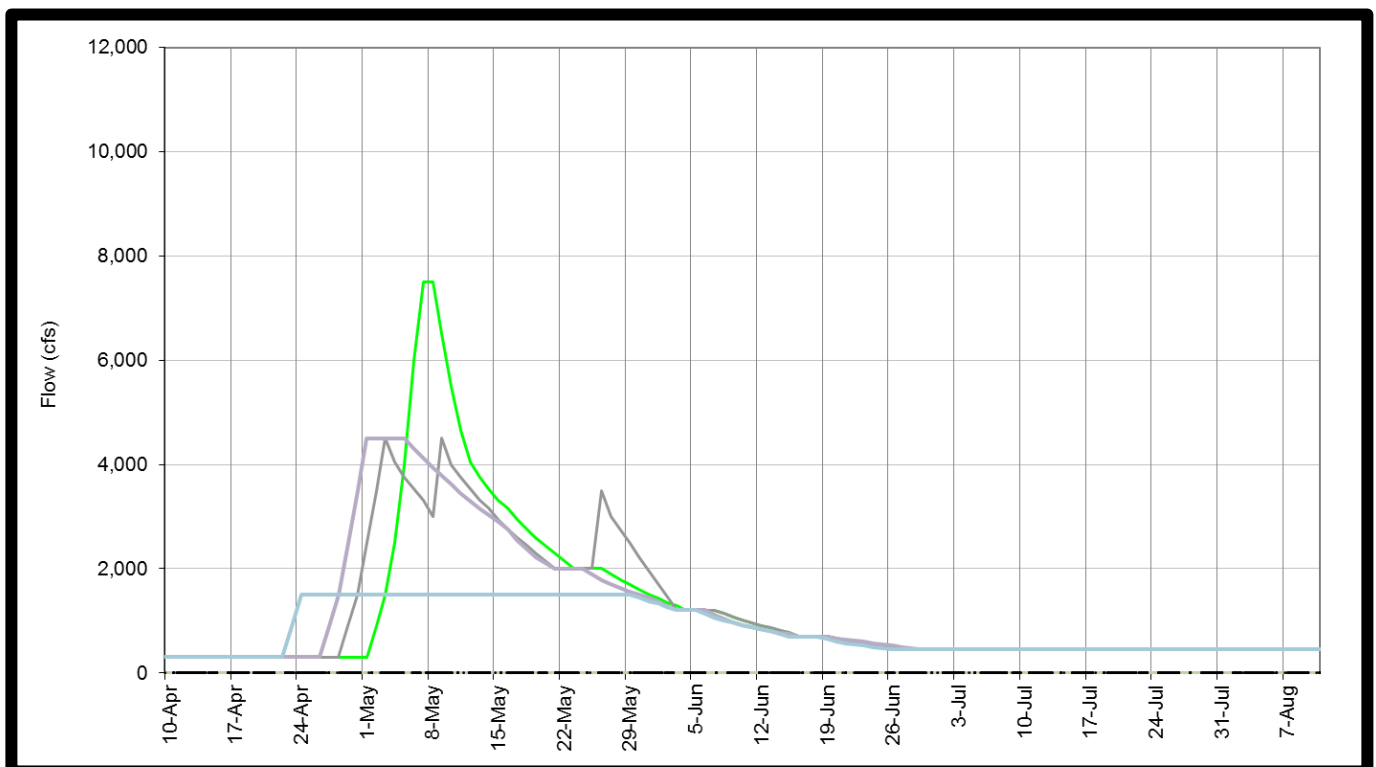




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Trinity River Restoration Flow Release Schedule Design Water Year 2014

Draft



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COMMON ACRONYMS

CDFW	California Department of Fish and Wildlife
CDWR	California Department of Water Resources
CNRFC.....	California-Nevada River Forecast Center (National Weather Service)
HVT	Hoopa Valley Tribe
ROD	Record of Decision
TAMWG	Trinity Adaptive Management Working Group
TMC	Trinity Management Council
TRRP	Trinity River Restoration Program
USBR.....	U.S. Bureau of Reclamation
USDI.....	U.S. Department of the Interior
USFS.....	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WY2014	water year 2014
YT.....	Yurok Tribe

EXECUTIVE SUMMARY

This report documents the development of the Trinity River Restoration Program restoration flow release schedule for Water Year 2014. The flow scheduling process was established under the U.S. Department of the Interior Record of Decision ([USDI 2000](#)). This document was provided in a draft form to the Trinity Adaptive Management Working Group and Trinity Management Council as background information for the presentation of the Flow Workgroup consensus recommendation.

