Trinity River Division

Draft Preliminary Alternatives

6/5/2023

These Draft Preliminary Alternatives for the Trinity River Division represent Reclamation's effort to date to incorporate information received from interested parties. Draft Preliminary Alternatives are not finalized and have not undergone modeling or legal sufficiency review. The alternative development process will continue to be refined.

No Action Alternative

Under the No Action Alternative, Reclamation would operate consistent with the 2000 Trinity River Mainstem Fishery Record of Decision (2000 Trinity ROD) and the 2017 Long-Term Plan to Protect Adult Salmon in the Lower Klamath River Record of Decision.

Trinity Lake Storage Management

Planning Minimum Pool

As described in the 2000 NMFS Biological Opinion, Trinity Reservoir would be operated to a planning minimum carryover storage of 600 thousand acre-feet (TAF) between water years. If Reclamation implements drawdowns below the 600 TAF planning minimum in Trinity Reservoir, Reclamation would coordinate with USFWS and NMFS on a case-by-case basis in dry and critically dry water years to help rebuild storage in drought years. The 2000 Trinity ROD volume would be used within a water year and carryover storage in the reservoir would otherwise be managed to meet Central Valley Project (CVP) purposes.

Trans-basin Diversion Season

As described in the 2000 NMFS Biological Opinion, diversions through Whiskeytown Lake will be prioritized lower in the spring/summer period and higher in the summer/fall period to provide temperature benefits to the Trinity River.

Variable Instream Flows

Restoration Flow Releases

As described in the 2000 Trinity ROD, Reclamation will provide annual instream flows below Lewiston Dam according to the recommendations provided in the Trinity River Flow Evaluation Study and adopted in the FEIS/EIR Preferred Alternative. The total volume of water released from the TRD to the Trinity River will range from approximately 369,000 AF to 815,000 AF depending on the annual hydrology (water-year type) determined as of April 1st of each year. The recommended flow regimes link two essential purposes deemed necessary to restore and maintain the Trinity River's fishery resources: (1) flows to provide fish habitat (i.e., appropriate depths and velocities, food web, and suitable temperature regimes for anadromous salmonids); and (2) flows to restore the riverine processes that create and maintain the structural integrity and spatial complexity of the fish habitats. Based on subsequent monitoring and studies guided by the Trinity Management Council, the schedule for releasing water on a daily basis, according to that year's hydrology, may be adjusted but the annual flow volumes established in Table 1 may not be changed.

Table 1. Annual Flow Volumes by Water-Year Class (2000 Trinity ROD)

Water-Year Class	Volume (acre-feet)
Critically Dry	369,000
Dry	453,000
Normal	647,000
Wet	701,000
Extremely Wet	815,000

Base Flows

As described in the 2000 NMFS Biological Opinion, fall/winter baseflows of 300 cubic feet per second (cfs) will be released starting October 15 to maintain habitat for spawning and rearing salmonids. The spring restoration release will commence on or around April 15 following the determination of the water year type. At the conclusion of the snowmelt recession limb of the hydrograph, summer baseflow of 450 cfs will be released through October 15 to provide suitable holding temperatures for spring-run Chinook salmon.

Lower Klamath Flow Augmentation Releases

As described in the 2000 NMFS Biological Opinion and further addressed in the 2017 Long-Term Plan to Protect Adult Salmon in the Lower Klamath River Record of Decision, supplemental flows from Lewiston Dam to prevent a disease outbreak in the lower Klamath River may be released when flow in the lower Klamath River is projected to be less than 2,800 cfs or when disease conditions in either river suggest immediate risk of a fish kill event. The water for supplemental flows would come from water stored in Trinity Reservoir.

Flow augmentation components are implemented as needed in a phased approach based on environmental and biological conditions. The three components include: (1) a preventative base-flow release that targets increasing the base flow of the lower Klamath River to 2,800 cfs from mid-August to late September to improve environmental conditions; (2) a one day preventative pulse flow (targeting 5,000 cfs in the lower Klamath River) to be used as a secondary measure to alleviate continued poor environmental conditions and signs of Ich infection in the lower Klamath River; and (3) a five-day emergency pulse flow (targeting 5,000 cfs in the lower Klamath River) to be used as an emergency basis as a tertiary treatment to avoid significant die-off of adult salmon when the first two components are not successful at meeting their intended objectives.

An adaptive management approach through a technical team that incorporates real-time environmental and biological monitoring is used to determine if and when to implement any or all of these three flow augmentation components. Reclamation would implement these flow augmentation components in coordination with federal, state, and tribal resources specialists, including fisheries biologists or pathologists.

Temperature Management

As described in the 2000 NMFS Biological Opinion, in accordance with the triennial basin plan and Water Rights Order 90-5, operations will target a daily average temperatures at the Douglas City gage of 60^{0}F or below from July 15 to September 15 and 56^{0}F or below from September 15 to September 30. From October 1 to December 31, operations will target a daily average temperature of 56^{0}F or below at the Trinity River above North Fork gage. As necessary to meet these temperature requirements based on hydrology and meteorology, diversion through Lewiston Reservoir and/or the use of the auxiliary outlet works at Trinity Dam to reach colder water may be required.

Alternative 1 – Water Quality Control Plan

Alternative 1 (Water Quality Control Plan) operates the Trinity River Division to the 1992 Central Valley Project Improvement Act. Alternative 1 does not include operations under the 2000 Trinity ROD. Comparisons using analyses of Alternative 1 inform the effectiveness of non-flow measures versus addressing stressors by restrictions on water operations. Large investments in habitat restoration have occurred and continue, yet long-lead times for landscape level changes and salmonid lifecycles mean that many projects remain in progress with few generations of fish to assess benefits.

Trinity Lake Storage Management

Planning Minimum Pool

NA

Diversion Season

NA

Variable Instream Flows

Under Alternative 1, Reclamation would make releases based on CVPIA, settlement contracts, and making use of available water supply for deliveries to CVP water service contractors while reducing the potential for spill.

Restoration Flow Releases

340,000 acre-feet per Section 3406(b)(23) of CVPIA

Base Flows

NA

Lower Klamath Flow Augmentation Releases

NA

Temperature management

NA

Alternative 2 – Multi-Agency Deliberation

Alternative 2 (Multi-Agency Deliberation) represents actions made to reach consensus with Reclamation, CDFW, NMFS, USFWS, and tribal interests. The objective of this alternative is to be able to shift flows earlier in the season compared to the No Action Alternative for fisheries benefits. The alternative describes two approaches to meeting this objective, subject to adaptive management.

Trinity Lake Storage Management

Planning Minimum Pool

Trinity Lake storage would be managed to provide contingency storage for multi-year drought. Trinity Reservoir would be operated to a planning minimum of 1.2 MAF*, including in the first year designated as dry or critically dry. In a second consecutive dry year, operations would be managed to a planning minimum end of September storage of 900 TAF*. In a third consecutive dry year, operations would be managed to a planning minimum end of September storage threshold of 750 TAF*. *[*Note: The various planning minimums for EOS are not finalized; these values are included as an example and will need to be modeled and evaluated before they can be finalized.]*

To achieve planning minimums, Reclamation would first reduce trans-basin diversions to minimum power operations. Next, Reclamation through governance, may seek to adjust instream flows. If the efforts through governance determine higher storage does not warrant the impacts from adjustments to instream flows, end of September storage may be lower than planning minimums.

[Placeholder for Governance]

Trans-basin Diversion Season

There is a period in the spring/early summer where diversions through Lewiston Reservoir contribute to water released to the Trinity River being colder than the optimal growth range of juvenile salmonids. In dry years this period is approximately April 1 - June 1; in wet years May 1 - July 1. Releases from Trinity Dam during that period would prioritize those needed to support Trinity River flow requirements and temperature objectives. Diversions to meet other CVP needs would occur after those dates through September 30, subject to planning minimums described above. Diversions after September 30 would generally be limited to those necessary to meet Trinity River temperature objectives unless reservoir storage remained above 1.2 MAF*.

[Placeholder for Governance]

Variable Instream Flows

Base Flows

Minimum winter (300 cfs) and summer (450 cfs) baseflows would not be altered initially, though the timing of when ramp up from winter base flows and ramp down to summer base flows would shift based upon the shift in timing of the restoration release allocation as described above.

