ungaged Project diversion in Keno Impoundment and around UKL***

The NMFS 2019 BiOp includes T&C 2C requires water level and flow measurement at the same sites but excludes a few that have been identified above with *. Additionally, items above with ** are not listed in NMFS 2019 T&C 2C but are requirements listed elsewhere.

Results

All of the required locations (See Table 4 and Figure 1) were successfully monitored on a daily basis during the 2022 WY and the following was observed:

The Klamath Basin experienced a third consecutive exceptionally dry water year in 2022. The snow water equivalent Basin Index was 86 percent of median on January 31, 66 percent by February 28, and dropped to 34 percent by March 31. Water Year-to-Date precipitation (rain and snow) at the SnoTel sites was 69 percent by March 31. The 2022 WY (October 2021 – September 2022) cumulative precipitation at the Klamath Falls airport was 7.73 inches, 69 percent of the water year average. There were no flood control operations during the 2022 WY.

Table 4. 2022 BiOp Gaging Station Summary.

Gaging Station	Operator	Gage	Data Collection
A Canal	Klamath Irrigation District (KID)	Flow, level	Radio Telemetry
Lost River Diversion Channel at Lost River Diversion Dam	Bureau of Reclamation (Reclamation)	Flow, reservoir elevation	Satellite Telemetry
Ady Canal at point of common agriculture diversion	U.S. Geological Survey (USGS)	Flow, level	Satellite Telemetry
Ady Canal at the point of entry into the Refuge	USGS	Flow, level	Satellite Telemetry
North Canal	USGS	Flow, level	Satellite Telemetry
Klamath Straits Drain (KSD) at Stateline	Reclamation	Flow, level**	Site Visit (daily)
KSD at Pumps F and FF	USGS	Flow, level	Satellite Telemetry
West Side Power Canal	NA	NA	NA
Station 48	Tulelake Irrigation District (TID)	Flow	Radio Telemetry
Miller Hill Pumping Plant	KID	Flow	Radio Telemetry
Miller Hill spill	KID	Flow **	Site Visit (daily)
Upper Klamath Lake (UKL)	USGS	Reservoir elevation	Satellite Telemetry
Clear Lake Reservoir	Reclamation/Langell Valley Irrigation District (LVID)	Flow**, reservoir elevation	Satellite Telemetry
Gerber Reservoir	Reclamation/LVID	Flow**, reservoir elevation	Satellite Telemetry
Tule Lake Sump 1B	TID	Sump elevation**	Site Visit (daily)
Link River Dam	PacifiCorp	Flow, level	Satellite Telemetry
Keno Dam	PacifiCorp	Reservoir elevation	Satellite Telemetry
Iron Gate Dam (IGD)	PacifiCorp	Reservoir elevation	Satellite Telemetry
IGD flow reductions due to UKL control logic	Reclamation	Calculation	NA
Environmental Water Account spending	Reclamation	Calculation	NA
Ungaged Klamath Project Diversions around Keno and UKL	Property owners	Site visit/Landowner reporting	Site Visit (annual)

** indicates measurement taken by daily site visit

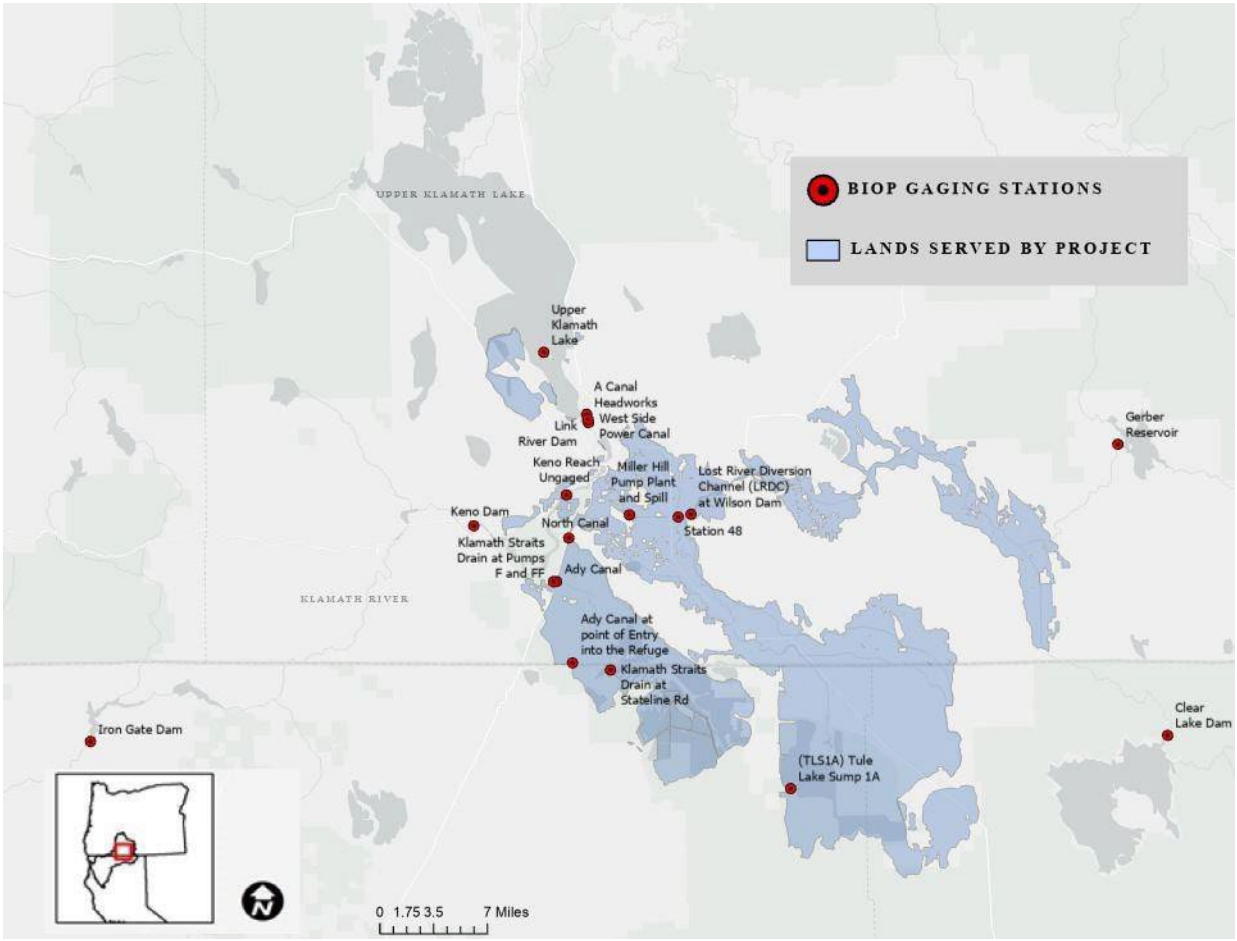

Figure 1. NMFS 2019 and USFWS 2020 BiOp Required Gaging Station Locations.

Upper Klamath Lake Hydrology and Project Diversions

In 2022, based on the Interim Operations Plan and requirements of the BiOps, 50,000 AF of Project Supply was originally allocated for the spring/summer irrigation season along with the implementation of a Temporary Operations Plan (TOP). The TOP included an adaptive management element which, among other elements split any additional water 50/50 between project supply and UKL volume. Based on improvements in hydrologic conditions later in the season, the 50,000 AF was adjusted upward to 82,000 AF and 95,000 AF was eventually delivered. The 95,000 AF is 27 percent of the 350,000 AF full supply.

Figure 2 shows the UKL elevations versus the central tendency in WY 2022. The central tendency is an estimate of UKL elevations as modeled for the USFWS 2020 BiOp. If UKL elevations fall below the central tendency, outflows are reduced. Figure 2 shows that UKL elevations remained below the central tendency throughout the 2022 WY.

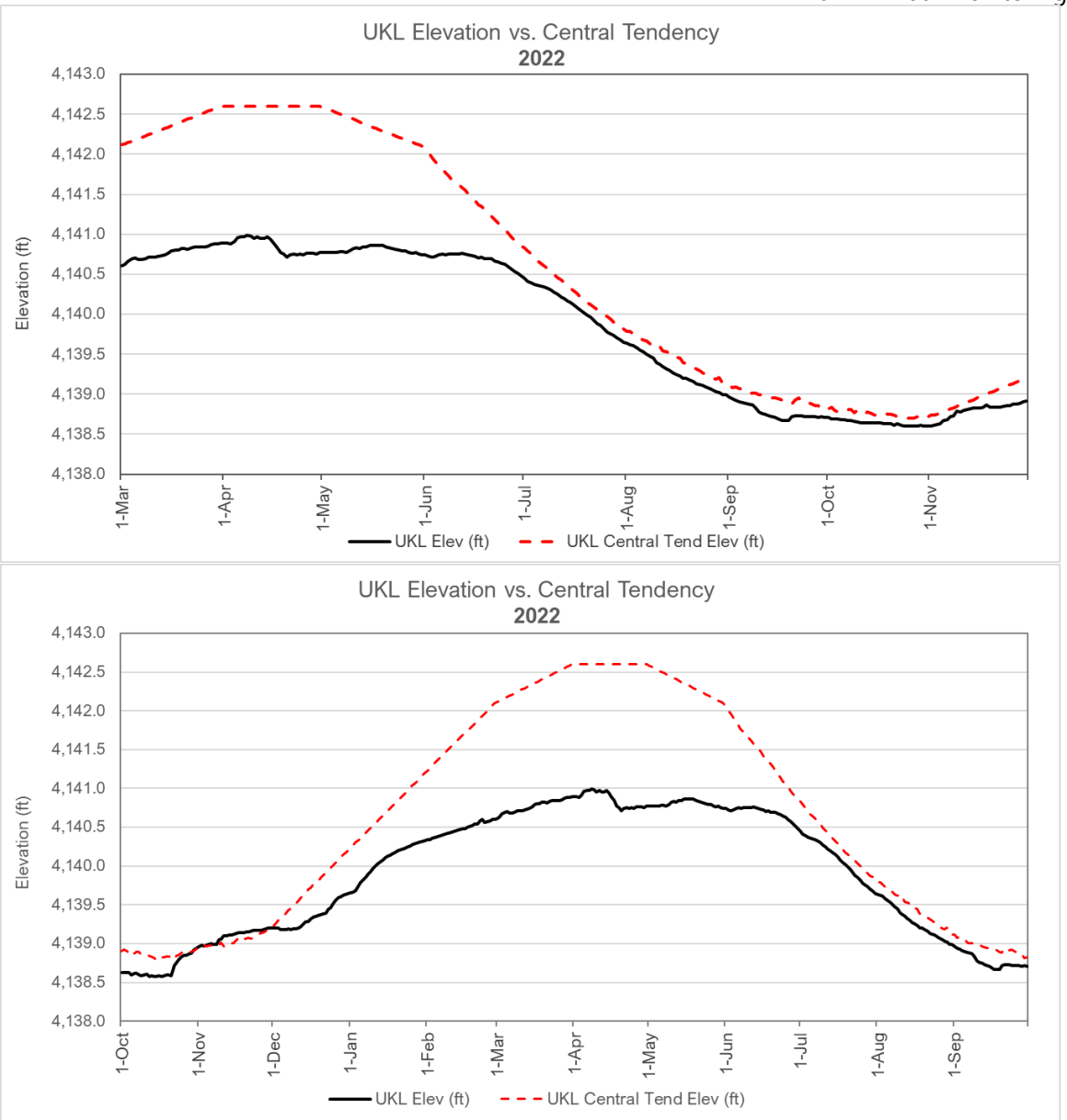

Figure 2. Upper Klamath Lake (UKL) and Central Tendency Elevations in Water Year 2022.

Clear Lake Reservoir Hydrology and Releases

There were no Clear Lake Reservoir releases during WY 2022 due to drought conditions and low resulting inflows. Historically, Clear Lake Reservoir deliveries have ranged between 30,000 and 40,000 AF of water annually, with a daily average discharge of 186 AF, except during drought or flood control conditions.

Clear Lake Reservoir began WY 2022 with an elevation of 4,521.57 feet on October 1, was 4,522.05 feet on March 1, and ended the water year with an elevation of 4,519.96 feet on September 30 (Figure 3).

On average, Clear Lake Reservoir has an elevation of 4,528.5 feet on March 1 and an elevation of 4,526.4 feet on September 30.

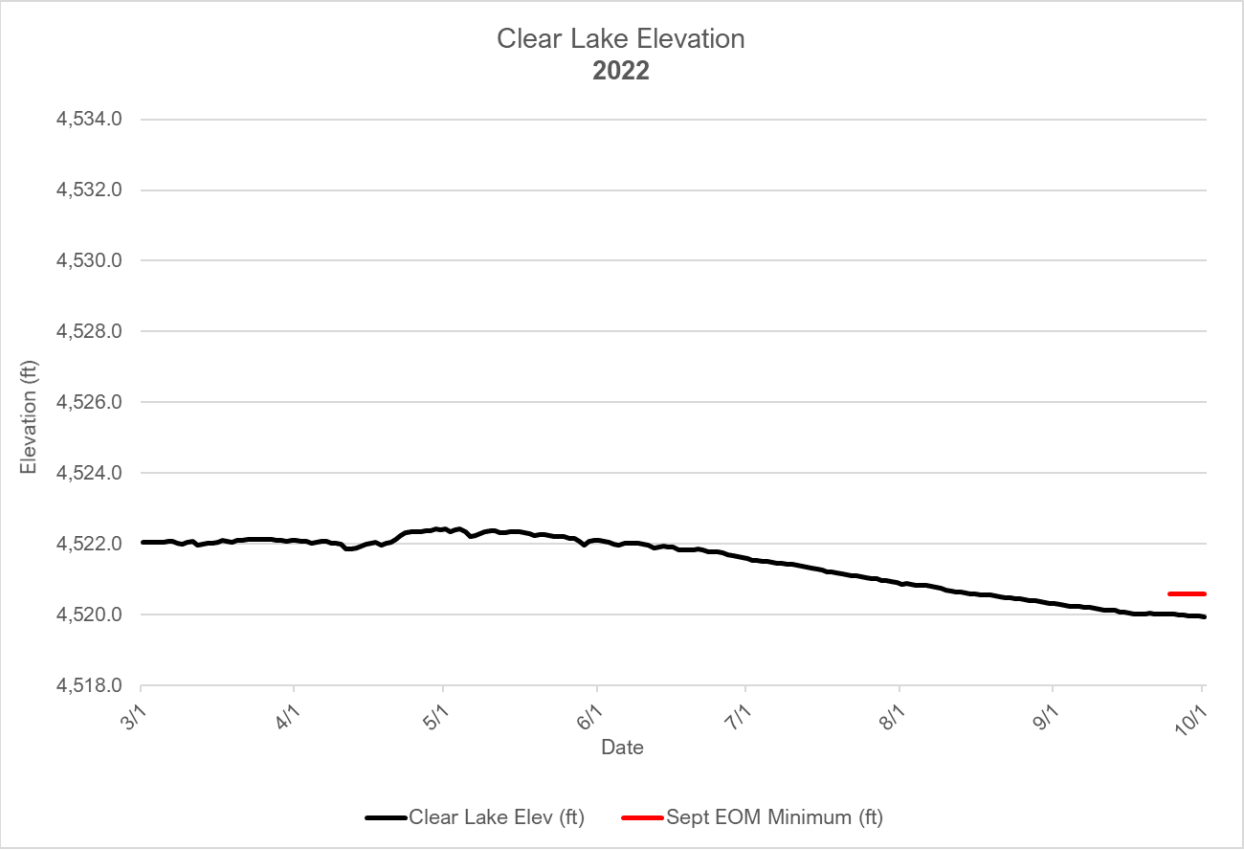

Figure 3. Clear Lake Reservoir Elevations in 2022 and end of September Minimum.

Gerber Reservoir Hydrology and Releases

Gerber Reservoir releases totaled 11,101 AF during WY 2022. Water was delivered from May 16, 2022, and continued through July 18, 2022, to meet Eastside irrigation demand. Historically, Gerber Reservoir deliveries have ranged between 30,000 and 40,000 AF of water with an average daily discharge rate of 180 AF, except during drought or flood control conditions.

Gerber Reservoir began WY 2022 with an elevation of 4,799.56 feet on October 1, was 4,804.19 feet by March 1, and ended the water year with an elevation of 4,798.23 feet on September 30. As depicted in Figure 4 below, Gerber Reservoir maintained elevations above the required minimum elevation of 4,798.1 feet throughout WY 2022.

On average, Gerber Reservoir has an elevation of 4,820.8 feet on March 1 and an elevation of 4,815.2 feet on September 30.

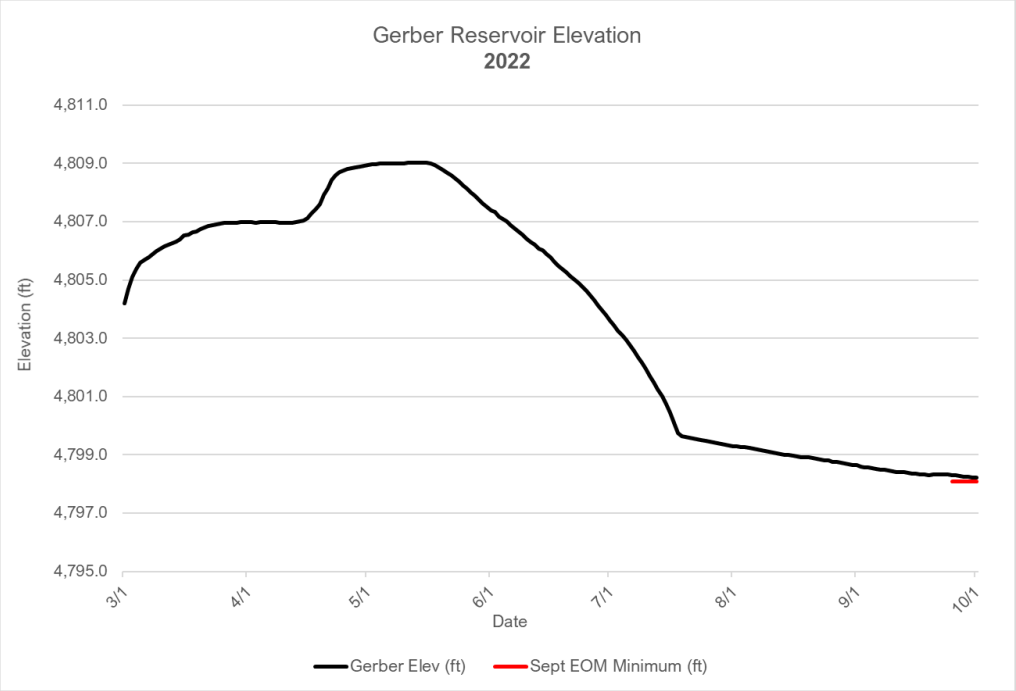

Figure 4. Gerber Reservoir Elevations in 2022 and End of September Minimum.

Tule Lake Sump 1A-1B Operations, WY2021-2022

Tule Lake Sump 1A (TLS1A) operations were adjusted in water year 2021 to account for the lack of Project return flows due to ongoing drought conditions and operations deviated from those described in the Modified 2018 Operations Plan/IOP (minimum elevation of 4,034.0 feet all season from April 1 to September 30). The Tule Lake Sumps are normally maintained through return flows from irrigation. However, with no Klamath Project diversions allowed in 2021, TLS1A began the season slightly above 4,034.0 feet and began rapidly decreasing early in the season. Reclamation assisted TID and USFWS at their requests to salvage suckers from Sump 1A and relocate them along with remaining Sump 1A water to Sump 1B, which would experience less evaporation due to its smaller surface area. Sump 1A subsequently went dry by the end of July 2021. When Sump 1B also began rapidly declining in summer 2021, PacifiCorp provided a loan of water to maintain elevations in 1B to benefit suckers as well as provide habitat for waterfowl on the Pacific flyway. A temporary Reclamation elevation gage was installed in Sump 1B in February 2022 to monitor water levels for water year 2022. As the drought continued with limited agriculture return flows in Water Year 2022, Sump 1B levels also declined. This required reclamation to assist in a Sump 1B Sucker fish salvage operation in the Spring/Summer of 2022. By mid-August 2022, Sump 1B also went dry. For the first time in recorded history, both Sumps 1A and 1B were dry at the end of Water Year 2022.

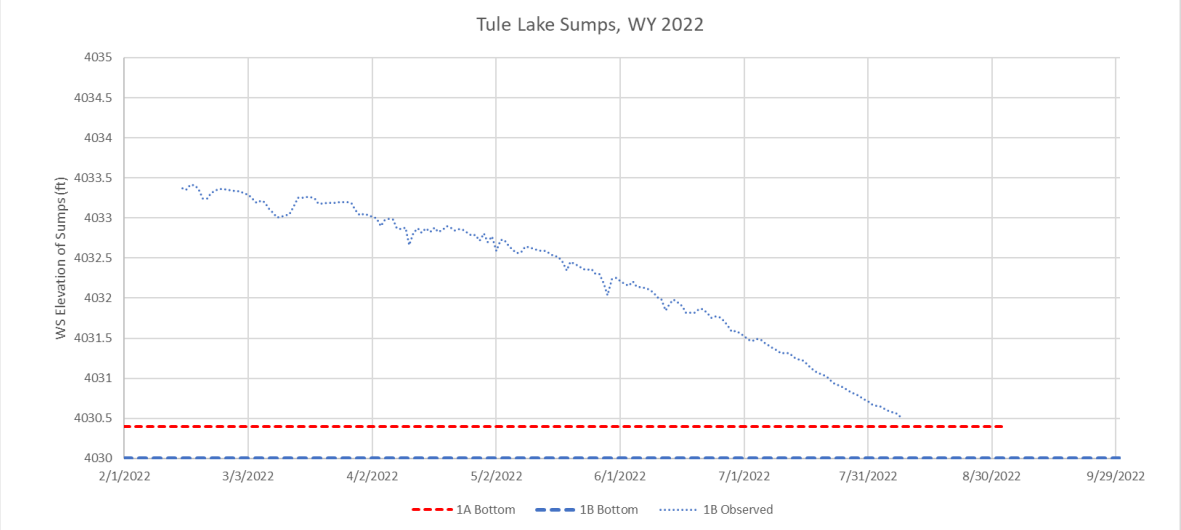

Figure 5. Tule Lake Sump 1A-1B Elevations in 2022 and Seasonal Minimum.

Project Diversions

The Project has five major points of diversion: A Canal, Miller Hill, Station 48, North Canal, and Ady Canal. Water released from UKL and diverted for Project irrigation counts against Project Supply. All water released from UKL and not diverted for Project irrigation counts against the EWA. When flows through the LRDC are not adequate to meet demands at Station 48, Miller Hill, North Canal, and Ady Canal, some of the Klamath River flow released at Link River Dam (LRD) is diverted for agricultural use. Project deliveries at these points were tracked daily with gage records entered into a spreadsheet, which was shared with resource agencies, irrigators, and other interested stakeholders. A summary showing the 2022 March through September irrigation deliveries versus historical statistics is included as Table A-13 in Appendix A. Values for daily flows are graphed in Figure 6 to Figure 17 and also shown as Tables A-1 to A-12 in Appendix A.

The irrigation season that is shown in the graphs below runs from March through November for Area 1 deliveries through Link River, A Canal, Station 48, and Miller Hill. Area 2 irrigation season deliveries through North and Ady canals occur from March through October. Miller Hill and North Canal had greater than the average diversion for the expanded period of record (POR) used in the Modified 2018 Operations Plan/IOP (1981-2019 WYs). However, these were more than balanced by reductions in Station 48 and Ady Canal as shown in Figure 6 to Figure 17.

Link River Dam Releases

During WY 2022, LRD released a total of 651 TAF of water during the irrigation season, 92 percent of the POR average of 710 TAF. Figure 6 displays daily discharges from LRD plotted against the POR average. (Note: Keno Canal is also known as West Side Power Canal. It runs parallel to the Link River and its flows are combined with the releases to Link River to calculate full releases from UKL, although it has not been used to generate power for several years.)

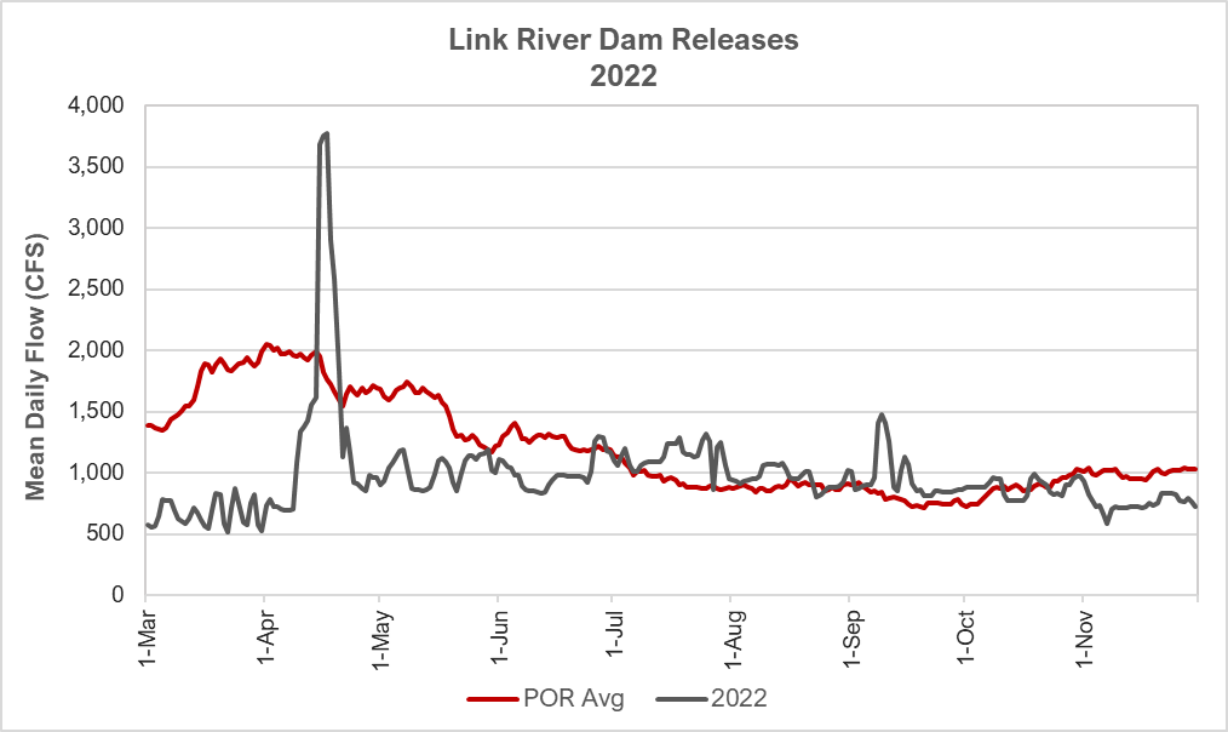

Figure 6. Seasonal Link River Dam plus Keno Canal Discharges. (Note: TAF=thousand acre-feet)

A Canal Diversions

Figure 7 plots WY 2022 A Canal diversions against the POR average. Due to the ongoing drought and limited project supply less than 15 percent of normal deliveries were made through the A Canal headworks in 2022.

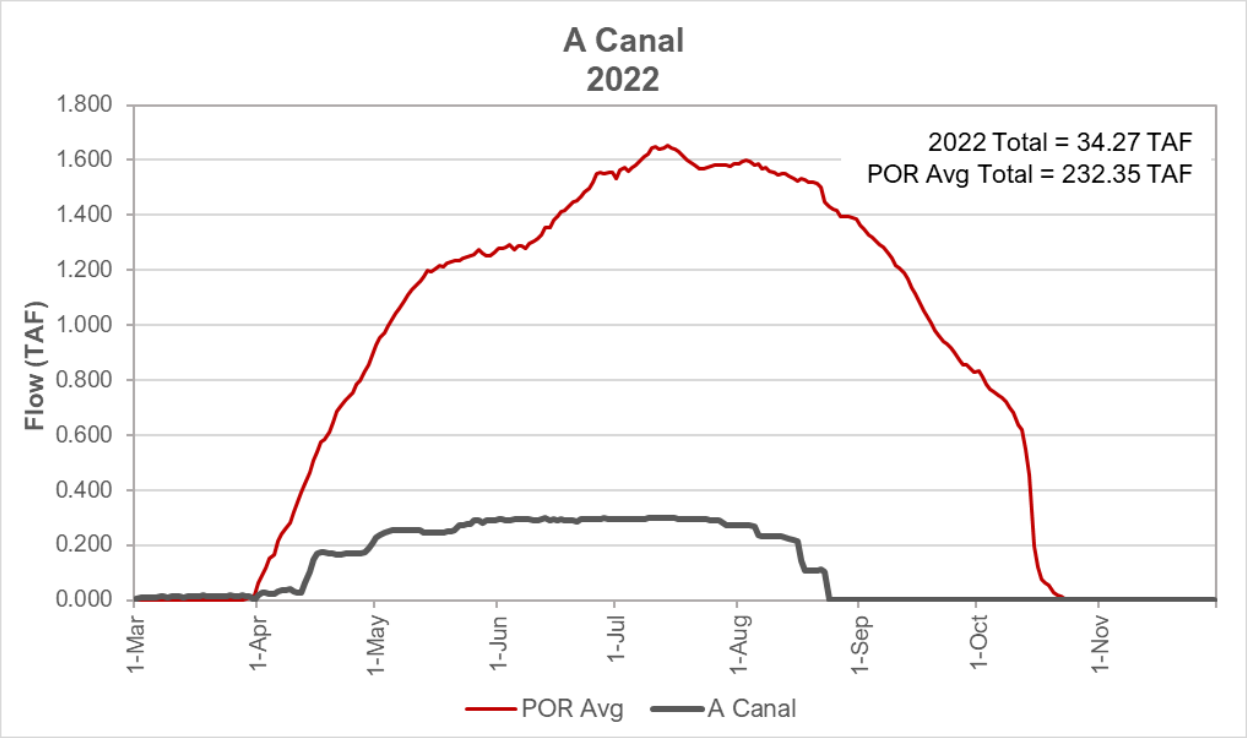

Figure 7. Seasonal flows through the A Canal.

Lost River Diversion Channel Flows

The LRDC connects the Lost River to the Klamath River and serves as a bi-directional channel to convey flow from, as well as return flows to, the Klamath River. LRDC flows are measured directly downstream of the Lost River Diversion Dam. Station 48 and Miller Hill diversions are located along the LRDC, downstream of the LRDC gaging station. The flows into the LRDC in 2022 were significantly less than the POR average as depicted in Figure 8. Most of the LRDC flows were diverted by TID, especially after LRDC gates were closed on Aug 23 to dewater the channel for maintenance purposes (the channel was refilled beginning on Dec 27 and the LRDC Klamath River gates were reopened on Jan 5).

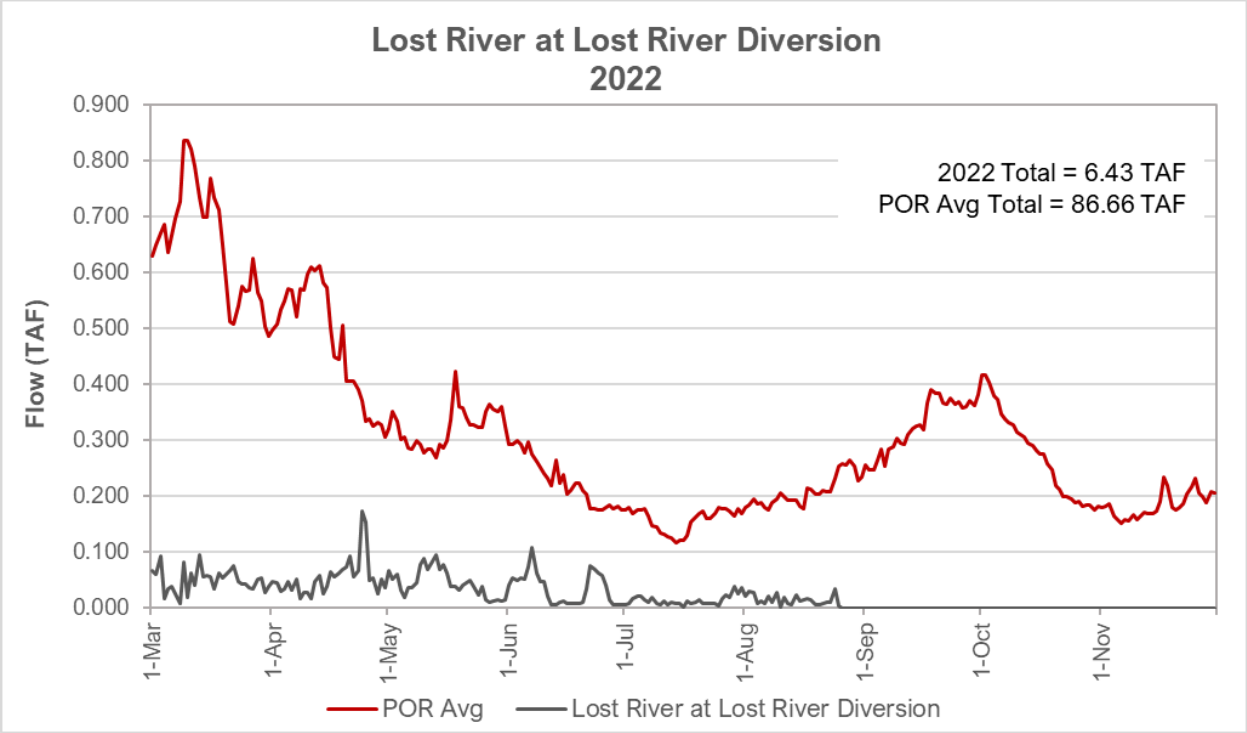

Figure 8. Seasonal flows through the Lost River Diversion Channel.

Miller Hill Pumps and Miller Hill Spill

Figure 9 shows that in 2022, Miller Hill Pump station pumped almost twice as much volume as the POR average. This is due in part to dewatering of LRDC for maintenance. Figure 10 shows that spills (flow routed back into the LRDC) at the Miller Hill station were zero in 2022.

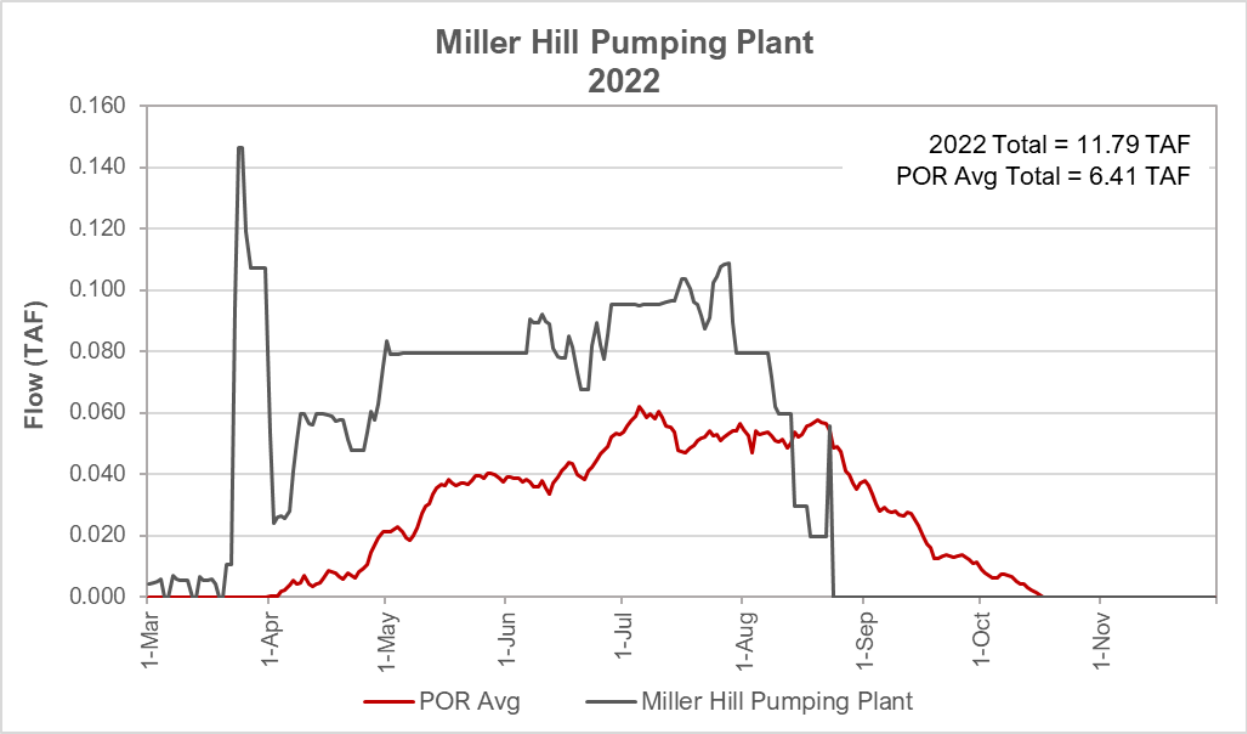

Figure 9. Seasonal Pumping at Miller Hill Pumps.

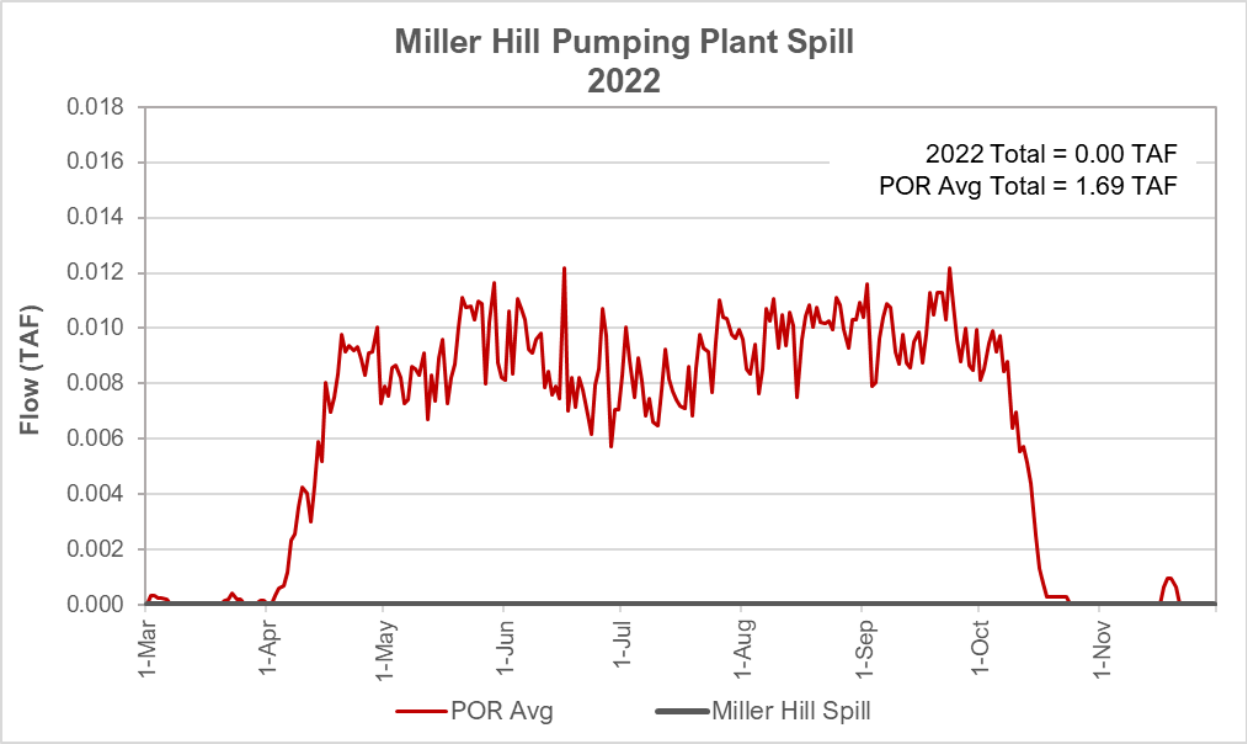

Figure 10. Seasonal Spill Volumes at Miller Hill.

Station 48 Diversions

Figure 11 shows that Station 48 total diversions in 2022 were only about half the POR average. Much of this reduction can be attributed to the shut-off of flows through the LRDC for maintenance.