Water Year 2014 is on track to end as one of the driest years on record. The Trinity & Shasta watersheds experienced exceptional drought throughout the water year, resulting in record low inflows into the Central Valley Project's northern storage reservoirs. The California-Nevada River Forecast Center daily predictions show a consistent decline throughout the water year, with some recovery in the February/March period. The California Department of Water Resources B120 monthly forecasts were consistently in the Critically Dry class beginning with their January forecasts. According to the March B120 forecast, (March 1, 50%) the forecast annual inflow for Trinity is 340,000 acre feet. This inflow volume corresponds to a Critically Dry restoration release volume of 369,000 acre feet to the Trinity River.

The flow workgroup considered an initial array of 24 hydrograph alternatives for all five possible water year types. These were screened to 15 options that underwent detailed evaluation. During late February and early March 2014, it emerged that the water year type would likely be Critically Dry or Dry. The flow workgroup therefore focused on assessing the four hydrograph options associated with these two water year types: (1) Record of Decision Critically Dry; (2) Record of Decision Dry; (3) Dry multi-peak; and (4) Dry Joint Physical Riparian Initiation Alternative 2. Based on consideration of temperature compliance, sediment transport, riparian establishment/scour, rearing habitat, juvenile outmigration, and learning opportunities the flow workgroup developed the following recommendations:

- If it is a Critically Dry year the group recommends the Record of Decision hydrograph.
- If it is a Dry year the group recommends the Joint Physical Riparian Initiation Alternative 2. This option was slightly preferred over the Multi-peak alternative as it has the potential to perform greater geomorphic work while also meeting other objectives (ie: temperature, habitat, etc.).

TAMWG input... TMC input...

1. INTRODUCTION

The goal of this document is to provide a consolidated record for the development and establishment of the Trinity River restoration flow release schedule for Water Year 2014 (WY2014), under the U.S. Department of the Interior (USDI) Record of Decision (ROD; [USDI 2000](#)). This document was provided in a draft form to the Trinity Adaptive Management Working Group (TAMWG) and Trinity Management Council (TMC) for their spring 2014 meetings.

1.1. Background

The Trinity River is located in the coastal mountains of Northern California. It is the largest tributary to the Klamath River. The U.S. Bureau of Reclamation (USBR) operates Trinity and Lewiston Dams on the Trinity River as part of the Central Valley Project. The Trinity River Division of the Central Valley Project (Figure 1) creates a trans-basin diversion that supplies water from the Trinity River, through tunnels, to the Sacramento River for water supply, hydro-power generation, and water temperature control. Flow regulation of the Trinity River by Trinity Dam began in November 1960 and diversion of water from the Trinity River to the Sacramento River via the tunnels began in April 1963. Following dam construction, salmon and steelhead populations in the Trinity River declined by 53-96%, depending on the species ([USFWS and HVT 1999](#)).

1.2. Restoration Water Allocation / TRRP Annual Flow Scheduling Process

The Trinity River Restoration Program (TRRP) was established by the ROD in December 2000 ([USDI 2000](#)). The ROD recommended a suite of restoration actions and directed the USBR to provide annual in-stream flows below Lewiston Dam as part of the restoration efforts to restore and maintain the Trinity River's fishery resources. These restoration flow releases are intended to accomplish a wide variety of objectives, from promoting fluvial process, to temperature control, to habitat improvement. The recommended releases attempt to mimic snowmelt hydrology, promote alluvial processes, and provide water temperature and habitat benefits for fishery resources. The ROD stipulates that, "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... may not be changed." Thus the ROD established a fixed set of five water year types (Table 1), water allocation volumes by water year type, and recommended hydrographs for dam releases with flexibility for adaptive management.

The TRRP develops annual flow release scheduling recommendations through a collaborative process with public input. The focus of flow scheduling has typically been the spring and early summer releases at rates greater than 450cfs (summer base flow), however "base-flows" throughout the year are part of the restoration water allocation and are subject to adaptive management. The TRRP Flow Workgroup develops annual flow release hydrographs to meet water year specific objectives and broader program goals, including the 300cfs winter base flow ([FLOW WORKGROUP MEETING SUMMARIES IN APPENDICES H-L](#)). Using technical input from the workgroup, the TMC makes the final flow recommendation in early April, which is forwarded for consideration by the USDI ([APPENDIX N](#)), represented by the USBR and the U.S. Fish and Wildlife Service (USFWS) at the regional level ([APPENDIX O](#)). The USBR has final authority over all releases and diversions from the Trinity River. The USBR also conducts non-restoration flow releases to the Trinity River. These non-restoration releases are conducted for dam safety, Native American ceremonies, and other purposes.