Restoration Flow Releases

The overarching goal of this alternative would be to meet the biological and physical objectives of the TRRP through restoration of the natural pattern of river flow timing in the Trinity River using the 2000 Trinity ROD flow volumes for each water year. The metric used to quantify flow timing in the Trinity River would be the date in the water year by which 50% of the flow of the river has passed the Trinity River at Lewiston (TRAL) gage. Management of the Trinity River under the 2000 Trinity ROD shifted the average date by which 50% of the flow of the river has passed TRAL by approximately five weeks and compressed the range of dates across years from approximately three months to one month set (Table 2; Figure 1). A date in the month of May for 50% of the volume to pass TRAL was rare in the pre-dam data set but became common as it was the only month in which this occurred under recent 2000 Trinity ROD (Table 2; Figure 1).

This alternative focuses on reestablishing pre-dam flow patterns in the Trinity River by using the date at which 50% of the flow for the water year has passed the Trinity River at Lewiston gage as a performance metric. In general, the Trinity River at Lewiston (TRAL) 50% date tends to fall between the Salmon River Above Somes Bar (SRASB) and Trinity River Above Coffee Creek (TRABCC) gages, with a closer match to TRABCC than SRASB (Table 2; Figure 1). Performance of the alternative for TRAL volume would be measured following each water year, and compared against the 50% date for TRABCC, with a goal of being within two weeks of the 50% date of that gage. Two approaches to meeting this objective are provided here, subject to adaptive management.

Table 2. Average date and range at which 50% of flow volume for the year passed the SRASB, TRAL, and TRABCC gages.

Gage and time period	Average	Range
SRASB (1912-2022)	3/22	2/1-5/6
TRAL (1912-1960)	4/7	2/13-5/11
TRAL (2001-2022)	5/15	5/1-5/31
TRABCC (1958-2022)	4/3	2/5-5/11

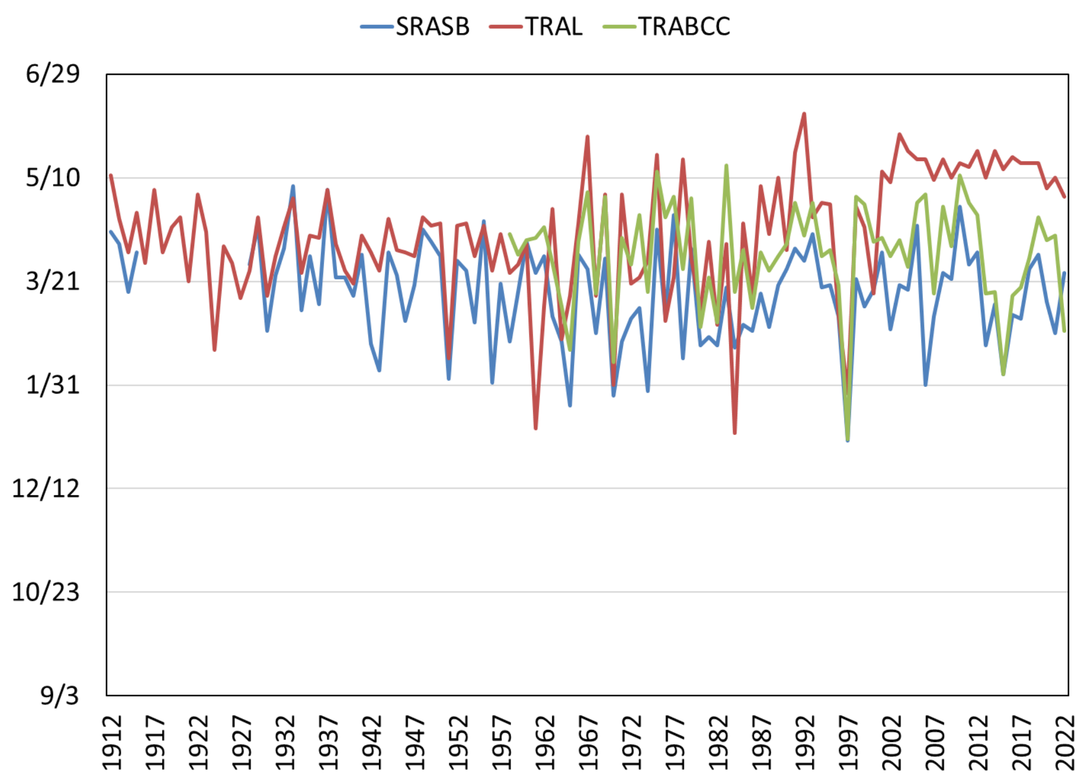

Figure 1. Date at which 50% of flow volume for the year passed the SRASB, TRAL, and TRABCC gages 1912 to 2022.

Method 1: Trigger Based Flows

The Trigger Based methodology, subject to adaptive management, is an approach that adheres to the water year volumes prescribed in the 2000 Trinity ROD. This method could be used to implement this alternative in accordance with established constraints for discharge from Lewiston Dam (infrastructure protection, ramping rates, etc.), and approval of Bureau of Reclamation.

Synchronized Flows

The main objective of synchronized flows is to use dam releases with tributary inputs of flow to cause geomorphic changes and associated biological response on the Trinity River. The synchronization flow period would be 10/15 through 2/15.

The maximum water volume allocation for synchronized flows is 97,364 acre-feet (AF), which is the discretionary volume beyond winter and summer baseflow according to the 2000 Trinity ROD in a Critically Dry water year. This is the most restrictive water year type in terms of the available volume of water that is above the expenditure of water for the 2000 Trinity ROD baseflow. The allocation of 97,364 AF above baseflow makes water available for synchronization flows, but its full expenditure during the synchronization period would result in baseflows throughout the remainder of the water year (i.e., elevated baseflow period, spring peak, and spring recession). This allocated volume would have been enough to allow all synchronization flows to occur when triggers were met in 13 of 17 water years between water year (WY) 2006 and 2022.

Triggers for synchronization flow release are projected discharges on the Trinity River at North Fork Trinity River (TRNF) according to the California Nevada River Forecast Center (CNRFC) 72-hour deterministic forecast. Synchronized flows released from Lewiston Dam are above and beyond the scheduled baseflow discharges, which are 300 cfs daily average from October 16 through April 15. For example, a 6,500 cfs synchronized flow includes 6,200 cfs in synchronized volume and 300 cfs in 2000 Trinity ROD winter baseflow.

Three types of synchronized flow events are proposed, including low, medium, and high flow events:

Low flow event: $1{,}200 \le Q_{cfs} \le 2{,}800$ at TRNF triggers ≤1,500 cfs release from Lewiston Dam

- Primary geomorphic objective is to disperse fine sediments onto the backside of bars that are exposed at summer baseflow preventing sedimentation of salmonid redds.

Medium flow event: $2{,}801 \le Q_{cfs} \le 5{,}600$ cfs at TRNF triggers ≤6,500 cfs release from Lewiston Dam

- Primary geomorphic objectives are to disperse sediment from where creeks join the river and move fine sediments from channel to floodplain surfaces that are away from the channel to support riparian revegetation, prevent sedimentation of redds and deliver coarse sediment to spawning areas.

High flow event: $Q_{cfs} \ge 5{,}601$ cfs at TRNF triggers ≤8,500 cfs release from Lewiston Dam

- Primary objectives are to simulate a large, infrequent flood to cause widespread geomorphic change, remove riparian stands of vegetation, recruit large wood, and initiate aquatic macroinvertebrate succession.

Three additional rules are that: (1) when prioritized, an 11,000 cfs release from Lewiston Dam can occur within the elevated baseflow period (described below) in the absences of or after any of the above trigger flows are projected at TRNF when the February 90% exceedance B120 forecast projects water year volume $\geq$ 1,350,000 AF (i.e., Normal or wetter years); (2) when prioritized, a flow that is higher than the peak discharge for a given trigger event may be released if there is water remaining in the allocated volume for synchronization flows; and (3) if a higher trigger is met after a lower synchronization flow has commenced, the higher flow synchronization release may be implemented before the prior event has completed, subject to ramping requirements for increasing and decreasing flows.