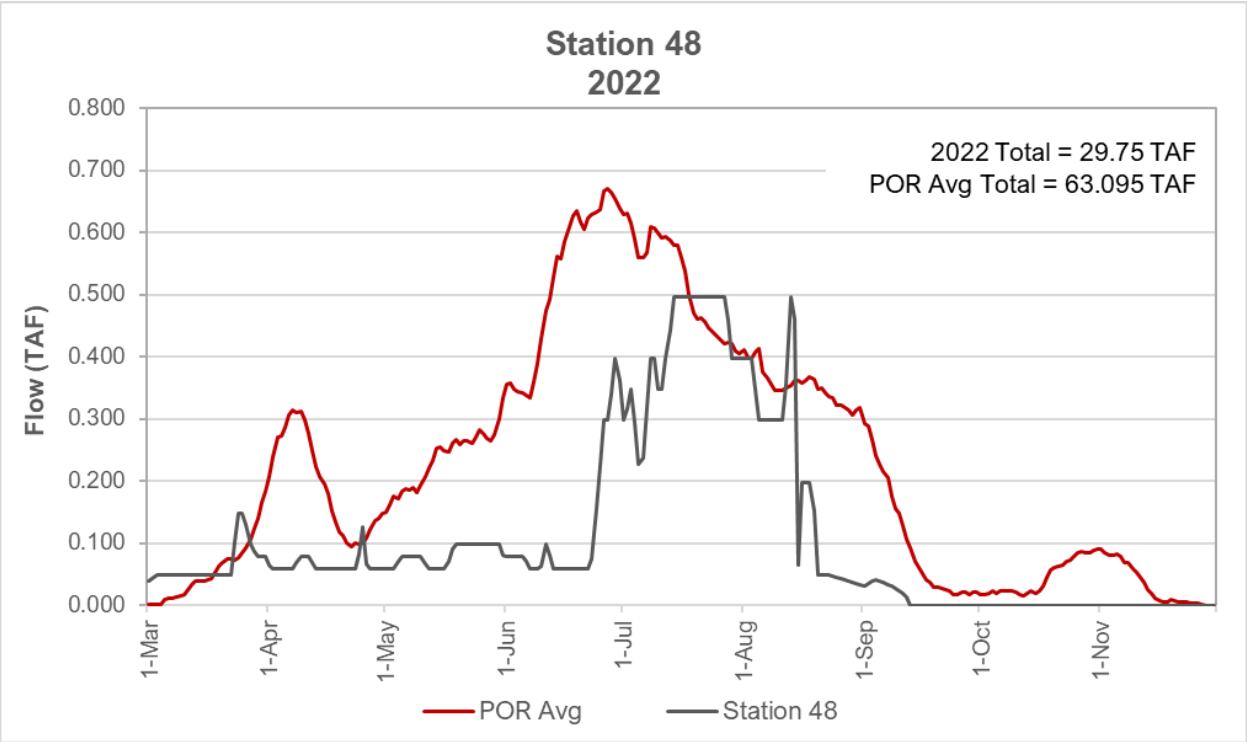

Figure 11. Seasonal Flows at Station 48.

North Canal Diversions

North Canal diversions in 2022 were 4.5 TAF above the POR average (Figure 12).

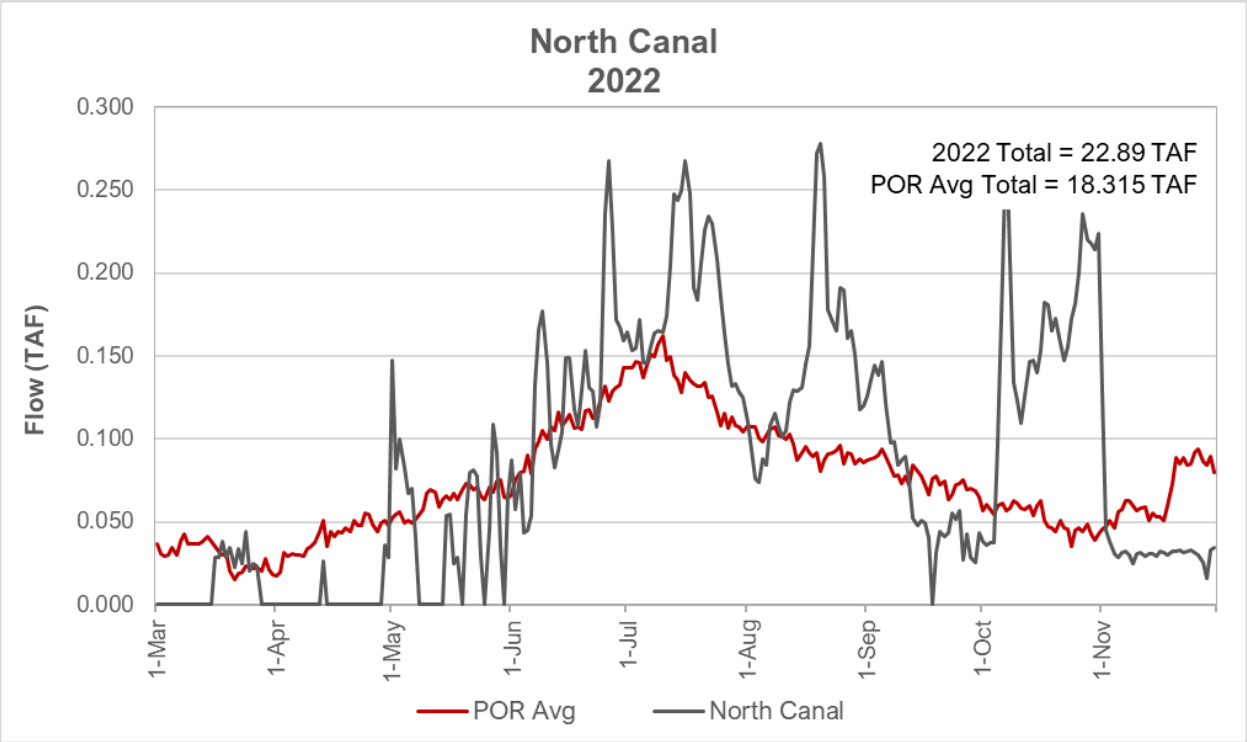

Figure 12. Seasonal Flows through North Canal.

Ady Canal Diversions

Deliveries in WY 2022 through the Ady Canal headgates are shown in Figure 13 whereas Figure 14 shows water conveyed via Ady Canal for delivery to the Lower Klamath National Wildlife Refuge (LKNWR). Deliveries through Ady were only 10 percent of normal due to a very limited project supply.

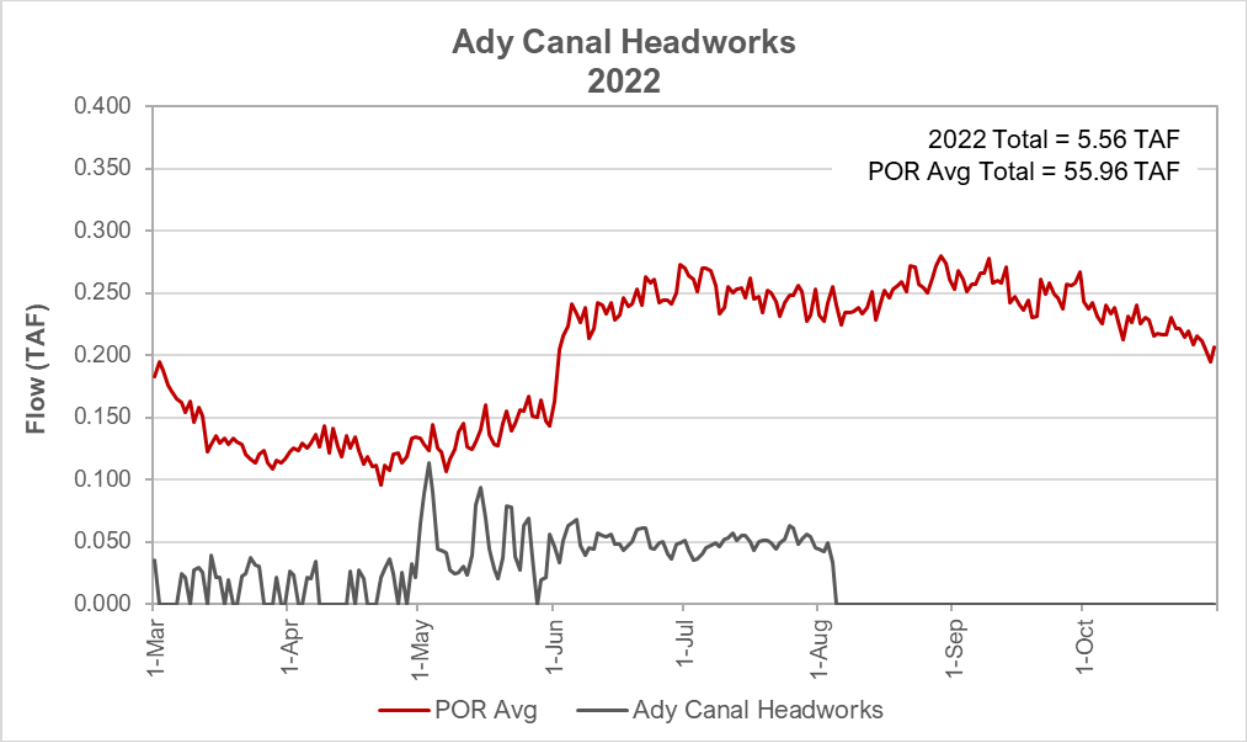

Figure 13. Flows at Ady Canal Headgates.

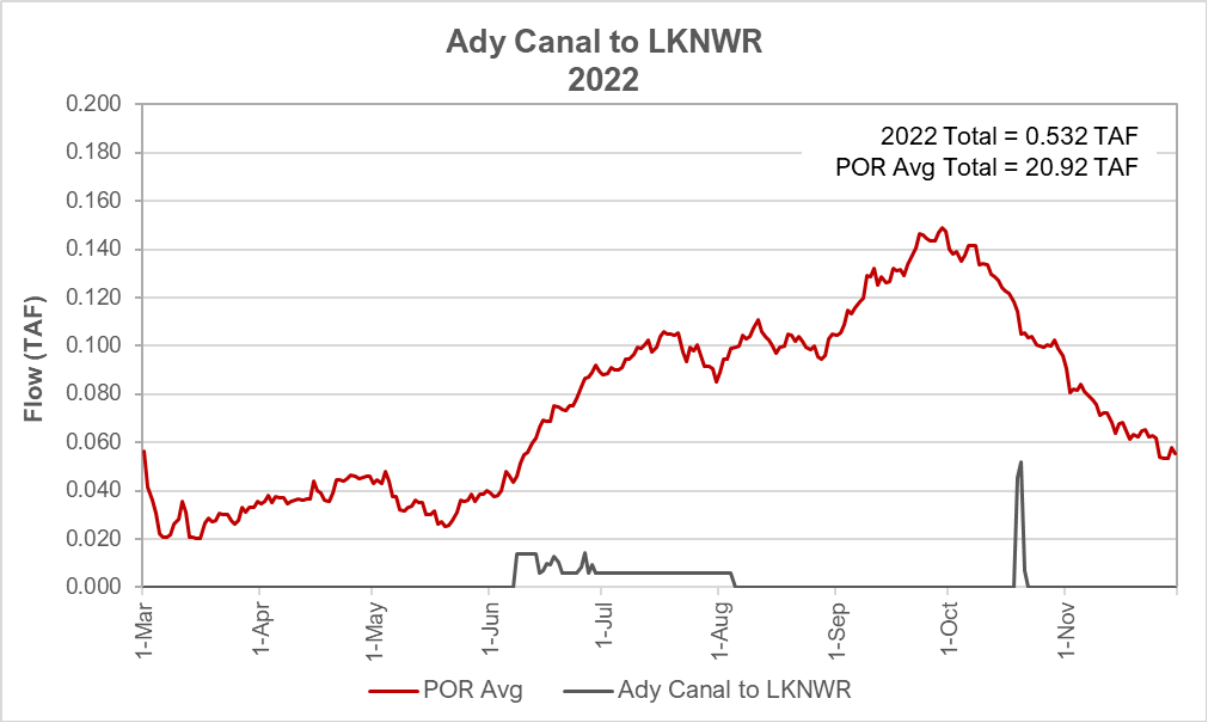

Figure 14. Flows through Ady Canal to Lower Klamath National Wildlife Refuge (LKNWR).

Klamath Straits Drain (KSD) at Stateline

Figure 15 shows the flows returning from LKNWR as measured at the KSD at Stateline. Due to the drought, KDD increased recirculation of return flows.

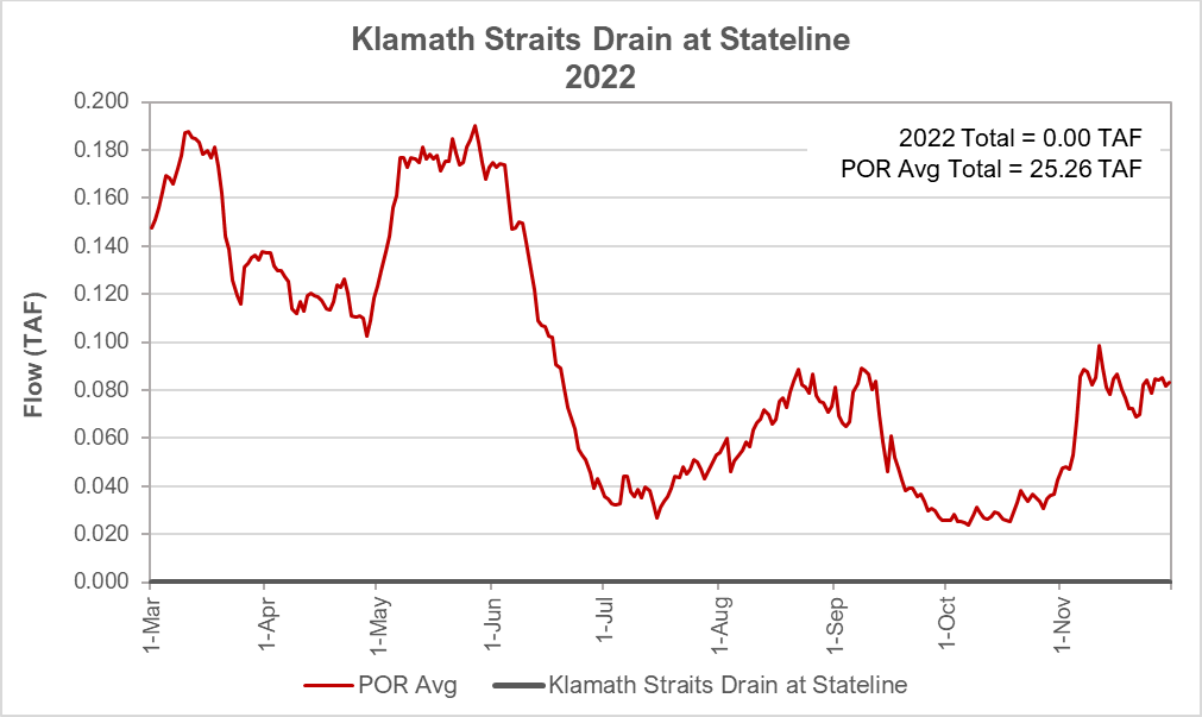

Figure 15. Flows through Klamath Straits Drain at Stateline Road.

Klamath Straits Drain at Pumps F/FF

The pumps at Pumping Plants F and FF return water from the KSD to the Klamath River. Due to the excessively dry hydrologic conditions, the F/FF pumps were not run during the irrigation season in 2022 (Figure 16).

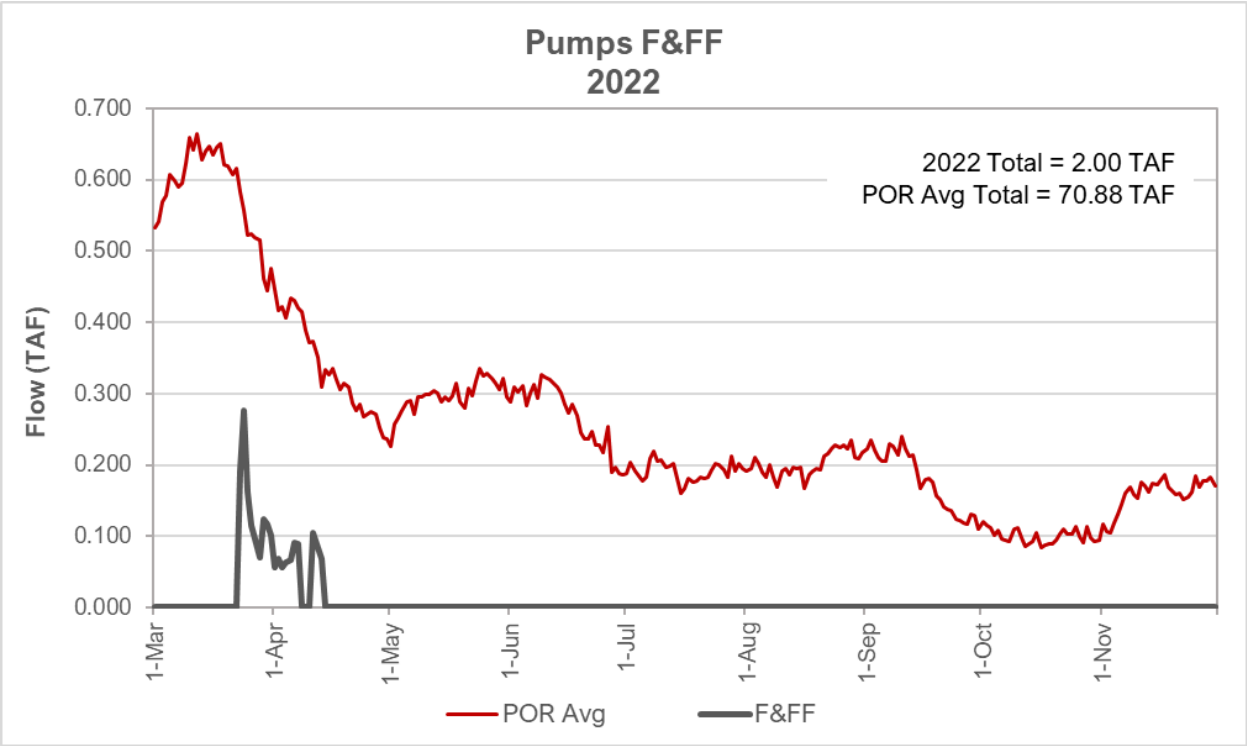

Figure 16. Flows through Klamath Straits Drain at Pumping Stations F and FF.

West Side Power Canal Diversions

In the past, PacifiCorp has used the West Side Power Canal, also known as the Keno Canal, for power generation at times throughout the year. Flows are self-reported by PacifiCorp. The canal usually runs at a constant rate during generation, though it is no longer used for power generation. Reclamation received confirmation that the Keno Canal conveyed an estimated 15 cubic-feet-per-second (cfs) in 2022, as depicted in Figure 17.

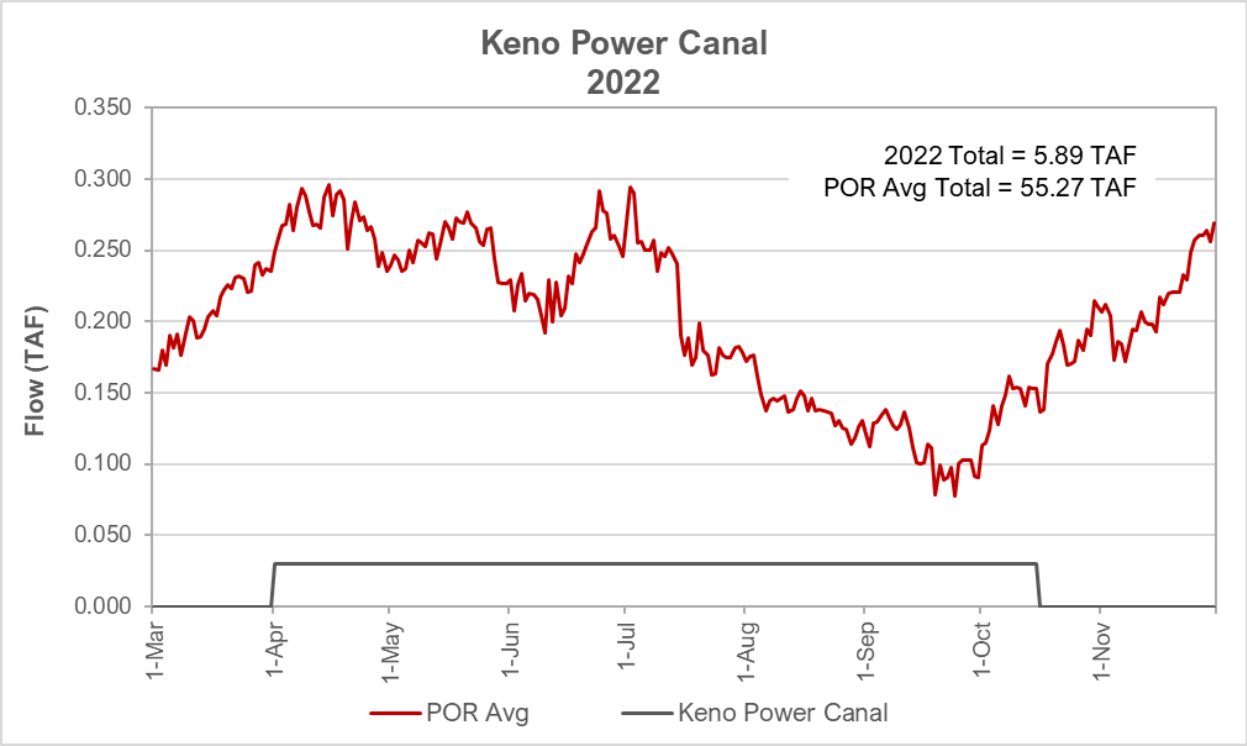

Figure 17. West Side (Keno) Power Canal Operation.

U.S. Fish and Wildlife Service Reporting Requirements

T&C 1a – Ensure that No Unnecessary Actions are Taken that Increase Entrainment at the Link River Dam.

Requirement

Reclamation shall coordinate with USFWS to ensure that no unnecessary actions are taken that increase entrainment at the LRD. T&C 1a requires Reclamation to monitor the numbers of age-0 and older suckers moving through the FES to determine the timing of the peak and determine a reasonable estimate of total abundance.

Results

Reclamation coordinated with USFWS before the typical irrigation season to ensure that no unnecessary actions that would increase entrainment of age-0 suckers would occur at the LRD. Reclamation did not monitor the number of age-0 and older suckers moving through the FES in the summer of 2022 due to safety concerns of night sampling at this location and the limited water deliveries for irrigation available through the A Canal. Thus, there was no peak of entrainment at the Fish Evaluation Station (FES) to monitor. The 2022 abundance estimate through FES was zero suckers. The forebay of the A Canal was charged in March prior to watering irrigation canals. Reclamation salvaged the A canal forebay December 8 and 12, 2022; 436 suckers were salvaged from the A Canal forebay. The 436 salvaged suckers were transported to the USFWS Hatchery where they were PIT-tagged prior to release in Upper Klamath Lake. Reclamation has summarized the results of these efforts under the A Canal FES Annual Monitoring Summary (M&RR 1.1a) and Appendix B includes the full report.

T&C 1b – Actions to Determine Irrigation Supply and Take Corrective Actions to Avoid Going Below Minimum Elevations in Clear Lake Reservoir, Gerber Reservoir, and Tule Lake Sump 1A.

Requirement

The USFWS BiOp states:

> *"Prior to initiation of deliveries to irrigators or prior to April 15, whichever comes first, of each year, Reclamation shall assess projected inflows and water levels in Clear Lake and Gerber Reservoirs to determine an anticipated irrigation supply from each reservoir along with projected end of season lake elevations. Reclamation shall coordinate with the Service to ensure the anticipated irrigation supply falls within the effects analyzed and incidental take authorized in this BiOp. This coordination is to ensure that releases, particularly those above and beyond typical historical releases, will not result in increased harm to listed suckers in Clear Lake Reservoir due to reduced access to spawning habitat in Willow Creek. Projected end of September targets shall be at or above minimum elevations.*
>
> *Irrigation releases from Clear Lake Reservoir greater than the typical historical demand could result in Clear Lake Reservoir elevations that are consistently lower than those analyzed in this document, which in turn may reduce the*

likelihood of adequate lake elevations to allow access to spawning habitat in Willow Creek (see Section 7.4.1). Therefore, the Service expects that deliveries from Clear Lake Reservoir will be similar to those typical across the 1986 through 2016 period, exclusive of atypical conditions (i.e., flood control releases, other releases for public health and safety, inadequate water supply, etc.). Typical total annual irrigation releases across the 1986 through 2016 period were as high as 40,376 AF, and the proposed action indicates that Reclamation expects typical annual irrigation releases to be approximately 35,000 AF.

At least once a week throughout the year, Reclamation shall assess projected water levels to determine if they are likely to fall below proposed minimums for Clear Lake Reservoir, Gerber Reservoir, and Tule Lake Sump 1A for that relevant time period. If conditions indicate that these reservoirs are likely to experience hydrologic conditions that would likely result in water levels going below the minimums, Reclamation shall alert the Service to determine the most appropriate action to minimize risk to affected listed species. Reclamation's required water-level monitoring for Clear Lake Reservoir, Gerber Reservoir, and Tule Lake Sump 1A is described below under section 11.4."

Reclamation shall take actions to determine Project Supply and take corrective actions to avoid going below minimum elevations in Clear Lake Reservoir, Gerber Reservoir, and TLS1A prior to initiation of deliveries to irrigators or April 15, whichever comes first. Reclamation shall coordinate with USFWS to ensure anticipated irrigation supply falls within the effects analyzed and incidental take authorized in USFWS 2020 BiOp.

Results

Reclamation initially coordinated with the USFWS on March 4, 2022, to assess water levels in and projected inflow to Clear Lake Reservoir and Gerber Reservoir after receiving the March inflow forecasts from the Natural Resources Conservation Service, with close coordination continuing throughout the irrigation season. Modeling showed that end of September surface elevations were expected to remain above the minimum in Gerber Reservoir, but were likely to drop below the minimum elevation in Clear Lake Reservoir with no projected irrigation deliveries or other discretionary actions by Reclamation. As such, Reclamation made no releases from Clear Lake Reservoir in 2022. TID expressed concern over potential drops in TLS1A and TLS1B due to lack of irrigation return flows. Reclamation coordinated with USFWS (both the Klamath office and the refuges) as well as TID. However, both sumps went dry during the summer.

T&C 1c – Take Corrective Actions to Ensure Upper Klamath Lake Elevations Are Managed within the Scope of the Proposed Action

Requirement

Reclamation shall monitor and take corrective actions to ensure UKL elevations are managed within the scope of the Modified 2018 Operations Plan/IOP described in the USFWS 2020 BiOp. Reclamation shall also determine causative factors of decreases in lake surface elevation and determine if factors are within the scope of the Proposed Action and the effects analyzed in the USFWS 2020 BiOp. Reclamation shall consult with USFWS if adaptive actions are necessary and take corrective actions.

Result

Reclamation monitored surface elevations for UKL during WY 2022 to ensure surface elevations were not outside the bounds of those analyzed in USFWS' effects analysis. Surface elevation for UKL missed the seasonal thresholds owing to the drought conditions in the Klamath Basin in 2022. Surface elevation was 4140.74 feet on June 1 and 4140.15 feet on July 15 in 2022. June 1 threshold is 4,141.28 feet and the July 15 threshold is 4,140 feet (4,140.5 feet if previous year missed and 4,140.8 feet if two previous years missed). Upper Klamath Lake did stay above 4,138.26 feet which is the

minimum lake elevation allowed at all times. UKL surface elevations are summarized in M&RR 3.3b - Monitor and Maintain Water Level and Flow- Measurement Gages throughout the Project.

T&C 1d – Activate the A-Canal Pumped-bypass System Annually by August 1

Requirement

Reclamation shall coordinate with USFWS by July 1 each year and activate the A-Canal Pumped-bypass System Annually by August 1. The A-Canal bypass is to begin being operated continuously no later than August 1 until no age-0 suckers are observed in FES or diversions into the A-Canal are terminated.

Results

Reclamation coordinated with USFWS before July 1, 2021, to confirm that the A Canal Pumped Bypass System would be operated in 2022. The pumped bypass ran 24 hours each day, 7 days each week from July 13 to August 23, 2022. The 2020 A-Canal FES Report can be found in Appendix B and 2022 estimated numbers of juvenile suckers bypassed is in Appendix E.

T&C 1f – Annual Identification and Installation of Needed Water-Level and Flow-Measurement Gages in the Project

Requirements

The USFWS 2020 BiOp requires that Reclamation consult with USFWS hydrologists and other appropriate agencies at least annually to assess the need for additional gages in the Project area beginning July 1, 2019.

Results

Reclamation took appropriate actions to identify and install new gages, as well as troubleshoot and maintain existing gages, within the Project. Regarding gage installations, in February 2022, a temporary water measurement gage was established at Tule Lake Sump 1B to monitor declining water levels. Equipment installed included at submersible pressure transducer and a combined data logger/satellite transmitter, Water level and temperature data was transmitted via satellite to Reclamation databases. Numerous visits were made to the gage to monitor site conditions and extend the pressure transducer further out into Sump 1B as the shoreline receded. The temporary gage was removed in August 2022.

During July 2022, inclinometers (gate position sensors) were installed at the Lost River Diversion Dam to monitor gate position for gate opening and flow calculations. In early 2023, plans include the installation of a Data Collection Platform (DCP), submersible pressure transducers, and supporting equipment to enable satellite telemetry of hydrologic data for input into Reclamation databases.

During April 2020, a new stream gage was installed by the USGS at the A Canal Headworks. The gage reports near-real time hydrologic data to the National Water Information System (NWIS) and is accessible via a web interface. In 2022, a number of discharge measurements were made to continue calibration of the velocity sensor (indexing) for flow calculations. Indexing efforts are ongoing. The new USGS gage serves as a backup to the primary A Canal Headworks flow sensor,

which reports flow information to a Supervisory Control and Data Acquisition (SCADA) network. operated by Klamath Irrigation District (KID).

During 2022 six Acoustic Doppler Velocity Meters (ADVMs) were purchased. The velocity meters will be used to replace older ADVM's in current use at Reclamation water measurement gages

Reclamation staff have identified the following existing hydrologic data collection sites—listed by priority—whose respective quality of data would benefit from improving channel conditions at and/or near the measurement location: Oregon Drain upstream LKNWR; Station 48; Ady Canal; and North Canal.

T&C 1j - Ensure Project Impacts on Spawning access in Clear Lake Reservoir are not Greater than Anticipated

Requirement

This T&C requires that Reclamation provide to USFWS an analysis on Project impacts to Clear Lake Reservoir spawning habitat access by March 1, 2020. The T&C specifies that:

> *"Reclamation shall coordinate with the Service to perform an analysis synthesizing the hydrologic conditions for sucker spawning" using anticipated data from monitoring at Clear Lake Reservoir."*

Results

Reclamation began working on this T&C in 2019, continued to work on it in 2020, then completed the analysis in 2021. Prior to completion, Reclamation met with USFWS to discuss this T&C on July 30, 2019, 10:00-12:00, October 15, 2019, 10:00-11:00, April 2, 2021 9:00-10:00, and April 20, 2021 3:30-4:30. Reclamation provided USFWS with consistent updates, as they were received from USGS regarding the analysis of adult sucker demographics in Clear Lake Reservoir.
Due to delays in receiving a draft of Hewitt et al. (2021), a revised completion date of May 1, 2021, was agreed upon by both agencies on February 26, 2021.

Reclamation received a courtesy copy of USGS's Clear Lake Adult Sucker Demographics Report on January 4, 2021, and a final copy in April of 2021. In a meeting on April 2, 2021, Reclamation agreed to provide USFWS with an exploratory assessment directed at using available data from the then draft Open File Report of Hewitt et al. (2021) *Dynamics of Endangered Sucker Populations in Clear Lake Reservoir, California* and identify possible approaches to better understand conditions hydrologic limitations in Clear Lake Reservoir.

Reclamation coordinated closely with the Services to assess and understand new data provided by USGS in Hewitt et al (2021). Reclamation and USFWS have identified several new analyses that can be performed on existing data, as well as improvements to current methods that could better answer management questions. Several of these recommendations have been developed into new methods and research projects that have been or will be funded in FY22. Reclamation completed this analysis and sent it to USFWS on April 30, 2021. Reclamation presented the results of this analysis to USFWS on May 17, 2021. As of 2022, there is no further update beyond this point and should be considered as complete.

Entrainment Monitoring: at Project Facilities

M&RR 1.1a (USFWS) - A Canal Fish Evaluation Station Monitoring Annual Report

Requirement

The 2020 USFWS BiOp states:

> *"Reclamation shall monitor entrainment of age-0 and age-1 juvenile suckers at the A Canal FES annually from July 15 to September 30. The level of effort shall be sufficient to determine when the peak of entrainment occurs and to provide an accurate estimate of the numbers of suckers entrained during the peak. An estimation of the number of juveniles moving through the bypass system during the peak period requires sufficient samples taken both within and among days.*
>
> *Monitoring at the FES shall begin approximately July 15 of every year with sampling on one night per week until at least 10 juvenile suckers are captured in a night or August 1, whichever comes first, after which sampling will continue four nights per week until no additional suckers are collected in the FES in a given week, September 30, or a date agreeable to the Service. Reclamation will sample consistent with recent FES sampling to ensure comparisons can be made among years.*
>
> *Samples need to be taken at night because that is when most sucker movement occurs. All suckers in FES samples will be counted, and measurements (such as length, weight, and other data as coordinated with the Service) will be collected from a representative sample. A brief summary report of numbers of suckers collected shall be provided to the Service every week via email, no later than the close of business on each Friday. This will provide the Service with the opportunity to assess patterns and provide comments to Reclamation concerning any adjustments that may be implemented to avoid unnecessary entrainment. The results of the monitoring shall be included in the Annual Monitoring Report due to the Service by March 1 of every year. The report shall describe the methods, results, and recommendations to improve monitoring in coordination with the Service to ensure appropriate analyses are performed."*

Results

Sampling at the FES for suckers did not occur in 2022 because there were safety concerns during the start of irrigation season having staff work at the A Canal location during night and early morning hours and only a fraction of the usual irrigation delivery was available from Upper Klamath Lake through the A Canal to the Klamath Project that indicated Reclamation would remain well below allowable Incidental Take in 2022. As a result, there was no direct observations to determine peak of entrainment and abundance was an estimate based on the volume of seasonally diverted water at the location that has been provided in Incidental Take Statements since the 2012 biological opinion. The A Canal pumped bypass was tested in early July and run continuously through the irrigation season from July 13 through August 23, 2022. A full description of typical annual sampling is in Appendix B. Incidental Take estimate that includes the estimate of juvenile suckers bypassed by the pump is in Appendix E.

M&RR 1.1b (USFWS)– Flow Monitoring at the A Canal, and Link River, Clear Lake Reservoir, and Gerber Dams as a Surrogate for Larval Sucker Entrainment Monitoring

Requirement

The 2020 USFWS BiOp states:

> *"Entrainment monitoring of larval suckers at the A Canal, and dams at Link River, Clear Lake Reservoir, and Gerber Reservoir is impracticable because of difficulty in identifying sucker larvae, expense, limited and sometime difficult or dangerous access at Clear Lake and Gerber reservoirs, and human safety concerns associated with night sampling at Gerber and Clear Lake dams. Therefore, Reclamation shall monitor flows at each dam during the larval period: Link River Dam - April 1 to July 15; Clear Lake Dam - April 1 to June 1, and Gerber Dam - April 1 to June 1. The use of flow as a surrogate for larval entrainment is reasonable and appropriate because entrainment of suckers has been determined to be proportional to flow at two of these facilities (additional information on the flow and entrainment is found in both the Environmental Baseline (section 7) and Effects of the Action (section 8) of this BiOp (Gutermuth et al. 2000a, 2000b). The studies that Gutermuth et al. (2000a, 2000b) conducted at the A Canal and Link River Dam found that the numbers of larval suckers entrained was a function of flow and that entrainment increased with increasing flow, and thus was proportional. Therefore, measurement of flow is a reasonable and appropriate surrogate for monitoring larval entrainment. The flow data, reported as acre-feet per day, shall be included in the March 1 Annual Monitoring Report described below, and presented as total flow through the A Canal, and the Link River, Clear Lake, and Gerber Dams. Reclamation shall know if they have likely exceeded authorized take of LRS and SNS larvae at these facilities when the discretionary monthly flow volumes, in acre-feet, exceeds those that occurred during the POR analyzed in this BiOp. We recognize that there are likely to be uncontrolled flow releases ("spills") at these dams, or emergency releases, due to high lake levels and concerns for large inflow events resulting from storms. Because these events are outside of Reclamation's discretion, any entrainment occurring during those events would not result in unauthorized take."*

Results

The results of the flow monitoring for this requirement are shown in Figure 18 through Figure 21 below. All locations were below maximum values calculated for the POR. In all instances, Reclamation released less water than was analyzed in the POR.

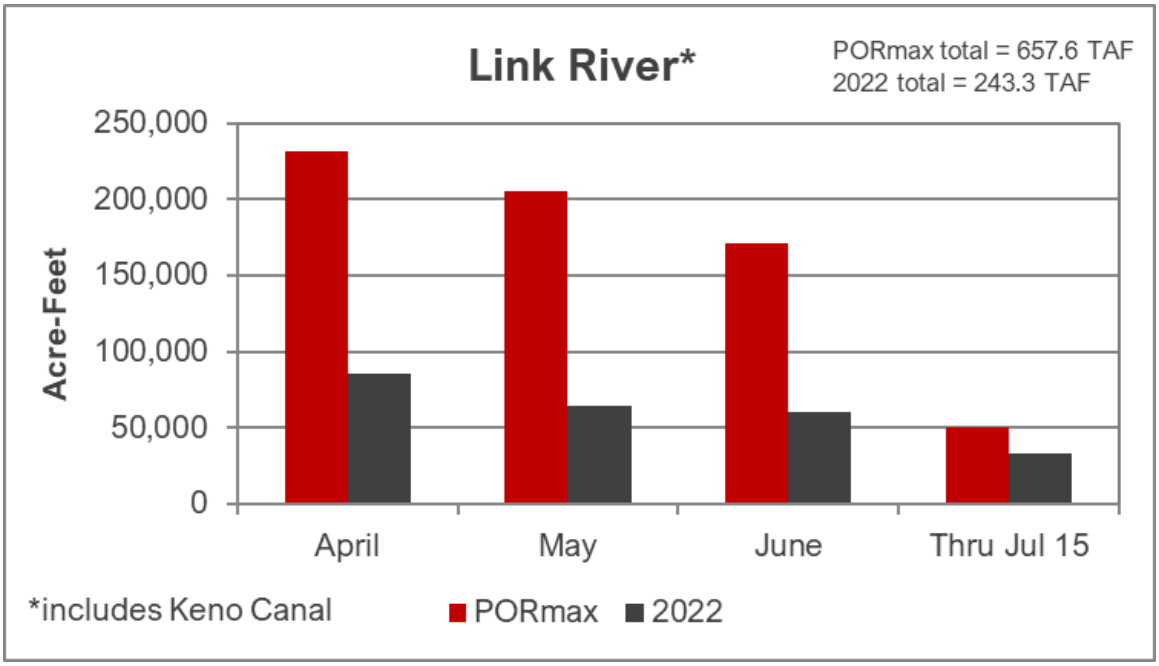

Figure 18. Link River Total Monthly Flows as Surrogate for Larval Sucker Entrainment. PORmax = period of record maximum.

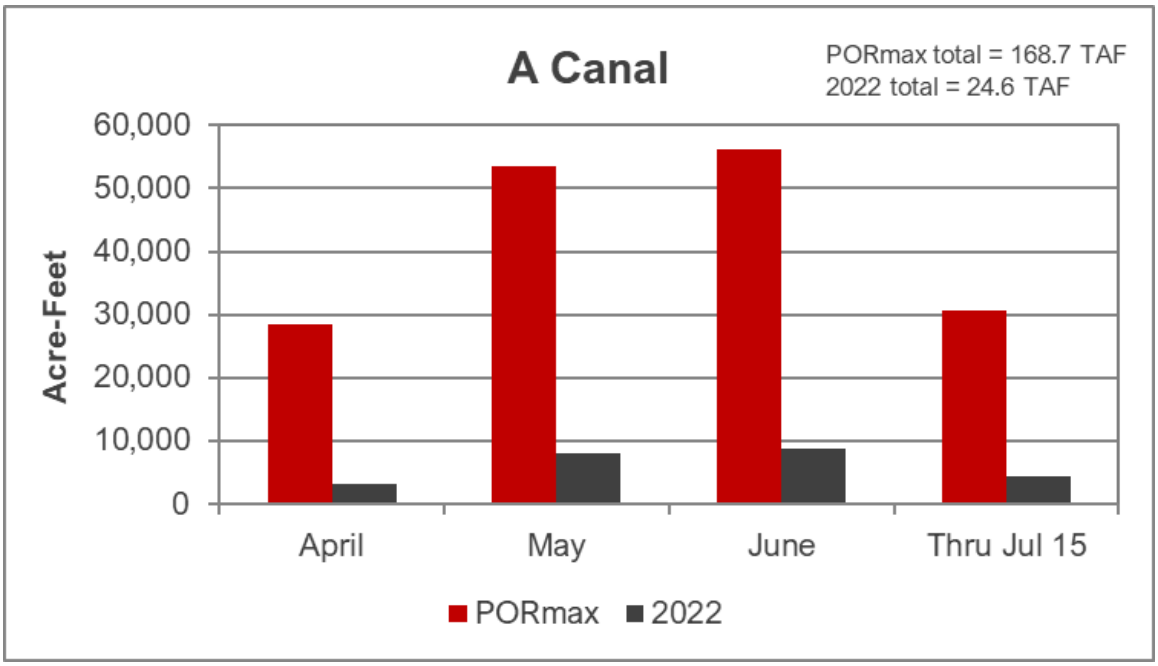

Figure 19. A Canal Total Monthly Flows as Surrogate for Larval Sucker Entrainment.