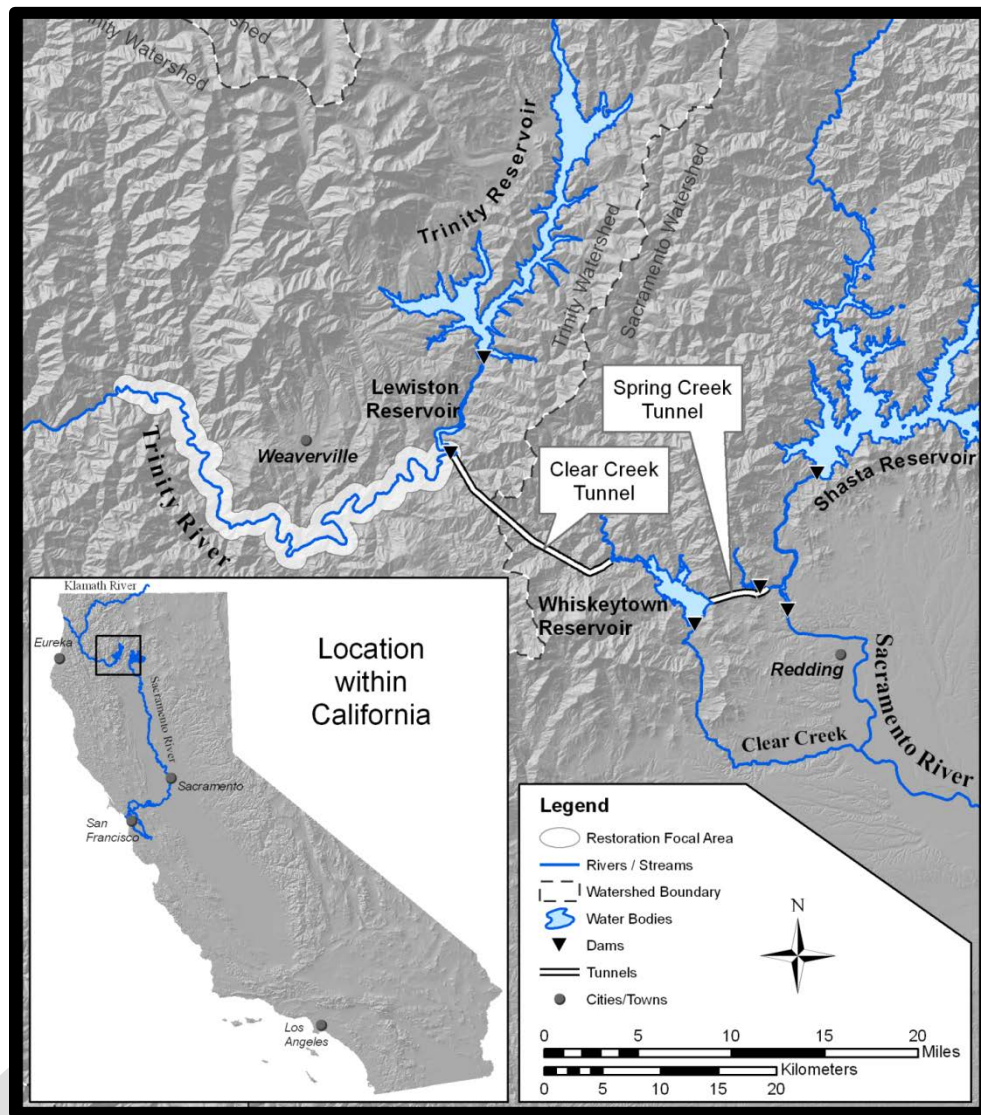


Figure 1. Location map of the Trinity River Division of the Central Valley Project.

Water allocation and flow releases are provided per water year, extending from October 1 to September 30. Reservoir inflow over a water year is not fully known until the water year ends. To set the water year type for restoration water allocation and flow scheduling, the water year type is based on the California-Nevada River Forecast Center (CNRFC) April 1st 50% exceedance-forecast for the unregulated annual runoff of the Trinity River at Lewiston, California (Table 2).