Finally, synchronized flow releases added to tributary accretions of water must be less than the maximum fishery flow (MFF) at TRNF at river mile (RM) 72.5, Junction City (TRJC, RM 79.7), Douglas City (TRDC, RM 92.7), and Limekiln Gulch (TRLG, RM 98.9). The MFF is defined as an 11,000 cfs release from Lewiston Dam with accretions from a 100-year flood generated by tributary inputs in spring (April through June). The MFF is 23,854 cfs at TRNF, 21,736 cfs at TRJC, 18,613 at TRDC, and 14,226 cfs at TRLG (CDWR 2007). No exceedances in MFF occurred in testing the synchronization flow rules in WY2006-2022, which is the period of record with full water years at TRNF.

Elevated Baseflows

The main objectives of releasing elevated baseflows is to provide juvenile salmonids access to floodplain areas for feeding and to inundate surfaces for a sufficient duration to enable the stream food web to increase the food base for consumption by fish. The elevated baseflow period is 2/16 through 4/15. The baseflow volume is set by the below decision tree using the 90th percentile forecast of full natural flow published in the February 1 and March 1 B120 reports (Figure 2).

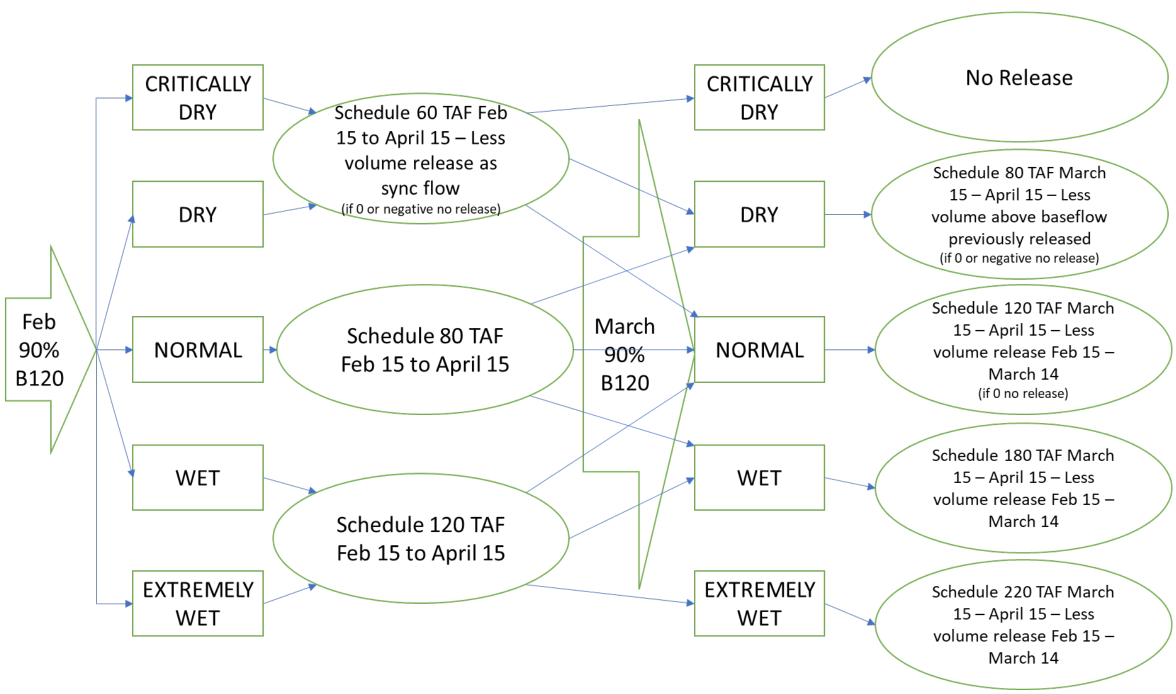

Figure 2. Decision tree to calculate volume allocated dependent upon prior flow releases during the synchronization period (only in Dry and Critically Dry water year types) and the 90% exceedance B120 forecast in February and March.

Spring Restoration Releases

The water volume available for release after the elevated baseflow period is the sum released through 4/15 subtracted from the volume allocated by the ROD based on the April B120 50% exceedance forecast. The resulting volume was scheduled for the spring peak and recession and summer baseflow period by distributing flow in to meet ROD objectives, similar to recent release patterns under the ROD (Figure 3; vertical dotted lines indicates April 15). Modifications to remain within ramping rates and to better meet riparian recession objectives were made. Peak flows were also prioritized to better meet geomorphic objectives. These modifications are reflective of what could be expected from the TRRP flow workgroup process due to monitoring and scientific learning. Hydrographs from daily average flows generated using the trigger based method are shown in Figure 3. Summary statistics are provided in Table 3.

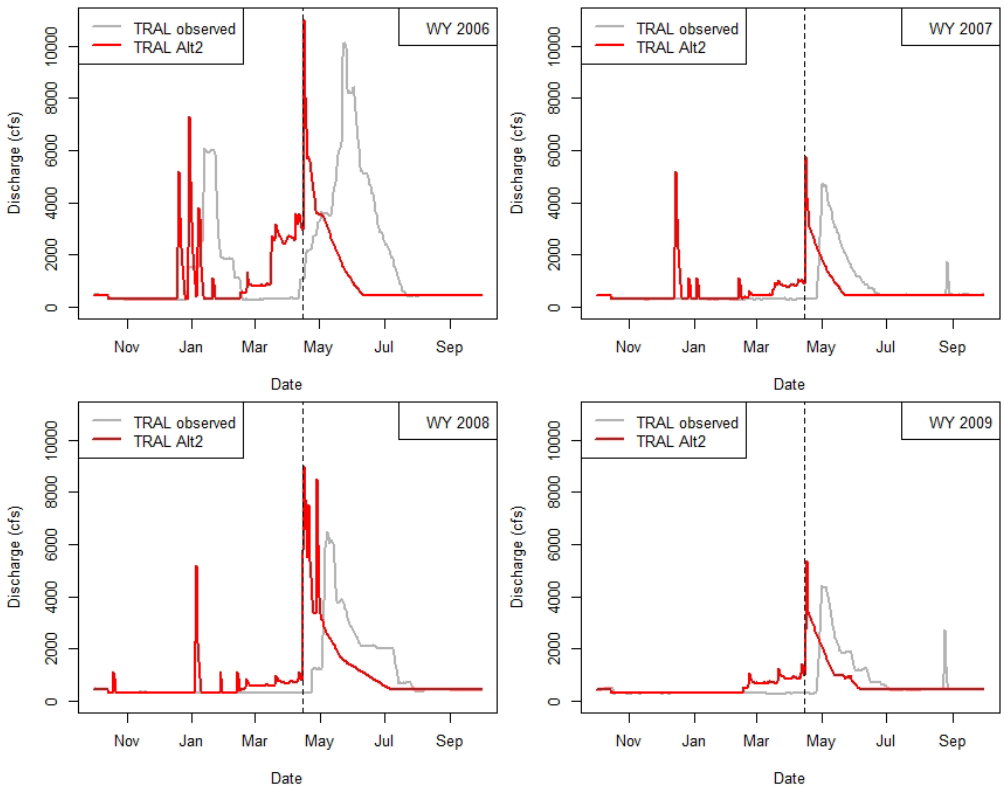

Figure 3a. Hydrographs derived using the trigger based methodology, 2006-2022.