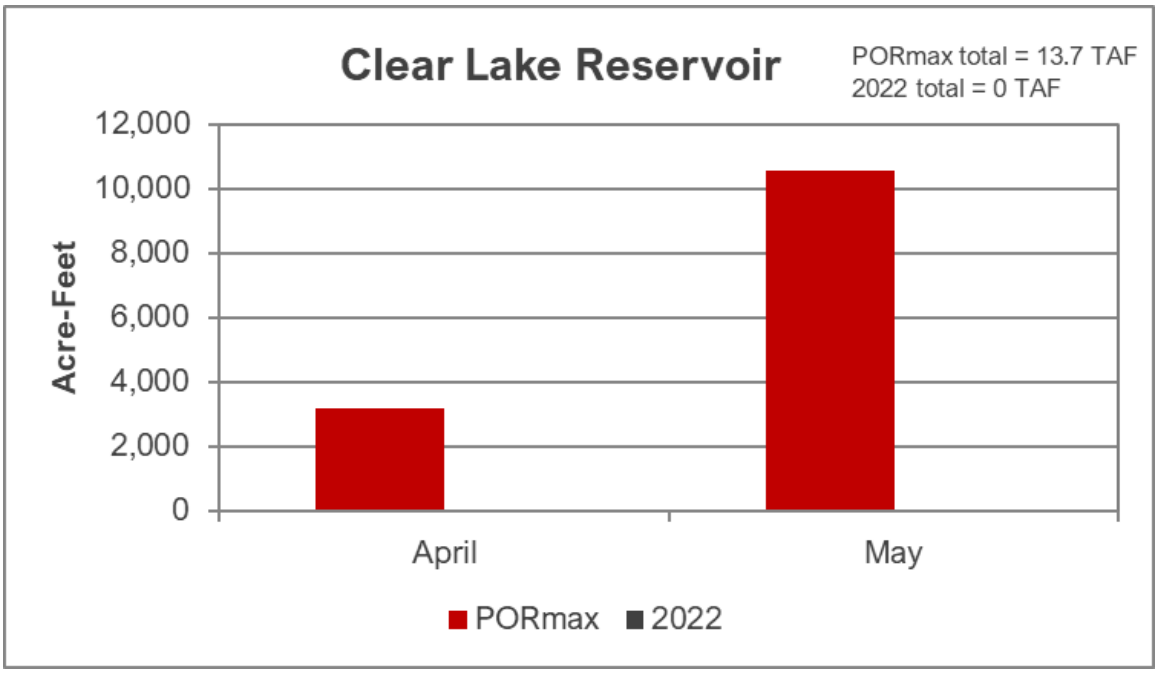

Figure 20. Clear Lake Reservoir Total Monthly Flows as Surrogate for Larval Sucker Entrainment.

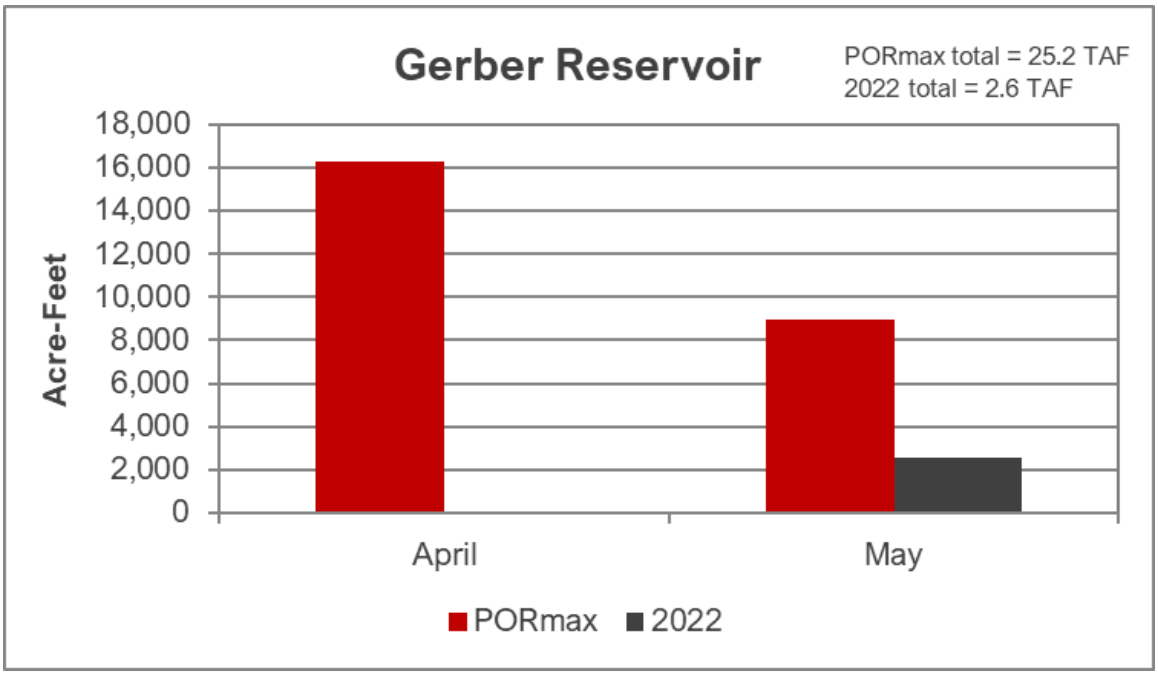

Figure 21. Gerber Reservoir Total Monthly Flows as Surrogate for Larval Sucker Entrainment.

M&RR 1.1c (USFWS)- Canal Salvage Report

Requirement

The 2020 USFWS BiOp states:

> *"Reclamation has proposed to salvage suckers entrained into the irrigation canal system during drawdown in the fall. Salvage efforts include take of individuals through capture, and the results of this salvage effort will be*

included in the Annual Monitoring Report…Reclamation will also continue to pursue alternative methods of dewatering canals, laterals, and drains and which could result in less sucker presence within these facilities at the end of the irrigation season."

Results

A summary of suckers caught during the 2022 salvage season, related to past years results are included in Figure 3. Zero suckers were salvaged from the Klamath Project Canals, 436 juvenile suckers from A canal forebay, (Table 1). Zero suckers were captured in the C, D, LRDC, Lost River, and J Canals. All suckers from A canal forebay were transported and released at KFNFH under the responsibility of the U.S. Fish and Wildlife Service.

During the last 5 years, Reclamation has engaged staff from USFWS, KID, and TID in conversation on how to reduce entrainment through operational shifts or dewater the canals differently at the end of each year. Each irrigation season is operationally different from the previous years. To date, the conversations have not yet identified a clear solution to reduce the quantity of fish, and endangered suckers, in the canal system.

Table 5. Summary of juvenile suckers salvaged from Klamath Project canals in 2022.

STATE	Canal	Site	Location description	UTM East	UTM North	2022
Oregon	A		A canal Forebay	598743	4676963	436
	C4	22	Miller Hill pumping plant	603128	4666343	-
	C4	22/23	between 22 & 23			-
	C4	23	Mac Check	603917	4665123	0
	C4	24	¼ mile S of Old Midland Rd.	603434	4664140	-
	C4	24/25	between 24 & 25	602753	4664526	-
	C4	25	¼ mile N of Old Midland Rd.	602141	4664625	-
	C4	26	1/8 mile west of Tingley Lane	601002	4664872	-
	C4	26b	¼ mile W of Tingley Lane	600900	4664736	-
	C4	26c	Check ¼ mile E of Tingley Ln.	601426	4665318	-
	C1	21	Adam's Flume area (S lat.)	613764	4654852	-
	C1	21a	Adam's Flume area (¼ S lat.)	613714	4654847	-
	D3	21	the check near site 21			-
	D3	20	Adam's Flume area (E lat.)	614120	4654933	-
	J	51	Anderson-Rose Dam	619184	4651944	-
	J	52	Check 1 and flume	621505	4651289	-
	J	53	S end of siphon	621537	4651657	-
	J	54	Check 2 (Check # C61010)	623272	4651694	-
	J	55	Check 3 (Check # C61016)	625700	4651923	-
	J	56	Check 4	627334	4651403	-
	J	57	Check 5	631061	4650688	-
	J	57a	North of stateline Rd at RR Xing	629028	4651413	-
California	J	58	Check 6 – S of Stateline Road	632352	4650628	-
	J	59	Check 7	634861	4648454	-
	J	60	Check 8 - D&J confluence	636333	4646278	-
	J	61	Check 9	636947	4643589	-
	J	62	Check 10	637823	4642453	-
	J	63	Check 11	637985	4640807	-
	J	64	Check 12	636846	4638865	-
	J	64/65	Culvert between sites 64 & 65	636056	4639656	-
	J	65	Check 13 (Check # C71113)	635770	4639596	-
	J	65/66	Culvert between sites 65 & 66	635360	4639471	-
	J	66	Culvert E of Highway 139	634874	4639183	-
	J	67	RR Bridge W of Highway 139	634282	4638730	-
	J	68	Check 14	633607	4638622	-
	J	69	Culvert at County Rd. 112	632874	4637953	-
	J	70	Pump 24 (tail end of J-canal)	631334	4636676	0
					Total:	436

- site was not salvaged, or could not be salvaged due to low water levels and/or heavy icing

Adult Lost River Sucker and Shortnose Sucker Monitoring in Project Reservoirs

M&RR 2 (USFWS) – Adult Lost River Sucker and Shortnose Sucker Monitoring in Project Reservoirs

Requirement

"Reclamation is required to continue to support monitoring efforts for adult sucker monitoring in UKL and Clear Lake Reservoir.

Additionally, Reclamation is required to undertake annual trammel net sampling at Gerber Reservoir to monitor populations, including the collection of size frequency data, implanting PIT-tags, and scan suckers for previously implanted PIT-tags."

Results

Adult sucker monitoring for both UKL and Clear Lake Reservoir occurred in 2021 consistent M&RR 2. The most recent UKL Adult Monitoring report was published in 2018 by USGS. A draft Clear Lake Reservoir Adult Monitoring Report was shared with Reclamation in January 2021. USGS Adult Sucker Monitoring reports are publicly available on their website (https://www.usgs.gov/centers/wfrc).

To better understand sucker abundance in Gerber Reservoir, Reclamation reinitiated an adult sucker monitoring program in 2018. To better understand sucker abundance in Gerber Reservoir, Reclamation reinitiated an adult sucker monitoring program in 2018. Reclamation set trammel nets 30 days in 2018, 23 days in 2019, 20 days in 2020, and 10 days in 2021 at Gerber Reservoir. Annual spring sampling in Gerber Reservoir was curtailed in 2021 so Reclamation staff could assist USFWS in a sucker relocation effort in Tule Lake Sump 1A, and did not occur in 2022 when Reclamation staff were asked to salvage suckers from Tule Lake Sump 1B.

Annual spring sampling in Gerber Reservoir did not occur in 2022 due to low surface elevations, and salvage efforts at Tule Lake Sump 1B. However, spawning suckers were observed and reported to Reclamation's fisheries staff in early May, and in response, trammel nets were set in Gerber Reservoir to confirm species and opportunistically tag suckers.

Due to low surface elevations and low inflow, USGS PIT-tag antenna arrays were not installed in Ben Hall Creek and Barnes Valley Creek in 2022. In coordination with USGS, USBR placed one submersible antenna at each boat ramp from May 5 to May 17, 2022. A 3' submersible antenna was deployed at the Gerber Boat Ramp on May 5 at 1200 and ran until the battery died around 1800 on May 6. The 3' submersible antenna was replaced by a 5' submersible on May 10 at 0900, which ran until May 17, 2022. A 5' submersible antenna was deployed at the Ben Hall boat ramp from May 5 until May 17, 2022; batteries were swapped on May 10.

Reclamation fisheries staff confirmed the reported spawning fish as suckers. Suckers were spawning in the gravel, course cobble, and boulders in the shallow water (~1-4 feet deep) beyond the end of the cement boat ramps.

Capture Summary

In 2022, Reclamation captured and PIT-tagged 14 suckers and recaptured 3 suckers that were PIT tagged in previous years, a total of 17 suckers (Table D-1). None of the females and 21% of the males were recaptures. Fin clips were collected from 4 suckers. Of the three recaptures, one male was tagged in 2018, and two males were tagged in 2020. Of the 17 suckers captured, 13 were captured on May 5, and 4 were captured on May 10, 2022.

All suckers were identified as Klamath Largescale Suckers (Photo D-3). Suckers ranged in size from 363 to 477 mm fork length (409.1 ± 31.3 mm; Figure D-1.) All suckers captured were in spawning condition and released eggs or milt.

Remote Detection Summary

The submersible antenna at Ben Hall detected 47 PIT-tagged suckers over 13 days and the submersible antenna at the Dam Channel Boat Ramp detected 32 PIT-tagged suckers over ten days (Figure D-2 and Figure D-3); only one sucker was detected on both antennas. The sucker (sex unknown) that was detected at both sites was detected only twice; first on the Dam Channel Boat Ramp submersible on May 10 at 858 and an hour later in Ben Hall on May 10 at 1001. Of the suckers whose sex was known, females made up 33% of the suckers at Ben Hall, and 48% of the suckers at the Dam Channel (Table D-2).

The days when the most individuals were detected on submersible antennas were May 5 and 6 (21 per day); the fewest fish were detected on May 14 (2 fish; Figure D-2 and Figure D-3). The majority (77%) of suckers were only detected on one day; 13% were detected on two days, 6% were detected on three days, 2.6% were detected on five days, and one fish (of 77) was detected on ten days. When fish were detected more than one day, their detections were almost always on consecutive days.

Klamath Project Implementation and Hydrologic Monitoring

M&RR 3.3a (USFWS) – Klamath Basin Planning Model

Requirements

Under the USFWS 2020 BiOp, Reclamation is required to use WRIMS 2.0 software platform for annual updates. Reclamation may update software to new versions as they are published and verified, and Reclamation shall inform USFWS prior to doing so. The potential use of software other than WRIMS will be evaluated in coordination with the Services.

Results

Reclamation has continued to use WRIMS 2.0 software platform for annual updates to the KBPM. Reclamation is also evaluating the use of the RiverWare software platform to support future operations.

U.S. Fish and Wildlife Service Conservation Measures

Reclamation proposed the following Conservation Measures in its 2020 BA.

1) Canal Salvage (pg. 164)
2) Sucker Captive Rearing Program (pgs. 165-167)
3) Sucker Monitoring and Recovery Program Participation (pgs. 167-168)
4) Coho Restoration Grant Program

Canal Salvage

See section: M&RR 1.1c (USFWS)- Canal Salvage Report and Appendix B.

Sucker Assisted Rearing

Requirement

> "*Reclamation proposes to provide funding to the Service to support assisted rearing of the LRS and the SNS with the purpose of increasing the number of suckers reaching maturity in UKL. As discussed above in this BiOp there has not been significant recruitment into the UKL adult population of the LRS and the SNS since the late 1990s. The current adult breeding population of suckers is aging and is nearing the end of their*

expected life span. The disappearance of juvenile suckers from UKL beginning in August and extending into October accounts for this situation. An assisted rearing effort is needed to prevent extinction until the causes of juvenile mortality are addressed (Burdick et al. 2018, Hewitt et al. 2018).

Specifically, Reclamation proposes to continue contributing approximately $300,000 per year to the Service that would be used for capital and operating costs associated with an assisted rearing program. Oversight of the assisted rearing program will continue to be provided by the Service with input from the Klamath Sucker Recovery Program, in coordination with Reclamation. Reclamation's support of the assisted rearing program will continue for the term of this consultation (April 1, 2022 to September 30, 2022)."

Results

Reclamation contributed $376,532 in 2022 to USFWS for the assisted rearing program.

Sucker Monitoring and Recovery Program Participation

Requirement

In the Modified 2018 Operations Plan/IOP, Reclamation proposed a Conservation Measure to support sucker recovery efforts. Reclamation proposed involvement and financial support of $1.5 million per year, with an additional $700,000 in FY 2020; and providing additional funding in later years, as funds are available.

Results

Consistent with the USFWS 2020 BiOp USFWS has plans to restructure the sucker recovery effort. Reclamation will participate and contribute funds to this effort in ways that will advance the needs of sucker recovery at the discretion of USFWS. Reclamation funds that have been used for research and monitoring projects for FY 2022 are summarized in Table 6.

Table 6. The List of Projects that Received Fiscal Year 2022 Recovery Funding.

Title	Funding Amount
SARP telemetry in Upper Klamath Lake (UKL)	$ 110,544
Thiamine Deficiency Evaluation in SNS and LRS life stages (USFWS)	$ 66,972
Thiamine Deficiency Evaluation in SNS and LRS life stages (USGS)	$ 29,964
Semi-Natural Wetland	$ 185,170
UKL juvenile sucker cohort tracking	$ 143,285
UKL Adult Monitoring	$ 654,445
Clear Lake Adult Monitoring	$ 294,523
Sucker Captive Propagation (and database)	$ 376,531

National Marine Fisheries Service Reporting Requirements

T&C 1A (NMFS)- Take actions to Ensure Environmental Water Account Distribution and Iron Gate Dam Flows are Managed within the Scope of the Proposed Action

Requirement

NMFS 2019 BiOp states:

> *"NMFS uses flow thresholds described in the Amount or Extent of Take section as surrogates to measure the amount or extent of incidental take. Monitoring annual EWA volumes and distribution and IGD flows and whether they are within the scope of the proposed action will provide Reclamation and NMFS with the information needed to determine whether incidental take surrogates are met. Therefore, as the irrigation season progresses from March 1 – September 30, Reclamation shall manage EWA distribution and IGD flows to meet the following surrogates and monitor EWA distribution and IGD flows (including reductions to IGD flows due to UKL control logic) to determine whether the following surrogates are met:*
>
> - *The minimum daily average flows described in Table 33 are met.*
> - *The daily reduction to IGD flow due to UKL control logic shall not exceed the largest daily reduction to IGD flow modeled in the POR of 74 percent.*
> - *The percentage of the final EWA volume based on June 1 supply and used between March 1 and June 30 shall not be less than 61 percent.*
> - *Based on annual June 1 EWA supply, EWA released between March 1 and September 30 shall not be underspent by more 5 percent.*
>
> *Based on monitoring, if Reclamation determines any of the thresholds listed above have not been met or EWA spending and/or IGD flows are expected to potentially fall outside the thresholds listed above, Reclamation shall immediately notify NMFS and consult with the Services to determine the causative factors. If EWA spending and/or IGD flows have not yet fallen outside the thresholds listed above and NMFS determines that causative factors are not due to extraordinary hydrologic conditions, Reclamation, in consultation with the Services, shall determine and take in-season corrective actions including adjustments to avoid falling outside the thresholds listed above.*
>
> *In addition, to reduce the likelihood of underspending EWA by greater than five percent by September 30th, Reclamation shall complete an assessment, in coordination with the Services, of EWA used and EWA remaining on May 1 of each calendar year to ensure that the percentage of EWA used in March and April is consistent with EWA distribution modeled in the KBPM for the POR and is not expected to fall outside the thresholds listed above."*

Results

The PA Calculator used to direct daily operations beginning in March 2022 tracks the percent of EWA expended by the dates in this T&C as well as logic that constrains the reduction in IGD flows based on the UKL control logic. Minimum daily average flows (cfs) for IGD were greater than those required in NMFS 2019 BiOp Table 33. Daily reductions to IGD flow due to UKL control logic did not exceed 74 percent, the largest daily reduction to IGD flow modeled in the POR.

The EWA allocation was 407,000 AF on June 1 in 2022. During the 2022 water year, 232,940 AF of EWA had been used between March 1 and June 30. In 2022, 94.3 percent of EWA was spent by October 1 with a total release of 384,005 AF because the flushing flow was reduced because of low UKL elevations and flows remained at minimums due to severe drought conditions.

Table 7. Minimum daily average flows (cubic-feet-per-second (cfs)) for Iron Gate Dam (IGD) from NMFS 2019 BiOp and actual daily minimum flows (cfs) for IGD for each month of Water Year 2022.

Month	Minimum Target Flow (cfs)	Actual Daily Minimum (cfs)
March	1,000	994
April	1,325	1,738
May	1,175	1,184
June	1,025	1,025
July	900	898
August	900	897
September	1,000	1,106

T&C 1F (NMFS)- Development of a Post-Facilities removal Operations plan

Requirement

NMFS 2019 BiOp states:

> *"To minimize incidental take of listed coho salmon as a result of Project Operations and ensure that Project Operations are implemented as analyzed in the opinion, Reclamation shall, by October 2020 or at least four months prior to the scheduled commencement of facilities removal, develop and provide to the Services an Operations plan that incorporates a flow release strategy from Keno Dam. The Operations plan shall include at least the following elements (1) ramp down rates at Keno Dam that minimize risks to stranding coho fry; (2) EWA releases consistent with the proposed action analyzed in the opinion; and (3) development of minimum flow releases at Keno Dam that represent conditions below IGD currently met through IGD minimum flows."*

Results

In 2019, Reclamation began the steps necessary for development of a Post-Facilities removal Operations Plan. This has included coordination with KRRC's contractor. The NMFS and USFWS BiOps for dam removal only became available during late December of 2021 and still lack operational details. Reclamation is working out these details with the services prior to the scheduled commencement of facilities removal. Reclamation's Denver Office for Safety of Dams produced a Condition Assessment report from the information collected during the 2019

inspections. The Condition Assessment report will be finalized to produce a Comprehensive Review report as Reclamation approaches title transfer. Reclamation is participating in ongoing planning efforts with the Klamath River Renewal Corporation contractors and PacifiCorp for operations during and subsequent to dam removal.

T&C 1G (NMFS)- Abundance, prevalence of infection, and predicted mortality of emigrating juvenile salmon in the Klamath River

Requirement

NMFS 2019 BiOp states:

> *"Reclamation shall fund monitoring and estimation of the abundance, prevalence of infection, and predicted mortality of emigrating juvenile Chinook and coho salmon disease in the lower Klamath River, with emphasis on determining the effects of flushing and dilution flow releases under the proposed action, updating data and recalibrating the 80 percent outmigration model. Continued operation of downstream migrant traps will support the further understanding of, among other things, population-level effects of disease on coho and Chinook salmon and the better estimation of associated mortality. This will support better in-season management of flows and minimization of incidental take of listed species."*

Results

In 2022, Reclamation funded Klamath River Juvenile Health Monitoring. This research was conducted by the CA-NV FHC. The draft report titled *Myxosporean Parasite (Ceratonova shasta and Parvicapsula minibicornis) Prevalence of Infection in Klamath River Basin Juvenile Chinook Salmon, March – August 2022* will be published in March 2023. The report can be requested from the address on their website:

https://www.fws.gov/canvfhc/

A summary of the report is as follows[1]:

Juvenile Klamath River Chinook Salmon (*Oncorhynchus tshawytscha*) were assayed for myxosporean parasite *C. shasta* from late March through July 2022 by quantitative polymerase chain reaction (QPCR) and late April through late May by histology. Annual C. shasta prevalence of infection decreased in 2022. The annual prevalence of *C. shasta* infection in 2022 by QPCR was 39%, compared to 59% in 2021. The annual prevalence of *C. shasta* infection in 2022 by histology was 21%, compared to 52% in 2021.

Natural fish were monitored in real-time for the first four weeks of the season to provide timely data to water resource managers and basin cooperators. Iron Gate Hatchery released Chinook Salmon smolts into the Klamath River on April 12, 2022. Real-time monitoring continued for seven additional weeks; however, fish were collected from the combined natural and hatchery fish population.

Ceratonova shasta was first detected by QPCR in fish sampled the week of March 27 from the I-5 rotary screw trap (~ river mile 183). Most fish collected in 2022 were of unknown origin and very few hatchery fish were recaptured (n = 22). Hatchery fish were only collected in the Estuary reach (K0) and while all Iron Gate Hatchery fish tested were infected with *C. shasta*, the infection severity was low.

The 2022 sampling season marks the first year where three rotary screw traps (RST) on the Klamath River were used to collect fish health samples. Fish were collected from I-5 RST, Kinsman RST, and Weitchpec RST. *Ceratonova shasta* prevalence of infection and severity was highest at the downstream Weitchpec RST location, especially in mid to late May. During the week of May 22, 60% of the weekly sample had over 3 logs of *C. shasta* DNA. DNA threshold greater than three logs is used by the Fish Health Center to describe *C. shasta* infections likely to lead to mortality.

Key Points

Typically, sample collection begins in late March and concludes in late August as fish migrate out of the basin, and the weekly sample size target can no longer be met. In 2022, fish health sampling concluded the week of July 31. In 2022, the CA-NV Fish Health Center tested 1,571 juvenile Chinook Salmon collected from the mainstem Klamath River. Natural fish accounted for 25% (399/1,571), fish of unknown origin accounted for 73% (1150/1571), and hatchery fish accounted for 1% (22/1571) of fish collected.

This was an unprecedented year given the release of unmarked hatchery fish from Iron Gate Hatchery (IGH) in April. In 2022, most fish were of unknown origin due to the early release of unmarked Chinook Salmon smolts from Iron Gate Hatchery in April. The CA-NV Fish Health Center has been monitoring and testing for *C. shasta* in the Klamath River since 2009, and during that time frame, there has never been an April hatchery release date. All release dates have been in either May or June. Fish collected after the week of April 10 were from the combined natural and hatchery population and the ratio of the two populations in the fish health samples was unknown. This release resulted in a combined natural and hatchery population in the river and therefore the highest proportion of unknown fish ever assayed (73% or 1,150/1,571). In previous years (2009-2021), the proportion of unknown origin fish tested has ranged from 3-59%.

Questions that arose last year, which was the first year of operation for the Weitchpec trap, are still outstanding. The amount of time infected fish spent in the mainstem Klamath is still unknown. We were unable to track a cohort of fish past all the rotary screw trap locations, due to the absence of marked fish in the river.

[1] Citation: Voss, A., Benson, C., & Freund, S. (2023). Myxosporean Parasite (Ceratonova shasta and Parvicapsula minibicornis) Prevalence of Infection in Klamath River Basin Juvenile Chinook Salmon, March – August 2022. U.S. Fish & Wildlife Service. California – Nevada Fish Health Center, Anderson, CA. http://www.fws.gov/canvfhc/reports.html.

T&C 1H (NMFS)- In the event of funding lapses, fund the monitoring and reporting requirements of California Department of Fish and Wildlife (CDFW) Shasta River Rotary Screw Trap (Trap)

Requirement

The NMFS 2019 BiOp states:

> *"Reclamation shall coordinate with CDFW to determine whether CDFW will continue to fund and operate the trap after 2019. In the event that CDFW will not continue to fund and operate the trap from 2020 through 2023, Reclamation shall ensure the trap is operated or operation is fully funded and reports are generated to inform the necessary requirements of data collection to evaluate incidental take of coho salmon described in the ITS."*

Results

California has operated the Trap in the Shasta River without requesting funding from Reclamation in each of 2020-2022.

T&C 1I (NMFS)- Incidental Take relative to disease as prevalence of mortality (POM)

Requirement

The NMFS 2019 BiOp states:

> *"Reclamation shall fund the development of (1) a spore concentration submodel, (2) updates to S3 model parameters, and (3) scenario model runs to evaluate the effect of in-season disease triggers on simulated prevalence of infection and mortality."*

By March 1 of the following year, Reclamation will provide an annual report on (1) the percent of *C. shasta* infection rates for Chinook Salmon in the mainstem between the Shasta River and the Trinity River during the months of May through July, and (2) the weekly actinospore genotype II concentrations in the mainstem Klamath River immediately upstream of Beaver Creek during mid-April to June. The requirement date was modified to May 1 for the in a communication exchange on February 4 and 5, 2020, between Reclamation and the Services.

Results

In late FY 2019, Reclamation entered an Interagency Agreement with USFWS-Arcata for the following tasks: 1) update Salmonid Stream Simulator (S3) model structure to include *C. shasta* spore concentration submodel and a function of among- and within-year flow events to better inform management decisions; 2) update S3 model with refined disease model based on an extended sentinel trial experiment, incorporate recent data, and re-calibrate model with new disease model structure (including updating flow and temperature data in RBM10); 3) run scenarios to support in-season management decision-making; and 4) model effects of *C. shasta* on out-migrating Coho Salmon in the Klamath River.

The agreement with USFWS-Arcata includes the joint effort with USGS-Columbia River Research Laboratory for updating the S3 model. The tasks are separated by periods of performance based on

federal FYs starting in FY 2020 through FY 2023, and to date, most effort has been expanded on Tasks 1 and 2. It is assumed that Tasks 1 and 2 will be annually occurring efforts based on the availability of new information. More effort is expected on Tasks 2, 3, and 4 in FY 2021 to the end of FY 2023 (the proposed effort end date in the current multiple-year agreement). In late FY 2020, Reclamation fully-funded the existing agreement with USFWS-Arcata for efforts through September 2023 based on work described in the current agreement.

Reclamation and Oregon State University (OSU) renewed their Klamath River Fish Health Studies contract in 2019. The Klamath River Fish Health Studies contract is monitoring of *C. shasta* total actinospore and genotype II concentrations in the mainstem Klamath River at five index sites mid-April to June and expedite analysis and data dissemination. In addition to the waterborne spore quantification, the contract with OSU also includes support to monitor prevalence of *C. shasta* infection in sentinel-exposed Chinook salmon, coho salmon and rainbow trout, the densities of *C. shasta* in water samples at six Klamath River sites, and the abundance and prevalence of infection in annelids. The data presented here are provisional and the final report is anticipated by mid-June 2023. The following is a summary of OSU's water sampling methods and results from the 2022 field season:

1. To detect total parasite abundance, water samples were collected weekly from six mainstem index sites. Each 1-liter water sample was filtered through a nitrocellulose membrane using a vacuum pump and any captured DNA was extracted using a commercial kit. A qPCR specific for *C. shasta* (*Cs*; Hallett & Bartholomew 2006) was used to detect and quantify any parasite DNA present. Cq values generated by the qPCR were converted to numbers of parasite spores per liter of water using reference samples with known quantities of spores.

   Actinospore densities in water samples collected at the index sites throughout the 2022 monitoring period are presented in Figures 22, 23 and Table 8. The general trend of spore densities increasing in spring, peaking during salmonid outmigration, then decreasing in late fall occurred, however, the timing and magnitude were unique to this field season. The first week in which water sampling occurred throughout the lower basin (March 28th), *Cs*-DNA was detected at 5 of the 6 sites. Prior to that, *Cs*-DNA was not detected at either of the two sites sampled, KBC and KSV; parasite density increased with site downstream, being highest at KTC (lowermost site) with 5 spores per liter measured. During the following week, densities then more than doubled at all sites to exceed 10 spores per liter at 3 of 6 sites (densities ranged from 3-30 spores per liter) and remained at or above 10 spores per liter at 5 of 6 sites the rest of April. Unusually, density was high at KTC this spring and was higher than upstream sites for several weeks. Densities during the prescribed surface flushing flow event were lower than the previous week, except at the lowermost site KTC, but remained above 10 spores per liter at 5 of the 6 sites (exception KI5); again, densities were lowest at the uppermost site KI5 with 4 spores per liter measured, then increased downstream to the lowermost site KTC with 26 spores per liter detected. Densities remained above 10 spores per liter the week following the surface flushing flow event (peak discharge of 4,300 cfs for 23 hours) at 5 of 6 sites; interestingly, density increased at the three uppermost sites (KI5, KBC & KMN, 14-15 sp/L) and decreased at the lowermost sites (KSV, KOR & KTC, 7-11 sp/L). Unusually, levels then dropped to below 10 spores per liter throughout the lower basin for most of May; in each of three weeks, fewer than 5 spores per liter were measured. Densities increased again in July, to over 10 spores per liter at every site except KBC. Spore densities peaked twice in 2022 – in April again in July. Unusually, densities were higher at lower sites than more upstream sites; notably, levels at KTC exceeded those at KBC. Levels increased earlier in 2022 than in 2021 (March vs April), but although they exceeded 10 spores per liter in 9 weeks, levels were lower overall

in 2022 than 2021. The highest density measured in 2022 was 30 spores per liter at KTC in April; the highest at KBC was 14 spores per liter.

2. There are multiple genotypes (strains) of C. shasta simultaneously present in the Klamath River that differentially impact various salmonid species: type I infects Chinook salmon, type II infects coho salmon, type O infects steelhead and redband trout. The density of genotype II is determined by a specific qPCR assay. Data are measured from April through June at all index sites on the Klamath mainstem. Samples can only be genotyped when spore densities are at least 1 - 2 spores per liter (the detection limit of the assays).

   Genotype II densities in water samples collected at the index sites throughout the 2022 monitoring period are presented in Table 9. In 2022, genotype II was detected at all index sites at some time. It was first detected April 25th at KSV and KOR (1 sp/L). Unlike the previous year, the density of genotype II remained low throughout 2022 and did not exceed 1 spore per liter at any site sampled. Thus, the coho salmon 40% mortality threshold of 5 type II spores per liter was not met in 2022.

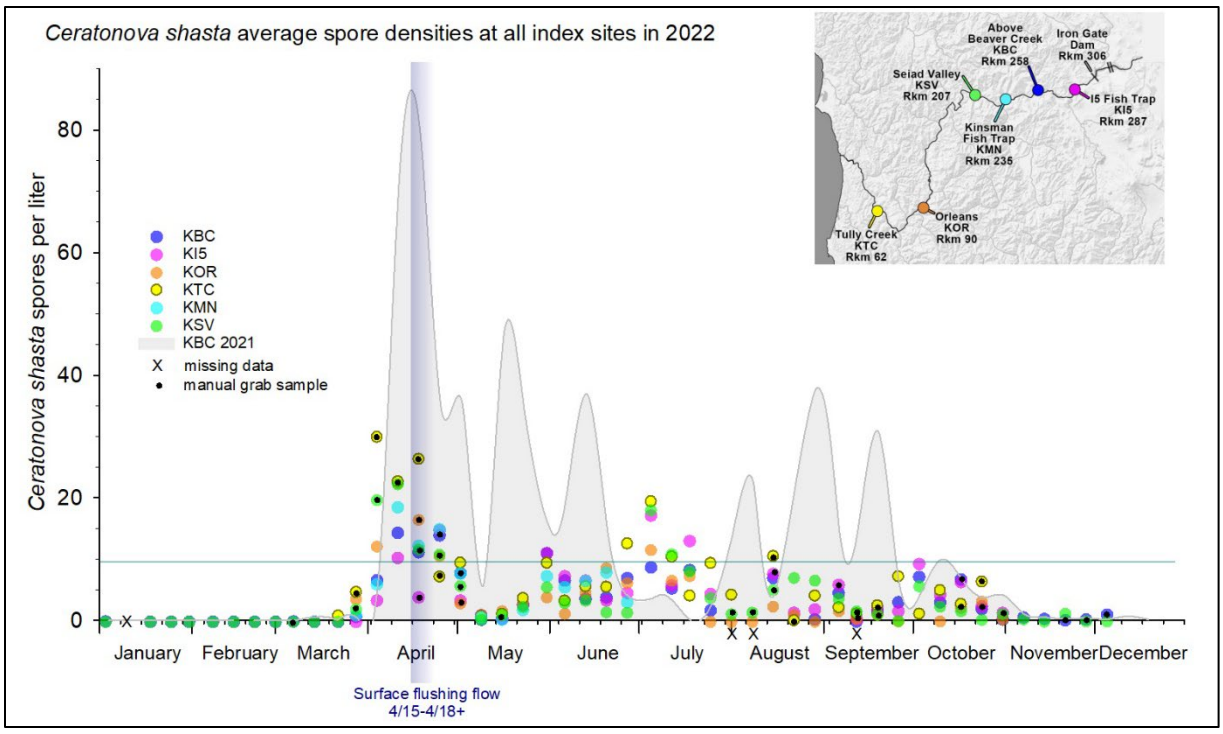

Figure 22. Density (average spores per liter) of *Ceratonova shasta* in water samples collected at the mainstem index sites in 2022. The data points are the average of three 1-liter water samples. Dots indicate manually collected grab samples (as opposed to the rest, which are ISCO automatic 24-hr composite samples). Note that KMN is sampled only during salmonid outmigration, KBC and KSV year-round and remaining sites April through October. KI5 = near I5 bridge, KBC = upstream of Beaver Creek, KMN = Kinsman Fish Trap, KSV = Seiad Valley, KOR = Orleans, KTC = Tully Creek.

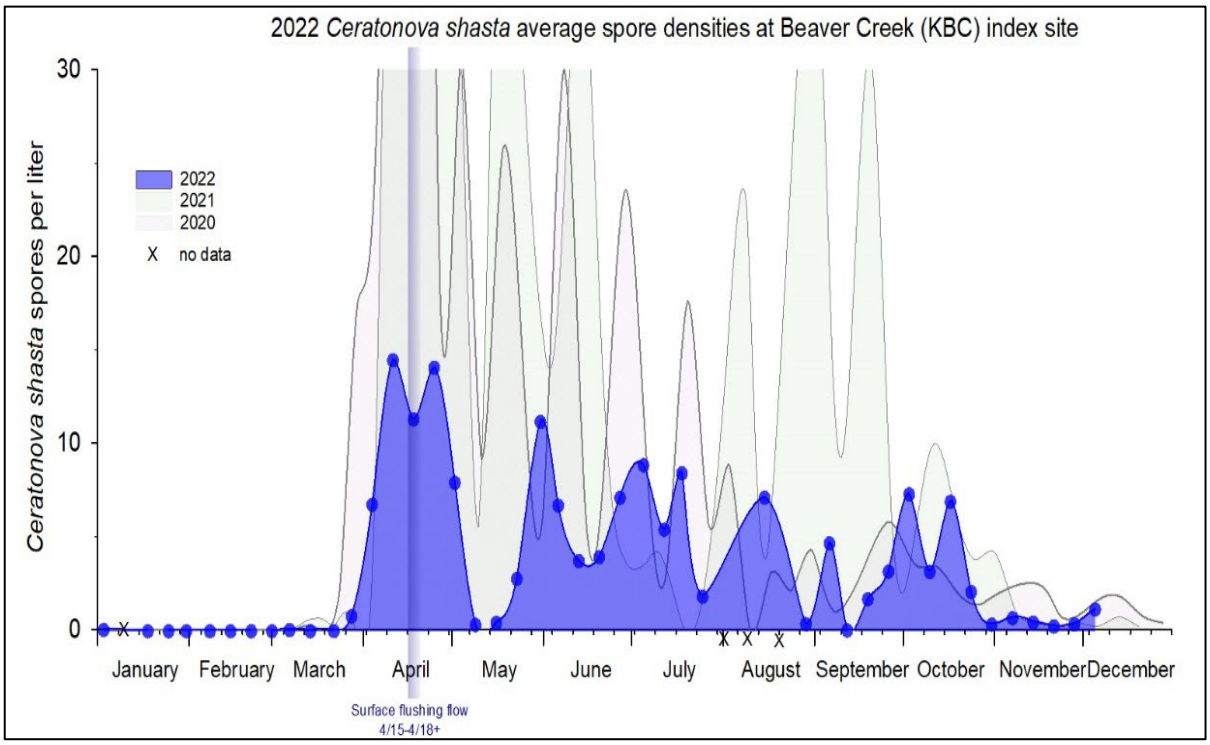

Figure 23. Density (spores per liter) of *Ceratonova shasta* in water samples collected in Klamath mainstem near confluence with Klamath River Beaver Creek (site KBC) in 2022. The data points are the average of three 1-liter water samples. Shading indicates spore density profiles for 2020 & 2021 for comparison.

Table 8. Density (spores per liter) of *Ceratonova shasta* in water samples collected at index sites in 2022. The bold data value represents the highest density recorded in 2022. Cells with zero (0) indicate spores were undetectable; cells with "x" indicate sites that were not sampled on those dates; "g" indicates manually collected 1-L "grab" samples taken at one time point (all other samples are ISCO 24-h composites); "nd" indicates data not determined (samples not yet received by OSU or not yet assayed); "inhib" indicates sample contained contaminants and no assay data were obtainable. KI5 = near I5 bridge, KBC = upstream of Beaver Creek, KMN = Kinsman Fish Trap, KSV = Seiad Valley, KOR = Orleans, KTC = Tully Creek. (Further details will be included in Oregon State University's 2022 annual report due to Reclamation June 1.)