This annual runoff forecast is jointly developed by the National Weather Service (NWS) and the California Department of Water Resources (CDWR) for the entire State of California, including the Trinity River, and are published in the 'DWR - Water Supply Outlook for California and Northern Nevada – Bulletin 120'. The forecast is based on a combination of snowpack measurements and predictive modeling using statistical and hydrological methods, computed as shown in Figure 2. The predictive models used to determine the water year type for the Trinity River use statistically average historical conditions, called "50% probability of exceedance".

Table 1: Restoration Release Water Volume Allocation (USFWS and HVT 1999). Probability of occurrence based on data from years 1912 to 1994.

Water Year Type	Restoration Water Allocation (Acre-Feet)	Annual Probability of Occurrence (Percent)
Extremely Wet	815,000	12%
Wet	701,000	28%
Normal	647,000	20%
Dry	453,000	28%
Critically Dry	369,000	12%

Table 2: Predicted Water Year Type. (USFWS et al 1999).

Forecast Annual River Runoff (acre feet)	Predicted Water Year Type
$\geq 2,000,000$	Extremely Wet
1,350,000 – 1,999,999	Wet
1,025,000 – 1,349,999	Normal
650,000 – 1,024,999	Dry
$< 650,000$	Critically Dry

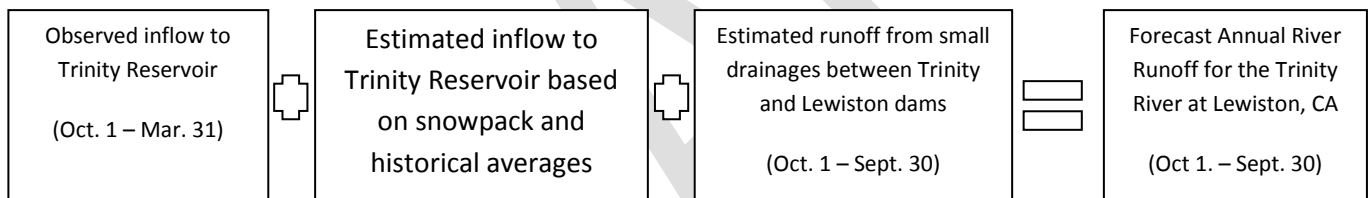


Figure 2: Computation of the April 1st Forecast for the Annual Runoff of the Trinity River

2. DETERMINATION OF WATER YEAR TYPE FOR WY2014

On April X, 2014, DWR published the 50% exceedance forecast for the annual inflow into Trinity reservoir. The forecast volume is XXX thousand acre-feet. This forecast indicates a Critically Dry water year (per Table 2) and corresponds (per Table 1) to a restoration release volume of 369,000 acre-feet.

2.1. Discussion of Conditions

The TRRP keeps track of inflow into Trinity & Lewiston reservoirs beginning October 1 of each water year (<http://www.usbr.gov/mp/cvo/current.html>). The TRRP also tracks the official DWR B120 monthly forecast (beginning in February of each year), and also tracks the CNRFC annual inflow daily forecast (<http://www.cnrfc.noaa.gov/ensembleProduct.php?id=CEGC1&prodID=9>).

As of February 27, 2014, storage in Trinity Reservoir was at 1,181 thousand acre-feet (TAF), 69% of the historical average for this date. Shasta Reservoir is at 1,732 TAF, 53% of the historical average for this date. 72 TAF of runoff has accumulated in Trinity Reservoir since October 1, 2013, the beginning of WY2014. The average annual runoff into Trinity Reservoir is roughly 1,300 TAF.

The Trinity Fish Hatchery has received 7.21 inches of precipitation since October 1, 2013, 32% of the historical average for this date. According to the US Drought Monitor (<http://droughtmonitor.unl.edu/>) the Trinity Basin is currently experiencing a D3 – Extreme Drought classification. The US Seasonal Drought Outlook, produced by NWS, forecasts the drought to persist or intensify through May 31, 2014. The NWS also predicted that over the next one to three months the Trinity Basin is likely to receive below normal precipitation.

The California Snow Water Content (SWC) analysis produced by DWR indicated, for the Northern Section, including Trinity through Feather & Truckee watersheds, very low volumes of SWC; even less than that in the 1976-77 drought period.

Central Valley Operations (CVO) provides the b2 Central Valley Project (CVP) operations forecast on a monthly basis. The February forecast for Trinity Reservoir includes the following predictions of End of September (EOS) Storage and exports to the Central Valley:

- 50% Exceedance
 - EOS Storage - 457 KAF
 - 2014 Carr Export - ~ 896 KAF
- 90% Exceedance – Min Regulatory Standards
 - EOS Storage - 334 KAF
 - 2014 Carr Export - ~ 720 KAF
- 90% Exceedance – Min Releases
 - EOS Storage - 334 KAF
 - 2014 Carr Export - ~ 720 KAF

2.2. Forecasts

Two factors figure prominently in the flow scheduling process: 1. Predicted inflow, and thus the water year type, and 2. CVP operations of Trinity and Lewiston reservoirs. CNRFC provides daily estimates of the first, and the CVO provides monthly updates of the second.