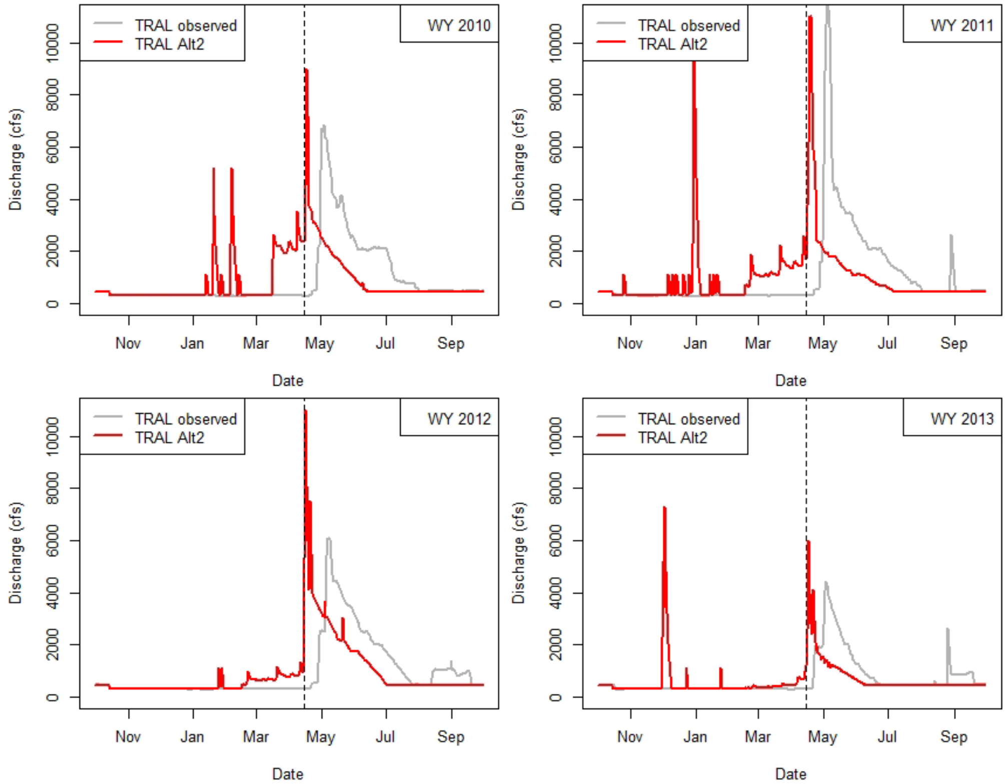

Figure 3b. Hydrographs derived using the trigger based methodology, 2006-2022.

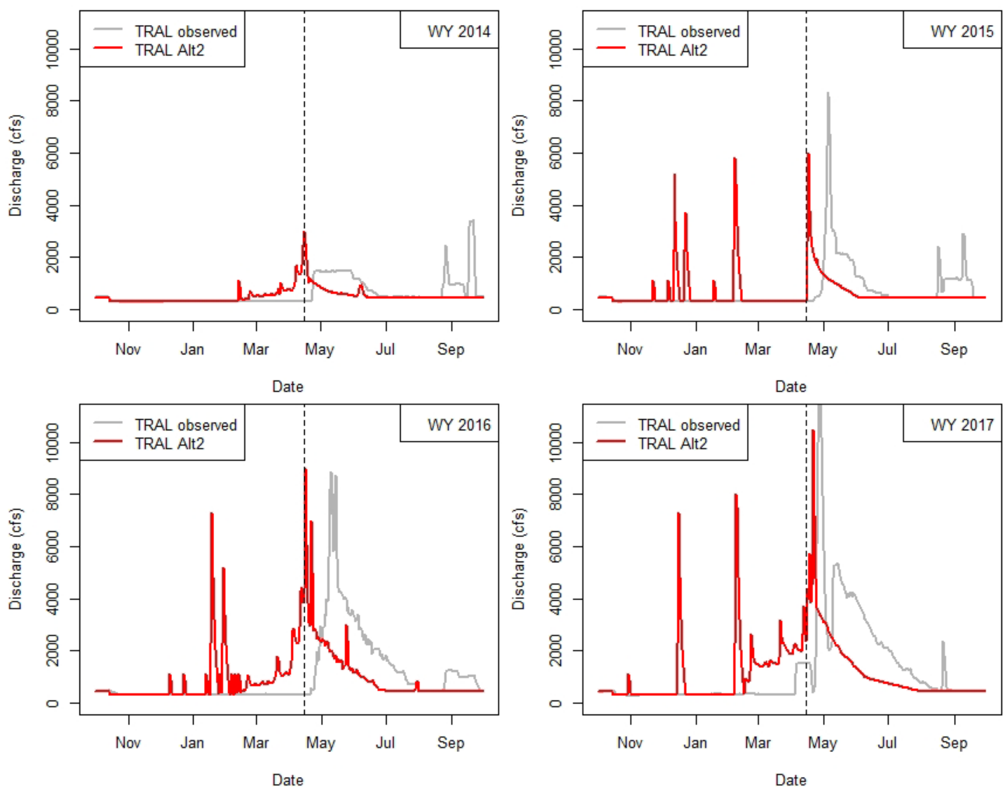

Figure 3c. Hydrographs derived using the trigger based methodology, 2006-2022.

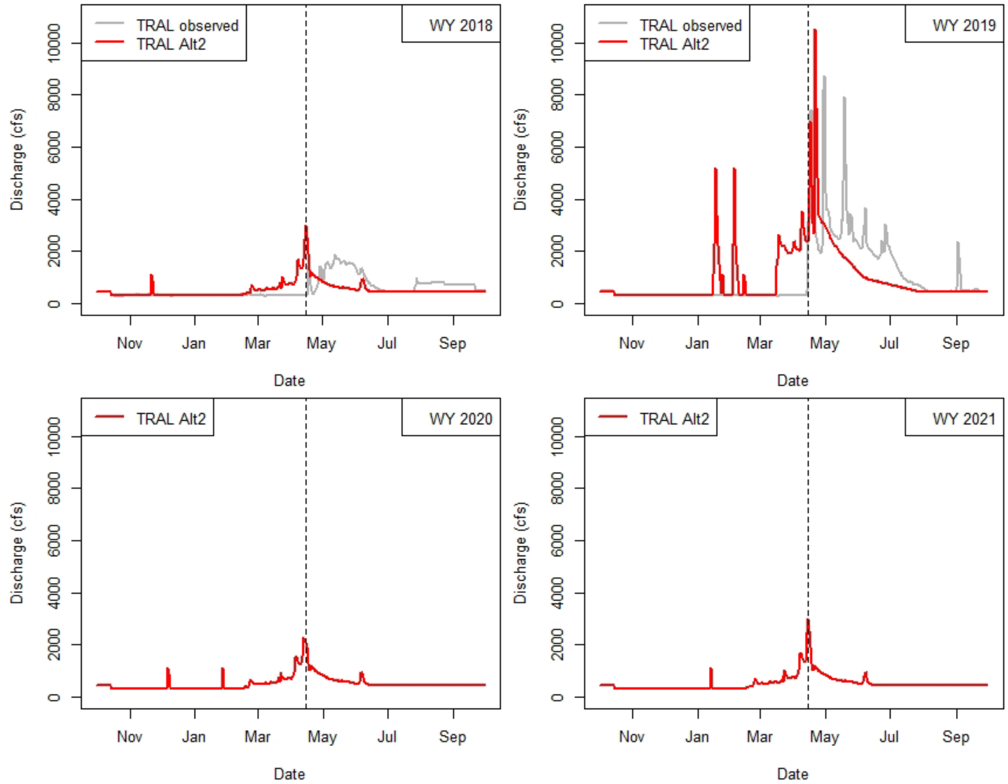

Figure 3d. Hydrographs derived using the trigger based methodology, 2006-2022.