COLLECTION DATE	INDEX SITE (Upstream Sites to Downstream Sites)					
	KI5	KBC	KMN	KSV	KOR	KTC
01/03/22	x	0	x	0	x	x
01/18/22	x	0	x	0	x	x
01/25/22	x	0	x	0	x	x
01/31/22	x	0	x	0	x	x
02/08/22	x	0	x	0	x	x
02/15/22	x	0	x	0	x	x
02/22/22	x	0	x	0	x	x
03/01/22	x	0	x	0	x	x
03/07/22	x	0	x	0	x	x
03/14/22	x	0	x	0	x	x
03/22/22	x	0	x	0	x	1 g
03/28/22	0	1	1	2	4	5 g
04/04/22	3	7	6	20 g	12	**30** g
04/11/22	10	14	19	22 g	23	23 g

COLLECTION DATE	INDEX SITE (Upstream Sites to Downstream Sites)					
	KI5	KBC	KMN	KSV	KOR	KTC
04/18/22	4 g	11	12	12 g	17 g	26 g
04/25/22	15 g	14	15	11 g	11 g	7 g
05/02/22	3	8	8 g	6 g	3 g	9
05/09/22	1	0	1	0	1	1
05/16/22	1 g	0	0	1	2	1
05/23/22	3	3	2	2	3	4
05/31/22	11	11	7	6	4	9
06/06/22	7	7	6	3	1	3
06/13/22	7	4	7	3	5	6
06/20/22	3	4	8	2	9	5
06/27/22	5	7	3	1	6	13
07/05/22	17	9	x	18	12	19
07/12/22	6	5	x	11	7	10
07/18/22	13	8	x	8	7	4
07/25/22	5	2	x	4	0	9
08/01/22	x	x	x	1 g	0	4
08/08/22	x	x	x	2 g	0	nd
08/15/22	8 g	7 g	x	5 g	2	11 g
08/22/22	1	x	x	7	1	0 g
08/29/22	2	0	x	7	0	4
09/06/22	6 g	5	x	4	2	2
09/12/22	0	0	x	2 g	0	1 g
09/19/22	2	2	x	1 g	1	3 g
09/26/22	2	3	x	0	0	7
10/03/22	9	7	x	6	nd	1
10/10/22	4	3	x	2	<1	5
10/17/22	6	7 g	x	2	2 g	3
10/24/22	3 g	2 g	x	<1	3	6 g
10/31/22	2 g	<1	x	1	<1	x
11/07/22	x	1	x	<1	x	x
11/14/22	x	1	x	0	x	x
11/21/22	x	<1 g	x	1 g	x	x
11/28/22	x	<1 g	x	<1 inhib	x	x
12/05/22	x	1 g	x	0 inhib	x	x
12/12/22	x	nd	x	nd	x	x
12/19/22	x	nd	x	nd	x	x
12/26/22	x	nd	x	nd	x	x

g - manual 1-L "grab" samples taken at one time point (all other samples are ISCO 24-h composites)

5 - Kingsman Fish Trap site (KMN) sampling finished for the season.

x - Data not available (sample not collected as planned, sample unable to be collected – wildfires)

nd - data not determined: samples not yet received by OSU or not yet assayed

inhib g - sample contained contaminants and no assay data were obtainable

Table 9. Density (spores per liter) of **genotype II** of *Ceratonova shasta* in water samples collected at index sites April - June 2022, determined by qPCR assay. "g" indicates manually collected grab samples (as opposed to the rest, which are ISCO automatic 24-hr composite samples); "-"=insufficient total Cs to assay; "x" site not sampled; "nd" = not yet determined. KI5 = near I5 bridge, KBC = upstream of Beaver Creek, KMN = Kinsman Fish Trap, KSV = Seiad Valley, KOR = Orleans, KTC = Tully Creek. (Further data will be included in Oregon State University's 2022 annual report due to Reclamation June 1.)

COLLECTION DATE	INDEX SITE (Upstream Sites to Downstream Sites)					
	KI5	KBC	KMN	KSV	KOR	KTC
04/04/22	0	0	0	0	0	nd
04/11/22	nd	nd	nd	nd	nd	nd
04/18/22	0	0	0	0	0	0
04/25/22	0	0	0	1	1	0
05/02/22	nd	nd	nd	nd	nd	nd
05/09/22	x	x	x	x	x	x
05/16/22	x	x	x	x	x	x
05/23/22	nd	nd	x	x	nd	nd
05/31/22	0	0	1	1	0	1
06/06/22	1	1	1	1	0	0
06/13/22	0	0	1	1	0	0
06/20/22	0	0	1	0	0	0
06/27/22	0	0	0	0	0	1

FWS-Arcata/USGS Update

Results of S3 modelling – POM Estimates for Coho and Chinook salmon (Southern Resident killer whale (SRKW))

Consistent with section 2.5.1.3. of the NMFS 2019 BiOp, Reclamation is required to report POM for Chinook salmon as a surrogate of effects to SRKW.

Chinook Salmon - Dr. Russ Perry, with the USGS Western Fisheries Research Center, simulated POM on naturally produced juvenile Chinook Salmon in water year 2022 at Reclamation's request. In order to complete this simulation, USGS needed to compile the following inputs from water year 2022 for use in the Stream Salmonid Simulator (S3) model: 1) water temperature data; 2) flow data; 3) spawner abundance, timing, and distribution data; 4) spore concentration data; and 5) tributary juvenile abundance and timing data. Because meteorological data required to run the Klamath Basin RBM10 water temperature model were unavailable, USGS used water temperature data collected throughout the Klamath River to develop the timeseries of daily water temperature data required to run S3. To fill data gaps, USGS applied methods from previous S3 POM simulations. USGS estimated temperatures for these missing locations by using historical temperature data to estimate the difference between the next upstream monitoring station and the missing station, and then adding this difference to temperature from the upstream monitoring location.

Given these inputs, USGS ran the S3 model as described in Perry et al. (2018), parameterized in Perry et al. (2019), and applied to assess disease effects in Plumb et al. (2019). To remain consistent with how POM was defined and calculated for Coho Salmon by the USFWS, Arcata Fish and Wildlife Office, USGS defined the POM to be the simulated proportion of juvenile Chinook Salmon passing the Kinsman Creek Juvenile Salmon Monitoring Site that are predicted to eventually die from ceratomyxosis. This metric does not account for ceratomyxosis mortalities occurring upstream of the Kinsman Creek monitoring Site.

The results from the S3 simulation were provided to Reclamation from Dr. Perry in an email on February 13, 2023 (attached letter dated 13 February 2023). The key points of the simulation are as below.

1. Simulated abundance for 2022 (0.978 million juveniles passing the Kinsman Trap) was similar to the mark-recapture estimates of abundance (0.886 million juveniles and within the range expected given statistical uncertainty in S3 model calibration, Kinsman abundance estimates (95% CI: 0.678 – 1.130 million juveniles), and rotary screw trap abundance estimates for juveniles entering the Klamath 2 of 4 River from tributaries. The S3 model simulated an **overall POM of 31% for naturally produced juvenile Chinook salmon** (emphasis retained). That is, the S3 model simulated that 31% of the naturally produced juvenile Chinook Salmon passing the Kinsman Trap site were infected with *C. shasta* and expected to eventually succumb to ceratomyxosis. This POM was driven by spore concentrations exceeding 10 spores / L for three weeks in April and one week in May and water temperatures exceeding 15 °C beginning in mid-May.

2. It is important to note that infected fish that die from ceratomyxosis upstream of the Kinsman Trap site will reduce the apparent prevalence of mortality calculated at the Kinsman Trap because infected fish are removed from the population prior to being censused. The amount of disease-caused mortality occurring upstream of the Kinsman

Trap will depend on the time to mortality after infection, which in turn depends on spore concentration, water temperature, and exposure duration (Perry et al. 2019). Increases in either of these variables will reduce the time to death, thereby increasing disease caused mortality upstream of the Kinsman Trap. For water year 2022, S3 simulations revealed that most disease-caused mortality was likely to occur downstream of the Kinsman rotary screw trap (Figure 24). Thus, the prevalence of mortality estimate produced by S3 was unlikely influenced by upstream mortalities caused by *C. shasta*. In contrast, simulations for water year 2021, when spore concentration were considerably higher, indicated substantial disease caused mortality occurring upstream of the Kinsman rotary screw trap.

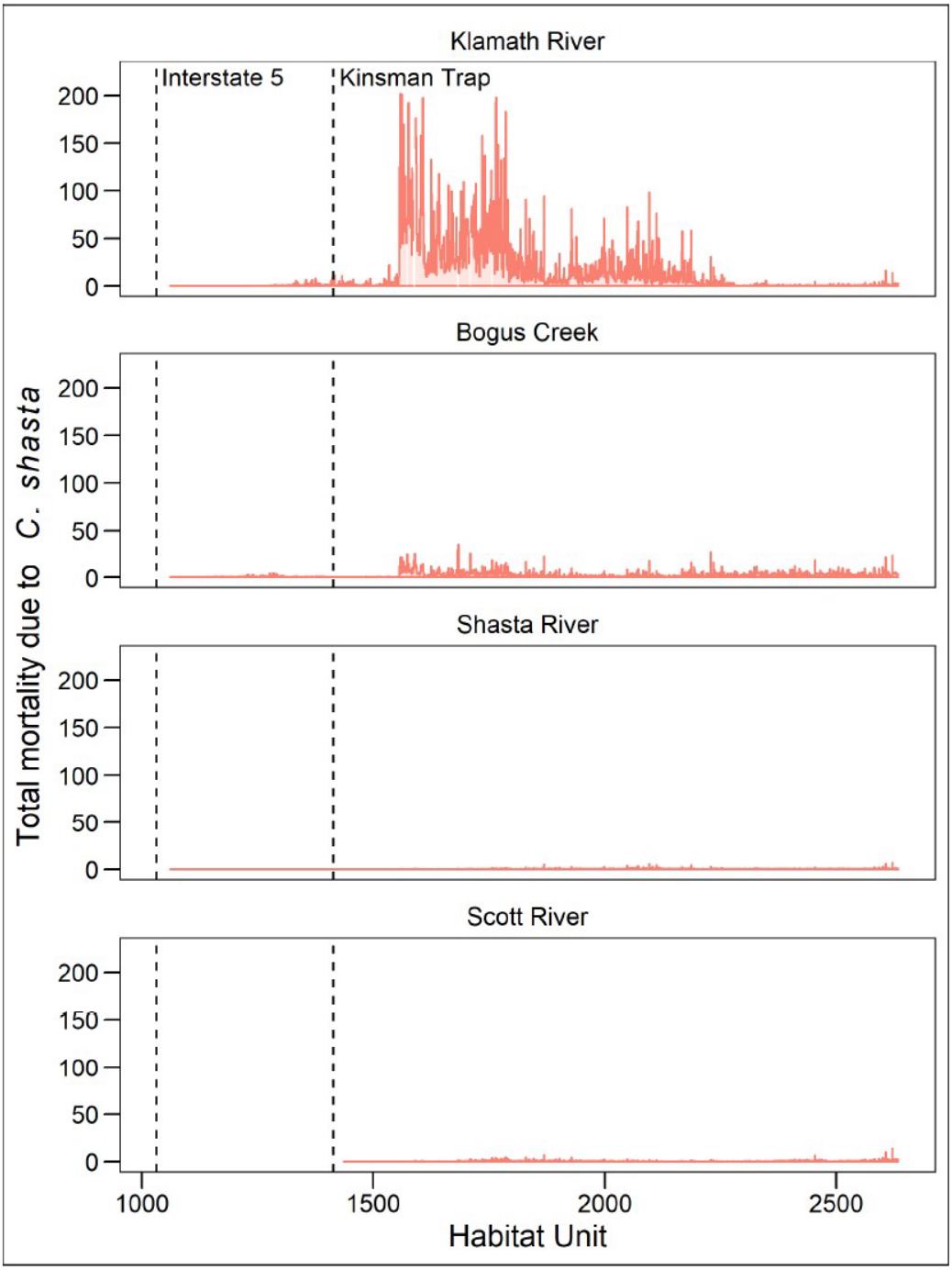

Figure 24. Location of simulated mortality due to ceratomyxosis in 2022 for different populations of juvenile Chinook salmon migrating through the Klamath River. Habitat units start at Iron Gate Dam (Unit 930) and end at the ocean (Unit 2,635). Vertical dashed lines mark the locations of the Interstate 5 and the Kinsman Cr. rotary screw traps.

Coho Salmon – USFWS' Arcata Office Fish and Aquatic Conservation Program (Dr. Nicholas Som) applied the methods of Som et al. (2019) to compute the estimated POM resulting from ceratomyxosis for Shasta River-origin Coho Salmon that entered the Klamath River mainstem in spring 2022. Computing these estimates requires data from several sources, including weekly outmigrant estimates provided by the CDFW, water temperatures occurring in the vicinity of the Beaver Creek confluence with the Klamath River mainstem provided by a monitoring program jointly run by the Karuk Tribe Department of Water Resources and OSU, and the concentration of infectious spores as provided by OSU.

The results from the S3 simulation were provided to Reclamation from a Technical Memorandum from Sommer et al. (2023) in a letter dated February 10, 2023. At the time this memorandum was prepared, spore data provided by Oregon State University are still provisional and will be finalized at a later date. As noted above, there also remain several weeks for which the assays have not be completed. As such, it is possible that an update POM estimate will be provided after securing the complete and finalized data set. The key points of the simulation are as below.

1. After gathering these data and applying the POM methods described in Som et al. (2019) for Shasta River-origin juvenile Coho Salmon entering the mainstem Klamath River, Coho Salmon POM is estimated to have been around 3% in 2022. However, this estimate should be considered preliminary, because there are several weeks from the months of April and May for which the laboratory assays measuring infectious spore concentrations have not yet been completed. Additionally, comparing this value to POM estimates for prior years is complicated by the fact that the CDFW's sampling season stopped approximately 3 weeks earlier than the years for which the POM model was constructed. The June weeks excluded from the 2022 monitoring correspond to a period when *C. shasta* mortality risk for Coho Salmon is usually elevated.

2. For the majority of the observed spring outmigration period in 2022 when Coho Salmon entered the mainstem Klamath River from the Shasta River, the concentrations of infectious spores specific to Coho Salmon (commonly called Type-II) measured at the Beaver Creek monitoring location were at or near zero spores/liter (0 spores/L). Spore concentrations began rising above 0 spores/liter in May. This increasing trend in spore concentrations appears to occur when the numbers of Shasta River outmigrants were declining. It's difficult to say this with certainty, however, because the last three weeks of June were not sampled in 2022, and in previous years, pulses of outmigrant Coho Salmon have been observed in June. For example, for the years of data used to fit the Coho Salmon POM model of Som et al. (2019), the percent of annual outmigrants entering the Klamath River mainstem in June or later averaged 25% (range 5% - 77%). However, the measured spore concentration of Type-II spores during the June weeks that were not sampled in 2022 were low.

Results of Ceratonova shasta (C. shasta) monitoring used in modeling

In 2022, 1,571 juvenile Chinook Salmon were collected from the mainstem Klamath River. Natural fish accounted for 25% (399/1,571), fish of unknown origin accounted for 73% (1150/1571), and hatchery fish accounted for 1% (22/1571) of fish collected. Natural fish were collected the week of March 20 through April 10 in river reaches above the Trinity River confluence (K5, K4, K3, and K2). All natural fish were collected using rotary screw traps, except for the first sample at the Weitchpec location which was collected using a fyke net. Ceratonova shasta POI in natural fish was highest in the Shasta River to Scott River reach (K4) at 6% (10/179, ci = 3-10%), and lowest in the

Iron Gate Dam to Shasta River reach (K5) at 1% (1/119, ci = 0-5%).

The annual prevalence of C. shasta infection in all juvenile Chinook Salmon tested in 2022 by QPCR was 39% (614/1571, confidence interval [ci] = 37-42%). Ceratonova shasta was first detected by QPCR in fish sampled the week of March 27 in the Iron Gate Dam to Shasta River reach (K5). Annual C. shasta POI by QPCR was lower in 2022, compared to 59% in 2021. The annual *C. shasta* POI by histology for all fish tested in 2022 was 21% (20/94, ci = 14-31%), and *P. minibicornis* POI was 47% (45/96, ci = 37-57%). *Ceratonova shasta* was detected by QPCR in 4% (17/399, ci = 3-7%) of natural fish in 2022. *Ceratonova shasta* POI in 2022 ties as the lowest prevalence in natural fish since 2009 (tied with 2012). The *C. shasta* prevalence of infection has ranged from a low of 4% in 2012 and 2022 to a high of 76% in 2014.

The annual prevalence of *C. shasta* infection in all juvenile Chinook Salmon tested in 2021 by QPCR was 59% (567/962, confidence interval [ci] = 56-62%). *Ceratonova shasta* was first detected on March 30 in the Shasta River to Scott River reach. Annual *C. shasta* POI by QPCR was higher in2021 than 2020 (65% and 61%, respectively). The slight increase in POI is was observed even though there were lower spore densities in spring 2021. Monitoring of waterborne stages of *C. shasta* from river water showed a pattern of decreased spore density in spring 2021. *Ceratonova shasta* was detected at a mean spore density of 3 spores/L in late March 2021 at the Kinsman water sampling location (Oregon State University, 2021), compared to 35 spores/L the previous year. A similar pattern occurred in mid-April when *C. shasta* was detected at 63 spores/L in 2021, compared to 180 spores/L during the same time period the previous year. The annual *C. shasta* POI by histology for all fish tested in 2021 was 52% (37/71, ci = 40-64%), and for *P. minibicornis* POI was 36% (22/61, ci = 24-49%).

Three logs or greater of *C. shasta* DNA is the threshold for describing *C. shasta* infections likely to lead to mortality under spring-summer temperatures. In the Shasta River to Scott River (K4) reach, *C. shasta* was undetected during the first three weeks of sampling. On week 4, the week of April 10, *C. shasta* POI was 17% (10/60, ci = 18-29%) with one fish having greater than three logs of DNA (3.29 logs). In the Scott River to Salmon River (K3) reach, two weekly samples of natural fish were collected. *Ceratonova shasta* was undetected in week 3 and the prevalence of infection in week 4 was 14% (3/21, ci = 3-36%). All natural fish that tested positive for *C. shasta* in week 4 had less than three logs of DNA. Overall, there was only a four-week sampling window to collect natural fish before the April hatchery release and therefore the progression of disease in natural fish could not be determined. In natural fish that were collected *C. shasta* prevalence of infection and severity was low, although this is common early in the spring.

A total of 1150 fish of unknown origin were collected from the week of April 17 to June 19. *Ceratonova shasta* was detected by QPCR in 50% (575/1150, ci = 47-53%) of unknown origin Chinook Salmon, and 10% (n = 114) of the fish had greater than three logs of *C. shasta* DNA. *Ceratonova shasta* POI was highest in the Estuary reach (K0); however, the sample size was very small (5 fish). *Ceratonova shasta* POI was 58% in the Trinity River to Blue Creek reach (K1), followed by 55% and 54% in the mid river (K2 and K3, respectively). The lowest prevalence of 41% was observed in the Iron Gate Dam to Shasta River reach (K5, Figure 1).

Histological assays were assigned a rating of clinical disease. All the histology sample sizes were small and represent a snapshot in time. *Ceratonova shasta* prevalence of infection by histology was 30% (3/10, ci = 7-65%) in late April and 33% (3/9, ci = 7-70%) in early May for fish collected at the Kinsman RST. These fish had *C. shasta* present, but no signs of disease were observed in the tissue. The first sign of disease histologically (Cs 2 rating) occurred in one fish collected in the Scott River to Salmon River reach (K3) in early May. By late May, prevalence of infection was higher in

K3 at 60% (6/10, ci = 26-88%), again with one fish having a Cs 2 rating. In late May, all fish in K5 with the parasite present showed signs of disease. The histology results in K5 match up well with the peak *C. shasta* POI and severity by QPCR.

Ceratonova shasta POI and severity were highest for fish collected downstream at the Weitchpec RST (Figure 4). In early May, the weekly sample size was very small, and *C. shasta* POI was 80% (4/5, ci = 28-99%). *Ceratonova shasta* prevalence peaked in mid-May at 92% (12/13, ci = 64-100%) and severity peaked one week later with 60% of the weekly sample over 3 logs of DNA.

Prevalence of *C. shasta* infection during the peak outmigration decreased in both QPCR and histology in 2022, relative to previous years (Table 2.). Prevalence of *C. shasta* infection by QPCR during this period was 53% (472/896, ci = 49-56%) in 2022, compared to 82% in 2021. Prevalence of infection was higher than the average of 49% for the past fourteen years (2009-2022). Prevalence of *C. shasta* infection by histology was 32% (16/50, ci = 20-47), compared to 75% observed in 2021 (Table 2). The 14-year average of *C. shasta* infection by histology is 27%.

For further detail beyond the summary provided here, the full report (Voss et al. 2023) can be accessed at (https://www.fws.gov/canvfhc/CANVReports.html).

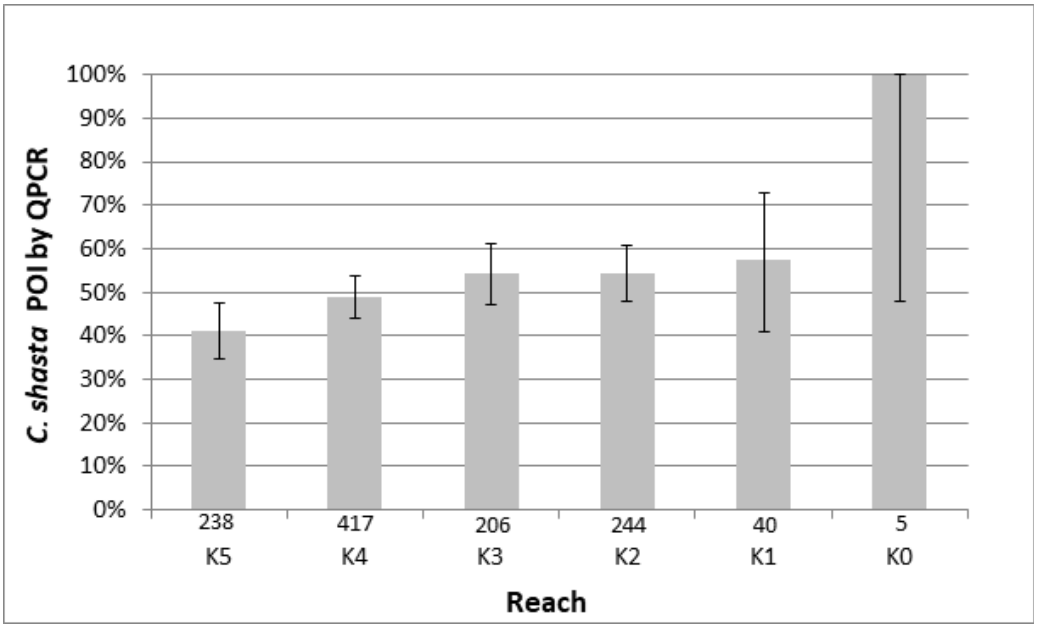

Figure 25. Prevalence of *Ceratonova shasta* infection in unknown origin juvenile Klamath River Chinook salmon by collection reach in 2022. Iron Gate Dam to Shasta River (K5), Shasta River to Scott River (K4), Scott River to Salmon River (K3), Salmon River to Trinity River confluence (K2), Trinity River to Blue Creek (K1), and Blue Creek to Klamath River Estuary (K0). Sample numbers collected in each reach are displayed below the bar graph. Error bars represent a 95% confidence interval.

Table 10. Historic annual prevalence of *Ceratonova shasta* infection in all juvenile Chinook Salmon collected from the mainstem Klamath River between Iron Gate Dam and Trinity River confluence during the peak out-migration period of May through July 2009-2022. Percent positive by assay is reported, as well as the number positive/number tested in parenthesis.

Year	Histology (% Positive)		QPCR (% Positive)	
2009	54%	(50/93)	47%	(264/561)
2010	15%	(22/146)	17%	(128/774)
2011	3%[1]	(3/118)	17%	(62/374)
2012	9%	(9/98)	30%	(160/526)
2013	16%	(6/37)	46%	(234/508)
2014	42%	(20/48)	81%	(467/576)
2015	62%	(37/60)	91%	(437/482)
2016	14%	(8/58)	48%	(243/504)
2017	8%	(3/40)	26%	(153/600)
2018	4%	(1/27)	20%	(114/570)
2019	40%	(16/40)	68%	(395/581)
2020	60%	(18/30)	73%	(433/593)
2021	75%	(24/32)	82%	(368/447)
2022	32%	(16/50)	53%	(472/896)
Mean	**27%**	**(233/877)**	**49%**	**(3930/7992)**

[1] Histology performed in K4 and K1 reach in 2011. From 2012 to 2022 histology was performed in K4 and K3 reach .

T&C 1J (NMFS) - Fund Fish Modeling to evaluate the effects of *Ceratonova shasta* (*C. shasta*) spore concentrations on the survival of out-migrating Coho Salmon in the Klamath River

Requirement

The 2019 NMFS BiOp states:

> *"Reclamation shall fund the application of a Bayesian hierarchical Cormack-Jolley-Seber model to assess the effects of C. shasta spore concentrations on the survival of actively migrating coho salmon in the Klamath River and provide results of that modeling to NMFS."*

Results

Reclamation funded USFWS-Arcata for FY 2021 to conduct Mark Recapture survival analysis based off screw-trap sampling conducted in the LKR and its tributaries.

In late FY 2019, Reclamation entered an Interagency Agreement with USFWS-Arcata for the following tasks: 1) update S3 model structure to include *C. shasta* spore concentration submodel and a function of among- and within-year flow events to better inform management decisions; 2) update S3 model with refined disease model based on an extended sentinel trial experiment, incorporate recent data, and re-calibrate model with new disease model structure (including updating flow and temperature data in RBM10); 3) run scenarios to support in-season management decision-making; and 4) model effects of *C. shasta* on out-migrating Coho Salmon in the Klamath River (using a Bayesian hierarchical Cormack-Jolley-Seber model).

The agreement with USFWS-Arcata includes the joint effort with USGS-Columbia River Research Laboratory for updating the S3 model. The tasks are separated by periods of performance based on federal FYs starting in FY 2020 through FY 2023, and to date, most effort has been expanded on Tasks 1 and 2. It is assumed that Tasks 1 and 2 will be annually occurring efforts based on the availability of new information. More effort is expected on Tasks 2, 3, and 4 in FY 2021 to the end of FY 2023 (the proposed effort end date in the current multiple-year agreement). In late FY 2020, Reclamation fully-funded the existing agreement with USFWS-Arcata for efforts through September 2023 based on work described in the current agreement.

T&C 2B-RR 1 (NMFS)- Weekly Updates

Summary of accretion data in addition to all of the Environmental Water Account, Project, and Refuge information.

Requirement

The 2019 NMFS BiOp states:
"Reclamation shall report all measured accretion data (Link River Dam to Keno Dam) and all measured and estimated accretion data (Keno Dam to IGD) in addition to all of the EWA, Project and Refuge information."

Results

An example of the Reclamation Daily Numbers report is presented as Table A-14 in Appendix A, as are the other tables in Appendix A. The first eight columns show daily values for water deliveries,

along with the elevation of UKL. The final two columns shown deal with Link River to Keno Dam accretions. (Additional columns showing more delivery points are omitted for clarity.) Releases from the dams and accretion data for LRD to Keno Dam is shown as Ewauna (Keno Net) Accretions in the bottom section, alongside the Keno to IGD Accretions. PacifiCorp distributes an accretion forecast update that shows the calculated Keno to IGD accretions which is shown as Table A-15. PacifiCorp's numbers are periodically checked for accuracy by Reclamation based on confidential reservoir data shared by PacifiCorp.

T&C 2B-RR 4 (NMFS) -Monthly Reports for fall/winter Operations

Summary of Environmental Water Account and Fall/Winter flow management

Requirement

The 2019 NMFS BiOp states:

> *"Reclamation shall provide monthly update reports for the formulaic approach during the fall/winter operations including reductions to IGD flows due to UKL control logic, UKL net inflow, Link River Dam to IGD accretions, UKL levels, winter Project deliveries, Refuge deliveries, and any other relevant data NMFS identifies during implementation of the proposed action."*

Results

The tables shown as A-14 and A-15 are produced year-round and show accretions between LRD and Keno and between Keno and IGD, respectively.

Link River releases are shown in Figure 26. Lake Ewauna accretions remained consistently low (Figure 27) as they are dependent largely on irrigation returns. Keno releases remained consistently low (Figure 28), reflecting the dry hydrologic conditions in the upper Klamath Basin.

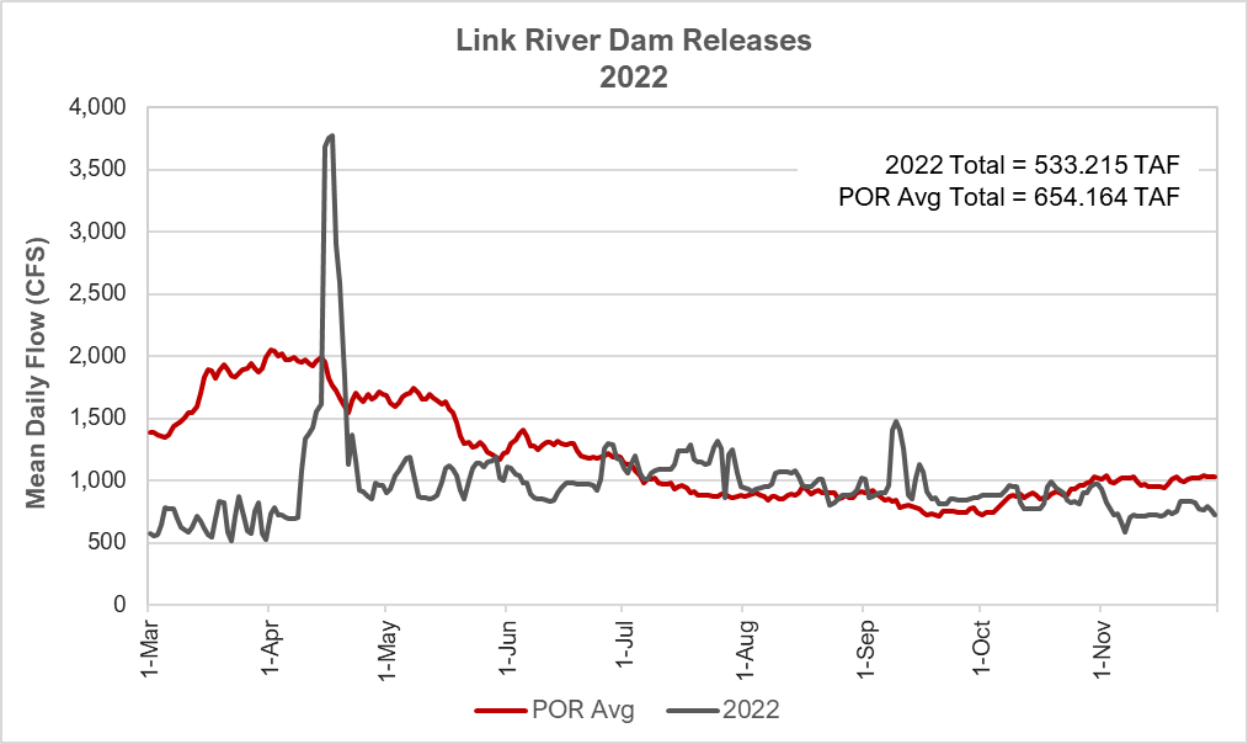

Figure 26. 2022 Link River Releases and Period of Record Average for March-September.

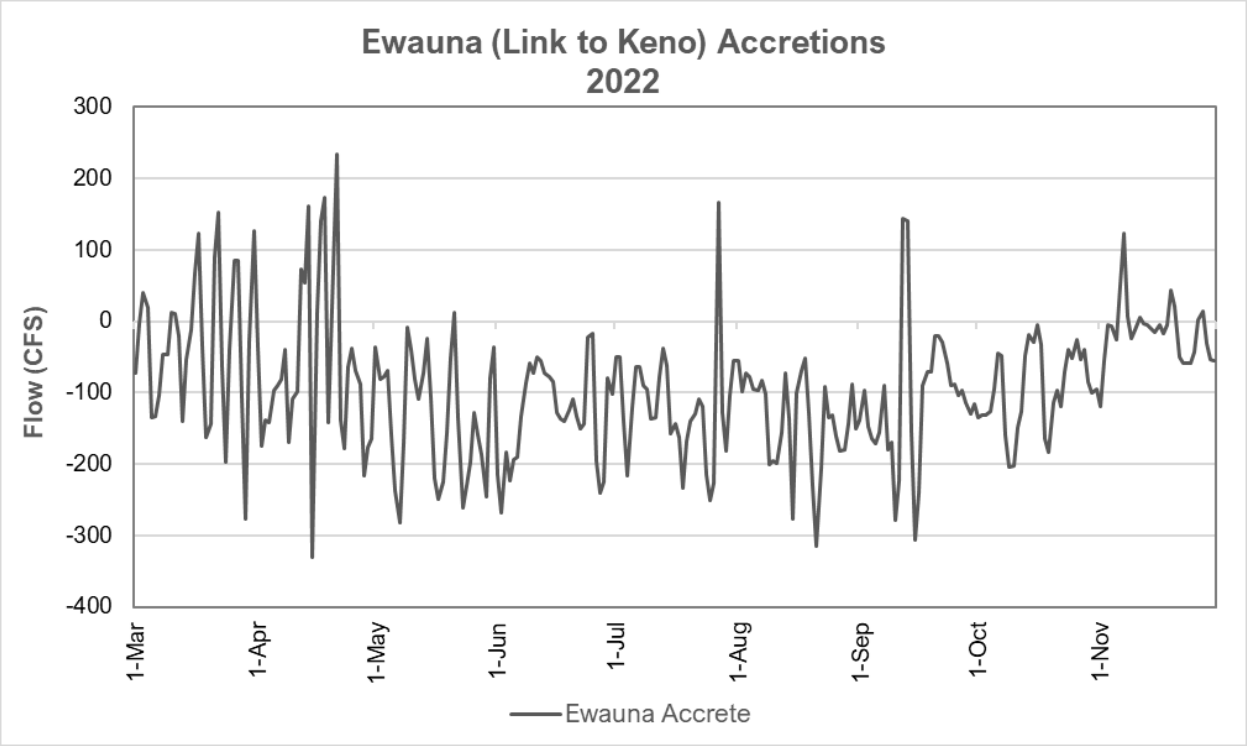

Figure 27. Ewauna 2022 Accretions.

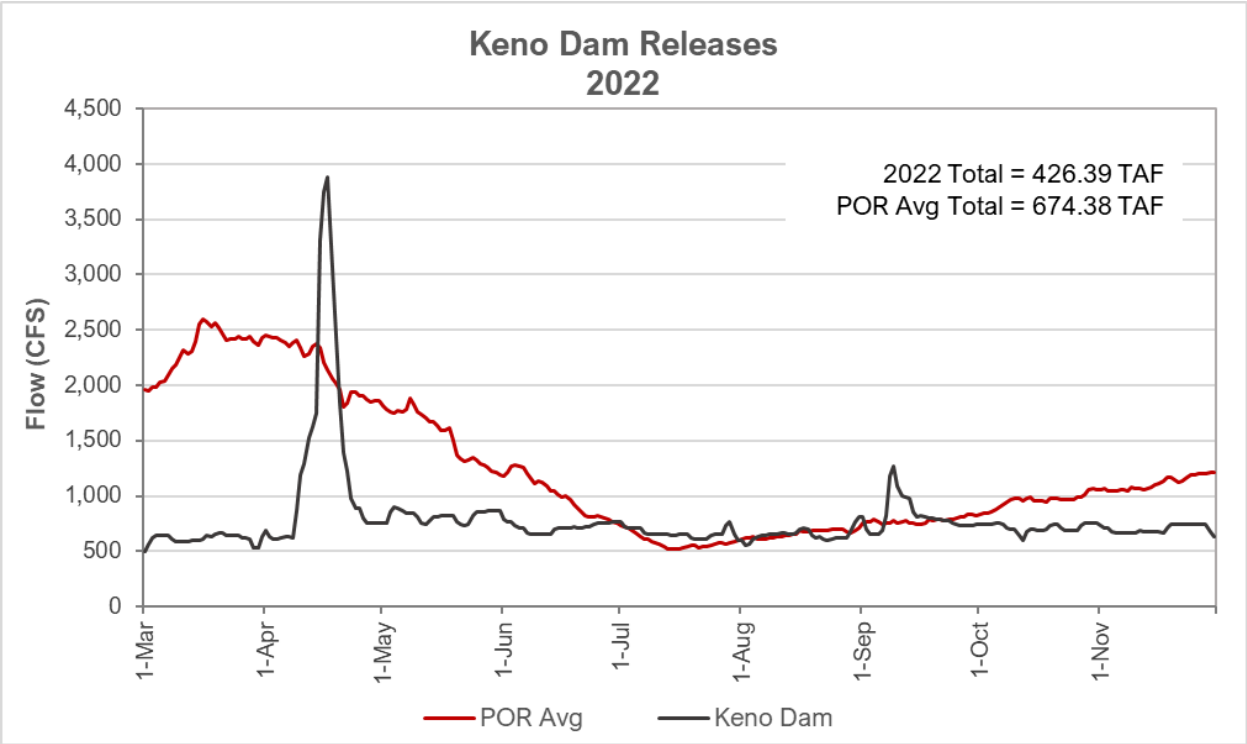

Figure 28. Keno Dam and Period of Record Average Releases during 2022.

The Keno to IGD accretions shown in Figure 29 and Figure 30 show that the projected values from PacifiCorp on a daily basis from November through February frequently differed slightly from the values calculated afterwards by Reclamation based on actual reservoir elevations and flow releases. On average, PacifiCorp projected 614 AF/day and the calculated Reclamation totals were 665 AF/day.

Figure 31 shows that although there was more day to day variability with the USBR estimates, the average flows were similar. The largest differences occurred during managed events from late-April through mid-June that impacted reservoir volumes.

On average, accretions for March through October projected by PacifiCorp were quite similar, 563 AF/day whereas those calculated by Reclamation were 570 AF/day.

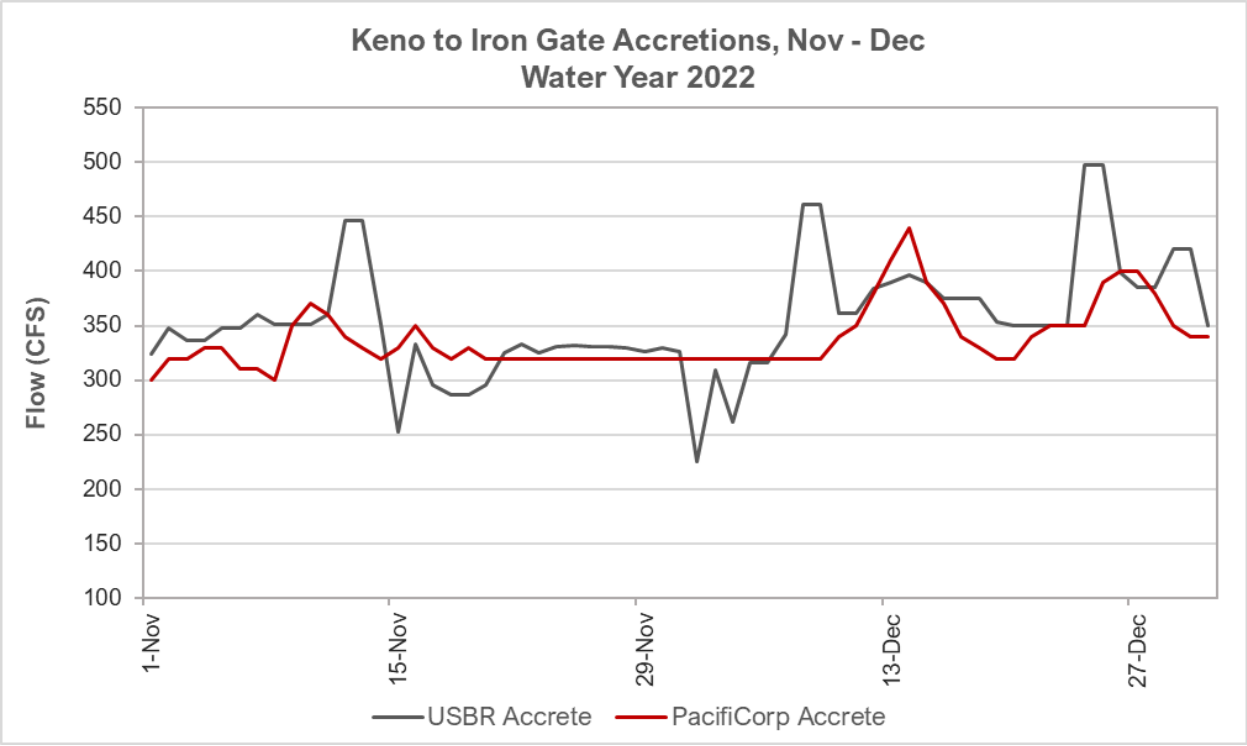

Figure 29. Keno to Iron Gate Accretions, November-December 2020 (Water Year 2022).