CNRFC began publishing a daily estimate of the annual inflow into the Trinity above Lewiston Dam (<http://www.cnrfc.noaa.gov/ensembleProduct.php?id=CEGC1&prodID=9>) beginning in WY2013. DWR continues to produce the official monthly forecast that is the basis of the water year determination. However, the daily CNRFC estimate is a valuable planning tool for the Program's flow scheduling process. Figure 3 is the graphical record of the daily annual inflow estimates beginning October 1, 2013. The estimates are published at the 10%, 50%, and 90% exceedance levels. Figure 3 also includes the monthly DWR 50% forecast beginning January 2014.

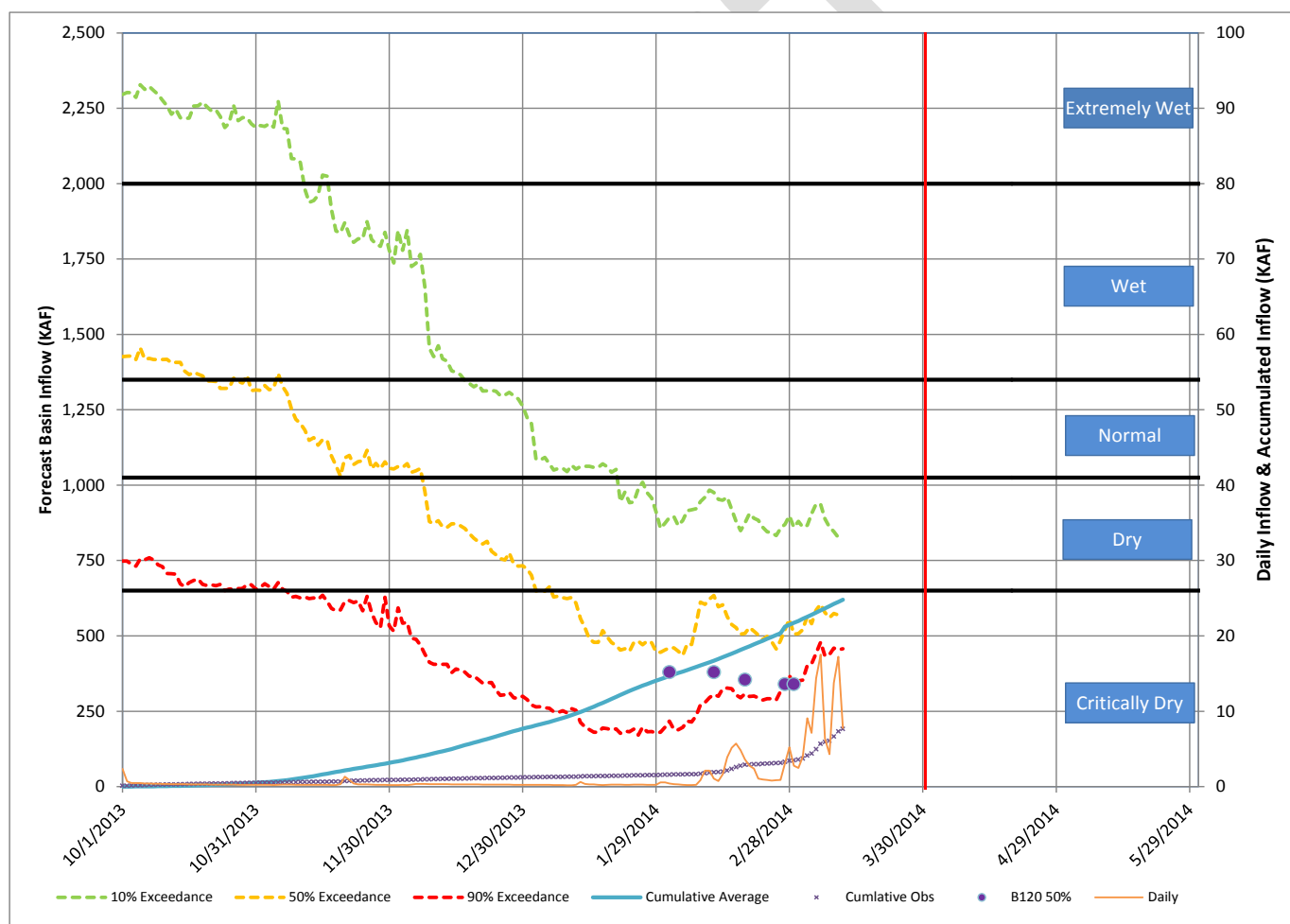


Figure 3. Daily EPS forecasts of annual inflow by CNRFC. Includes the Monthly (Feb & Mar) B120 forecasts by DWR (circles).