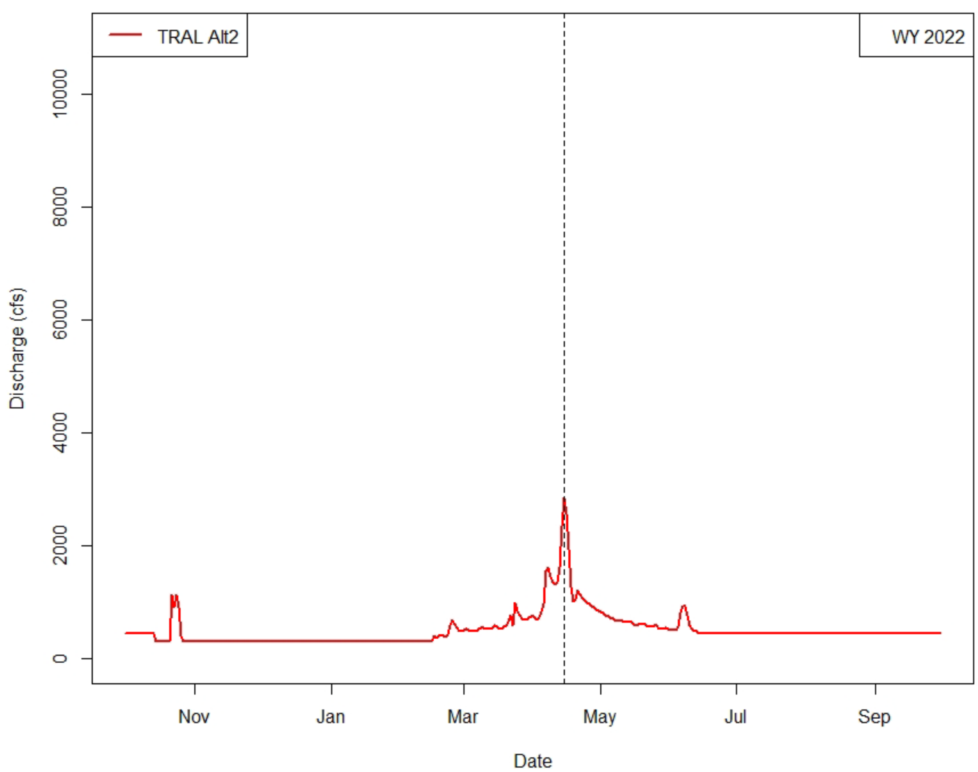

Figure 3e. Hydrographs derived using the trigger based methodology, 2006-2022.

Table 3. Summary statistics from daily flow schedules derived using the trigger based methodology, 2006-2022.

Water year	Feb B120 90%	Mar B120 90%	Apr B120 50%	ROD allocation (AF)	Sync vol abv base (AF)	El base vol abv base (AF)	Total 1 Oct - 15 Apr (AF)	% before 15 Apr	Date of 50%
2006	Normal	Wet	ExWet	815,000	96,077	179,998	397,464	49%	4/16/2006
2007	CritDry	Dry	Dry	453,000	36,516	43,480	201,384	44%	4/18/2007
2008	Dry	Dry	Normal	647,000	36,518	54,303	212,805	33%	4/25/2008
2009	CritDry	CritDry	Dry	453,000	0	60,012	181,400	40%	4/22/2009
2010	CritDry	Normal	Normal	647,000	63,913	120,000	305,302	47%	4/17/2010
2011	Normal	Normal	Wet	701,000	85,327	119,998	326,713	47%	4/18/2011
2012	CritDry	CritDry	Normal	647,000	6,081	63,850	191,915	30%	4/28/2012
2013	Dry	Dry	Dry	453,000	61,264	18,728	201,381	44%	4/19/2013
2014	CritDry	CritDry	CritDry	369,000	3,041	56,961	181,390	49%	4/16/2014
2015	CritDry	Dry	Dry	453,000	97,363	0	218,751	48%	4/17/2015
2016	Normal	Normal	Wet	701,000	87,981	128,089	338,053	48%	4/16/2016
2017	Wet	Wet	ExWet	815,000	97,369	180,004	398,761	49%	4/17/2017
2018	CritDry	CritDry	CritDry	369,000	3,041	56,958	181,388	49%	4/16/2018
2019	Dry	Normal	Wet	701,000	62,509	120,000	303,898	43%	4/21/2019
2020	CritDry	CritDry	CritDry	369,000	6,081	57,481	185,546	50%	4/15/2020
2021	CritDry	CritDry	CritDry	369,000	3,041	56,961	181,391	49%	4/16/2021
2022	CritDry	CritDry	CritDry	369,000	5,867	54,113	181,369	49%	4/16/2022

Method 2: Gage Based Flow Algorithm

The Gage Based methodology, subject to adaptive management, is an approach that adheres to the water year volumes prescribed in the 2000 Trinity ROD. This method could be used to implement this alternative in accordance with established constraints for discharge from Lewiston Dam (infrastructure protection, ramping rates, etc.), and approval of Bureau of Reclamation.

Under this method, the technique for establishing a Lewiston hydrograph that returns elements from a natural flow regime centers on two key components: (1) A series of weights that scale natural flow levels from a Trinity River discharge gage upstream of the reservoir (Trinity above Coffee Creek gage); and (2) a set of constraints that protect dam infrastructure, flooding concerns, water year volume totals, and other compliance requirements. The weights start as fixed multipliers in the months of October - January, when there is little information regarding what the upcoming water year type will be (dry, wet, etc.). For the months of February, March, and the beginning of April, the weights change with incoming information about the potential water year type. As the B120 forecasts signal potential wetter year types, then the weights commensurately increase. Once the water year has been determined in the beginning of April, any volume of remaining water for that years' scheduled volume, would be scheduled for release starting on April 16 by staff from the TRRP communicating the flow schedule to CVO following recommendations from the TRRP flow work group (Figure 5; vertical dotted lines indicates April 15).

The list of constraints for this alternative would include protection of water year volume totals: there is an automatic mechanism that switches to the minimum flow levels when the amount of water year volume total remaining equals the volume required to meet minimum flow levels for the remaining days in the water year. The method would also cap the maximum Lewiston dam discharge to 11,000 cfs to protect dam infrastructure, prevents discharge levels exceeding 18,500 cfs at the Trinity above North Fork gage to prevent flood risk, includes the No Action TRRP ramp-up and ramp-down rates, and also includes the No Action TRRP minimum discharge levels. The technique operates on daily-mean discharges, but can be flexible in regard to time scales, and additionally can be implemented using near-term discharge forecasts (for example, three-day ahead forecasts) for the Trinity above Coffee Creek gage. Hydrographs using daily average flows generated using the real time flow method are shown in Figure 4. Summary statistics are provided in Table 4.

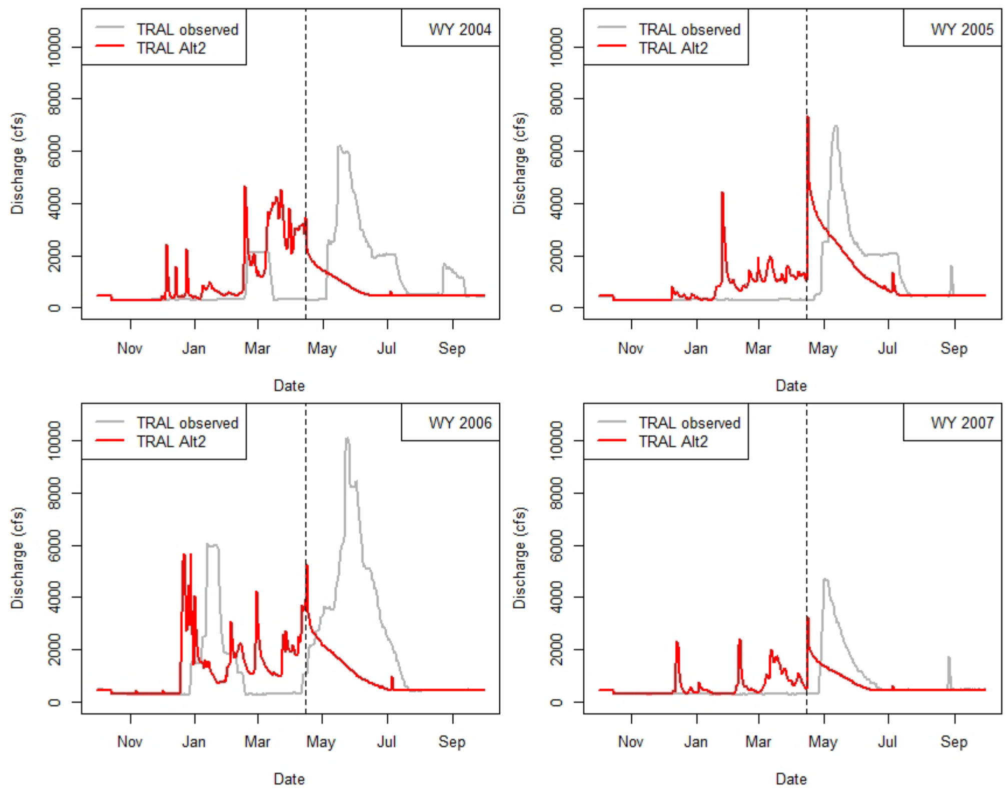

Figure 4a. Hydrographs derived using the real time flow methodology, 2004-2020.