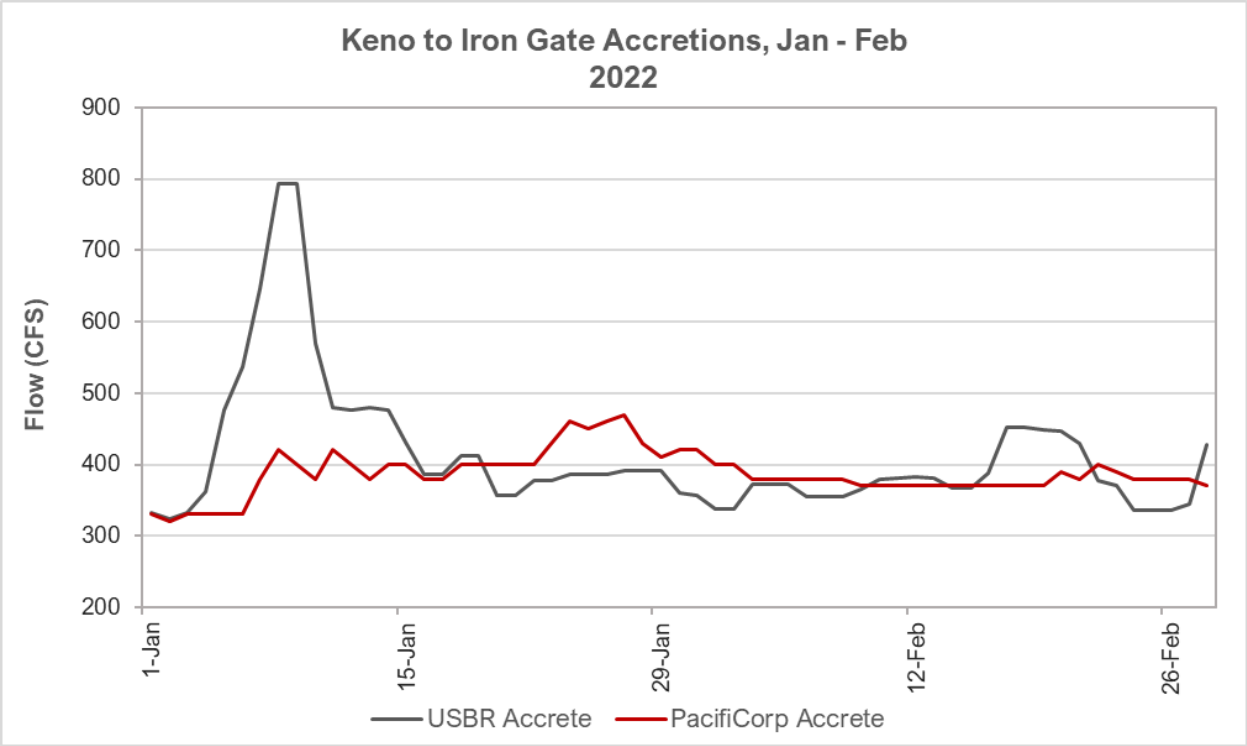

Figure 30. Keno to Iron Gate Accretions, January-February.

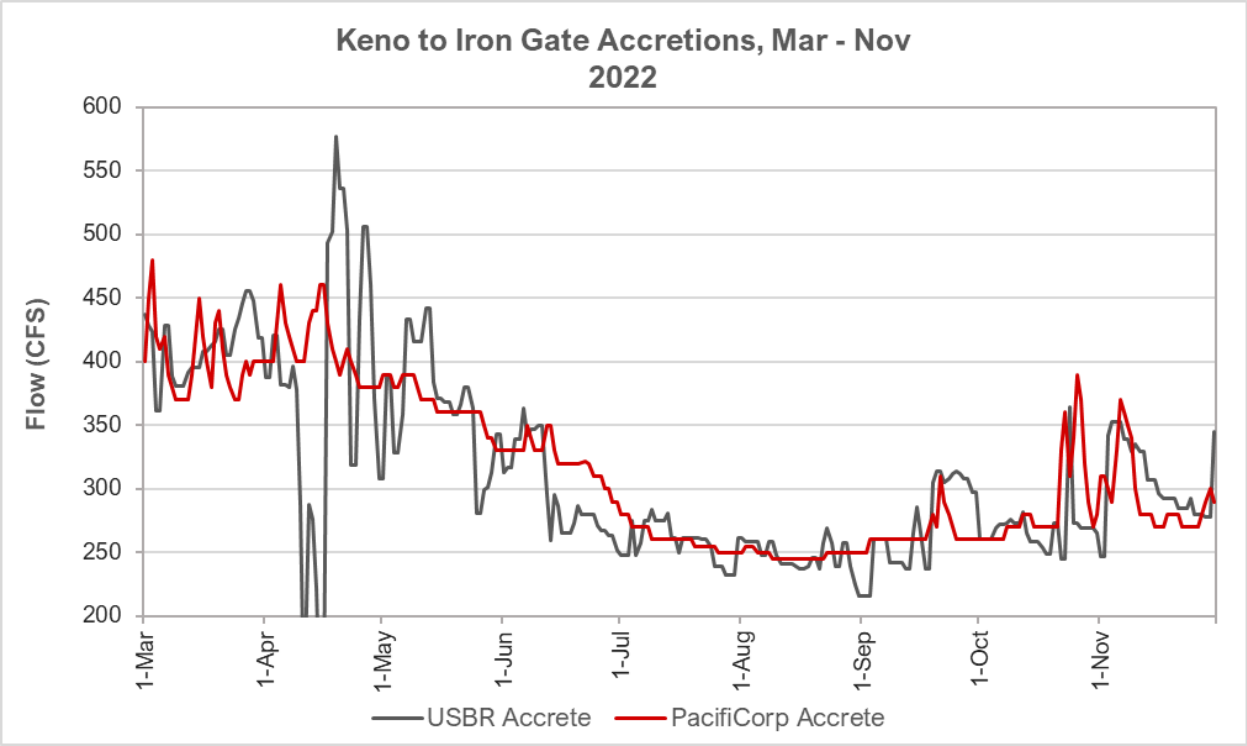

Figure 31. Keno to Iron Gate Accretions, March-November.

The graphs comparing observed and projected daily flows for IGD are shown as Figure 32 through Figure 35. Figure 32 shows flows at or near minimums throughout the water year. Calculated and actual IGD releases closely track each other. Figure 35 shows a similar congruence and that actual IGD releases closely fit the scheduled flows.

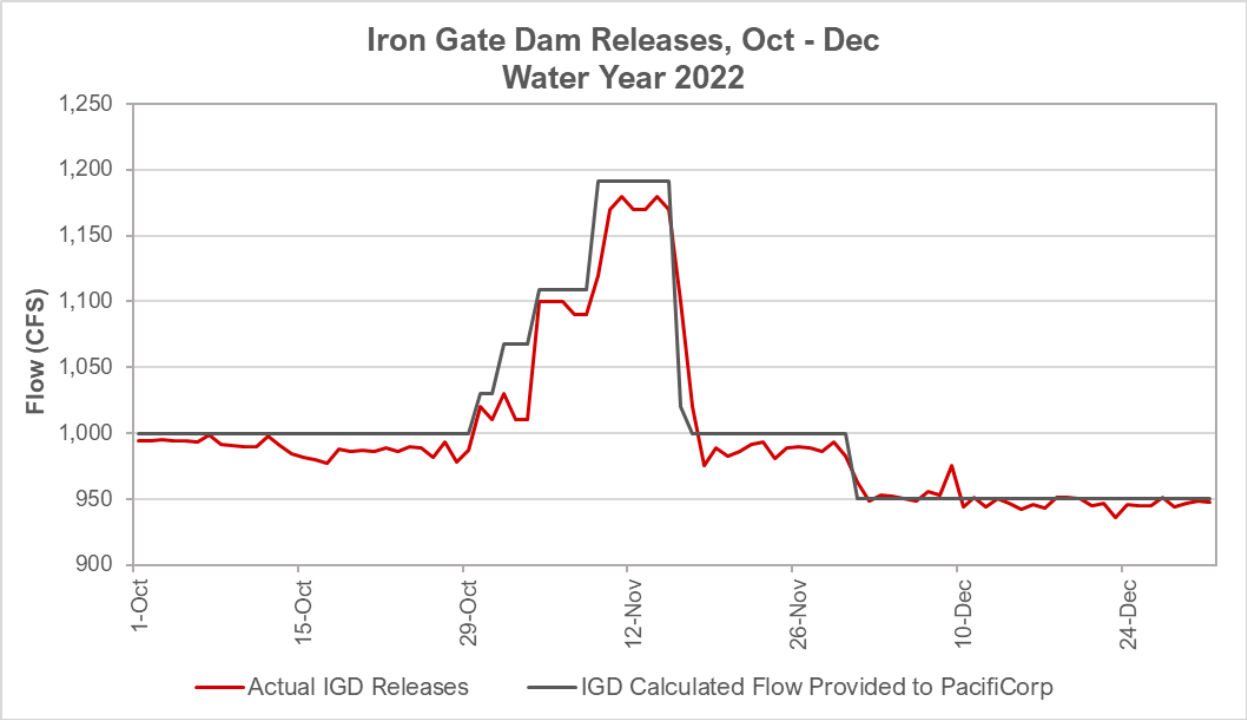

Figure 32. Iron Date Dam Daily Flows Projected Versus Actual (October-December).

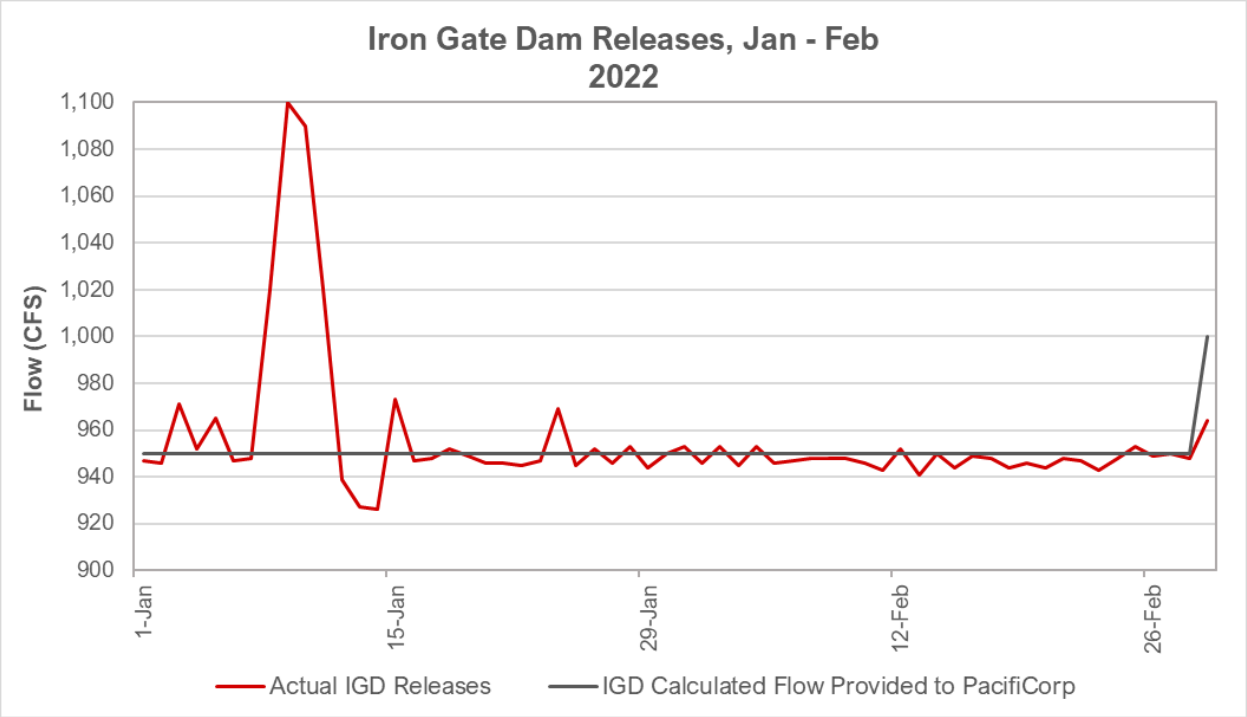

Figure 33. Iron Gate Dam Daily Flows Projected Versus Actual (January-February).

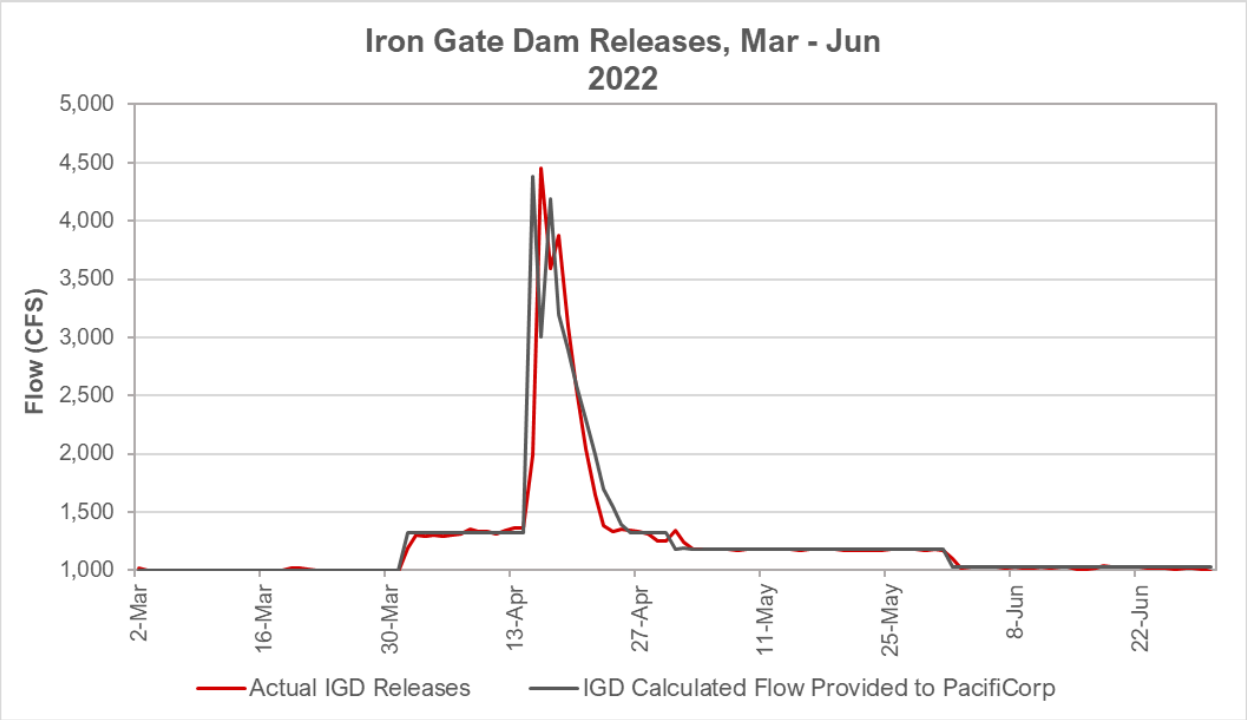

Figure 34. Iron Gate Dam Daily Flows Projected Versus Actual (March-June).

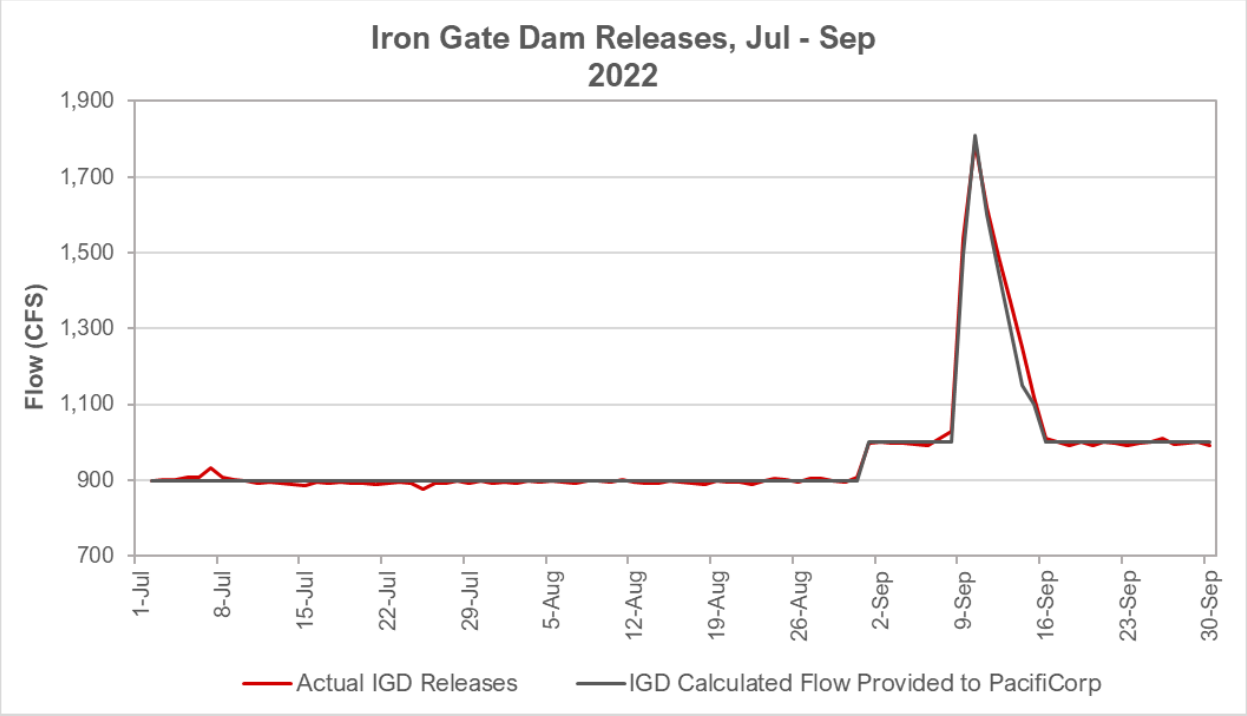

Figure 35. Iron Gate Dam Daily Flows Projected Versus Actual Flows (July-September).

T&C 2B-RR 6 (NMFS) Klamath River Restoration

Requirement

The 2019 NMFS BiOp states:

> *"Reclamation will provide an annual report on the type and location of each restoration project implemented. The monitoring report shall include the total number of coho salmon captured, relocated, injured, or killed for each restoration project, and will be submitted annually by March 1 to the NMFS Northern California office:*
>
> *National Marine Fisheries Service*
> *Jim Simondet, Klamath Branch Supervisor*
> *1655 Heindon Road*
> *Arcata, California 95521*
>
> *All coho salmon mortalities encountered must be retained, placed in an appropriately sized whirl-pak or zip-lock bag, labeled with the date and time of collection, fork length, location of capture, and frozen as soon as possible. Frozen samples must be retained until specific instructions are provided by NMFS."*

Regarding the Klamath River Coho Restoration Program, the NMFS 2019 BiOp specifically states:

> *"On March 25, 2019, NMFS received a letter from Reclamation entitled "Addendum 3 to the Proposed Action (PA) included in the Bureau of Reclamation's December 21, 2018, Final Biological Assessment on the Effects of the Proposed Action to Operate the Klamath Project (Project) from April 1, 2019 through March 31, 2029, on Federally-Listed Threatened and Endangered Species, as modified on February 15, 2019 (modified 2018 BA)" (USBR 2019c). In their letter, Reclamation clarified the proposed Klamath River Coho Restoration Program will be at a level of $700,000 in each of fiscal years 2019 and 2020, and $500,000 in each of the successive fiscal years beginning with fiscal year 2021 and ending with fiscal year 2024."*

Results

Restoration and recovery actions in the Klamath Basin are improving habitat and water quality conditions for anadromous salmonids. For the Klamath River Coho Habitat Restoration Grant Program (Grant Program), Reclamation provided $500,000 in funding per year for 2013 and 2014. In 2015, Reclamation awarded a grant and executed a 5-year agreement with the National Fish and Wildlife Foundation (NFWF) to administer the Grant Program and awarded $500,000 more per year from 2015 - 2018 and $700,000 in 2019. Under the initial grant, NFWF completed four grant cycles (2016, 2017, 2018, and 2019) for restoration and research/monitoring projects, selecting a total of 25 projects for funding (partial and full funding). In 2020 Reclamation worked to secure another grant administrator as the 5-year agreement with NFWF was schedule to conclude. However, due to extenuating circumstances the new funding agreement for a new grant administrator was not able to be awarded in 2020. Reclamation therefore extended the administrative duties of NFWF to September 30, 2021. In November 2021, Reclamation awarded a new funding agreement to NFWF to again administer the program until September 2025. Conservation funding for FY 2020 ($700,000) and FY 2021 ($500,000) was combined with FY 2022 ($500,000) funding for a total of $1.7 Million for the 2022 grant cycle. The grant cycle was initiated and completed in 2022, and those grants, and funded projects, are included in this description. An additional $500,000 is planned for each FY 2023 and FY 2024.

Project descriptions and funding amounts (Table 11) were described using information organized by NFWF. NFWF requested proposals in 2016, 2017, 2018, 2019, and 2022, where they received a total of 80 pre-proposals. Of these proposals, they requested full proposals for 42 applications, and a total of 32 projects were selected for funding. A total of $4,607,232.79 has been awarded under the Klamath River Coho Restoration Program since 2016. Grantees have leveraged this funding by contributing over $3,900,000 in match funding (cash and in kind) for a total conservation impact of approximately $8,500,000 in restoration funds as a result of the program.

NFWF received 11 pre-proposals for the 2022 grant cycle. Out of the 11 pre-proposals received, 7 projects were invited to submit full proposals. NFWF received full proposals and selected for funding each of the 7 projects (Table 12). NFWF began developing and executing contracts for each of the projects in late 2022.

Project Descriptions of Awarded Projects for the 2022 Grant Cycle

South Fork Floodplain Connectivity Phase IV
The South Fork Scott River Floodplain Connectivity Phase IV project is a collaborative, multi-phased effort between California Trout, the Siskiyou Resource Conservation District, the U.S. Fish and Wildlife Service, and the private landowner to enhance instream habitat in the South Fork of the Scott River through the installation of large wood structures, side channel excavation, and riparian planting. The project will restore floodplain function and connectivity, improve habitat cover and complexity, and enhance cold water rearing habitat for one of the core populations of Southern Oregon Norther California Coast (SONCC) coho salmon in the Klamath Basin.

Patterson Creek Engineered Log Jam Project
The project will install Engineered Log Jams on Patterson Creek, a key tributary to the Scott River, consisting of 12 single root wad structures, three double root wad structures and one apex jam, with associated planting of cottonwood and willow, to enhance rearing habitat for overwintering and over-summering SONCC coho salmon. The instream structures will enhance floodplain connectivity and result in improved groundwater recharge and primary food production for coho salmon.

French Creek Spawning and Rearing Habitat Improvement Project
The project will install six large wood structures instream, add spawning gravels, excavate a side channel, and remove non-native vegetation with subsequent planting of a mix of willows and cottonwoods along a 590-foot-long reach of French Creek. The project will improve degraded habitat and assist in enhancing natural populations of SONCC coho salmon by enhancing instream habitats in a cold water refugial stream.

Sugar Creek Coho Refugia Project- Phase 1
The project will create 1 acre of high-quality floodplain habitat connected to Sugar Creek, a key SONCC coho salmon spawning and rearing tributary to the Scott River. The project will improve coho salmon habitat and increase access to cold water refugia.

Lower Beaver Creek Aquatic Habitat Restoration Project
This project will add 13 wood structures to 1,300 feet of Beaver Creek, a key tributary to the Klamath River, to improve spawning and rearing habitat for SONCC coho salmon and other critical anadromous fish species. The wood structures will restore structure, spawning and rearing habitat, and floodplain connectivity to 1,300 feet of simplified and incised channel and 4.5 acres of disconnected floodplain. The structures will provide immediate benefit to coho salmon by providing

cover and areas of low velocity habitat. Long term benefits include spawning gravel sorting and activating approximately 4.5 acres of floodplain.

Klamath River Creek Mouth Enhancement Project
The project focuses on improving fish passage at the mouths of important cold water tributaries of the Middle Klamath, Salmon, and Scott Rivers by removing or modifying fish passage barriers at the creek mouths. Passage may be improved by creating fish step pools, concentrating flow at spread out river deltas, or increasing flow into lower slope channels. The project will improve access for juvenile and adult salmonids to cold water tributaries of the Middle Klamath, Salmon, and Lower Scott rivers that can become blocked during periods of low stream flow. The project takes place along the mainstem Klamath River from Weitchpec to Horse Creek (31 tributaries), the Salmon River from the confluence with the Klamath to Plummer Creek on the North Fork and Shadow Creek on the South Fork (22 tributaries), and the Lower Scott River tributaries (10 tributaries).

Shasta River Coho Salmon Habitat Enhancement through Design and Assessment
The project will complete design and permitting of the Hole in the Ground Diversion Combine Project on the Shasta River. The objective of the Hole in the Ground Diversion Combine Project is to connect two diversions with a single gravity pipeline. Future implementation of this project will allow efficiencies for instream benefit while also isolating a significant cold-water spring to protect over-summering habitat and providing flexible diversion management to maximize instream benefit.

Table 11. Grant Year, National Fish and Wildlife Foundation (NFWF) EZG Number, Project Titles, and general location, Project Type and amount of funding provided by Reclamation for the restoration effort.

Grant Year	NFWF -- EZ Grant Number	Project Title	Basin	Stream	Project Type	Funding Provided by Reclamation Funding
2022[1]	75192	South Fork Floodplain Connectivity Phase IV	Scott River	South Fork Scott River	Implementation	$264,500
2022	75205	Patterson Creek Engineered Log Jam Project	Scott River	Patterson Creek	Implementation	$155,500
2022	75220	French Creek Spawning and Rearing Habitat Improvement Project	Scott River	French Creek	Implementation	$189,300
2022	75282	Sugar Creek Coho Refugia Project – Phase 1	Scott River	Sugar Creek	Implementation	$230,100
2022	75308	Lower Beaver Creek Aquatic Habitat Restoration Project	Klamath River	Beaver Creek	Implementation	$391,200

Grant Year	NFWF -- EZ Grant Number	Project Title	Basin	Stream	Project Type	Funding Provided by Reclamation Funding
2022	75312	Klamath River Creek Mouth Enhancement Project	Klamath, Salmon, Scott	Various	Implementation	$56,300
2022	75449	Shasta River Coho Salmon Habitat Enhancement through Design and Assessment	Shasta River	Shasta River	Planning and Design	$122,600

[1] Seven projects were selected in calendar year 2022 utilizing fiscal year 2020, 2021, and 2022 funds.

Table 12. Summary of the number of funded projects Reclamation has supported over the years with assistance from NFWF as the Grant Administrator.

Grant Cycle Or Year	NFWF Number of Pre-Proposals	NFWF Number of Full-Proposals	NFWF Number of Projects Funded
2016	31	12	12
2017	20	9	4
2018	12	10	5
2019	6	4	4
2022	11	7	7
Totals	80	42	32

Appendix A – Supporting Information for Water Level and Flow Measurements Gages

M&RR 3.3b (USFWS)- Monitor and Maintain Water Level and Flow-Measurement Gages Throughout the Project, Summary of reservoir water level and flow monitoring compliance

Table A- 1. Link River 2022 flows (Thousand Acre-Feet).

DAY \ MONTH	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
1	1.142	1.488	1.819	2.231	2.212	1.900	2.033	1.781	1.857
2	1.109	1.583	1.870	2.212	2.132	1.878	1.747	1.773	1.626
3	1.125	1.476	2.093	2.112	2.291	1.837	1.769	1.775	1.527
4	1.271	1.472	2.172	2.093	2.410	1.884	1.803	1.773	1.444
5	1.553	1.418	2.271	1.983	2.132	1.904	1.823	1.771	1.450
6	1.543	1.416	2.370	1.968	2.033	1.918	1.827	1.771	1.309
7	1.533	1.400	2.390	1.799	2.033	1.908	1.946	1.860	1.164
8	1.369	1.420	2.112	1.736	2.132	1.966	2.826	1.930	1.390
9	1.232	2.172	1.761	1.720	2.172	2.132	2.965	1.924	1.440
10	1.204	2.688	1.740	1.716	2.192	2.152	2.826	1.920	1.422
11	1.160	2.767	1.741	1.696	2.192	2.152	2.529	1.672	1.420
12	1.246	2.866	1.728	1.692	2.192	2.152	1.771	1.571	1.426
13	1.424	3.124	1.734	1.708	2.192	2.132	1.718	1.573	1.430
14	1.337	3.243	1.771	1.811	2.271	2.172	2.053	1.573	1.442
15	1.226	7.329	1.991	1.890	2.489	2.073	2.271	1.573	1.444
16	1.127	7.468	2.212	1.983	2.489	1.932	2.152	1.537	1.422
17	1.083	7.507	2.251	1.976	2.489	1.908	1.837	1.620	1.434
18	1.379	5.782	2.192	1.978	2.588	1.914	1.718	1.882	1.496
19	1.648	5.167	2.093	1.966	2.350	1.974	1.747	1.976	1.464
20	1.624	3.640	1.851	1.960	2.311	2.033	1.652	1.876	1.501
21	1.170	2.271	1.726	1.960	2.311	2.033	1.638	1.827	1.644
22	1.025	2.747	2.013	1.956	2.271	1.843	1.648	1.797	1.658
23	1.422	2.331	2.212	1.944	2.291	1.624	1.712	1.672	1.656
24	1.722	1.855	2.291	1.857	2.549	1.656	1.716	1.624	1.660
25	1.496	1.849	2.291	2.033	2.648	1.716	1.696	1.652	1.632
26	1.178	1.755	2.231	2.529	2.529	1.773	1.696	1.617	1.537
27	1.148	1.728	2.311	2.608	1.741	1.787	1.694	1.799	1.507
28	1.492	1.968	2.331	2.588	2.430	1.785	1.712	1.797	1.579
29	1.630	1.946	2.390	2.370	2.509	1.809	1.743	1.886	1.513
30	1.146	1.932	2.053	2.350	2.132	1.855	1.743	1.918	1.434
31	1.041		2.013		1.910	2.053		1.920	
Total	40.806	85.805	64.022	60.422	70.623	59.855	58.013	54.643	44.932
Avg	1.316	2.860	2.065	2.014	2.278	1.931	1.934	1.763	1.498
Max	1.722	7.507	2.390	2.608	2.648	2.172	2.965	1.976	1.857
Min	1.025	1.400	1.726	1.692	1.741	1.624	1.638	1.537	1.164

Note: Westside Power Canal is no longer used for power generation, however, its data is included in above table.

Table A- 2. A Canal 2022 flows (Thousand Acre-Feet)

DAY \ MONTH	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
1	0.004	0.018	0.226	0.294	0.295	0.271	0.000	0.000	0.000
2	0.010	0.026	0.239	0.295	0.296	0.273	0.000	0.000	0.000
3	0.010	0.029	0.245	0.292	0.293	0.272	0.000	0.000	0.000
4	0.010	0.022	0.251	0.290	0.295	0.273	0.000	0.000	0.000
5	0.010	0.025	0.253	0.295	0.297	0.267	0.000	0.000	0.000
6	0.011	0.033	0.253	0.295	0.296	0.236	0.000	0.000	0.000
7	0.015	0.035	0.255	0.294	0.295	0.233	0.000	0.000	0.000
8	0.013	0.037	0.254	0.294	0.293	0.233	0.000	0.000	0.000
9	0.012	0.040	0.254	0.294	0.298	0.233	0.000	0.000	0.000
10	0.012	0.033	0.254	0.290	0.300	0.231	0.000	0.000	0.000
11	0.012	0.029	0.256	0.291	0.300	0.233	0.000	0.000	0.000
12	0.012	0.028	0.254	0.296	0.300	0.232	0.000	0.000	0.000
13	0.011	0.064	0.246	0.299	0.299	0.228	0.000	0.000	0.000
14	0.012	0.102	0.245	0.292	0.298	0.223	0.000	0.000	0.000
15	0.014	0.146	0.244	0.294	0.299	0.220	0.000	0.000	0.000
16	0.015	0.172	0.248	0.290	0.299	0.215	0.000	0.000	0.000
17	0.015	0.173	0.247	0.293	0.297	0.144	0.000	0.000	0.000
18	0.016	0.173	0.246	0.292	0.296	0.106	0.000	0.000	0.000
19	0.012	0.171	0.249	0.288	0.295	0.108	0.000	0.000	0.000
20	0.014	0.171	0.249	0.291	0.297	0.109	0.000	0.000	0.000
21	0.016	0.168	0.254	0.286	0.296	0.108	0.000	0.000	0.000
22	0.014	0.167	0.272	0.293	0.296	0.110	0.000	0.000	0.000
23	0.014	0.169	0.271	0.296	0.293	0.103	0.000	0.000	0.000
24	0.013	0.170	0.276	0.295	0.293	0.000	0.000	0.000	0.000
25	0.019	0.170	0.277	0.297	0.292	0.000	0.000	0.000	0.000
26	0.016	0.169	0.288	0.294	0.291	0.000	0.000	0.000	0.000
27	0.016	0.170	0.288	0.295	0.291	0.000	0.000	0.000	0.000
28	0.017	0.176	0.281	0.298	0.280	0.000	0.000	0.000	0.000
29	0.016	0.186	0.290	0.294	0.271	0.000	0.000	0.000	0.000
30	0.016	0.205	0.291	0.296	0.273	0.000	0.000	0.000	0.000
31	0.002		0.290		0.272	0.000		0.000	
Total (TAF)	0.399	3.275	8.046	8.805	9.086	4.659	0.000	0.000	0.000
Avg	0.013	0.109	0.260	0.294	0.293	0.150	0.000	0.000	0.000
Max	0.019	0.205	0.291	0.299	0.300	0.273	0.000	0.000	0.000
Min	0.002	0.018	0.226	0.286	0.271	0.000	0.000	0.000	0.000

Table A- 3. Lost River Diversion Channel 2022 flows (Thousand Acre-Feet)

DAY \ MONTH	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
1	0.066	0.047	0.068	0.040	0.006	0.022	0.000	0.000	0.000
2	0.060	0.046	0.051	0.053	0.009	0.029	0.000	0.000	0.000
3	0.094	0.031	0.060	0.049	0.017	0.028	0.000	0.000	0.000
4	0.017	0.035	0.032	0.054	0.020	0.009	0.000	0.000	0.000
5	0.035	0.048	0.020	0.052	0.022	0.013	0.000	0.000	0.000
6	0.039	0.032	0.037	0.073	0.015	0.007	0.000	0.000	0.000
7	0.025	0.051	0.037	0.109	0.011	0.021	0.000	0.000	0.000
8	0.008	0.017	0.045	0.063	0.019	0.010	0.000	0.000	0.000
9	0.083	0.027	0.077	0.046	0.008	0.028	0.000	0.000	0.000
10	0.019	0.029	0.089	0.048	0.006	0.002	0.000	0.000	0.000
11	0.063	0.017	0.068	0.021	0.013	0.018	0.000	0.000	0.000
12	0.041	0.046	0.080	0.007	0.007	0.008	0.000	0.000	0.000
13	0.094	0.059	0.095	0.006	0.010	0.005	0.000	0.000	0.000
14	0.055	0.026	0.069	0.011	0.009	0.023	0.000	0.000	0.000
15	0.059	0.039	0.078	0.012	0.007	0.012	0.000	0.000	0.000
16	0.057	0.064	0.062	0.009	0.002	0.015	0.000	0.000	0.000
17	0.033	0.057	0.039	0.009	0.012	0.017	0.000	0.000	0.000
18	0.063	0.062	0.039	0.009	0.008	0.014	0.000	0.000	0.000
19	0.053	0.070	0.033	0.008	0.010	0.006	0.000	0.000	0.000
20	0.060	0.074	0.041	0.009	0.015	0.006	0.000	0.000	0.000
21	0.068	0.092	0.045	0.035	0.009	0.009	0.000	0.000	0.000
22	0.077	0.056	0.049	0.075	0.007	0.010	0.000	0.000	0.000
23	0.047	0.066	0.038	0.069	0.009	0.010	0.000	0.000	0.000
24	0.043	0.173	0.024	0.063	0.008	0.033	0.000	0.000	0.000
25	0.044	0.154	0.040	0.059	0.004	0.005	0.000	0.000	0.000
26	0.036	0.049	0.015	0.042	0.018	0.000	0.000	0.000	0.000
27	0.035	0.053	0.010	0.016	0.023	0.000	0.000	0.000	0.000
28	0.053	0.026	0.012	0.006	0.020	0.000	0.000	0.000	0.000
29	0.054	0.051	0.015	0.006	0.038	0.000	0.000	0.000	0.000
30	0.027	0.037	0.012	0.006	0.025	0.000	0.000	0.000	0.000
31	0.039		0.016		0.037	0.000		0.000	
Total (TAF)	1.545	1.634	1.395	1.064	0.425	0.362	0.000	0.000	0.000
Avg	0.050	0.054	0.045	0.035	0.014	0.012	0.000	0.000	0.000
Max	0.094	0.173	0.095	0.109	0.038	0.033	0.000	0.000	0.000
Min	0.008	0.017	0.010	0.006	0.002	0.000	0.000	0.000	0.000

Table A- 4. Miller Hill Pumps 2022 flows (Thousand Acre-Feet)

DAY \ MONTH	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
1	0.004	0.053	0.083	0.079	0.095	0.079	0.000	0.000	0.000
2	0.005	0.024	0.079	0.079	0.095	0.079	0.000	0.000	0.000
3	0.005	0.026	0.079	0.079	0.095	0.079	0.000	0.000	0.000
4	0.006	0.026	0.079	0.079	0.095	0.079	0.000	0.000	0.000
5	0.000	0.026	0.079	0.079	0.095	0.079	0.000	0.000	0.000
6	0.000	0.028	0.079	0.079	0.095	0.079	0.000	0.000	0.000
7	0.007	0.041	0.079	0.090	0.095	0.079	0.000	0.000	0.000
8	0.006	0.051	0.079	0.089	0.095	0.072	0.000	0.000	0.000
9	0.006	0.060	0.079	0.089	0.095	0.062	0.000	0.000	0.000
10	0.006	0.060	0.079	0.092	0.095	0.060	0.000	0.000	0.000
11	0.005	0.057	0.079	0.090	0.096	0.060	0.000	0.000	0.000
12	0.000	0.056	0.079	0.089	0.096	0.060	0.000	0.000	0.000
13	0.000	0.060	0.079	0.081	0.096	0.060	0.000	0.000	0.000
14	0.007	0.060	0.079	0.078	0.096	0.030	0.000	0.000	0.000
15	0.005	0.060	0.079	0.078	0.100	0.030	0.000	0.000	0.000
16	0.005	0.059	0.079	0.078	0.104	0.030	0.000	0.000	0.000
17	0.006	0.059	0.079	0.085	0.104	0.030	0.000	0.000	0.000
18	0.004	0.057	0.079	0.081	0.101	0.020	0.000	0.000	0.000
19	0.000	0.058	0.079	0.073	0.096	0.020	0.000	0.000	0.000
20	0.000	0.058	0.079	0.067	0.095	0.020	0.000	0.000	0.000
21	0.010	0.051	0.079	0.067	0.092	0.020	0.000	0.000	0.000
22	0.011	0.048	0.079	0.067	0.087	0.020	0.000	0.000	0.000
23	0.095	0.048	0.079	0.082	0.091	0.056	0.000	0.000	0.000
24	0.146	0.048	0.079	0.089	0.103	0.000	0.000	0.000	0.000
25	0.146	0.048	0.079	0.082	0.105	0.000	0.000	0.000	0.000
26	0.119	0.054	0.079	0.077	0.108	0.000	0.000	0.000	0.000
27	0.107	0.060	0.079	0.086	0.108	0.000	0.000	0.000	0.000
28	0.107	0.058	0.079	0.095	0.109	0.000	0.000	0.000	0.000
29	0.107	0.063	0.079	0.095	0.089	0.000	0.000	0.000	0.000
30	0.107	0.075	0.079	0.095	0.079	0.000	0.000	0.000	0.000
31	0.107		0.079		0.079	0.000		0.000	
Total (TAF)	1.140	1.528	2.463	2.474	2.987	1.201	0.000	0.000	0.000
Avg	0.037	0.051	0.079	0.082	0.096	0.039	0.000	0.000	0.000
Max	0.146	0.075	0.083	0.095	0.109	0.079	0.000	0.000	0.000
Min	0.000	0.024	0.079	0.067	0.079	0.000	0.000	0.000	0.000

Table A- 5. Miller Hill Spill 2022 flows (Thousand Acre-Feet)

DAY \ MONTH	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
31	0.000		0.000		0.000	0.000		0.000	
Total (TAF)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Avg	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Max	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table A- 6. Station 48 2022 flows (Thousand Acre-Feet)