3. FLOW SCHEDULE RECOMMENDATION FOR WY2014

This section summarizes alternative development, screening, evaluation, and identification of the Flow workgroup's recommended hydrograph. Additional information about the recommended hydrograph, other alternatives, and analyses conducted are in the Appendices.

3.1. Alternative Development and Screening

In planning for WY2014, the flow workgroup first assembled a portfolio of previously developed hydrograph alternatives (Peterson 2013). This portfolio includes the hydrographs that have been implemented since WY2004 plus some flow schedules that were previously evaluated but not enacted. Concurrently, flow workgroup members developed new hydrographs options, in each case specifying the following: purpose; rationale; hypothesis/predicted response; effect on management targets; recommended modeling and technical analyses; monitoring; uncertainties/potential risks/confounding variables; and other constraints and management considerations. The portfolio of previously developed hydrographs and the newly developed options were combined to form an initial array of alternatives considered for WY 2014 (Table 3).

Table 3: Hydrograph alternatives considered for implementation in WY2014. Water year classes are included in parentheses: EW = Extremely Wet; W = Wet; N = Normal; D = Dry; CD = Critically Dry. Hydrographs designated with * are included in the restoration flow release portfolio (Peterson 2013).

Initial Array of Hydrograph Alternative	Hydrograph Alternatives Subjected to Evaluation	Hydrograph Alternatives Relevant to WY2014
(EW) ROD*	(EW) ROD*	-
(EW) Riparian Initiation	(EW) Riparian Initiation	-
(W) ROD*	(W) ROD*	-
(W) Alt 1	(W) Alt 1	-
(W) Alt 2	(W) Alt 2	-
(W) Multi-peak 1	(W) Multi-peak 1	-
(W) Multi-peak 2	(W) Multi-peak 2	-
(W) 11,000 cfs*	-	-
(N) ROD*	(N) ROD*	-
(N) Multi-peak 1	(N) Multi-peak 1	-
(N) Multi-peak 2	(N) Multi-peak 2	-
(N) 2004 Modified*	-	-
(N) 2008 Modified*	-	-
(N) Riparian Descending Limb*	-	-
(N) Riparian/Wildlife Peak + Monitoring*	-	-
(N) 7000 cfs Model Calibration*	-	-
(N) Joint Physical-Riparian*	(N) Joint Physical-Riparian*	-
(D) ROD*	(D) ROD*	(D) ROD*
(D) Multi-peak	(D) Multi-peak	(D) Multi-peak
(D) Monitoring Benches*	-	-
(D) Spring Habitat Bench*	-	-
(D) Joint Physical-Riparian Alt 1*	-	-
(D) Joint Physical-Riparian Alt 2*	(D) Joint Physical-Riparian Alt 2*	(D) Joint Physical-Riparian Alt 2*
(CD) ROD*	(CD) ROD*	(CD) ROD*

After developing the initial array of 24 hydrograph alternatives, the flow workgroup screened those to a smaller set of 15 options that would undergo evaluation (Table 3; see November meeting summary in Appendix I). During late February and early March 2014 it emerged that the water year type would likely be Critically Dry or Dry. The flow workgroup focused on assessing the four hydrograph options associated with those two water year types (Table 3; Figure 4).