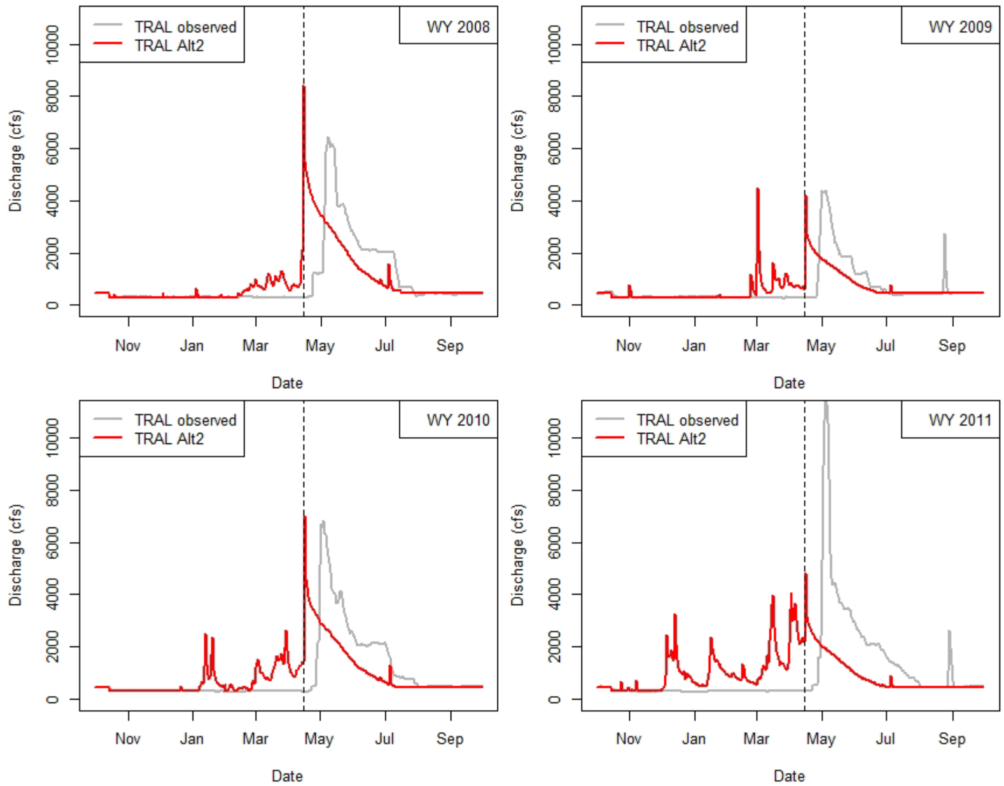

Figure 4b. Hydrographs derived using the real time flow methodology, 2004-2020.

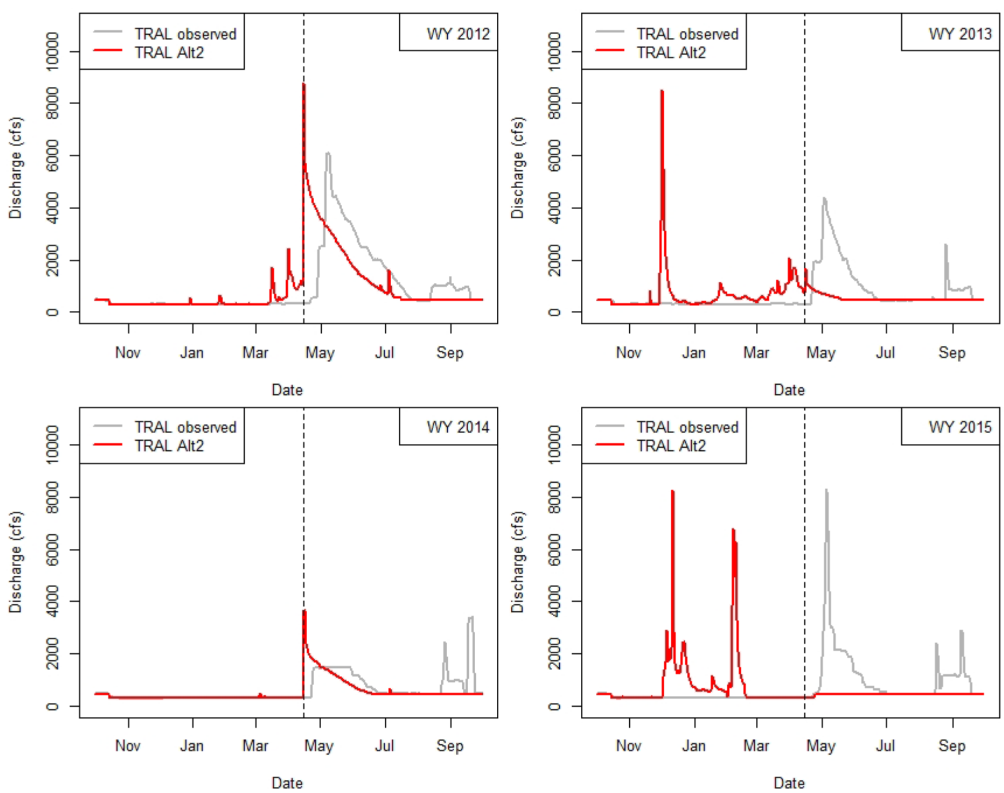

Figure 4c. Hydrographs derived using the real time flow methodology, 2004-2020.

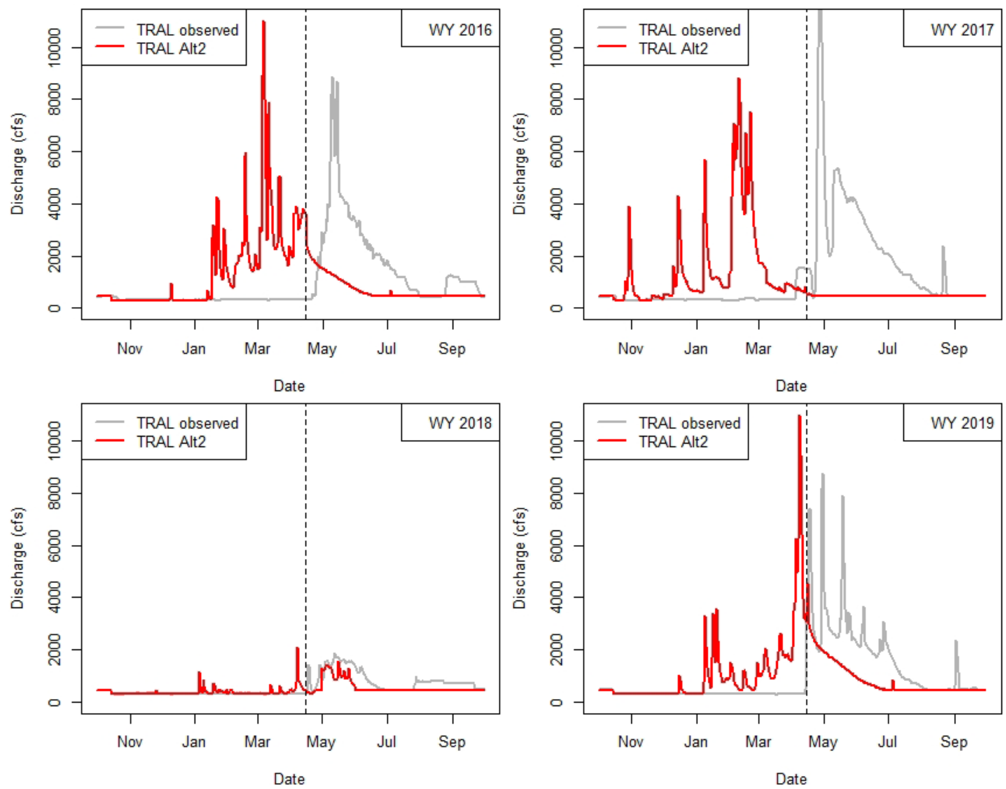

Figure 4d. Hydrographs derived using the real time flow methodology, 2004-2020.