DAY \ MONTH	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
1	0.040	0.065	0.060	0.079	0.298	0.397	0.032	0.000	0.000
2	0.046	0.060	0.060	0.079	0.315	0.397	0.036	0.000	0.000
3	0.050	0.060	0.060	0.079	0.347	0.397	0.040	0.000	0.000
4	0.050	0.060	0.071	0.079	0.294	0.347	0.042	0.000	0.000
5	0.050	0.060	0.079	0.079	0.228	0.298	0.040	0.000	0.000
6	0.050	0.060	0.079	0.071	0.236	0.298	0.038	0.000	0.000
7	0.050	0.060	0.079	0.060	0.317	0.298	0.034	0.000	0.000
8	0.050	0.069	0.079	0.060	0.397	0.298	0.032	0.000	0.000
9	0.050	0.079	0.079	0.060	0.397	0.298	0.028	0.000	0.000
10	0.050	0.079	0.079	0.063	0.347	0.298	0.024	0.000	0.000
11	0.050	0.079	0.067	0.099	0.347	0.298	0.020	0.000	0.000
12	0.050	0.069	0.060	0.081	0.397	0.355	0.014	0.000	0.000
13	0.050	0.060	0.060	0.060	0.442	0.496	0.000	0.000	0.000
14	0.050	0.060	0.060	0.060	0.496	0.460	0.000	0.000	0.000
15	0.050	0.060	0.060	0.060	0.496	0.064	0.000	0.000	0.000
16	0.050	0.060	0.060	0.060	0.496	0.198	0.000	0.000	0.000
17	0.050	0.060	0.071	0.060	0.496	0.198	0.000	0.000	0.000
18	0.050	0.060	0.091	0.060	0.496	0.198	0.000	0.000	0.000
19	0.050	0.060	0.099	0.060	0.496	0.153	0.000	0.000	0.000
20	0.050	0.060	0.099	0.060	0.496	0.050	0.000	0.000	0.000
21	0.050	0.060	0.099	0.060	0.496	0.050	0.000	0.000	0.000
22	0.050	0.060	0.099	0.060	0.496	0.050	0.000	0.000	0.000
23	0.103	0.060	0.099	0.075	0.496	0.050	0.000	0.000	0.000
24	0.149	0.083	0.099	0.157	0.496	0.048	0.000	0.000	0.000
25	0.149	0.127	0.099	0.226	0.496	0.046	0.000	0.000	0.000
26	0.131	0.067	0.099	0.298	0.496	0.044	0.000	0.000	0.000
27	0.099	0.060	0.099	0.298	0.496	0.042	0.000	0.000	0.000
28	0.087	0.060	0.099	0.339	0.458	0.040	0.000	0.000	0.000
29	0.079	0.060	0.099	0.397	0.397	0.038	0.000	0.000	0.000
30	0.079	0.060	0.099	0.361	0.397	0.036	0.000	0.000	0.000
31	0.079		0.081		0.397	0.034		0.000	
Total (TAF)	2.033	1.970	2.525	3.636	12.952	6.266	0.377	0.000	0.000
Avg	0.066	0.066	0.081	0.121	0.418	0.202	0.013	0.000	0.000
Max	0.149	0.127	0.099	0.397	0.496	0.496	0.042	0.000	0.000
Min	0.040	0.060	0.060	0.060	0.228	0.034	0.000	0.000	0.000

Table A- 7. North Canal 2022 flows (Thousand Acre-Feet)

DAY \ MONTH	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
1	0.000	0.000	0.147	0.087	0.164	0.110	0.126	0.038	0.129
2	0.000	0.000	0.082	0.057	0.153	0.093	0.136	0.036	0.045
3	0.000	0.000	0.100	0.079	0.155	0.076	0.144	0.037	0.038
4	0.000	0.000	0.083	0.043	0.172	0.074	0.138	0.038	0.031
5	0.000	0.000	0.067	0.045	0.146	0.088	0.146	0.097	0.028
6	0.000	0.000	0.070	0.054	0.146	0.084	0.121	0.198	0.031
7	0.000	0.000	0.040	0.132	0.156	0.108	0.097	0.286	0.033
8	0.000	0.000	0.000	0.166	0.164	0.115	0.098	0.208	0.030
9	0.000	0.000	0.000	0.177	0.165	0.107	0.084	0.134	0.025
10	0.000	0.000	0.000	0.146	0.164	0.101	0.087	0.123	0.031
11	0.000	0.000	0.000	0.097	0.174	0.105	0.090	0.109	0.032
12	0.000	0.000	0.000	0.083	0.204	0.122	0.075	0.126	0.029
13	0.000	0.026	0.000	0.093	0.248	0.130	0.052	0.147	0.031
14	0.000	0.000	0.000	0.105	0.244	0.129	0.048	0.147	0.031
15	0.000	0.000	0.054	0.149	0.250	0.131	0.051	0.140	0.029
16	0.029	0.000	0.054	0.149	0.268	0.145	0.049	0.153	0.032
17	0.028	0.000	0.025	0.118	0.248	0.156	0.041	0.182	0.031
18	0.038	0.000	0.028	0.108	0.191	0.214	0.000	0.181	0.030
19	0.028	0.000	0.000	0.130	0.184	0.272	0.032	0.165	0.032
20	0.035	0.000	0.055	0.153	0.206	0.278	0.044	0.173	0.032
21	0.022	0.000	0.080	0.131	0.226	0.258	0.041	0.158	0.033
22	0.034	0.000	0.081	0.129	0.234	0.178	0.044	0.147	0.032
23	0.025	0.000	0.077	0.107	0.230	0.170	0.055	0.156	0.032
24	0.044	0.000	0.029	0.120	0.208	0.165	0.051	0.172	0.033
25	0.020	0.000	0.000	0.236	0.185	0.191	0.057	0.181	0.032
26	0.025	0.000	0.045	0.268	0.164	0.190	0.027	0.200	0.030
27	0.023	0.000	0.108	0.226	0.145	0.161	0.042	0.236	0.025
28	0.000	0.000	0.092	0.172	0.132	0.165	0.028	0.220	0.016
29	0.000	0.036	0.035	0.167	0.133	0.151	0.026	0.218	0.033
30	0.000	0.029	0.000	0.159	0.128	0.118	0.043	0.214	0.035
31	0.000		0.066		0.125	0.120		0.224	
Total (TAF)	0.351	0.090	1.420	3.888	5.712	4.505	2.074	4.847	1.030
Avg	0.011	0.003	0.046	0.130	0.184	0.145	0.069	0.156	0.034
Max	0.044	0.036	0.147	0.268	0.268	0.278	0.146	0.286	0.129
Min	0.000	0.000	0.000	0.043	0.125	0.074	0.000	0.036	0.016

Table A- 8. Ady Canal 2022 flows (Thousand Acre-Feet)

DAY \ MONTH	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
1	0.035	0.026	0.065	0.046	0.051	0.044	0.000	0.000	0.048
2	0.000	0.024	0.088	0.034	0.043	0.043	0.000	0.000	0.055
3	0.000	0.000	0.114	0.051	0.036	0.049	0.000	0.000	0.061
4	0.000	0.000	0.090	0.063	0.036	0.033	0.000	0.000	0.052
5	0.000	0.021	0.044	0.065	0.040	0.000	0.000	0.000	0.050
6	0.000	0.020	0.043	0.068	0.045	0.000	0.000	0.000	0.051
7	0.025	0.034	0.041	0.047	0.048	0.000	0.000	0.000	0.054
8	0.022	0.000	0.028	0.039	0.049	0.000	0.000	0.000	0.053
9	0.000	0.000	0.025	0.045	0.047	0.000	0.000	0.000	0.046
10	0.027	0.000	0.025	0.044	0.052	0.000	0.000	0.000	0.048
11	0.030	0.000	0.030	0.057	0.053	0.000	0.000	0.000	0.048
12	0.025	0.000	0.024	0.056	0.058	0.000	0.000	0.000	0.047
13	0.000	0.000	0.039	0.055	0.051	0.000	0.000	0.000	0.049
14	0.040	0.000	0.080	0.056	0.055	0.000	0.000	0.000	0.053
15	0.022	0.026	0.094	0.048	0.056	0.000	0.000	0.000	0.049
16	0.022	0.000	0.069	0.048	0.050	0.000	0.000	0.000	0.048
17	0.000	0.028	0.044	0.043	0.043	0.000	0.000	0.000	0.040
18	0.020	0.020	0.028	0.047	0.050	0.000	0.000	0.000	0.037
19	0.000	0.000	0.021	0.050	0.051	0.000	0.000	0.000	0.037
20	0.000	0.000	0.037	0.060	0.051	0.000	0.000	0.000	0.037
21	0.022	0.000	0.079	0.061	0.049	0.000	0.000	0.000	0.039
22	0.025	0.022	0.078	0.061	0.044	0.000	0.000	0.000	0.040
23	0.038	0.028	0.038	0.045	0.049	0.000	0.000	0.000	0.040
24	0.031	0.037	0.027	0.045	0.052	0.000	0.000	0.000	0.042
25	0.030	0.024	0.063	0.050	0.063	0.000	0.000	0.000	0.040
26	0.000	0.000	0.069	0.050	0.061	0.000	0.000	0.000	0.038
27	0.000	0.026	0.037	0.041	0.048	0.000	0.000	0.000	0.038
28	0.000	0.000	0.000	0.036	0.053	0.000	0.000	0.000	0.033
29	0.022	0.033	0.020	0.049	0.056	0.000	0.000	0.000	0.038
30	0.000	0.021	0.021	0.049	0.055	0.000	0.000	0.000	0.034
31	0.000		0.056		0.045	0.000		0.000	
Total (TAF)	0.435	0.390	1.518	1.508	1.539	0.168	0.000	0.000	1.345
Avg	0.014	0.013	0.049	0.050	0.050	0.005	0.000	0.000	0.045
Max	0.040	0.037	0.114	0.068	0.063	0.049	0.000	0.000	0.061
Min	0.000	0.000	0.000	0.034	0.036	0.000	0.000	0.000	0.033

Table A- 9. Ady Canal to Refuge (flow to Lower Klamath National Wildlife Refuge) 2022 flows (Thousand Acre-Feet)

DAY \ MONTH	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
1	0.000	0.000	0.000	0.000	0.006	0.006	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.006	0.006	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.006	0.006	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.006	0.006	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.006	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.006	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.006	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.014	0.006	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.014	0.006	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.014	0.006	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.014	0.006	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.014	0.006	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.014	0.006	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.006	0.006	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.007	0.006	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.010	0.006	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.009	0.006	0.000	0.000	0.000	0.000
18	0.000	0.000	0.000	0.013	0.006	0.000	0.000	0.000	0.000
19	0.000	0.000	0.000	0.011	0.006	0.000	0.000	0.046	0.000
20	0.000	0.000	0.000	0.006	0.006	0.000	0.000	0.052	0.000
21	0.000	0.000	0.000	0.006	0.006	0.000	0.000	0.007	0.000
22	0.000	0.000	0.000	0.006	0.006	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	0.006	0.006	0.000	0.000	0.000	0.000
24	0.000	0.000	0.000	0.006	0.006	0.000	0.000	0.000	0.000
25	0.000	0.000	0.000	0.008	0.006	0.000	0.000	0.000	0.000
26	0.000	0.000	0.000	0.014	0.006	0.000	0.000	0.000	0.000
27	0.000	0.000	0.000	0.006	0.006	0.000	0.000	0.000	0.000
28	0.000	0.000	0.000	0.010	0.006	0.000	0.000	0.000	0.000
29	0.000	0.000	0.000	0.006	0.006	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.006	0.006	0.000	0.000	0.000	0.000
31	0.000		0.000		0.006	0.000		0.000	
Total (TAF)	0.000	0.000	0.000	0.219	0.184	0.024	0.000	0.104	0.000
Avg	0.000	0.000	0.000	0.007	0.006	0.001	0.000	0.003	0.000
Max	0.000	0.000	0.000	0.014	0.006	0.006	0.000	0.052	0.000
Min	0.000	0.000	0.000	0.000	0.006	0.000	0.000	0.000	0.000

Table A- 10. Klamath Straits Drain at Stateline (flows from Lower Klamath National Wildlife Refuge) 2022 flows (Thousand Acre-Feet)

DAY \ MONTH	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
31	0.000		0.000		0.000	0.000		0.000	
Total (TAF)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Avg	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Max	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table A- 11. Klamath Straits Drain at F&FF Pumps 2022 flows (Thousand Acre-Feet)

DAY \ MONTH	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
1	0.000	0.057	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.069	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.056	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.063	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.067	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.090	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.090	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.105	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.084	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.000	0.069	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	0.192	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	0.276	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	0.162	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	0.116	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27	0.096	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28	0.069	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	0.123	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	0.116	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
31	0.102		0.000		0.000	0.000		0.000	
Total (TAF)	1.252	0.751	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Avg	0.040	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Max	0.276	0.105	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table A- 12. Keno Canal 2022 flows (Thousand Acre-Feet)

DAY \ MONTH	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV
1	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.000
2	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.000
3	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.000
4	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.000
5	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.000
6	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.000
7	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.000
8	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.000
9	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.000
10	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.000
11	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.000
12	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.000
13	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.000
14	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.000
15	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.000
16	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.000	0.000
17	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.000	0.000
18	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.000	0.000
19	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.000	0.000
20	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.000	0.000
21	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.000	0.000
22	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.000	0.000
23	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.000	0.000
24	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.000	0.000
25	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.000	0.000
26	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.000	0.000
27	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.000	0.000
28	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.000	0.000
29	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.000	0.000
30	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.000	0.000
31	0.000		0.030		0.030	0.030		0.000	
Total (TAF)	0.000	0.892	0.922	0.892	0.922	0.922	0.892	0.446	0.000
Avg	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.014	0.000
Max	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.000
Min	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.000	0.000

Table A- 13. WY2022 Klamath Project Deliveries and Demands.

Agricultural Deliveries (POR 1981-2021, excluding 2001, 2010, 2021) through Saturday, October 1, 2022 Units: thousands of acre-feet (TAF)

Project Supply Used-to-date 90.341 Available Project Supply 82.253

Remaining Project Supply -8.088

		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Mar-Sep Total	Oct-Nov 15th Total
A Canal	min	0.00	1.35	12.48	14.56	20.36	21.70	14.79	1.16	0.00	85.23	1.16
	median	0.00	14.50	40.57	45.13	53.59	50.79	35.96	10.77	0.00	240.54	10.77
	average	0.03	15.96	38.63	44.61	52.43	48.61	34.76	10.57	0.00	235.03	10.57
	max	0.38	28.42	53.50	56.06	62.16	58.41	45.04	17.53	0.03	303.97	17.56
	SS2022 to-date	**0.40**	**3.28**	**8.05**	**8.81**	**9.09**	**4.66**	**0.00**	**0.00**	**0.00**	**34.271**	**0.00**
Miller Hill	min	-0.12	-0.45	-0.22	0.10	0.47	0.20	-0.23	-0.33	-0.13	-0.25	-0.46
	median	0.00	0.00	2.43	3.22	4.49	3.71	1.04	-0.04	0.00	14.89	-0.04
	average	0.00	0.29	2.22	3.17	4.21	3.50	1.28	0.04	0.00	14.67	0.04
	max	0.04	2.76	5.95	6.06	6.45	5.91	3.78	0.88	0.00	30.96	0.88
	SS2022 to-date	**1.14**	**1.53**	**2.46**	**2.47**	**2.99**	**1.20**	**0.00**	**0.00**	**0.00**	**11.792**	**0.00**
Station 48	min	0.00	0.00	0.43	4.03	8.99	2.64	0.31	0.00	0.00	16.40	0.00
	median	1.09	4.41	6.66	17.64	17.20	11.55	2.91	1.10	0.22	61.46	1.32
	average	1.81	6.25	7.84	16.85	16.98	10.94	3.19	1.44	0.95	63.86	2.40
	max	8.09	24.96	18.99	25.34	25.17	20.52	10.24	10.00	11.00	133.30	21.00
	SS2022 to-date	**2.03**	**1.97**	**2.52**	**3.64**	**12.95**	**6.27**	**0.38**	**0.00**	**0.00**	**29.759**	**0.00**
North Canal	min	0.00	0.00	0.58	1.76	1.64	0.98	0.61	0.10		5.57	0.10
	median	0.69	1.04	2.01	3.26	4.50	3.04	2.27	1.42		16.80	1.42
	average	0.97	1.19	2.02	3.23	4.11	2.90	2.35	1.66		16.77	1.66
	max	4.71	4.15	5.00	7.47	7.08	8.00	9.00	10.00		45.41	10.00
	SS2022 to-date	**0.35**	**0.09**	**1.42**	**3.89**	**5.71**	**4.51**	**2.00**	**0.00**		**17.972**	**0.00**
Ady Canal to Ag	min	0.11	0.00	0.14	0.27	0.77	0.16	0.06	0.05		1.52	0.05
	median	3.84	6.92	7.45	9.74	9.34	8.99	7.95	6.93		54.23	6.93
	average	3.68	2.38	3.73	5.68	4.79	5.26	3.69	3.17		29.20	3.17
	max	7.40	0.00	0.14	0.27	0.77	0.16	0.06	0.05		8.81	0.05
	SS2022 to-date	**0.43**	**0.39**	**1.52**	**1.37**	**1.35**	**0.14**	**0.00**	**0.00**		**5.215**	**0.00**
GW to LRDC	SS2022 to-date	**0.00**	**0.00**	**0.17**	**0.17**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**	**0.365**	**0.00**
Total Ag	min	0.23	2.22	21.25	29.15	39.85	37.68	27.39	2.97	0.34	157.76	3.31
	median	7.05	23.89	53.92	75.60	89.29	73.70	47.56	17.27	6.94	371.00	24.21
	average	6.55	26.76	54.78	74.03	83.17	71.15	45.81	17.16	7.68	362.25	24.84
	max	14.07	61.68	86.53	97.28	101.34	87.85	57.81	29.10	29.20	506.56	58.30
	SS2022 to-date	**4.36**	**7.25**	**15.97**	**20.17**	**32.09**	**16.77**	**2.38**	**0.00**	**0.00**	**99.00**	**0.00**
Ag From UKL	min	0.00	1.89	15.89	24.21	37.69	33.88	22.29	1.19	0.00	135.83	1.19
	median	0.35	20.56	48.04	68.67	82.85	65.03	40.96	11.06	0.00	326.45	11.06
	average	1.61	22.03	48.34	66.96	77.55	64.01	39.22	11.06	0.29	319.73	11.35
	max	9.63	60.43	85.08	87.37	95.77	82.10	56.11	18.30	3.15	476.49	21.44
	SS2022 Projected Demand	**1.68**	**4.93**	**14.40**	**18.94**	**31.65**	**16.41**	**2.32**	**0.00**	**0.00**	**90.34**	**0.00**
	SS2022 to-date	**1.68**	**4.93**	**14.40**	**18.94**	**31.65**	**16.41**	**2.32**	**0.00**	**0.00**	**90.34**	**0.00**
Ady to Refuge	SS2022 to-date	**0.00**	**0.00**	**0.00**	**0.14**	**0.18**	**0.02**	**0.00**	**0.00**	**0.00**	**0.34**	**0.00**
Total LRDC	min	1.95	0.51	0.79	0.42	0.21	0.22	0.53	0.00	0.00	4.62	0.00
	median	13.15	7.09	8.15	6.36	4.91	5.98	9.56	8.47	4.97	55.20	13.44
	average	20.97	14.91	10.45	7.11	5.07	6.71	10.18	8.63	5.61	75.38	14.24
	max	113.34	72.30	80.17	31.84	11.21	18.35	42.06	32.65	17.09	369.26	49.74
	SS2022 to-date	**1.54**	**1.63**	**1.40**	**1.06**	**0.43**	**0.36**	**0.06**	**0.00**	**0.00**	**6.48**	**0.00**
To KR from LRDC	min	-9.62	-33.88	-32.55	-34.55	-42.59	-36.49	-14.02	-8.51	-23.95	-203.71	-32.45
	median	7.01	0.24	-5.42	-20.91	-25.54	-15.67	-1.76	1.15	-2.02	-62.06	-0.88
	average	14.63	4.63	-4.75	-21.10	-24.55	-15.08	-0.37	2.33	-1.78	-46.58	0.56
	max	109.30	69.50	75.92	17.74	-7.36	0.17	33.92	26.99	10.99	299.17	37.97
	SS2022 to-date	**-2.41**	**-2.34**	**-6.53**	**-10.31**	**-22.58**	**-11.75**	**-2.32**	**0.00**	**0.00**	**-58.26**	**0.00**
LRDC to Ag	min	0.23	0.31	0.76	0.42	0.21	0.22	0.53	0.00	0.00	2.68	0.00
	median	5.39	4.03	4.96	5.64	4.63	5.89	5.71	4.35	4.14	36.25	8.48
	average	4.75	4.15	5.29	6.05	4.78	6.04	5.67	4.43	3.87	36.73	8.29
	max	10.59	11.49	12.97	13.31	9.76	13.94	13.19	9.77	6.74	85.24	16.51
	SS2022 to-date	**1.42**	**1.63**	**1.40**	**1.06**	**0.43**	**0.36**	**0.06**	**0.00**	**0.00**	**6.357**	**0.00**
Total F&FF	min	0.28	3.07	0.51	0.35	0.22	0.01	0.22	0.39	0.17	4.65	0.56
	median	17.58	9.10	9.27	9.67	6.36	5.14	4.81	2.42	2.12	61.94	4.55
	average	19.07	10.66	9.86	8.63	6.27	6.57	5.64	3.12	4.79	66.71	7.91
	max	37.00	31.18	23.82	17.38	15.76	16.15	17.17	8.81	20.85	158.47	29.66
	SS2022 to-date	**1.25**	**0.75**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**2.00**	**0.00**
F&FF to Ag	SS2022 to-date	**1.25**	**0.69**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1.95**	**0.00**

District	SS2022-to-date Total Diversion*
KID	46.063
TID	29.759
KDD	23.187

*Excludes LRDC, F&FF, Sukraw offset

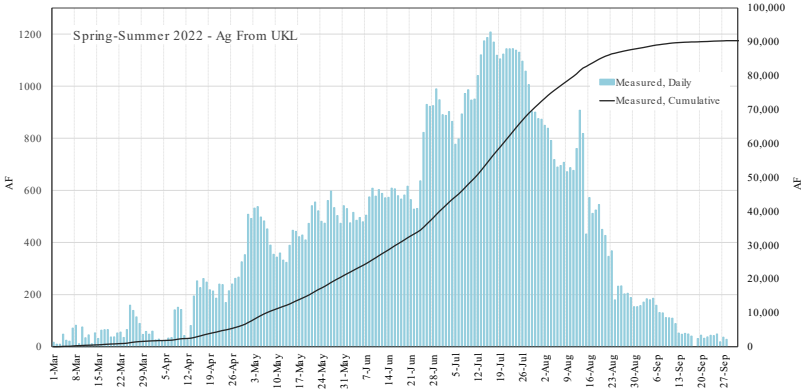

Table A- 14. Example of Reclamation Daily Numbers report.

From: Bureau of Reclamation
Ph: (o) 541-880-7506 (c) 541-891-6956
Fax: 541-884-9053

Water Data*

Date	UKL ELEV	UKL STORAGE	LINK RIVER DAM	KENO POWER CANAL	A CANAL	KENO DAM	IRON GATE DAM	WILSON DAM	STATION 48	MILLER HILL PUMPS	LOST RIVER DIVERSION CHANNEL (LRDC)	TO LOST River FROM Klamath	FROM LOST River TO Klamath	SUKRAW WELLS	STUKEL PUMPS (KID)	ADAMS PUMPS (KID)	F+FF TO Klamath River	NORTH Canal	ADY Canal	ADY To Refuge	North+ADY TOTAL	(F/FF - North/ADY) NET TO Klamath River	Keno Impoundment Net Accretions	Net Increase/Decrease Inflow to Klamath River
	FT	AF	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS	CFS
8/24/2022	4139.11	210,749	820	15	0	609	905	0	25	0	17	8	0	0	0	0	0	83	0	0	83	(83)	(134)	(92)
8/25/2022	4139.09	209,359	850	15	0	616	903	0	25	0	2	23	0	0	0	0	0	96	0	0	96	(96)	(130)	(119)
8/26/2022	4139.07	207,969	879	15	0	616	897	0	25	0	0	25	0	0	0	0	0	96	0	0	96	(96)	(157)	(121)
8/27/2022	4139.05	206,584	886	15	0	617	906	0	25	0	0	25	0	0	0	0	0	81	0	0	81	(81)	(178)	(106)
8/28/2022	4139.03	205,204	885	15	0	617	904	0	25	0	0	25	0	0	0	0	0	83	0	0	83	(83)	(175)	(108)
8/29/2022	4139.02	204,513	897	15	0	674	899	0	25	0	0	25	0	0	0	0	0	76	0	0	76	(76)	(137)	(101)
8/30/2022	4138.99	202,442	920	15	0	770	897	0	25	0	0	25	0	0	0	0	0	59	0	0	59	(59)	(81)	(84)

*Data are provisional and subject to revision

250	Wednesday, August 31, 2022
250	Thursday, September 1, 2022
250	Friday, September 2, 2022
260	Saturday, September 3, 2022
260	Sunday, September 4, 2022
260	Monday, September 5, 2022
260	Tuesday, September 6, 2022
260	Wednesday, September 7, 2022
260	Thursday, September 8, 2022
260	Friday, September 9, 2022

Table A- 15. Example of PacifiCorp Accretions Forecast.

Appendix B – A Canal Fish Evaluation Station Endangered Sucker Monitoring Annual Report, 2022

Klamath Project, Oregon/California
Interior Region 10 California Great Basin

Cover Photo: Sampling flume in the Fish Evaluation Station at A Canal, Klamath Project. Photo by Darin Taylor.

Executive Summary

Reclamation's A Canal is the largest agricultural diversion in Oregon and draws water from UKL, home to the largest populations of two species of endangered catostomids: LRS, and SNS. A fish screen was installed at the A Canal intake in 2003 and includes a pumped bypass that returns screened fish to the lake. To estimate entrainment of suckers at the screen each year, Reclamation samples the bypass facility one night a week until sucker catches are greater than ten in one 6-hour sampling period or until August 1 to ensure Reclamation captures the peak of juvenile sucker entrainment, and the ascending and descending limbs of the catch curve. Once Reclamation reaches this limit, sampling occurs four days a week at 30-minute intervals during the peak period (20:00 – 02:00 hours) until September 30.

Sampling at the FES for suckers did not occur in 2022 because there were safety concerns about working during the night at this location in 2022. Irrigation supply from Upper Klamath Lake was limited and less water passed through A Canal to the Klamath Project than typically would. Based on the small amount of irrigation supply through the A Canal, Reclamation was well below the allowable Incidental Take for this location (see Appendix C.). The pumped fish bypass operated full-time starting July 13 through August 22, 2022.

Introduction and Background

The purpose of this A Canal FES Entrainment Monitoring Report (Report) is to meet certain requirements outlined in the USFWS April 2020 *Biological Opinion on the Effects of Proposed Klamath Project Operations from April 1, 2020 through September 30, 2022, on the Lost River sucker and the Shortnose sucker* (BiOp).

The BiOp requires Reclamation to monitor entrainment of listed suckers resulting from Project operations. T&C 1a requires Reclamation ensure that no unnecessary actions are taken that increase entrainment [of listed suckers] at the LRD. The associated M&RR l.la requires monitoring of entrainment at the A Canal FES. Specifically, M&RR l.la requires that Reclamation monitor entrainment of age-0 and age-l suckers at the A Canal FES annually from August 1 through September 30 with a level of effort enough to determine when the peak of entrainment occurs, and to provide an accurate estimate of the number of suckers entrained during the peak.

Monitoring entrainment at the A Canal FES is a cost-effective method for obtaining the information required under M&RR 1.la and provides a good indication of annual juvenile sucker production and condition. Historic monitoring data shows there is a defined pulse and resultant entrainment peak. The goal of the monitoring effort is to collect data that covers the peak entrainment period for suckers. As such, Reclamation, in close coordination with the Service, developed the A Canal FES Entrainment Monitoring Plan (Plan).

This report was developed to meet the RRs outlined in the 2020 BiOp, and includes monitoring results, estimates of entrainment, and notable observations associated with entrainment and fish condition.

The BiOp specifies that the A Canal FES entrainment monitoring effort will begin no later than August 1 of every year and continue until no suckers are collected at the FES in each week or through September 30, whichever comes first. According to the BiOp, under certain circumstances, it may be necessary to implement entrainment monitoring earlier than August 1 and later than September 30. In all such instances, Reclamation will coordinate with the Service to determine whether initiation or shutdown is warranted outside of the dates specified in the Plan and the BiOp.

Nightly monitoring begins at 2000 hours and continues until 0200, unless through coordination with the Service it is decided that sampling should occur during other periods. If the scheduled sampling period falls on a federal holiday or weekend, samples are not taken.

Methods

The A Canal fish screen and bypass system collects fish which have been screened from entrainment and returns them back to UKL above the LRD (Figure B-1; Figure B-2). The bypass system is bifurcated into a primary pump-based system and a secondary gravity-based system. The primary pump bypass system is operated with a fish-friendly hydrostal helical pump which lifts fish into a pressurized pipeline then flows through an open flume inside the FES before fish are discharged through an outfall pipe in UKL. The secondary bypass is a 3,500-foot gravity flow system which discharges fish into the Link River immediately downstream of LRD.

The gravity bypass operates from the start of the irrigation season (typically April 1) until the pump

system begins to operate (always prior to August 1, typically around July 15). In 2021, sampling did not occur because no water deliveries were made from the A-Canal. However, when sampling does occur, the pump system operated from early or mid- July to October 31. Fish are monitored at FES when the pumped bypass system is operated, typically from August 1 through September 30, with a level of effort enough to determine when the peak entrainment occurs and to provide an accurate estimate of the numbers of suckers larger than 30 mm entrained during the peak (see the Plan for further information).

Fish are sampled using a modified 0.25-inch mesh net fitted securely into reinforced slots within the flume walls. The net consists of an aluminum frame mouth 6 feet wide by 5 feet high, with four semi-rigid rings that hold the throat of the net open and taper it down over fifteen feet, terminating in a customized, triangular-shaped aluminum trap box. The reinforced cod end connects to the trap box via pipe clamps over a cylindrical opening. The interior of the trap box is baffled to prevent fish impingement against the terminal end. There are two removable slide gates to release the fish and water trapped within the box when sampling is complete: a main gate in the box floor and a second at the terminal end.

Sampling is conducted by first lowering the trap box and then the net mouth frame into the flume slots using a 1,000-lb bridge crane. The net throat and trap box are pulled downstream to remove bends and to ensure that fish are swept into the trap box. At the end of the sample, the bridge crane is used to lift the net mouth frame and then the trap box out of the flume. The trap box is partially drained before its contents are released into holding containers of UKL aerated water with appropriate conditions (e.g., similar temperature) to reduce stress to the fish. Additionally, water quality measurements are taken every hour to ensure suckers are being held in a suitable environment and to prevent shock or additional stress to suckers.

Sampling crews visually inspect the trap to ensure that all fish and debris are removed. Suckers and non-suckers (bycatch) are sorted from this holding tank as quickly as possible. Processing consists of a complete count of captured suckers and the following measurements on all suckers: SL (mms), weight (grams), and fish health observations (abrasions, parasites, etc.). When 100 suckers are present, every tenth sucker is measured according to the process outlined in the Plan, with a minimum of 50 individuals measured. This is done to minimize risk to suckers while still obtaining the targeted information.

Bycatch is estimated for each species in each net pull using bins: 1-10, 11-25, 26-50, 51-100, 101-200, 201-300, 301-500, and 501-1000. These bins have been used since 2016. Juvenile suckers, sculpin, and lamprey cannot be identified to species because phenotypic characteristics are not well developed, and species-specific identification is extremely difficult, and time consuming. The general physical condition of suckers was recorded, and specific health information was documented including incidence of injuries, disease, and parasites.

To estimate the total number of juveniles (> 30 mm SL) entrained into the A Canal and returned to the lake through the pumped bypass system over the entire season, Reclamation used a simple 5-day smoothing average, and then simply interpolated between nearest neighbors for the nights that weren't sampled. The earliest two and last two samples of the season were only averaged across three and four samples because of the limits of the data.

To quantify take for all nights, each interpolated or calculated CPUE was multiplied by 12 (reflecting 12, 30-minute sample periods between 20:00 and 02:00) and summed to yield an estimated number of juvenile suckers processed through the FES during the sample period. Previous studies (Laeder

and Wilkens 2010) found the majority of entrainment of juvenile suckers occurs between 2000 hours and 0200 each night, thus Reclamation samples during these hours to originate our entrainment estimate. Water quality measurements were taken hourly using sondes in front of the trash rack at FES.

Results

Sampling at the FES for suckers did not occur in 2022 because there were safety concerns about working during the night at this location in 2022. Irrigation supply from Upper Klamath Lake was limited and less water passed through A Canal to the Klamath Project than typically would. Based on the small amount of irrigation supply through the A Canal, Reclamation was well below the allowable Incidental Take for this location (see Appendix C.). The pumped fish bypass operated full-time starting July 13 through August 22, 2022.

Recommendations

Reclamation and the Service should consider the following recommendations to further improve the sampling process and/or maximize the utility of the FES sampling effort to benefit federally listed suckers:

1. Reclamation should continue to begin sampling at the FES prior to August 1. The earlier sampling could occur one night a week, until catches meet a certain Catch Per Unit of Effort. With this approach Reclamation would coordinate with the Service and agree to a CPUE at which full-time sampling (four nights a week) should commence. This approach could provide more accurate entrainment estimates and improve the likelihood of capturing the peak timing by collecting more data during the ascending and descending limbs of the catch curve.

2. Continue to establish more robust data collection for afflictions observed. For example, typically only the most severe affliction per sucker is identified while many fish have several afflictions. Additionally, a fish health rating system could be established to better analyze afflictions observed at FES Station. More consistent and robust affliction data collection would allow for the comparison of afflictions among years.

3. Conduct a robust analysis on all years, including pre 2013 data before more establish protocols were established and report of all FES entrainment data available and assess trends relative to other research and monitoring efforts including juvenile and adult sucker monitoring, water quality, and weather patterns.
4. In 2020, Reclamation recaptured a juvenile PIT-tagged sucker for the first time in FES sampling history. The sucker was originally captured during salvage event at A Canal forebay in 2019. It was held and treated by USFWS and released at Malone Springs in December of 2019. With more suckers be introduced back into UKL, FES could be a useful site in tracking and assessing movement of juvenile suckers if used in coordination with other antenna arrays.

Figures and Tables

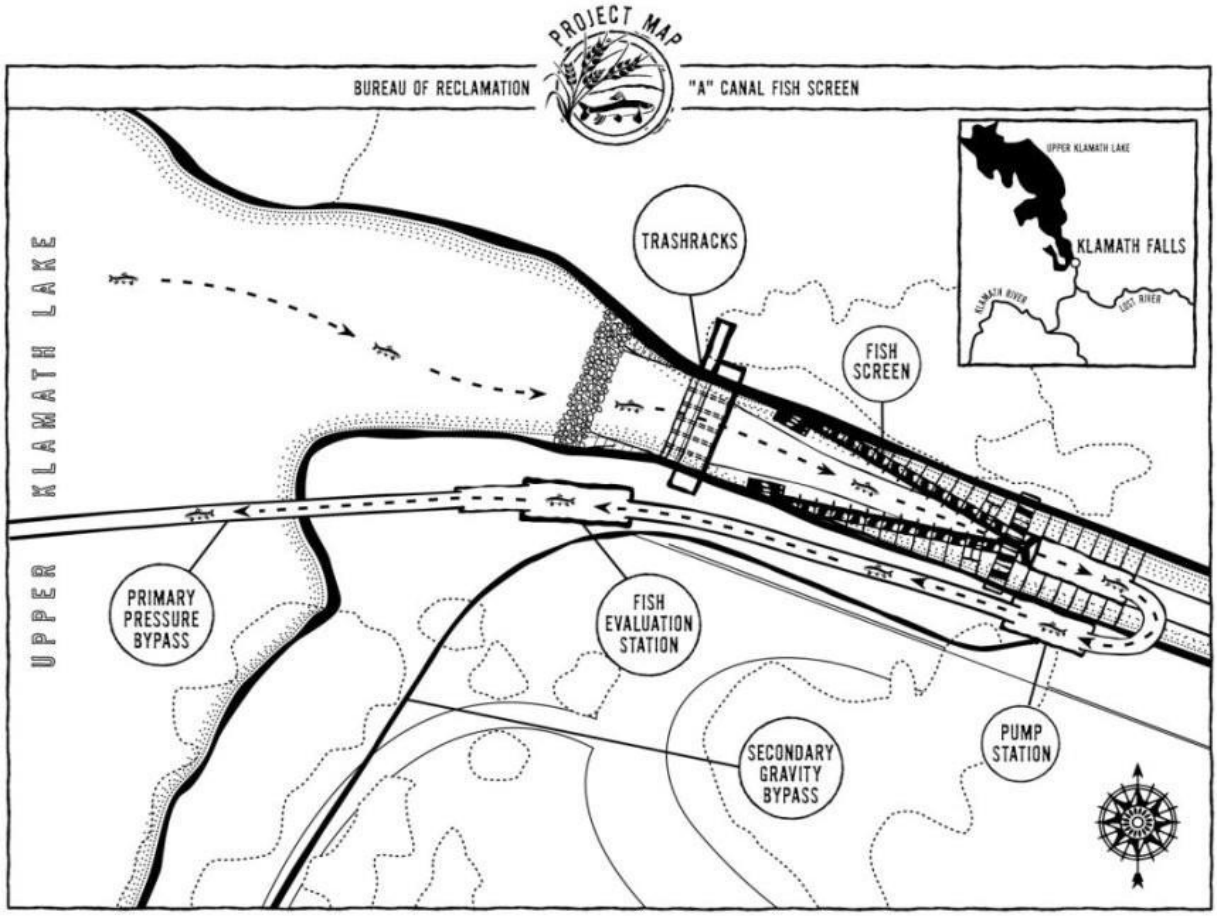

Figure B- 1. The Fish Evaluation Station at the A Canal headworks in Klamath Falls, Oregon

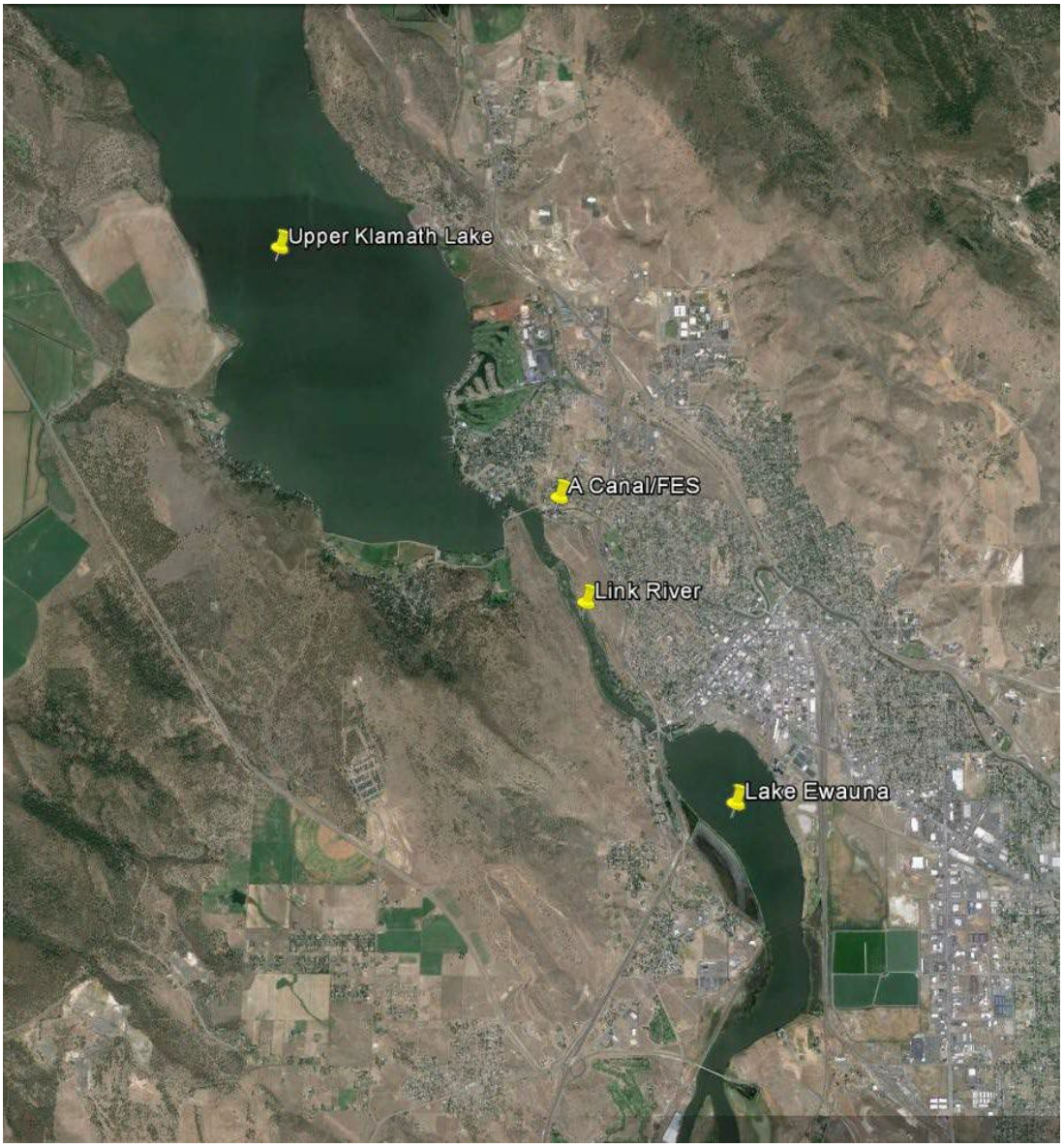

Figure B- 2**.** Location of the A Canal and Fish Evaluation Station in relationship to Upper Klamath Lake, the Link River, and Lake Ewauna.

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Appendix C – Klamath Project Canal Salvage Annual Report, 2022

Klamath Project, Oregon/California
Interior Region 10 California Great Basin

Cover Photo: Reclamation's fisheries field crew salvaging fish from the J Canal during irrigation drawdown, December 2017. Photo credit: Darin Taylor.

Executive Summary

The Klamath Project (Project) delivers water to approximately 200,000 acres of irrigated land in the Upper Klamath River Basin, located in southern Oregon and northern California. The Project includes hundreds of miles of irrigation canals, and several large lakes and reservoirs, including Upper Klamath Lake, Clear Lake, and Gerber Reservoir. In most years, nearly 260,000 acre feet of water is delivered through the A Canal system from Upper Klamath Lake (UKL) during the season of April through September. Additional irrigation water is supplied to parts of the Lost River drainage from multiple surface and groundwater inputs throughout the Lost River sub-basin. Salvage operations occur at the end of irrigation season during dewatering of the canals.