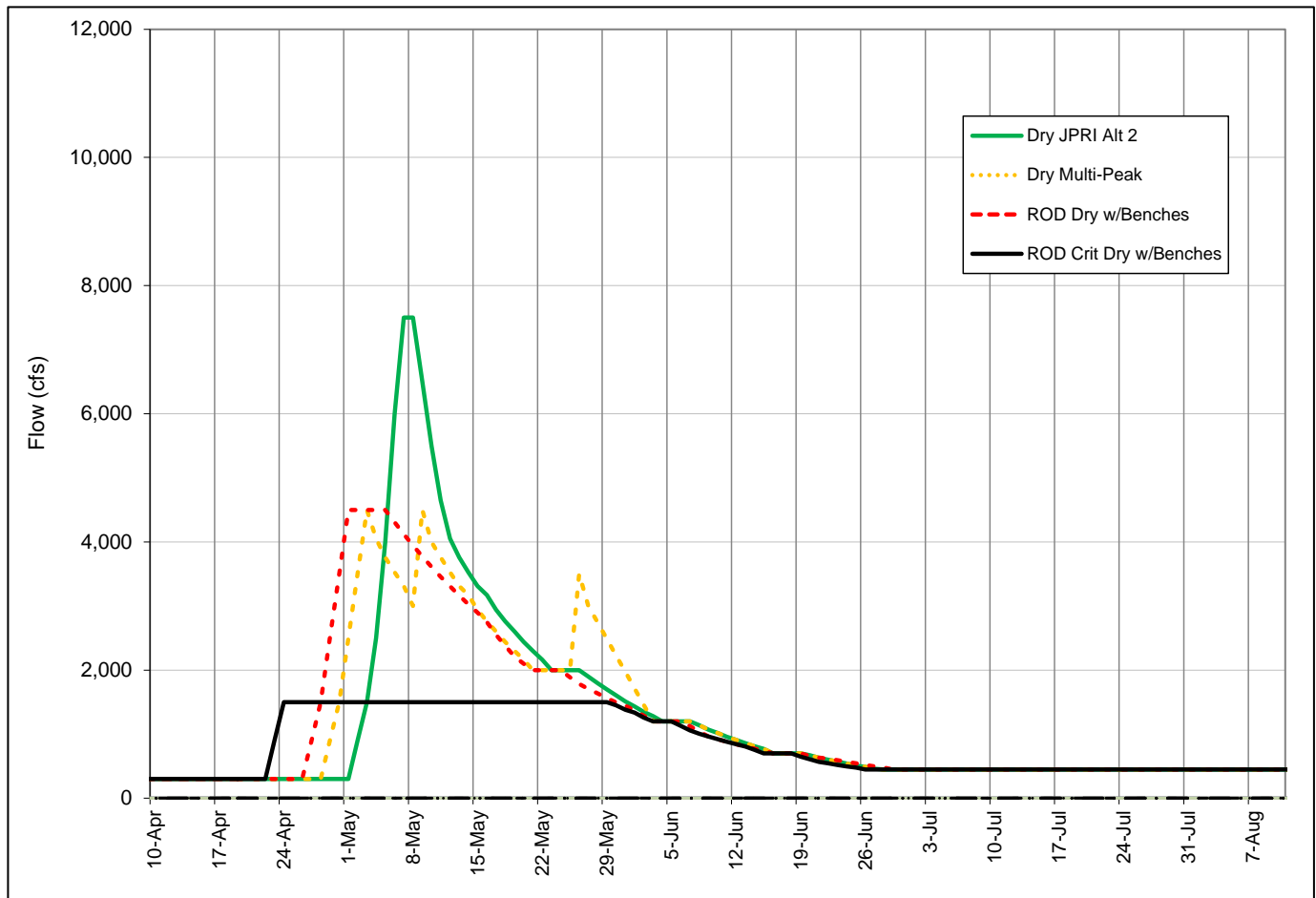


Figure 4. 2014 suite of hydrographs under consideration by the Flow Work Group.

The ROD Dry and Critically Dry hydrographs are described in Chapter 8 of the Trinity River Flow Evaluation Final Report (USFWS and HVT 1999). The other two hydrographs are described below.

Dry water year multi-peak hydrograph (Appendix A) - *The purpose of this flow schedule alternative is to: 1) test the effect of multiple flow peaks on sediment transport, 2) achieve temperature and smolt outmigration objectives for a dry water year, 3) provide a flow schedule that more closely mimics a natural flow regime of multiple snowmelt peaks and 4) provide diverse rearing and feeding conditions for salmonid juveniles and smolts. The flow schedule alternative was also formulated to provide benches for habitat monitoring personnel to perform fish habitat data collection.*

Joint Physical Riparian Initiation Alternative 2 (JPRI Alt. 2; Appendix B) - *The peak portion of the ROD Dry hydrograph was modified from a five-day duration peak of 4,500 cfs to a two-day peak of 7,500 cfs. There are several objectives associated with this change: 1) Increase the total sediment transport given available release water volume to closer meet sediment transport objectives defined in the Trinity River Flow Evaluation Final Report (TRFEFR, prepared by USFWS & HVT, 1999); 2) Increase the mobilization of sediments from the Rush Creek Delta; and 3) Induce fine sediment flushing and gravel sorting at the Upper Junction City rehabilitation site that was constructed in 2012; 4) Induce scouring of seedlings in order to prevent*

encroachment (given that this is the second consecutive year of dryer basin hydrology and future opportunities to provide scour remain uncertain).