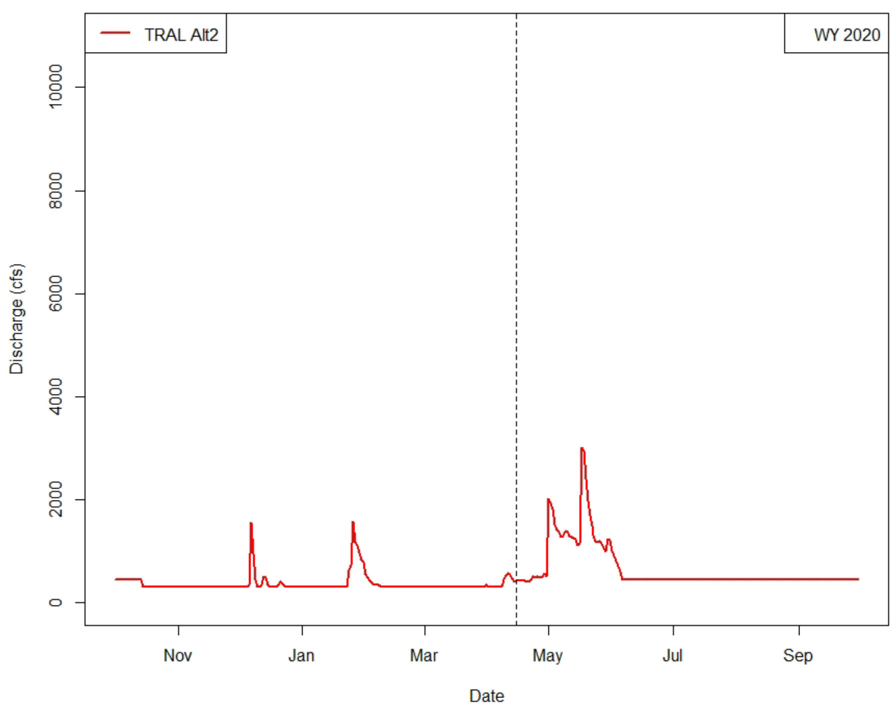

Figure 4e. Hydrographs derived using the real time flow methodology, 2004-2020.

Table 4. Summary statistics from daily flow schedules derived using the real time flow methodology, 2004-2020.

Water year	Feb B120 90%	Mar B120 90%	Apr B120 50%	ROD allocation (AF)	Total 1 Oct - 15 Apr (AF)	% before 15 Apr	Date of 50%
2006	Normal	Wet	ExWet	815,000	497,620	61%	3/28/2006
2007	CritDry	Dry	Dry	453,000	224,038	50%	4/16/2007
2008	Dry	Dry	Normal	647,000	205,337	32%	4/29/2008
2009	CritDry	CritDry	Dry	453,000	184,668	41%	4/24/2009
2010	CritDry	Normal	Normal	647,000	242,945	38%	4/25/2010
2011	Normal	Normal	Wet	701,000	405,998	58%	4/5/2011
2012	CritDry	CritDry	Normal	647,000	184,767	29%	5/1/2012
2013	Dry	Dry	Dry	453,000	268,751	61%	3/25/2013
2014	CritDry	CritDry	CritDry	369,000	128,718	35%	4/30/2014
2015	CritDry	Dry	Dry	453,000	305,568	67%	2/8/2015
2016	Normal	Normal	Wet	701,000	585,730	71%	3/17/2016
2017	Wet	Wet	ExWet	815,000	565,579	79%	2/14/2017
2018	CritDry	CritDry	CritDry	369,000	147,403	44%	5/4/2018
2019	Dry	Normal	Wet	701,000	420,454	60%	4/8/2019
2020	CritDry	CritDry	CritDry	369,000	142,229	39%	5/8/2020

Lower Klamath Flow Augmentation Releases

Same as the No Action Alternative, except that action components equal to or less than the volumes described therein could also be leveraged to address the risk of a major fish kill in the lower Trinity River.

Temperature Management

Same as the No Action Alternative. In addition, to provide a thermal regime that promotes growth and survival of juvenile salmonids throughout the rearing period, operations would target the TRRP's adopted North Fork Temperature objective of a 7-day average of the daily average (7DADA) of 55.4 – 61.7°F upstream of NF during the later portion of the critical rearing period.

The TRD would be operated to target the TRRP's adopted temperature objectives at the Lewiston gage that are protective of holding and spawning adult Chinook and coho salmon and which are necessary for successful propagation of juvenile salmonids in the upper river and at Trinity River Hatchery. Releases from Trinity Lake through Lewiston Reservoir would be managed to attempt to achieve temperature objectives. [Placeholder for Governance].

Alternative 3 – Modified Natural Hydrograph

The overarching goal of this alternative is to meet the biological and physical objectives of the TRRP through restoration of a pre-dam seasonality of river flows in the Trinity River.

Trinity Lake storage management

Same as Alternative 2.

Planning Minimum Pool
Same as Alternative 2.

Diversion Season
Same as Alternative 2.

Variable Instream Flows

Restoration Flow Releases
This alternative uses the 2000 Trinity ROD flow volumes according to water year type but allows for a portion of those volumes to be released the subsequent water year. The objective of this alternative is to provide an optimized seasonally oscillating hydrograph to promote anadromous fish production and accentuate key ecological and physical phenomena while simplifying dam operations (i.e., easy to schedule, easy to implement). The most important component of a seasonally oscillating hydrograph is following natural solar and precipitation phenomena of the region. A seasonally oscillating hydrograph would produce six months of inundated floodplain and six months of desiccated floodplains, in any 12-month timeframe, and includes the possibility of summer base-flows lower than have been scheduled under the 2000 Trinity ROD. Additional water volumes are made available for pulse flows to achieve additional physical and biological objectives under the 2000 Trinity ROD.

Seasonal Oscillating Hydrograph
A Seasonally Oscillating Hydrograph (SOH) is a flow regime for regulated river systems which is based on sine wave geometry, set to a 365-day wavelength. The shape, wavelength, and timing of a SOH are based upon the astronomical phenomena of obliquity (position of the Earth relative to the Sun), a phenomenon which anadromous salmon's lifecycle is adapted to use. Obliquity is the reason that daylengths on earth change through a year, and the change in daylengths becomes more pronounced with increasing north/south distance from the equator. Viewed at a daily time step, daylength oscillates as a wave across a year, with the amplitude of this wave increasing with increasing latitude. It is the variations in daylength that produces seasons with their variations in temperature and precipitation.

Northern California's native anadromous fish species have evolved under and adapted to the variable intra-annual climatic conditions for the region (i.e. a Mediterranean climate has winters typified by high precipitation and cool temperature, while summers are hot and dry; Figure 5). In the Trinity River, juvenile Chinook Salmon, Coho Salmon, and steelhead are generally present in abundance when daylengths are short and precipitation is high[1]. Utilizing the wet season allows these juvenile salmonids to take advantage of abundant cool water and food-rich seasonally inundated floodplain habitats. Adult spring-run Chinook salmon migrate upstream in the Trinity River system (and elsewhere) during the descending limb of an annual hydrograph (Figure 5). This contrasts with fall-run Chinook salmon, which migrate with the beginning of the ascending limb of an annual hydrograph. Both spring-run and fall-run Chinook salmon spawn in the fall season with the beginning of the ascending limb of the wet season, so that their offspring hatch into favorable environmental conditions (e.g., peak precipitation and inundated floodplains). Floodplains that see long-term inundations and maintain acceptable water

[1] Harris, N.J., P. Petros, and W.D. Pinnix. 2016. Juvenile Salmonid Monitoring on the Mainstem Trinity River, California, 2015. Yurok Tribal Fisheries Program, Hoopa Valley Tribal Fisheries Department, and U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office. Arcata Fisheries Data Series Report Number DS 2016-46, Arcata, California.

temperatures provided the optimal habitat for rearing juvenile salmonids. Seasonally inundated rice fields have been shown to produce invertebrate communities that can support rapid growth and high survival in juvenile Chinook salmon. The lack of perennial aquatic invertebrates on the desiccated floodplains during the low flow period would promote desirable early successional species (e.g., chironomids and daphnia) colonization of the inundated floodplain during the high flow periods. The SOH would provide constant increases in flows through the late summer into the winter. This ascending limb would continually change the distribution of spawning habitat. This provides continual variations in prime spawning habitat locations with the ascending limb of the SOH, expanding total habitat and reducing superimposition.