Since 2005, salvage efforts have focused on the A Canal forebay, and sites within J, C, and D Canals. Since 2008, suckers salvaged from the A Canal forebay and from sites in the Klamath Irrigation District and Tulelake Irrigation District have been implanted with Passive Integrated Transponder tags.

During the 2022 salvage effort 436 juvenile suckers were salvaged from A Canal forebay, no suckers were salvaged from J canal. J canal was not dewatered at the end of irrigation season, however site J70 was disconnected and salvaged but yielded no suckers. Zero juvenile sucker were captured in the C and D Canals (Table1). Lost River Diversion Channel (LRDC) was dewatered for maintenance, salvage effort found no suckers. TID removed an earthen dam along the lost river during October 2022, BOR staff made an effort to salvage suckers prior to removal, no suckers were found. Because no suckers were found at any salvage location apart from A Canal, (which does not reflect actual effort due to the use of electrofishers or nets to capture fish) CPUE was not calculated for this report. All salvaged suckers from A canal forebay were taken to Klamath Falls National Fish Hatchery (KFNFH Figure 2).

Introduction and Background

The purpose of this Klamath Project Lost River and Shortnose Sucker Salvage Report is to meet certain requirements outlined in the National Marine Fisheries Service and U.S. Fish and Wildlife Service's May 2013 Biological Opinions on the Effects of Proposed Klamath Project Operations from May 31, 2013 through March 31, 2023, on Five Federally Listed Threatened and Endangered Species (BiOp). The Proposed Action analyzed in the BiOp includes a Conservation Measure proposed by Reclamation to continue fish salvage in certain Klamath Project Canals, in cooperation with the U.S. Fish and Wildlife Service (Service), consistent with the salvage efforts that have occurred in Project Canals since 2005. Specifically, the Conservation Measure proposed to perform salvage activities in the C4, D1, and D3 Canals within the Klamath Irrigation District (KID), and the J Canal within Tulelake Irrigation District (TID). Other locations proposed for salvage by the Service will be considered by Reclamation on a case-by-case basis. As part of the canal Salvage Conservation Measure, Reclamation may also research alternative methods of dewatering canals, laterals, and drains which could result in reduced sucker presence within these facilities at the end of irrigation season. Should Reclamation determine that fish salvage at specific locations is no longer needed or can be modified, Reclamation would coordinate with the Service.

The 2020 BiOp also includes Mandatory Monitoring 1c which requires Reclamation to optimize salvage of listed suckers from Project Canals and include these results in the Annual Monitoring Report. Effective salvage operations are especially critical in years when there is an abundance of age-0 suckers. As such, Reclamation is also required to consider potential production in its annual salvage plans. Reclamation's A Canal Fish Evaluation Station monitoring provides for a variety of information including the relative abundance of age-0 suckers in Upper Klamath Lake and has been used to inform the level of salvage effort necessary. Project Canal salvage is a cost-effective method for returning suckers to their natural environment where the opportunity exists for long-term survivorship and contribution to population growth. As such, in the fall of 2015, and, in close coordination with the Service, Reclamation developed the Klamath Project Lost River and Shortnose Sucker Salvage Plan (Plan). The goal was to salvage Lost River and shortnose suckers in a collaborative manner as soon as irrigation season ends and to affect the most benefit to the species. Therefore, the Plan provides for an efficient and cost-effective method to salvage Lost River and shortnose suckers from Project canals that maximizes the benefit to the species as required by the BiOp.The purpose of this Klamath Project Lost River and Shortnose Sucker Salvage Report is to meet certain requirements outlined in the National Marine Fisheries Service and U.S. Fish and Wildlife Service's May 2013 *Biological Opinions on the Effects of Proposed Klamath Project Operations from May 31, 2013 through March 31, 2023, on Five Federally Listed Threatened and Endangered Species* (BiOp).

Coordination

As required by the BiOp, Reclamation coordinated with the Service, TID, and KID prior to implementing the 2022 salvage operations and throughout canal dewatering. Some effort was made to salvage C, and D canals but no suckers were found. The Service and USGS, aided salvage efforts at the A Canal forebay, which significantly reduced sucker handling time. KID staff was also on site during A Canal forebay salvage activities and assisted in monitoring water levels associated with dewatering the canal forebay. Additionally, TID did not dewater J Canal in order to recharge ground water supply. TID also coordinated removal of an earthen dam along the Lost River. With the exception to site J70 which contained some standing water disconnected from other canal sites, there was no salvage effort within the J canal at the end of 2022 irrigation season (Figure 1).

Timing

Salvage activities in the A Canal forebay were performed on December 8, and December 12, 2022. Due to maintenance of bulk heads salvaging of A canal forebay occurred over a month later than normal. C and D canals were salvaged November 2, 2022. TID did not dewater J canal after the 2022 irrigation season, however some water was present in site J70 and was salvaged November 17, 2022. LRDC was dewatered September 2022, and salvaged September 16, 2022. An earthen dam was removed from Lost River October 20, 2022, an effort was made to salvage in suckers in front of the dam October 6, 2022, no suckers were found.

Methods

Salvage efforts at the A Canal forebay upstream of the fish screen were performed in coordination with the Service. Bulkheads were removed at the beginning of irrigation season and taken to KID for maintenance. Due to the extended period of maintenance on the bulkheads they were not placed back until December 1, 2022. Aerators and agitators were place for oxygenation and ice mitigation. KID and Reclamation monitored the forebay during the dewatering process until fish salvage began December 8, 2022. Water level in the forebay was maintained for 24 hours to allow groundwater around the structure to drain. After the initial 24 hours, the valve providing bypass flow around the bulkhead was opened to provide water flow-through. Water levels were then lowered at an approximate rate of one foot per 24-hour period by allowing slightly more water to drain through the head gates than was provided through the bypass valve.

Salvage of the A Canal forebay was conducted on December 8, and 12, 2022 using seines and backpack electrofishers once a water depth of approximately 18-24. For effective and safe capture of fish, conductivity measurements were taken prior to canal electroshocking to help determine the necessary voltage. A Canal forebay conductivity tends to measure around 100 μS/cm, and canal salvage sites vary between 100 and 500 μS/cm. Bycatch was immediately returned to Upper Klamath Lake (UKL), west of the bulkheads at the trash rack. Suckers were held on site in tanks with KFNFH aerated water and appropriate temperature and salinity (approximately 1%) to reduce stress to the fish. Once the majority of the fish were removed, as determined by fewer than 100 fish captured during a sweep of the forebay, bypass flows were ceased and the forebay and fish screen was fully dewatered to a depth of 4 inches.

The abundance of bycatch was estimated as they were released back into the system from which they were collected. Collected suckers were transported in covered tanks according to the *Fish Handling Guidelines for Salvaged and Transported Klamath Basin Suckers* protocol developed by Reclamation (2008).

Results

A summary of suckers caught during the 2022 salvage season, related to past years results are included in Figure 3. Zero suckers were salvaged from the Klamath Project Canals, 436 juvenile suckers from A canal forebay, (Table 1). Zero suckers were captured in the C, D, LRDC, Lost River, and J Canals. All suckers from A canal forebay were transported and released at KFNFH under the responsibility of the U.S. Fish and Wildlife Service.

Reclamation estimated non-sucker bycatch as follows: blue chub (236,470), tui chub (203,150), fathead minnow (135,255), yellow perch (101,750), sculpin spp. (200), goldfish (585), brown bullhead (15), pumpkinseed (215), and largemouth bass (10) (Table 2). Bycatch at A Canal forebay

were released back into Upper Klamath Lake above the headgates, whereas bycatch within LRDC, Lost River, J, C, and D canals were released at the site of capture.

Discussion

Suckers salvaged from the A canal forebay, subsequently tagged and released into UKL, may provide biologists with meaningful information about juvenile suckers.

A comparison of the numbers of endangered suckers salvaged throughout Project Canals over the last 17 years reveals substantial variation in sucker capture rates. It is possible that some of this variation may be attributed to fluctuating water deliveries or salvage effort, more in depth anaylisis would be required to understand any relationship between suckers salvaged and project water release.

Later than average dewatering of A canal forebay due to maintanace of bulkheads caused an increased effort associated with snow and ice. December weather can be unpredictable and could potentially make salvage impossible. KID and BOR should make efforts to not repeat such a late salvage in the future.

Recommendations

Future recommendations include:

1) Continue to give salvaged suckers to KFNFH.
2) Make efforts toward earlier salvage, December weather is to unpredictable.
3) Continue the same level of coordination between agencies, along with weekly salvage updates during salvage operations.
4) Continue to gradually acclimate suckers to temperature differences between holding tanks and release ponds at KFNFH.
5) Continue postponing PIT tagging, weighing, and measuring of salvage suckers until a time that they have been acclimated to KFNFH environments.

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Tables and Figures

Table C- 1. Summary of juvenile suckers salvaged from Klamath Project canals in 2022.

STATE	Canal	Site	Location description	UTM East	UTM North	2022
Oregon	A		A canal Forebay	598743	4676963	436
	C4	22	Miller Hill pumping plant	603128	4666343	-
	C4	22/23	between 22 & 23			-
	C4	23	Mac Check	603917	4665123	0
	C4	24	¼ mile S of Old Midland Rd.	603434	4664140	-
	C4	24/25	between 24 & 25	602753	4664526	-
	C4	25	¼ mile N of Old Midland Rd.	602141	4664625	-
	C4	26	1/8 mile west of Tingley Lane	601002	4664872	-
	C4	26b	¼ mile W of Tingley Lane	600900	4664736	-
	C4	26c	Check ¼ mile E of Tingley Ln.	601426	4665318	-
	C1	21	Adam's Flume area (S lat.)	613764	4654852	-
	C1	21a	Adam's Flume area (¼ S lat.)	613714	4654847	-
	D3	21	the check near site 21			-
	D3	20	Adam's Flume area (E lat.)	614120	4654933	-
	J	51	Anderson-Rose Dam	619184	4651944	-
	J	52	Check 1 and flume	621505	4651289	-
	J	53	S end of siphon	621537	4651657	-
	J	54	Check 2 (Check # C61010)	623272	4651694	-
	J	55	Check 3 (Check # C61016)	625700	4651923	-
	J	56	Check 4	627334	4651403	-
	J	57	Check 5	631061	4650688	-
	J	57a	North of stateline Rd at RR Xing	629028	4651413	-
California	J	58	Check 6 – S of Stateline Road	632352	4650628	-
	J	59	Check 7	634861	4648454	-
	J	60	Check 8 - D&J confluence	636333	4646278	-
	J	61	Check 9	636947	4643589	-
	J	62	Check 10	637823	4642453	-
	J	63	Check 11	637985	4640807	-
	J	64	Check 12	636846	4638865	-
	J	64/65	Culvert between sites 64 & 65	636056	4639656	-
	J	65	Check 13 (Check # C71113)	635770	4639596	-
	J	65/66	Culvert between sites 65 & 66	635360	4639471	-
	J	66	Culvert E of Highway 139	634874	4639183	-
	J	67	RR Bridge W of Highway 139	634282	4638730	-
	J	68	Check 14	633607	4638622	-
	J	69	Culvert at County Rd. 112	632874	4637953	-
	J	70	Pump 24 (tail end of J-canal)	631334	4636676	0
					Total:	436
- site was not salvaged, or could not be salvaged due to low water levels and/or heavy icing						

Table C- 2. Estimated non-sucker species catch during 2022 fish salvage efforts. FHM-fathead minnow, PS-pumpkinseed sunfish, GF-goldfish, YP- yellow perch, SP- Sacramento perch, SCP- unidentified sculpin species, SD- speckled dace, BB- brown bullhead, CR- unidentified crappie species, LMB- largemouth bass.

2022 Salvage	Blue Chub	Tui Chub	FHM	PS	GF	YP	SP	SCP	SD	BB	CR	LMB	LMP
A-CANAL /FORBAY	236250	202,500	135,000	200	5	101,250	200			10			
C4-22													
C4-22/23													
23	10	40	50		100								
24													
24/25													
25													
26													
26b													
26c													
D1-21													
D1-21a													
D3-21													
D3-20													
J-51													
J-52													
J-53													
J-54													
J-55													
J-56													
J-57													
J-57a													
J-58													
J-59													
J-60													
J-61													
J-62													
J-63													
J-64													
J-64-65													
J-65													
J-65-66													
J-66													
J-67													
J-68													
J-69													
J-70	10	200	200		100								
LRDC	200	400		15	350	500		20		5		10	
Lost River		10	5		30								
Totals=	236,470	203,150	135,255	215	585	101,750	200	20	0	15	0	10	0

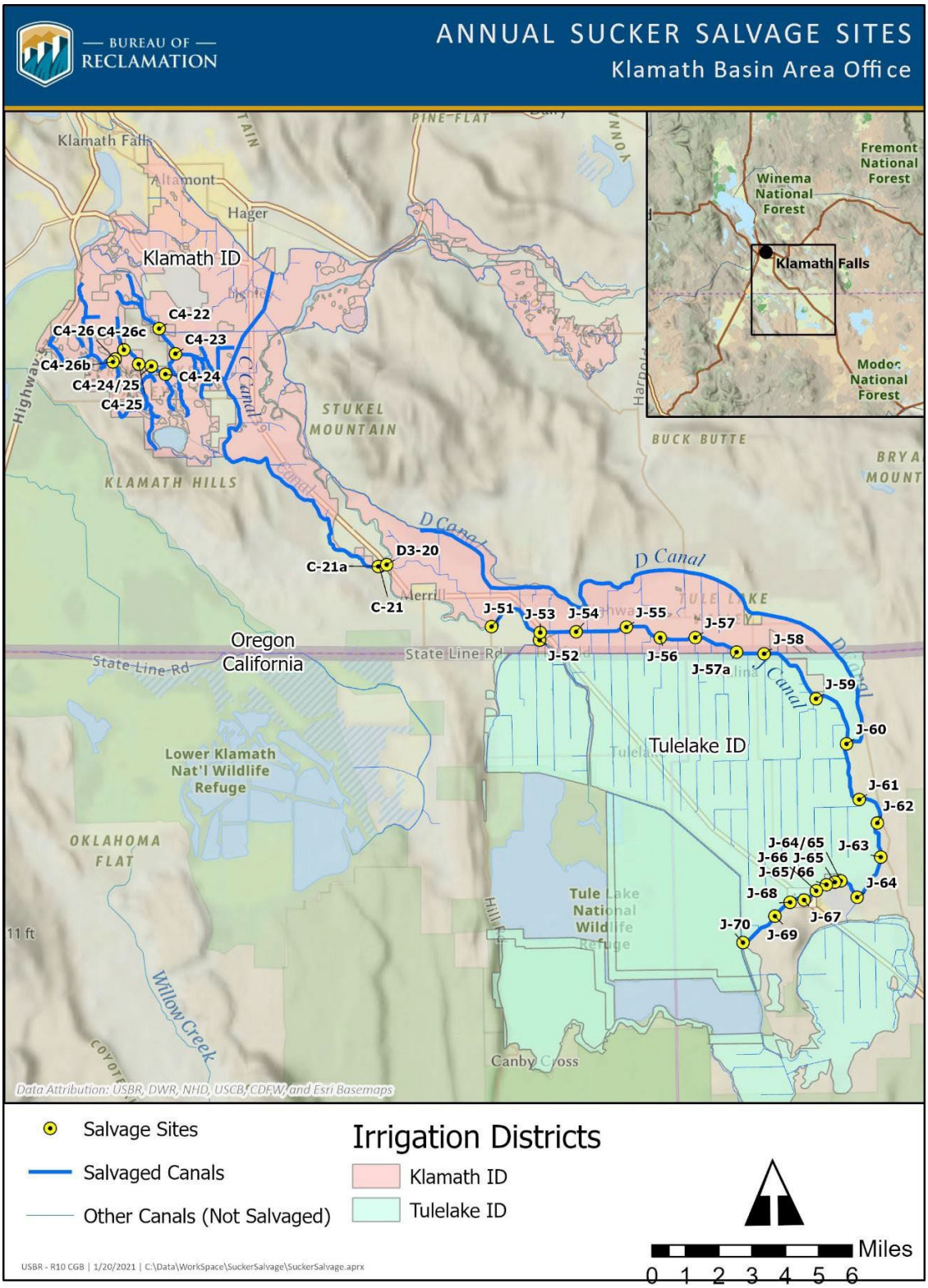

Figure C- 1. Map of Klamath Project canal system and canal salvage sites.

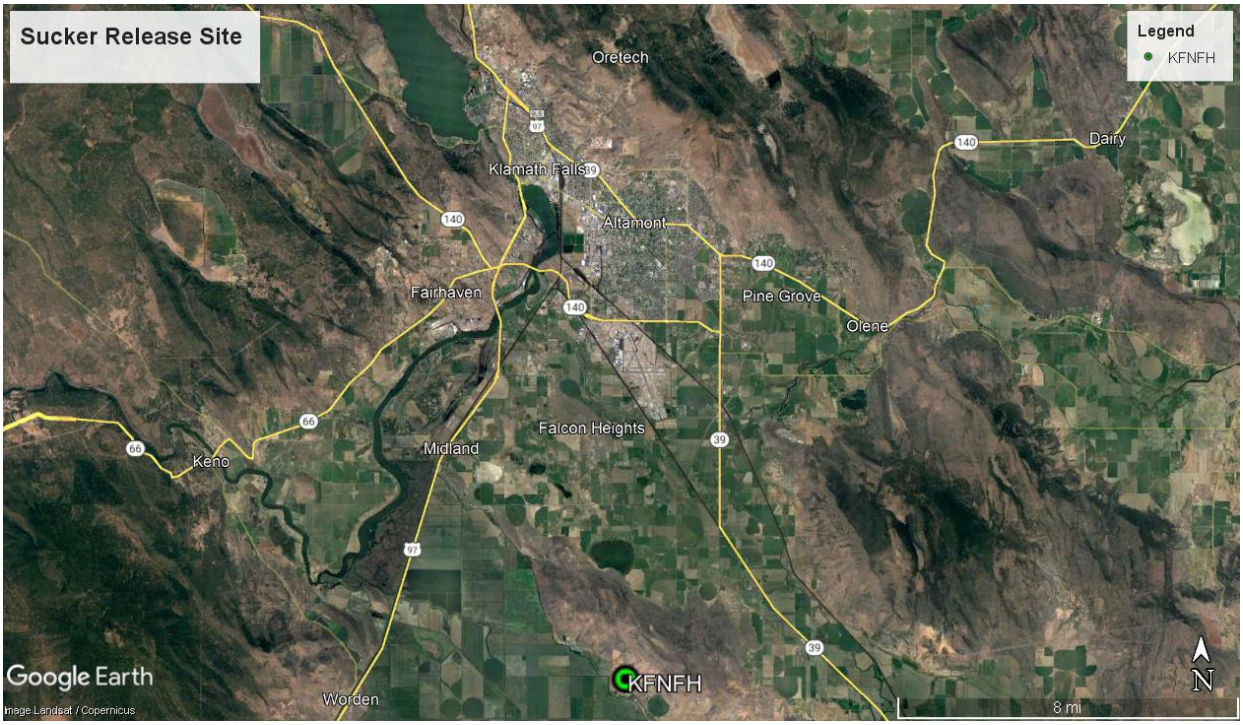

Figure C- 2. Map of sucker release sites in 2022.

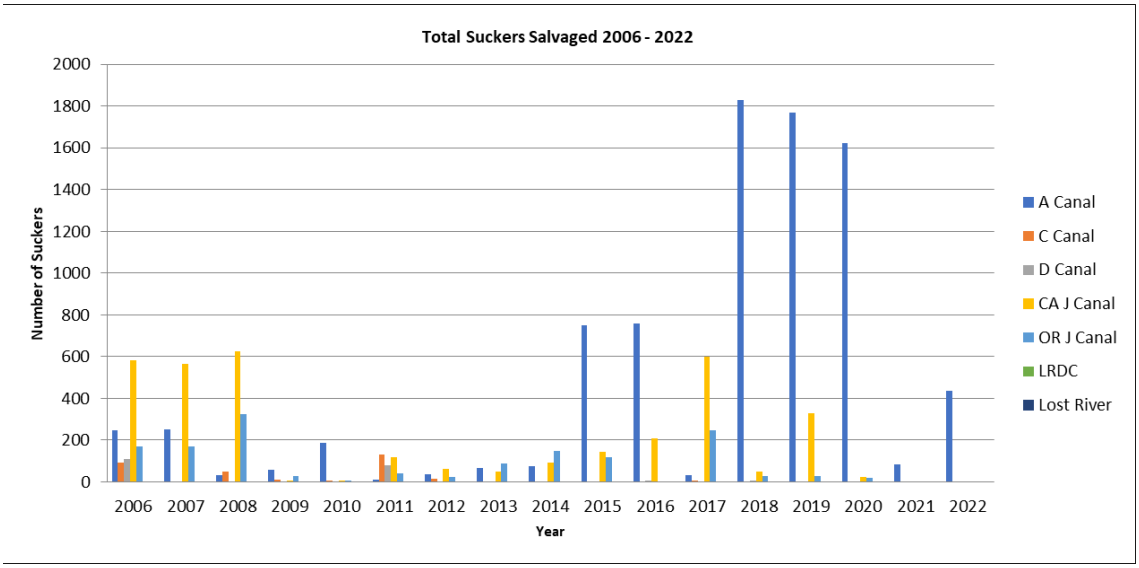

Figure C- 3. Number of endangered suckers captured at several Klamath Project canals, 2006-2022.

Appendix D – Passive Integrated Transponder-tagging Endemic Adult Suckers in Gerber Reservoir, 2022

Klamath Project, Oregon/California
Interior Region 10 California Great Basin

Cover Photo: Trammel nets set on May 10, 2022 at the Gerber Dam boat ramp to target spawning suckers.

Executive Summary

Gerber Reservoir is one of three major reservoirs in the Upper Klamath Basin in south-central Oregon inhabited by endangered SNSs (USFWS 1988). The dam was built in 1925 by Reclamation to store water from Miller Creek for irrigation of lands in Langell Valley and to prevent flooding of agricultural lands in Tule Lake district (Darr 1925). Suckers in Gerber Reservoir have been intermittently monitored during the last three decades. More recent monitoring efforts were conducted by USGS in 2000, 2003, 2004, and 2005 (Piaskowski and Buettner 2003, Leeseberg et al. 2007, Barry et al. 2007). Over 2,000 suckers were PIT-tagged in 2004 and over 2,200 were PIT-tagged in 2005 by USGS. While relatively large numbers of suckers have been captured in Gerber Reservoir, it is unclear how large these populations are especially as available habitat for suckers has fluctuated with surface elevations. Gerber was below the 2013 BiOp minimum of 4,798.1 ft (4,797.9 feet) in 2016, then increased to 4,835.4 ft and spilled in 2017 and 2019 (NMFS and USFWS, 2013). Surface elevations were intermediate at the end of water year 2020 (4,815.74), and low at the end of water year 2021 (4,799.57ft) and 2022 (4,798.23 ft). Suckers in Gerber Reservoir have been geographically isolated from other sucker populations since the construction of Gerber Dam (Piaskowski and Buettner 2003, Reclamation unpublished data 2018) and species identification is especially challenging as some individuals have characteristics of non-listed KLS, suggesting introgression.

To better understand sucker abundance in Gerber Reservoir, Reclamation reinitiated an adult sucker monitoring program in 2018 (Reclamation 2022-compliance report). Annual spring sampling in Gerber Reservoir was curtailed in 2021 so Reclamation staff could assist USFWS in a sucker relocation effort in Tule Lake Sump 1A and did not occur in 2022 due to low surface elevations, and salvage efforts at Tule Lake Sump 1B. However, three trammel nets were set near the boat ramps on May 5 (1) and May 10 (2) after suckers were observed spawning in the area.

Introduction

Shortnose suckers were federally listed as endangered in 1988 throughout their range (USFWS 1988). SNSs are endemic to the Klamath Basin and co-occur with LRSs), another federally listed endangered sucker endemic to the Klamath Basin, and KLSs, a non-listed species that is similar in morphology to SNSs (Markle et al. 2005). SNSs are long lived fish and have been aged up to 30 years in UKL (Scoppettone 1988, Buettner and Scoppettone 1990, Terwilliger et al. 2010).

Gerber Reservoir is one of three major reservoirs in the Upper Klamath Basin in south-central Oregon. The dam was built in 1925 by Reclamation to store water from Miller Creek for irrigation of lands in Langell Valley and to prevent flooding of agricultural lands in Tule Lake district (Darr 1925). Ben Hall Creek and Barnes Valley Creek are major tributaries to Miller Creek and now, Gerber Reservoir. There is one federally listed species in Gerber Reservoir; SNSs. LRSs are not known to occur in Gerber Reservoir. Ben Hall Creek, Barnes Valley Creek, and possibly Barnes Creek provide spawning habitat for suckers. Suckers make spawning migrations in the spring, in years when tributary flows and lake elevations are sufficient for suckers to access these habitats. Spawning surveys in 2006 detected approximately 1,700 SNSs of the nearly 2,400 that had been tagged the previous year (Barry et al. 2007a). Spawning migrations have not been regularly monitored by remote antennas. However, in 2006 suckers were present in tributaries from early March to mid-May (Barry et al. 2007). Some suckers in Gerber have demonstrated great mobility; moving among spawning tributaries at opposite ends of the reservoir within 24 hours (Barry et al. 2007).

Due to fluctuations in surface elevation, suckers in Gerber Reservoir have endured large fluctuations in habitat size (reservoir down to 4,796 feet in the early 90s and 4,797.9 feet in 2016) and have remained geographically isolated from other sucker populations in the basin since dam construction in 1925 (Piaskowski and Buettner 2003). Gerber is 3769 acres in surface area (94,270 acre-feet storage capacity) when it is at its maximum (spill) surface elevation of 4,835.4 ft, and 339 acres in surface area (1308 acre-feet capacity) when at a Biological Opinion minimum of 4798.1 ft (USFWS 2020; Reclamation, Unpublished Data). Reduced habitat and physical isolation from other sucker populations has likely restricted genetic variation and population size in the region.

In the field, KLS are differentiated from SNS based on habitat type and morphology of feeding structures characters. KLS, primarily residents of rivers, have larger, fleshy lips, while SNS have smaller lips and are primarily residents of lakes that make spawning migrations into river tributaries each spring (Markle et al. 2005). Species identification using morphology varies geographically and has been especially challenging in Gerber Reservoir and most reports have combined Klamath Largescale and SNS species (Piaskowski and Buettner 2003, Leeseberg et al. 2004, Barry et al. 2007). LRSs do not inhabit Gerber Reservoir. While lip morphology, mouth position, snout shape, and body shape are characteristics used in the field to identify species, other species-identification methods are lethal, such as counting vertebrae and gill rakers (Markle et al. 2005). Many factors influence sucker phenotype including habitat, age, size, region, and genetics. While recent advanced genetic analyses have been able to differentiate KLS and SNS in UKL and the Upper Williamson River, these assays have not yet identified different genetic markers between KLS and SNS in Gerber Reservoir (Smith et al. 2020). Due to the similarities between KLS and SNS, Reclamation follows USFWS guidance and treats all suckers in Gerber Reservoir as endangered.

Suckers in Gerber Reservoir have been intermittently monitored in the last three decades and less is known about suckers in Gerber than sucker populations in UKL and Clear Lake Reservoir.

Reclamation tagged an unknown number of suckers with floy tags and/or PIT-tags from 1992 to 1996 (Piaskowski and Buettner 2003) and USGS conducted monitoring in 2000 and 2003, and in 2004 PIT-tagged 2,023 suckers with 125 kHz PIT-tags and in 2005 PIT-tagged 2,275 suckers with 134.2 kHz PIT-tags.

In an effort to better understand the population dynamics and species status in Gerber, USBR began monitoring adult suckers in Gerber Reservoir in 2018. Reclamation's recent sampling efforts are summarized in annual reports. This report is a summary of Reclamation's reduced sampling and observations from 2022. Because the effort in 2022 was non-typical, we have summarized this effort separate from other annual monitoring.

Methods

Annual spring sampling in Gerber Reservoir did not occur in 2022 due to low surface elevations, and salvage efforts at Tule Lake Sump 1B. However, spawning suckers were observed and reported to Reclamation's fisheries staff in early May, and in response, trammel nets were set in Gerber Reservoir to confirm species and opportunistically tag suckers. On May 5, 2022 one net was set at the Ben Hall boat ramp (Photo D-1); on May 10, 2022 one net was set at the Ben Hall boat ramp and one net at the Dam Channel boat ramp (Photo D-2). Trammel nets used at boat launches were 15 to 20 m long, 1.8 m tall, and consisted of two outer panels with 30 cm bar mesh, an inner panel with 3.8 cm bar mesh, a foam core float line, and a lead core sink line.

All fish were removed from trammel nets as they were pulled from the water. Non-target species were identified to species, enumerated, and returned to the reservoir. Suckers were placed in a large, holding container with water from Gerber Reservoir on the shore. Suckers were measured to fork length and checked for the presence of a PIT-tag. If a PIT- tag was not detected, then a PIT tag was implanted under the skin anterior to the pelvic girdle using a hypodermic needle. Sucker sex and spawning condition was identified by the presence of gametes and morphology (e.g., tubercles and anal fin shape). Full and firm bodies were indicative of maturing ova in females. Any parasites, signs of disease, or other afflictions were recorded. Suckers were identified as SNS, KLS, KLS x SNS hybrids, or unknown sucker. As described earlier, species identification between KLSs and SNSs is challenging. Field biologists typically assign species to the best of their ability using primarily lip morphology, but also mouth position, snout shape, and body shape. Suckers are returned to Gerber Reservoir as quickly as possible. A subsample of trammel- netted adult suckers were fin-clipped for genetic analysis. Samples were preserved in 95% ethanol and stored for extraction and analysis by USFWS Abernathy Fish Technology Center.

PIT-tags were detected on BioMark handheld PIT-tag antennas, and PIT-tag IDs were automatically populated into data fields. Data was collected on Trimble Ranger 3 handheld computers in the spring and on Dell Latitude 7212 rugged extreme tablets. Data was downloaded onto office computers daily. Data was entered into an Access database and summarized to the best of our ability. Because the effort in 2022 was non-typical, we have summarized this effort separate from other annual monitoring.

Due to low surface elevations and low inflow, USGS PIT-tag antenna arrays were not installed in Ben Hall Creek and Barnes Valley Creek in 2022. In coordination with USGS, USBR placed one submersible antenna at each boat ramp from May 5 to May 17, 2022. A 3' submersible antenna was deployed at the Gerber Boat Ramp on May 5 at 1200 and ran until the battery died around 1800 on May 6. The 3' submersible antenna was replaced by a 5' submersible on May 10 at 0900, which ran

until May 17, 2022. A 5' submersible antenna was deployed at the Ben Hall boat ramp from May 5 until May 17, 2022; batteries were swapped on May 10.

Results

Reclamation fisheries staff confirmed the reported spawning fish as suckers. Suckers were spawning in the gravel, course cobble, and boulders in the shallow water (~1-4 feet deep) beyond the end of the cement boat ramps.

Capture Summary

In 2022, Reclamation captured and PIT-tagged 14 suckers and recaptured 3 suckers that were PIT tagged in previous years, a total of 17 suckers (Table D-1). None of the females and 21% of the males were recaptures. Fin clips were collected from 4 suckers. Of the three recaptures, one male was tagged in 2018, and two males were tagged in 2020. Of the 17 suckers captured, 13 were captured on May 5, and 4 were captured on May 10, 2022.

All suckers were identified as Klamath Largescale Suckers (Photo D-3). Suckers ranged in size from 363 to 477 mm fork length (409.1 ± 31.3 mm; Figure D-1.) All suckers captured were in spawning condition and released eggs or milt.

Remote Detection Summary

The submersible antenna at Ben Hall detected 47 PIT-tagged suckers over 13 days and the submersible antenna at the Dam Channel Boat Ramp detected 32 PIT-tagged suckers over ten days (Figure D-2 and Figure D-3); only one sucker was detected on both antennas. The sucker (sex unknown) that was detected at both sites was detected only twice; first on the Dam Channel Boat Ramp submersible on May 10 at 858 and an hour later in Ben Hall on May 10 at 1001. Of the suckers whose sex was known, females made up 33% of the suckers at Ben Hall, and 48% of the suckers at the Dam Channel (Table D-2).

The days when the most individuals were detected on submersible antennas were May 5 and 6 (21 per day); the fewest fish were detected on May 14 (2 fish; Figure D-2 and Figure D-3). The majority (77%) of suckers were only detected on one day; 13% were detected on two days, 6% were detected on three days, 2.6% were detected on five days, and one fish (of 77) was detected on ten days. When fish were detected more than one day, their detections were almost always on consecutive days.

Discussion

Spring field activities were focused on salvaging Tule Lake Sump 1B when USFWS requested Reclamation fisheries staff to trap and haul of suckers from Tule Lake Sump 1B to a holding pond on Lower Klamath National Wildlife Refuge. However, low surface elevations in Gerber Reservoir also prevented routine trammel netting efforts from occurring. However, low surface elevations allowed for the observation and documentation of shoreline spawning at boat ramps in Gerber Reservoir.

To our knowledge, this is the first reported incidence of suckers in Gerber Reservoir using gravels at

boat ramps as spawning substrate. When surface elevations are higher, suckers in Gerber Reservoir are known to spawn in Ben Hall and Barnes Valley tributaries. While uncertainty remains, it is likely that suckers in Gerber Reservoir typically spawn in tributaries when surface elevations allow access, and suckers may only utilize boat ramps when surface elevations are low as shoreline spawning in Gerber has not been documented before. While the plasticity of spawning behavior is interesting, it is unclear if eggs developed or gametes survived as no post-spawning season sampling efforts occurred.

Antennas were not deployed for the entire duration of the spawning season and based on our very small 2022 sample (3 recaptures out of 17 fish from our May 2022 net sets), only a small percentage of the population is tagged. Thus, the data presented here is only a portion of actual spawning activity. Because the majority of the detections occurred on the first two days antennas were deployed, it appears that we captured part of the end of the spawning season. The antennas we used for this project needed to be deployed elsewhere so we were unable to confirm that spawning was indeed nearly over when antennas were removed on May 17, 2022. However, it is likely that we captured part of the end of the spawning season given the timing aligns with sucker spawning seasons in other locations.

Very few detections of each fish may be due to the abbreviated sampling period. The majority of suckers were detected on only one day at one site. With the exception of one individual, all suckers were only detected at one of the two sites. While suckers typically have spawning site fidelity, it is unclear if suckers spawning in gravels downhill of boat ramps in Gerber are site exhibiting site fidelity as these data are extremely sparse. However, if a larger percentage of the population is tagged, and monitoring continues, the spawning behavior of Gerber suckers may be better understood.

Another factor that likely contributed to the observed trends is weather; a cold front (including snow and cooler ambient temperatures) moved into the Basin on or before May 9, 2022. It is likely that cooler temperatures impacted the observed changes in detections on antennas. Monitoring in future years should include deploying HOBO temperature loggers to understand spawning behavior relative to an environmental condition.

Surface elevations in Gerber Reservoir range from 4,798.1(BiOp minimum) to 4,835.4 ft (full pool). As such, access to spawning tributaries opportunities in are variable among years, and as surface elevations change, spawning opportunities also change. Suckers in Gerber may exhibit plastic spawning behavior.

If many more suckers are tagged each year and spawning events are monitored each year, it may be possible to derive meaningful estimates of population size and survival of suckers in Gerber Reservoir within a few years. Maintaining antenna arrays in spawning tributaries or other spawning areas will markedly increase detection probability and reduce the number of years until these population parameters are estimable. In addition to life history population trends, growth rates and afflictions may vary with conditions in Gerber Reservoir. Additional years of trammel netting and antenna deployment will provide key information about the plasticity, locations, timing, seasonality, duration, and conditions necessary for spawning to occur which will allow researchers and managers to compare populations within and among reservoirs throughout the Klamath Basin. These findings may help make informed management decisions to benefit the species.

Recommendations

1) Continue PIT-tagging and monitoring suckers annually in Gerber Reservoir.
2) Collect fin rays from a subsample of small and large suckers for age analysis.
3) Collect morphometric measurements and fin-clips for genetic analysis on suckers identified as KLS, KLS x SNS, and SNS.
4) Maintain antenna arrays in Barnes Valley Creek and Ben Hall Creek, or deploy other antennas when tributaries are inaccessible.
5) Increase frequency of flow measurements at Barnes Valley Creek and Ben Hall Creek.

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Tables and Figures

Table D- 1. Total number of suckers captured with Passive Integrated Transponder (PIT) tags or implanted with PIT-tags, new PIT-tags implanted, and the number of recaptured PIT-tagged suckers (tagged prior to 2022) in 2022 for each sex. Each PIT-tag was counted once per year, within year recaptures are not included in these totals.

	All captures and recaptures	**New PIT-tagged fish**
Sex	**2022**	**2022**
female	3	3
male	14	11
unknown	-	-
all	17	14
F:M ratio	0.21	0.27

Table D- 2. Total number of Passive Integrated Transponder (PIT) tagged suckers detected on submersible antennas at Ben Hall Boat Ramp, Dam Channel Boat Ramp, and detected at both sites from May 5 to May 17, 2022. Fish with "unknown" sex are not in Reclamation's database.

	Ben Hall Boat Ramp	**Dam Channel Boat Ramp**	**Both sites**	**Total**
female	14	14	-	**28**
male	29	15	-	44
unknown	3	2	1	6
all	46	31	1	78

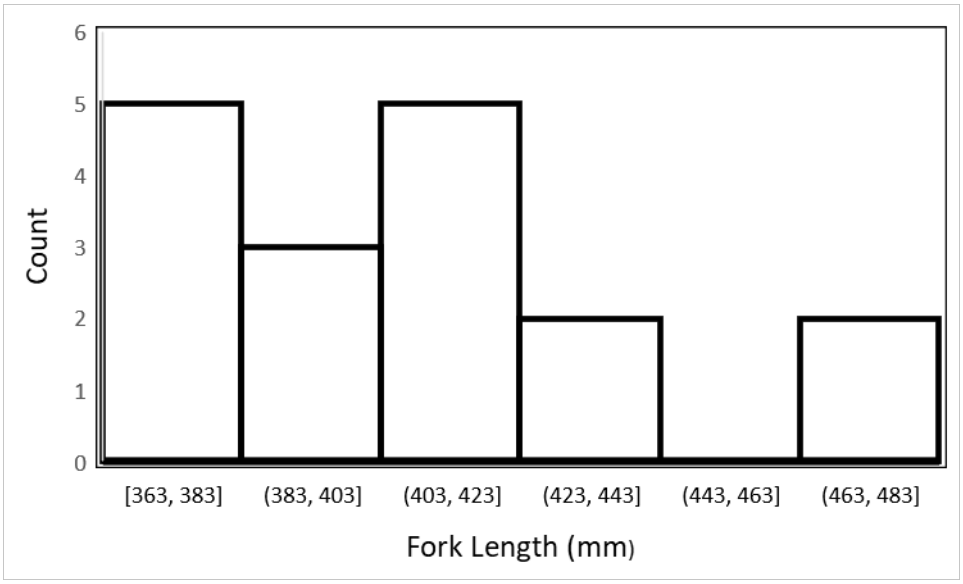

Figure D- 1. Fork length (measured in millimeters) frequencies and sample size for PIT-tagged suckers (male and female combined) captured from Gerber Reservoir in 2022.

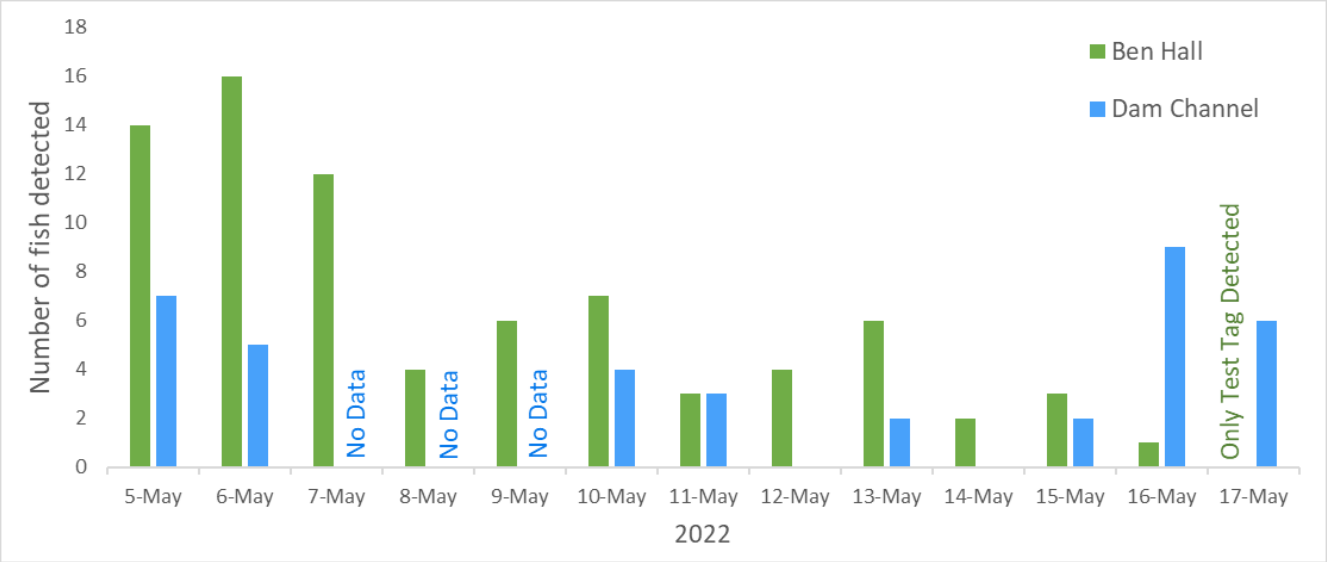

Figure D- 2. Number of PIT- tagged suckers detected on submersible antennas from May 5 to May 17, 2022 at Ben Hall Boat Ramp and Dam Channel Boat Ramp at Gerber Reservoir. The battery died on the Dam Channel submersible and data was not collected on May 6 1900-May 10 0900, 2022. Figure includes 6 unknown sex suckers that are not included in Figure D-3.

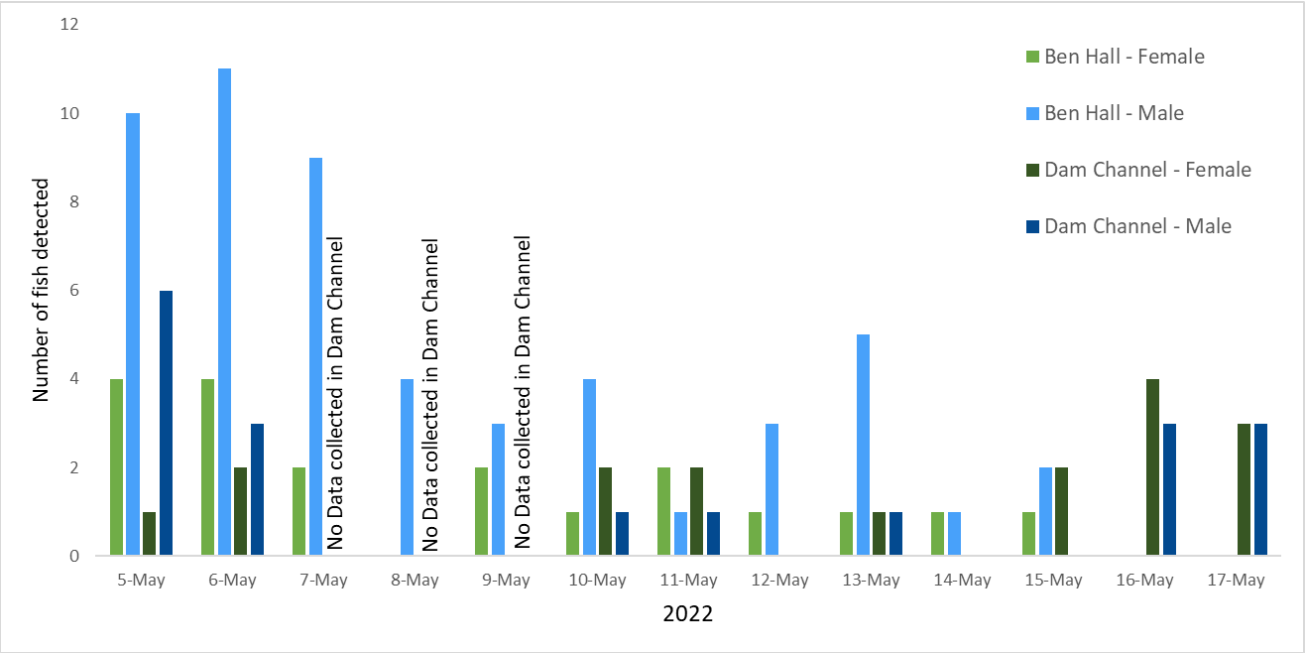

Figure D- 3. Number of male and female PIT- tagged suckers detected on submersible antennas from May 5 to May 17, 2022 at Ben Hall Boat Ramp and Dam Channel Boat Ramp at Gerber Reservoir. The battery died on the Dam Channel submersible and data was not collected on May 6 1900-May 10 0900, 2022.

Photo D-1. Ben Hall boat ramp on May 10, 2022.

Photo D-2. Dam Channel boat ramp on May 10, 2022. Trammel nets set around location suckers were observed spawning.

Photo D-3. Sucker captured in a trammel net set at the Ben Hall boat ramp on May 5, 2022.

Appendix E – Incidental Take Report for Endangered Suckers of the Upper Klamath Basin, 2022 Operational Season

Klamath Project, Oregon/California
Interior Region 10 California Great Basin

Cover Photo: B. Phillips and J. Ross conduct fish salvage of Klamath Project canals, 2014. Image credit D. Taylor, USBR.

Executive Summary

Estimated Incidental Take is calculated using water data from the 2022 Project operations and assumptions explained by the USFWS in the *Biological Opinion on the Effects of Proposed Interim Klamath Project Operations Plan from April 1, 2020, through September 30, 2022, on the Lost River Sucker and the Shortnose Sucker*. After assessing the impact of water deliveries and several monitoring and conservation measures, Reclamation concludes that cumulative incidental take was not exceeded in WY 2022 according to requirements outlined in the Biological Opinion, Reclamation provides detailed estimates of 2022 incidental take in this report to further validate incidental take was not exceeded. Reclamation did not monitor at the Fish Evaluation Station near A Canal in 2022 as there were some security and safety issues not yet resolved at A Canal and irrigation deliveries through A Canal were well below a typical irrigation supply from Upper Klamath Lake, indicating that Incidental Take at this location would be lower than allowable. Also related to the unusual irrigation season in 2022 was reduced irrigation delivery from Gerber Reservoir, no delivery from Clear Lake reservoir, and a reduced effort and result to salvage fish from canals. The USFWS 2020 biological opinion analyzed the impacts of surface elevation change as it relates to sucker access to habitat. Reclamation acknowledges that surface elevations were below thresholds where impacts are anticipated in 2022 for spawning in Upper Klamath Lake shoreline areas and stranding is possible for suckers in Clear Lake Reservoir. These impacts remain largely unquantified but are characterized in the 2020 biological opinion. Detailed calculations of incidental take estimates summarized in this report and their associated assumptions are found in Appendix e to this report.

Table E-1. Summary of Reclamation's estimated incidental take of Lost River and shortnose suckers resulting from Water Year 2022 Klamath Project operations compared with the maximum annual amount of incidental take authorized in the 2020 Biological Opinion (USFWS 2020).

Activity Description	**Number of Suckers "Harassed" in 2022**	**Maximum Annual Incidental Take ("Harass") Allowed in 2020 Biological Opinion**	**Number of Suckers "Harmed" in 2022**	**Maximum Annual Incidental Take ("Harm") Allowed in 2020 Biological Opinion**
A Canal Larvae	75,208	140,011	20,307	140,011
A Canal Juveniles	0	1,200	35	1,200
A Canal Adults	0	0	0	0
Link R Larvae	901,843	2,333,460	18,405	46,669
Link R Juveniles	4,316	31,627	89	633
Link R Adults	9	111	1	2
Other Larvae	< 1,160,904	1,160,904	< 23,692	23,692
Other Juveniles	< 24,821	24,821	< 1,508	1,508
Other Adults	0	0	0	0
Canal fish salvage	436	1,500 juveniles	48	240 juveniles
Fish Evaluation Station	0	20,000 juveniles	0	200 juveniles
Gerber Adult Monitoring and Tule Lake Sump	47	15,000 adults	1	150 adults
O&M fish salvage	0	All encountered	0	10 of all stages

Introduction

Section 9 of the ESA makes it unlawful for any person to "take" any endangered species. The ESA defines "take" to mean to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." However, under ESA section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of an agency action is not considered to be prohibited under the ESA provided that such taking is in compliance with an Incidental Take Statement. The *Biological Opinion on the Effects of Proposed Interim Klamath Project Operations Plan from April 1, 2020, through September 30, 2022, on the Lost River Sucker and the Shortnose Sucker* (BiOp) issued by the USFWS provided Reclamation with allowable annual take of ESA-listed suckers in the Incidental Take Statement (USFWS 2020). This document estimates the incidental take of federally endangered LRSs and SNSs, by life-stage and activity, resulting from Reclamation's Project operations analyzed in the 2020 BiOp**.**

Estimated Incidental Take

A Canal and Link River Dam (South End of Upper Klamath Lake)

Entrainment Estimates and Assumptions

In the 2020 BiOp (USFWS 2020; Table 11-1, p. 200), USFWS calculated the maximum amount of allowable incidental take of endangered suckers at the A Canal and LRD based on sampling during the late 1990's at both locations (e.g., Gutermuth et al. 2000a, 2000b). The maximum amount of incidental take was adjusted from the 1990's numbers to reflect reduced abundances of both sucker species in UKL (e.g., Hewitt et al. 2011). The USFWS used the specific assumption that there has been an 80 percent reduction in adult populations since Gutermuth et al. (2000a, 2000b) evaluated entrainment at the A Canal and Link River (USFWS 2020, p. 112-113). The 80 percent reduction is applied to each life history stage: larvae, juveniles, and adults.

The maximum amount of incidental take for larvae, juveniles, and adult suckers was also adjusted to account for the reduced likelihood of entrainment due to construction of the A Canal fish screen in 2003. The A Canal fish screen prevents the entrainment of fish with total length greater than 30 mm and reduces entrainment by 50 percent of fish with a total length less than 30 mm (Bennetts et al. 2004). Recent efforts to evaluate entrainment in 2012 and 2013 at the A Canal suggests the fish screen reduces fish entrainment by a greater percent than the previously reported 50 percent for fish with a total length less than 30 mm and that the reduction is variable based on the size of individuals (i.e., <15 mm, <20mm, and <30mm) approaching the fish screen (Markle et al. 2014). USFWS estimated that 20 percent of small fish (i.e., <30mm) that approach the A Canal fish screen are entrained through the screen into the canal system (USFWS 2020). All larvae that pass through the A Canal fish screen are assumed to die (USFWS 2020).

Using the 2022 WY conveyance data, Reclamation has quantified entrainment at the A Canal and LRD following the same assumptions outlined in the 2020 Biological Opinion Incidental Take Statement. Specifically, Reclamation's estimates for entrainment of endangered suckers at the A Canal and LRD rely on earlier entrainment measurement efforts (Gutermuth et al. 1999, 2000a, 2000b), a reduction of

sucker populations by 80 percent in UKL since the 1990s (Hewitt et al. 2011), the assumption that 80 percent of larval suckers with total length less than 20 mm are prevented from the A Canal (Bennetts et al. 2004, Simon et al. 2014, USFWS 2019, 2020), all suckers with total length greater than 30 mm are prevented from entering the A Canal (Bennetts et al. 2004), and 50 percent of all suckers that are bypassed at the A Canal fish screen via the pumped bypass are subsequently entrained at the LRD. More detailed calculations of incidental take estimates summarized in this report and their associated assumptions can be found in Appendix e. The flow of this report is organized similar as the 2013, 2019, and 2020 biological opinions and only addresses incidental take of endangered suckers associated with implementation of Reclamation's Project operations.

A Canal Entrainment Estimates

A Canal: Larvae

The larval sucker life-history stage is present from April 1 through July 14 (USFWS 2008; Appendix, p. A6). Based on the sum of daily average flows, 24,278 acre-feet of water was conveyed through A Canal from April 1 through July 14, 2022. Assuming entrainment of larval sucker density is equal to 19.361 fish/acre-feet (Appendix e) and consistent for each day throughout the 2022 irrigation season, Reclamation's Klamath Project operations entrained an estimated 18,802 larval suckers (20% of 94,010 * 0.2 for those remaining after an 80 percent reduction) through the A Canal fish screen in 2022. The 2020 biological opinion assumes that all larval suckers passing through the A Canal fish screen are "harmed" (USFWS 2020).

Of the 75,208 larval suckers (94,010 total, less the 20% that pass through the screen into the canals) that are bypassed at the screen, all enter the gravity bypass which posited larvae in the Link River below Link River Dam. USFWS estimates that 2% of the larval suckers entering the gravity bypass are harmed as a result of the bypass (USFWS 2020). In 2022, this resulted in an additional 1,505 harmed larval suckers.

A Canal: Juveniles

During previous entrainment monitoring, juvenile suckers were most readily observed from July 15 through October 31 (Gutermuth et al. 2000a). Reclamation monitoring of the A Canal pumped bypass from mid-July until the end of September usually informs the estimated number of juvenile suckers that are passed from the A Canal fish screen to UKL (USFWS 2022). In 2022, the monitoring effort at the A Canal for juvenile suckers was not conducted. In 2022, the estimate is based on similar calculations of relativity to previous monitoring efforts by Gutermuth et al. (2000) and modern assumptions.

In 2022, 5,202 acre-feet of water was delivered through A Canal July 15 through August 23, 2022. Assuming entrainment of juvenile sucker density is equal to 1.65902 fish/acre-feet (Appendix e) and consistent for each day throughout the 2022 irrigation season, Reclamation's Klamath Project operations bypassed an estimated 1,727 juvenile suckers after an 80 percent reduction adjustment at A Canal fish screen to Upper Klamath Lake in 2022. It is assumed that 2% of the estimated juvenile suckers that enter the pumped bypass are harmed (USFWS 2020). In 2022, 35 juvenile suckers were harmed by passing the A Canal pumped bypass.

A Canal: Adults

Reclamation and USFWS (2020) expect entrainment of adult suckers at A Canal to be prevented at the trash rack. However, based on observations from Gutermuth et al. (density of 0.00173 adult suckers/acre-foot; 2000), an 80% population reduction, and the 29,480 acre-feet of water that was delivered through the A Canal April 1 through August 23, 2022, Reclamation assumes that 11 adult suckers were prevented from entering A Canal at the trash rack (Appendix e).

Table E-2. Summary of endangered sucker take incidental to the operation and conveyance of water through A Canal during the 2022 irrigation season (April 1 - October 31). Refer to USFWS (2020) for additional background information. No water was conveyed through the A Canal in 2022.

A Canal Entrainment – Estimated Incidental Take	Number of Suckers "Harassed" in 2022	Maximum Annual Incidental Take ("Harass") Allowed in 2020 Biological Opinion	Number of Suckers "Harmed" in 2022	Maximum Annual Incidental Take ("Harm") Allowed in 2020 Biological Opinion
Larval Suckers	75,208	140,011	20,307	140,011
Juvenile Suckers	0	1,200	35	1,200
Adult Suckers	0	0	0	0

Link River Entrainment Estimates

Link River: Larvae

The larval sucker life-history stage is present between April 1 through July 14 (USFWS 2008; Appendix, p.A6). Based on the sum of daily average flows of 237,655 AF (Link River gauge 11507500) of water passed through the LRD from April 1 through July 14, 2022. Assuming the entrainment of larval suckers is equal to 19.361 fish/AF (Appendix e), consistent for each day throughout the 2022 irrigation season, and an update since Gutermuth et al. measured entrainment at this location, Reclamation's Project operations entrained an estimated 920,248 larval suckers below the LRD during 2022 (4,601,238 larvae * 0.2 for those remaining after an 80 percent reduction). The 2020 biological opinion assumes that 98 percent of suckers passing through LRD are "harassed" and 2 percent are "harmed" (USFWS 2020); therefore, 901,843 (920,248 * 0.98) were "harassed" and 18,405 (920,248 * 0.02) were "harmed" in 2022.

Link River: Juveniles

During previous entrainment monitoring, juvenile suckers were most readily observed from July 15 through October 31 (Gutermuth et al. 2000a). Based on the daily average flow (gage 11507500), approximately 210,416 AF of water was conveyed below the LRD from July 15 through October 31, 2022. Assuming the entrainment of juvenile suckers is equal to 0.0841 fish/acre-foot (Appendix e), and the density is consistent for each day throughout the 2022 irrigation season, Reclamation's Project operations entrained an estimated 3540 juvenile suckers (17,696 * 0.2 for those remaining after an 80 percent population reduction) below the LRD. In 2022, an additional 864 (50 percent of 1,727) juvenile suckers were entrained below the LRD after being bypassed from the A Canal. Thus, the total number of juvenile suckers entrained at the Link River in 2022 was 4,404. The 2020 biological opinion assumes that 98 percent of suckers are "harassed" when they pass through the LRD and 2 percent are "harmed" (USFWS 2020); therefore, 4,316 (4,404 * 0.98) were "harassed" and 89 (4,404 * 0.02) "harmed" in 2022.

Link River: Adults

Adult suckers may be present in front of the LRD throughout the year; however, Gutermuth et al. (1999, pp. 15-17) indicated most of the entrainment likely occurs April 1 through October 31. Based on the sum of daily average flows (gauge 11507500), approximately 448,070 AF of water passed through the LRD from April 1 through October 31, 2022. Assuming the

entrainment of adult suckers is equal to 0.000025 fish/acre-foot (Appendix e), is consistent for each day throughout the 2022 irrigation season, and an 80% reduction in population, Reclamation's Project operations entrained 3 adult suckers below LRD. In 2022, an additional 6 (50 percent of 11) adult suckers were entrained below the LRD after being bypassed at the trash rack from the A Canal. The 2020 biological opinion assumes that 2 percent of the 9 adult suckers entrained at the LRD are "harmed". Therefore, 1 adult sucker was "harmed" in 2022.

Table E-3. Summary of endangered sucker take incidental to the operation and conveyance of water through Link River Dam during the 2022 irrigation season (April 1 through October 31). Details of Reclamation's estimated 2022 incidental take can be found in Appendix e of this document.

Link River Entrainment - Estimated Incidental Take	**Number of Suckers "Harassed" in 2022**	**Maximum Annual Incidental Take ("Harass") Allowed in 2020 Biological Opinion and Memoranda**	**Number of Suckers "Harmed" in 2022**	**Maximum Annual Incidental Take ("Harm") Allowed in 2020 Biological Opinion and Memoranda**
Larval Suckers	901,843	2,333,460	18,405	46,669
Juvenile Suckers	4,316	31,627	89	633
Adult Suckers	9	111	1	2

Entrainment at other Project Facilities

Table E-4. Summary of endangered sucker take incidental to the operation and conveyance of water at Klamath Project (Project) facilities, principally Clear Lake Reservoir and Gerber Reservoir, other than A Canal and Link River Dam in 2022 (USFWS 2020). Reclamation's assumptions for these estimates are explained below and are based on the operations within the context of the USFWS effects analysis.

Other Project Facilities - Estimated Incidental Take	**Number of Suckers "Harassed" in 2022**	**Maximum Annual Incidental Take ("Harass") Allowed in 2020 Biological Opinion**	**Number of Suckers "Harmed" in 2022**	**Maximum Annual Incidental Take ("Harm") Allowed in 2020 Biological Opinion**
Larval Suckers	< 1,160,904	1,160,904	< 23,692	23,692
Juvenile Suckers	< 24,821	24,821	< 1,508	1,508

Other Project Facilities - Estimated Incidental Take	Number of Suckers "Harassed" in 2022	Maximum Annual Incidental Take ("Harass") Allowed in 2020 Biological Opinion	Number of Suckers "Harmed" in 2021	Maximum Annual Incidental Take ("Harm") Allowed in 2020 Biological Opinion
Adult Suckers	0	0	0	0

Data is lacking to estimate entrainment at other Project facilities (USFWS 2020). Where some fish entrainment information exists, such as data from Miller Creek downstream of Gerber Dam, the information is limited (Reclamation 2012, p. 6-47), or represents only one year at Clear Lake (USFWS 2020). The USFWS explains assumptions used to determine numbers of incidental take at other Project facilities in the current BiOp (2020).

Reclamation provides the rationale for the statement that incidental take of endangered suckers did not exceed the maximum allowable take in 2022 in the following tables for Clear Lake and Gerber Reservoirs. This statement is based on the 2022 Project operations remaining within the range of deliveries and surface elevations at Project reservoirs and points of diversion that were analyzed in the POR by USFWS within the 2020 BiOp. During water shutdown at Gerber Reservoir, Reclamation staff did not observe suckers in Miller Creek directly downstream of the dam.

Clear Lake and Gerber Reservoirs Entrainment Estimates and Assumptions

Water deliveries during 2022 from both reservoirs (Gerber and Clear Lake) were within the ranges analyzed in the 2020 Biological Opinion. In 2022, Reclamation's monthly flows did not exceed those from the POR analyzed in the 2020 BiOp; therefore, incidental take was not exceeded (Tables E-5 and E-6).

Table E-5. Water releases from Clear Lake Reservoir by month, 1986 through 2022. Water releases were made through the dam gates during months when irrigation releases are made and may include releases for purposes other than irrigation delivery such as flood control. These releases are identified with an asterisk in the table below. Values for each time period are displayed as thousand acre-feet. In 2020, the September and October column includes total releases September through December.

Year	April 15-30	May 1-31	June 1-30	July 1-31	August 1-31	September & October	Total
1986	2.276	0.234	0	0	0	0	2.510
1987	3.181	8.077	6.256	8.527	10.442	6.613	43.097
1988	0.692	4.936	8.636	14.180*	11.176	7.038	46.658*
1989	0.089	5.836	8.814	8.975	8.993	5.757	38.464
1990	1.931	9.278	6.782	10.912	10.353	6.822	46.079
1991	1.233	5.848	11.246*	15.261*	14.514*	2.556	50.658*
1992	0	2.594	7.270	3.111	1.210	0	14.184
1993	0	6.143	5.987	7.502	6.827	6.990	33.449
1994	2.842	5.850	8.688	12.406	11.004	1.557	42.345
1995	0.234	1.618	5.782	9.469	8.507	7.288	32.898
1996	0.056	6.942	7.412	7.036	7.077	4.513	33.037
1997	0.561	5.051	5.253	7.686	5.743	4.979	29.273
1998	13.352*	61.348*	26.203*	9.461	8.672	6.467	125.502*
1999	8.493	6.012	7.153	7.575	5.981	5.326	40.540
2000	0.147	5.140	7.103	6.520	11.630	54.205*	84.745*
2001	0.149	13.823*	22.812*	24.657*	36.360*	6.681	104.482*
2002	0.125	6.544	8.505	9.514	12.455	7.510	44.653
2003	0	2.296	8.495	7.155	6.252	5.457	29.656
2004	0.718	6.732	7.157	7.676	7.817	8.957	39.057
2005	0	0.071	5.503	7.268	5.195	1.573	19.610
2006	0	4.472	8.440	9.919	7.946	7.571	38.347
2007	0.077	6.877	6.586	7.046	7.541	6.225	34.352
2008	0.075	5.826	5.826	7.756	7.518	6.320	33.320
2009	1.374	5.297	4.008	2.227	0	0	12.905
2010	0	0	0	0	0	0	0
2011	0	3.532	5.769	6.270	6.893	5.665	28.129
2012	0	4.890	5.610	6.262	6.601	1.918	25.281
2013	0.188	5.507	5.221	5.061	0	0	15.977
2014	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0
2016	0.325	5.014	5.949	6.835	6.536	1.589	26.248
2017	0	0.964	6.645	7.107	7.145	6.534	28.394
2018	0.375	6.868	5.154	6.517	5.414	4.482	28.810
2019	0	4.921	5.496	6.014	6.361	3.846	26.638
2020	1.842	5.334	6.052	7.114	7.207	11.564	39.113
2021	1.779	6.903	6.917	6.424	0.596	0	22.619
2022	0	0	0	0	0	0	0
MIN	0	0	0	0	0	0	0
MAX	8.493	9.278	8.814	12.406	12.455	8.957	46.079

Table E-6. Water releases from Gerber Reservoir by month, 1986 through 2022. Water releases were made through the dam gates during months when irrigation releases are made and may include releases for purposes other than irrigation delivery such as flood control. Values for each time period are displayed as thousand acre-feet. In 2020, the September and October column includes total releases September through December.

Year	April 15-30	May 1-31	June 1-30	July 1-31	August 1-31	September & October	Total
1986	2.352	6.032	8.410	7.867	8.003	4.402	37.066
1987	2.544	7.853	6.851	6.597	8.299	6.425	38.569
1988	0.220	5.556	5.533	8.073	7.129	6.213	32.724
1989	0.083	5.977	8.134	8.939	6.768	5.880	35.781
1990	0.389	7.020	6.627	8.333	6.635	6.582	35.586
1991	0	1.287	7.063	3.532	0	0	11.882
1992	0	1.057	0	0	0	0	1.057
1993	0.028	4.765	5.168	7.763	6.554	6.830	31.108
1994	2.475	4.696	7.339	8.243	7.775	6.177	36.705
1995	0.055	2.466	5.310	8.582	8.172	7.335	31.920
1996	0	2.407	7.085	7.754	7.438	5.602	30.286
1997	1.382	6.824	6.233	7.781	6.893	5.723	34.836
1998	4.283	0.270	2.203	7.906	7.224	6.770	28.656
1999	3.969	6.625	7.639	8.357	7.529	6.940	41.059
2000	0.442	6.116	8.323	8.202	7.997	5.267	36.347
2001	0.384	7.816	7.895	7.750	7.710	5.101	36.656
2002	0.748	6.387	8.061	8.249	8.245	6.992	38.682
2003	0.032	2.5432	8.633	8.649	7.338	6.255	33.450
2004	1.471	5.696	6.977	8.143	7.944	5.961	36.192
2005	0	0	6.554	8.3084	8.350	7.089	30.301
2006	0	4.532	6.757	8.153	7.636	6.376	33.454
2007	0.040	7.107	7.339	7.679	7.838	6.077	36.080
2008	0.045	6.237	5.656	7.843	7.910	6.997	34.688
2009	1.389	5.133	4.347	7.998	7.777	6.657	33.301
2010	0	3.080	6.757	7.991	7.738	5.669	31.235
2011	0	3.693	6.492	7.731	7.277	6.515	31.708
2012	0	5.575	6.781	7.734	7.855	6.030	33.975
2013	0	7.005	6.748	7.230	6.554	5.098	32.635
2014	0.066	6.165	5.933	2.759	0	0	14.923
2015	0.629	5.349	6.004	1.149	0.094	0	13.225
2016	0.444	5.526	6.363	7.378	7.275	5.397	32.383
2017	0	4.253	5.891	6.718	5.891	5.207	27.959
2018	0.213	5.275	5.629	6.181	5.951	5.128	28.377
2019	0	4.360	3.981	6.716	6.579	3.594	25.230
2020	2.496	5.882	6.540	7.174	7.250	10.370	39.712
2021	2.024	5.583	5.949	5.887	3.197	0	22.640
2022	0	2.571	5.253	3.278	0	0	11.101
MIN	0	0	0	0	0	0	1.057
MAX	4.283	7.853	8.633	8.939	8.35	7.335	41.059

Incidental Take Caused by Seasonal Reductions in Habitat Due to Water Management and Reduced Instream Flows

In USFWS' 2020 effects analysis, it was determined that annual reductions in habitat due to water diversions could adversely affect suckers through take in UKL and Clear Lake Reservoir (USFWS 2020). The adverse impacts are related to surface elevations in each of the reservoirs.

Upper Klamath Lake achieved a surface elevation of 4141.0 ft in early April 2022. A surface elevation below 4142 ft from the end of March to the end of May in UKL is assumed to reduce sucker spawning activity at shoreline springs similar to observations from 2010. The impact is estimated at 20% of the spawning activity, or 20% of the eggs laid at this area. Reclamation has determined through a review of 2022 surface elevations that take of spawning suckers at the shoreline springs could have occurred in UKL in 2022. However, Reclamation has no means to accurately quantify the amount of take relative to low lake elevations during sucker spawning at the eastern shoreline March through May.

Upper Klamath Lake was at 4140.15 ft on July 15, 2022. A reduction of wetland habitat could impact larval suckers when surface elevation in UKL drop below 4140 ft by July 15 (USFWS 2020). Adverse impacts from loss of habitat could lead to increased mortality at this life history stage; however, there is no data to indicate the magnitude of the impact. In 2022, UKL surface elevation was above 4140 ft through July 20. Thus, Reclamation assumes that unquantified take of suckers associated with loss of wetland habitat in 2022 was low or non-existant.

Similar to surface elevation and habitat relationships in UKL, USFWS has described that adverse impacts in the form of stranding take can occur at Clear Lake Reservoir at surface elevations below 4522 ft (USFWS 2020). Take associated with access to the Willow Creek for spawning suckers has not yet been determined, but adverse impacts at access Willow Creek are recognized to occur at a similar elevation (USFWS 2020). Reclamation assumes some take due to stranding could have occurred at Clear Lake Reservoir in 2022 as surface elevations dropped below 4522 ft by early June. However, the continuation of drought conditions, including no irrigation deliveries were made from Clear Lake in 2022, were responsible for relatively low surface elevations in 2022.

Incidental Take Caused by Lost River Sucker and Shortnose Sucker Monitoring Activities in Project Reservoirs

In addition to incidental take of endangered suckers that was analyzed by the USFWS as part of Reclamation's Proposed Action to operate the Project, the USFWS requires Reclamation to salvage and monitor suckers under multiple T&Cs (USFWS 2020). Only the take associated with Reclamation's fish salvage of canals, monitoring at the FES, fish salvage with O&M activities, and adult sucker monitoring at Gerber Reservoir is reported here. The USGS reports adult sucker take associated with adult sucker monitoring at UKL and Clear Lake Reservoir to USFWS annually under their Section 10 permit.

Since 1992, USFWS has required Reclamation to salvage suckers from Project water delivery systems (i.e., canals, drains, headgates) at the end of irrigation season (USFWS 1992, 2001, 2008). In 2012, Reclamation proposed to continue fish salvage of irrigation canals as part of Project operations (Reclamation 2012) and currently continues that commitment in 2022. The numbers of suckers

reported here are from the 2022 salvage effort of canals reported to USFWS in greater detail as another chapter in the 2022 annual compliance report. Reclamation captured 436 young of the year and older juvenile suckers from the A Canal forebay in 2022. All suckers were transferred to USFWS at an aquaculture facility on Lower Klamath Lake Road. In addition, Reclamation salvaged an additional 0 juvenile suckers from Project canals in both Oregon and California.

Reclamation applied an assumed "harm" rate to juvenile suckers that were salvaged from canals of 11% as specified in the 2020 BiOp to determine that 48 juvenile suckers were harmed during fish salvage.

Reclamation has monitored the pumped bypass at the A Canal fish screen during the irrigation season since 2003 when the screen was installed. Consistent with the 2020 BiOp, monitoring for suckers at the pumped bypass is a condensed effort from July through September to evaluate the peak timing and abundance of suckers at this location (USFWS 2020). No monitoring at the pumped bypass occurred in 2021 as water was not delivered through the A Canal. No monitoring was conducted in 2022 as there were some security concerns of night sampling at this location and the amount of surface available from Upper Klamath Lake was relatively small that it was unlikely that Reclamation would approach allowable take at this location.

In 2022, Reclamation captured 17 adult suckers in trammel nets at Gerber Reservoir as part of monitoring the population. No direct harm was observed; however, Reclamation and USFWS both assume that 1% of these adults (1) could be harmed during capture and handling prior to release. Also in 2022, Reclamation captured 30 adult suckers in Tule Lake Sump 1B and relocated those suckers to

Every year, Reclamation conducts routine maintenance activities related to the Project infrastructure. Some activities, particularly those requiring the dewatering of an area that remains watered throughout the year or impact water flow structures, could impact suckers. The USFWS has allowed take of individuals of all life history stages to be incidentally harassed or harmed during these activities (USFWS 2020). Several O&M activities that required fish salvage were conducted in 2022, namely low water level in the Lost River Diversion Channel and removal of earthen berm in the lower Lost River near Tule Lake National Wildlife Refuge. No juvenile suckers were captured.

Table E-7. Additional incidental take caused by salvage of suckers from Klamath Project (Project) canals and during O&M of infrastructure, monitoring of suckers at the Fish Evaluation Station, and adult suckers in Project reservoirs (USFWS 2020).

Monitoring Activities - Estimated Incidental Take	Number of Suckers captured in 2022	Maximum Annual Capture Allowed in 2019 Biological Opinion	Number of Suckers Harmed during Capture in 2020	Maximum Annual Capture Harm Allowed in 2019 Biological Opinion
Canal fish salvage	436	1,500 juveniles	48	240 juveniles
Fish Evaluation Station	0	20,000 juveniles	0	200 juveniles
Gerber Adult Monitoring	17	15,000 adults	1	150 adults
O&M fish salvage	0	All encountered	0	10 of all stages
Tule Lake Sump 1B sucker relocation	30	15,000 adults	1	150 adults

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Appendix e

Detailed summary of calculations and assumptions used to estimate incidental take of Lost River and shortnose suckers resulting from implementation of the Klamath Reclamation Project, 2022

A Canal: Larvae

Larval sucker entrainment at A Canal was estimated at 3.3 million in 1996 and 1.7 million in 1997 (Gutermuth et al. 1998, p. iii). In 1996 and 1997, the amount of water entering A Canal from UKL during the larval life history stage of April 1 through July 14 (as defined in USFWS 2008 Appendix, p. A6) was 121,488 AF and 136,760 AF, respectively. These numbers were derived from multiplying daily averaged flow for dates of interest from Reclamation's water record by 1.983. The product is the total AF during a specific date or range of dates.

For the purpose of reporting incidental take, Reclamation is combining the estimated larval fish and water conveyance in A Canal for both years to derive a fish per volume of water. Both years are combined to capture more variability than using one year. The total estimated entrainment of larval suckers at A Canal over both years was 5.0 million larvae and total water conveyance through A Canal from April through mid-July during both years was 258,248 acre- feet. The equation to derive a fish per AF multiplier that can be applied to the volume of water in future years is 5,000,000 / 258,248, or 19.361 larvae per acre-foot of water (for 1996 and 1997).

From April through July 14, 2022, 24,278 AF of water was drawn into A Canal (sum of 2022 daily averaged flow in A Canal for date range). The estimated number of larval suckers on that water, before applying assumptions for reduced sucker populations in UKL or assumptions on the efficiency of the fish screen to bypass larvae, was 470,047 (from 24,278 AF * 19.361 sucker larvae/acre-foot).

Two principal assumptions need to be applied to this estimate in order to provide for other changes in UKL since the time that Gutermuth et al. sampled for larval entrainment at A Canal. Assuming that larval sucker production is reduced by 80 percent from both 1996 and 1997 to 2022 (USFWS 2020), an estimated 94,010 larval suckers (470,047 larvae * 0.2 for those remaining after an 80 percent population reduction) are available to entrainment at A Canal without a fish screen in 2022. The fish screen is assumed to bypass 80 percent of the larvae and entrain the other 20 percent at A Canal (USFWS 2020), harming all that pass through the fish screen. With both assumptions applied, Reclamation harmed an estimated 18,802 larval suckers by passing them through the fish screen at A Canal through the fish screen in 2022. The other 75,208 larval suckers were bypassed to below the LRD resulting in an additional 1,505 (2%) harmed (USFWS 2020). Total harmed larval suckers at A Canal fish screen were 20,307.

A Canal: Juveniles

The period when juvenile suckers were most readily observed during previous entrainment studies was from July 15 through October 31 (Gutermuth et al. 2000a). In 1998, Gutermuth et al. (2000a, p. 14) estimated that 246,524 juvenile suckers were entrained at the then unscreened A Canal. From July 15 through October 16 (end of irrigation season), 148,596.11 AF of water was diverted through A Canal in 1998.

In 2022, 5,202 AF of water entered A Canal from July 15 through October 31. All juvenile suckers at A Canal avoid entrainment by entering a pumped bypass at the fish screen. Reclamation did not monitor the pumped bypass in 2022 out of a safety precaution. That monitoring is used to derive an estimate that is the current basis for incidental take at the A Canal. It is assumed that 2% of the estimated juvenile suckers that enter the pumped bypass are harmed (USFWS 2020).

In 2022, for 5,202 AF of water July 15 through August 23, assuming entrainment of juvenile sucker density is equal to 1.65902 fish/acre-feet and consistent for each day throughout the 2022 irrigation season, Reclamation's Klamath Project operations bypassed an estimated 1,727 juvenile suckers after an 80 percent reduction adjustment at A Canal fish screen to Upper Klamath Lake in 2022. It is assumed that 2% of the estimated juvenile suckers that enter the pumped bypass are harmed (USFWS 2020). In 2022, 35 juvenile suckers were harmed by passing the A Canal pumped bypass.

A Canal: Adults

Based on information from the 2008 biological opinion (USFWS 2008, Appendix p. A19), Gutermuth et al. (2000a) estimated that entrainment of adult suckers at A Canal was 411 individuals. Estimated 1998 entrainment of adult suckers and the 1998 A Canal water delivery indicates that a fish density of 0.00173 (411 adults/236,939.747 AF) adults/acre-foot would be expected prior to any other assumptions. Applying this fish density to the 2022 A Canal delivery indicates that potentially 51 adult fish (0.00173 adults/acre-foot * 29,480 AF) could encounter the trash rack at the fish screen prior to any adjustments for reduction in sucker production. Considering an estimated 80 percent reduction in sucker populations of UKL, the number of adult suckers that could encounter the A Canal fish screen is 11 (51 adults * 0.2 for those remaining after an 80 percent reduction). These 11 adult suckers are prevented by the trash rack at A Canal from approaching the fish screen and the bypass. Reclamation assumes no harm or harassment to adult suckers as they encounter and turn away from the trash rack which is designed with 2-inch openings.

Link River: Larvae

The value of 19.361 larvae/acre-foot from combining Gutermuth et al. results (both 1996 and 1997) also represents entrainment in Link River power canals (combined East and West) as larval entrainment through A Canal and Link canals (combined East and West) is thought to be similar as the mean diversions for both locations during larval entrainment period of April through mid-July were similar (USFWS 2008 Appendix, p. A12). In the Link River, about 40% of the total flow previously passed through the dam and the associated fishways (USFWS 2008 Appendix, p. A12). However, the current conditions apply the "larvae/acre-foot" density to the total flow from the Link River gage station (USGS gage 11507500) that accounts for all flow (power canals, dam gates, causeways, and some accretions), as very little water enters the power canals and causeways.

In 2022, the Link River gage (11507500) registered 237,655 AF of water from April 1 through July 14. This number is based on the daily average flow (cfs). The estimate of flow in the Link River (237,655 AF) multiplied by the density of larvae/acre-foot (19.361) would indicate that 4,601,238 larval suckers would be entrained prior to any adjustments for present-day sucker production.

Assuming that 80 percent reduction in adult sucker populations translates to the same reduction in larval production, Reclamation likely entrained 920,248 larval suckers in the Link River during 2022 (4,601,238 larvae * 0.2 for those remaining after an 80 percent reduction). The 2020 biological opinion assumes that 98 percent (901,843) are harassed and 2 percent (18,405) are harmed (USFWS 2020).

Link River: Juveniles

Gutermuth et al. (2000a, p. 31) estimated 30,466 young suckers (mostly young-of-the-year) passed the West- and Eastside power canals at the Link River on 361,916 AF. Gutermuth et al. (2000a) represents the number of suckers by the volume of water during these observations creates a means to estimate the entrainment in subsequent years (30,446 suckers/361,916 AF = 0.0841 juvenile suckers/acre-foot).

The sum of the 2022 daily flows from July 15 through October 31 in Link River (gage 11507500) was 210,416 AF. The seasonal flow multiplied by the fish/acre-foot density equals 17,696 juvenile suckers that were entrained at the Link River before adjusting for an 80 percent decline in UKL sucker production. After adjusting for a reduction in sucker production, 3,540 (17,696 juvenile suckers*0.2 for those remaining after an 80 percent reduction) were carried on the discharge at the LRD. There were an additional 864 (50 percent of 1,727) juvenile suckers in 2022 that were entrained at the Link River after being bypassed from the A Canal. Thus, the total number of juvenile suckers entrained at the Link River in 2022 was 4,404. The 2020 biological opinion assumes that 98 percent (4,316) are harassed and 2 percent (89) are harmed (USFWS 2020).

Link River: Adults

Based on information from the 2008 (USFWS 2008, Appendix p. A19), Gutermuth et al. (2000a) estimated that entrainment of adult suckers at the Link River power canals (both West- and Eastside) was 14 individuals. Using the assumption that 20 percent of the total Link River flows pass through the dam and associated fishways in 1998 (USFWS 2008, Appendix p. A19), an estimated 17 adult suckers were entrained at the Link River in 1998 (combining entrainment for both power canals and the dam gate flows). Link River flow from Link River gage (11507500) April 1 through October 31, 1998, was 686,512.62 AF. Thus, 1998 adult sucker density on the Link River flow was (17 adults/686,512.62 AF) or 0.000025 fish per acre-foot in Link River.

Flow from April 1 through October 31, 2022, in the Link River was 448,070 AF. Thus, the number of adult suckers entrained at the Link River in 2022 was 11 (0.000025 adults/acre-foot * 448,070 AF) before considering a reduction of 80 percent in UKL sucker production. In 2022, Reclamation's operation of the LRD entrained 3 adult suckers (11 adult suckers * 0.2 for those remaining after an 80 percent reduction, plus 6 additional adult suckers (50%) bypassed from the A Canal). Of these 9 adult suckers entrained (harassed) at the LRD, 1 is harmed.