Each water year type would utilize most of the allotted ROD water volumes for SOH flow releases (Figure 5, Table 5). The remaining water volume would be utilized for pulse flows or other flow manipulations (Table 5). The ROD water volumes are set by the April 1 B-120 50% forecast inflow for the year (distributed approximately April 10). Implementation of SOH would start April 15 and use all volume within the subsequent year. Due to how late in the year the water year determinations are made, the majority of the SOH water volumes are implemented in the winter of the following year. Following the water year determination, there would need to be a transition between the water year types. This transition should occur quickly, ramping up or down to meet the new SOH releases.

In the provided hydrographs, August 11 is utilized as the lowest flow day of the year, which may need to be adjusted in the future. The date of the lowest flow period should balance the needs of migrating adult spring-run Chinook salmon in the spring (later low flow period would be better) and of the migrating adult fall-run Chinook salmon (earlier low flow period would be better). The highest flow period in the SOH would be 6 months after, or before, the lowest flow period (approximately February 10). The highest flow period of the SOH matches the approximate date of peak abundance of age-0 Chinook and Coho Salmon fry at the Pear Tree juvenile trapping site (Harris et al 2016).

The magnitude of the lowest flows range from 300 cfs in Critical water years to 500 cfs in Extremely Wet water years, with the other water years stepping up from 300 cfs in 50 cfs increments. The magnitude of the lowest flows range from 300 cfs in Critical water years to 500 cfs in Extremely Wet water years, with the other water years stepping up from 300 cfs in 50 cfs increments.

In addition to the SOH flow releases, there are set volumes for each water year type which would be used to supplement the releases, such as geomorphic pulse flows (Table 5). Scheduling of pulse flows would be achieved with an adaptive management approach through a technical team that incorporates real-time environmental and biological monitoring. Reclamation would implement these flow augmentation components in coordination with federal, state, and tribal resources specialists, including fisheries biologists or pathologists. The volumes allocated to pulse flow are large enough in Normal, Wet, and Extremely Wet water year types to implement pulses that achieve geomorphic processes described within the 2000 Trinity ROD. An example of SOH applied to past water-year hydrology is shown in Figure 6.

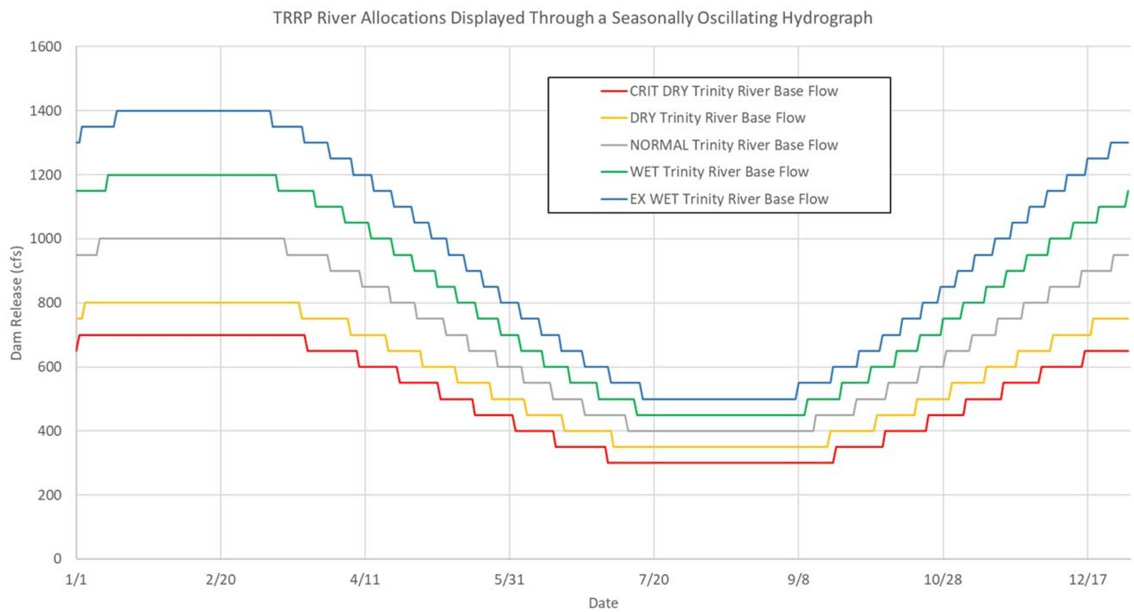

Figure 5. Seasonally Oscillating Hydrographs for the Trinity River, shown without pulse flows to be scheduled by a technical team.

Table 5. Seasonally oscillating hydrograph water volumes and pulse volumes, based on water year type determinations. Water use for oscillations and scheduled pulse flows would occur from April 15 (following the water year determination) through the following April 14.

Water Year Designation	ROD Volume Allocation	SOH Lowest Flow (cfs)	SOH Highest Flow (cfs)	SOH Volume (acre*ft)	Pulse(s) Volume (acre*ft)	Total Volume (acre*ft)
Critical	369,000	300	700	361,984	7,016	369,000
Dry	453,000	350	800	426,232	36,768	463,000
Normal	647,000	400	1,000	506,778	140,222	647,000
Wet	701,000	450	1,200	597,225	103,775	701,000
Ext Wet	815,000	500	1,400	687,770	127,230	815,000

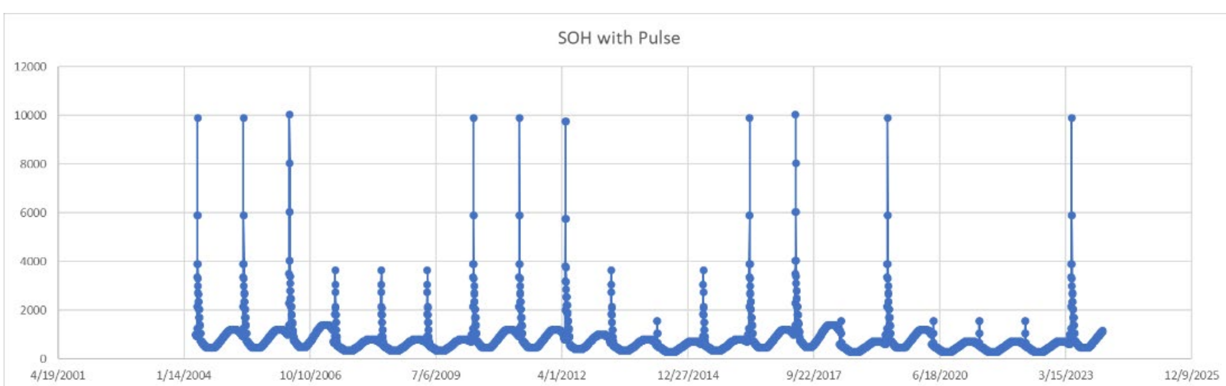

Figure 6. Illustration of Seasonally Oscillating Hydrographs applied to the water-year hydrology from April 2004 through December 2023, with spring pulse flows applied to expend pulse volumes per Table 5.

Alternative 4 – Risk-Informed Operations

Alternative 4 provides alternative criteria for Trinity River releases that prioritizes water deliveries over drought protection.

Trinity Lake storage management

Planning Minimum Pool

Trinity Reservoir would be operated to a planning minimum carryover storage of 750 TAF between water years. If Reclamation implements drawdowns below the 750 TAF planning minimum in Trinity Reservoir, Reclamation would coordinate with USFWS and NMFS on a case-by-case basis in dry and critically dry water years to help rebuild storage in drought years.

Diversion Season

Same as the No Action Alternative.

Variable Instream Flows

Restoration Flow Releases

Same as Alternative 2, except that if storage fell below 750 TAF following a multi-year drought the total volume allocated by water year type for restoration releases would be reduced by 15% during ongoing drought years and in the first normal or wetter year following drought to accelerate recovery of storage.

Base Flows

Same as Alternative 2.

Lower Klamath Flow Augmentation Releases

Same as the No Action Alternative.

Temperature Management

Same as the No Action Alternative.