Given the limited water available in a Critically Dry year, no options to the ROD hydrograph were considered for that water year type.

3.2. Evaluation of Alternatives

Flow workgroup members used several metrics to evaluate differences among flow schedule alternatives. Reports for the metrics are included in Appendices C-G and generally include: purpose and intended use; calculation method; input parameters; output; accuracy, precision, uncertainty; evaluation and interpretation; and literature cited. Metrics were in the following categories:

- Temperature Compliance (Appendix C) – *Flow volumes and timing are designed to address temperature needs for all riverine life stages of salmonids.*
- Sediment Transport (Appendix D) – *The peak magnitude and duration of the spring high flow releases recommended in the ROD were developed to meet specific geomorphic objectives including sediment transport and channel bed mobility and scour to create and maintain salmonid habitats.*
- Salmonid Rearing Habitat (Appendix E) – *The Trinity River Flow Evaluation Final Report ([USFWS and HVT 1999](#)) identified juvenile and fry Chinook rearing habitat as a primary limiting factor.*
- Riparian Assessments (Appendix F) – *Within a decade of Trinity River Division completion, stable streamflows allowed narrowleaf willow to colonize the bed of the Trinity River for most of the length of the Trinity River between Lewiston Dam and the North Fork Trinity River confluence. Combined with high sediment loads and a lack of scouring floods, this condition led to steep vegetated banks that resisted lateral erosion and contributed to the simplification of hydraulics and loss of salmonid rearing habitat.*
- Outmigrant Timing (Appendix G) – *In order to quantitatively estimate the relative effects of various flow release alternatives, the Yurok Tribe developed a linear-regression model to estimate changes in Chinook salmon smolt outmigration timing as a function of water temperature.*
- Learning Opportunities – *Adaptive management is a systematic approach for improving resource management by learning from management outcomes. The learning opportunities associated with flow options were described in the hydrograph write-ups (APPENDIX A and B).*

Ranks for Dry year hydrographs are summarized in Table 4. Joint Physical Riparian Initiation Alternative 2 (JPRI Alt. 2) tended to rank the highest based on factors considered. However, three factors (Sediment Transport, Riparian Scour, and Bed Scour / Mobility) overlap to some degree.

Table 4: Evaluation of Dry year hydrograph alternatives. A rank of three is the highest, one is the lowest. The ranks were developed based on the analysis described in Appendices C – G.

Factor	Temperature Compliance	Sediment Transport	Riparian Scour	Bed Scour / Mobility	Rearing Habitat	Riparian Initiation / Inundation	Juvenile Outmigration	Learning Opportunity
Hydrograph								
ROD	2	1.5	1.5	2	1.5	3	2	1
Multi Peak	2	1.5	1.5	1	1.5	1.5	2	2.5
JPRI Alt 2	2	3	3	3	3	1.5	2	2.5

3.3. Consensus Recommendation by the Flow Workgroup

If it is a Critically Dry year the group recommends the ROD hydrograph. If it is a Dry year the group recommends JPRI Alt. 2. This option was slightly preferred over the Multi-peak alternative as it has the potential to perform greater geomorphic work while meeting other objectives.

3.4. Input from the TAMWG

The workgroup recommendation was presented to the TAMWG on March 18, 2014. TAMWG provided the following input to the TMC...

3.5. Recommendation by the TMC

The workgroup recommendation and TAMWG input were presented to the TMC on March 27, 2014. TMC recommended...

The TMC recommendation (Appendix J) was forwarded to the USBR and USFWS Regional Directors for approval (Appendix K).

Implementation of these recommendations will be covered in a future report, "Flow Releases and Diversions on the Trinity River, Water Year 2014."

4. PUBLIC SAFETY PREPARATIONS

Several preparatory steps have been taken to allow for the maximum flow releases including: infrastructure improvements, recent identification of infrastructure of concern, public outreach, and emergency preparedness.

4.1. Infrastructure Improvements and Concerns

No concerns for public infrastructure (e.g. bridges and roads) have been identified for this year's 1,500 – 7,500 cfs peak release schedule.

4.2. Public Outreach

TRRP posted a note on the Program's world-wide-web home page (<http://www.trrp.net>) on April 12th to inform the public that the TMC recommendation included increased flows as of April 21st.

Upon approval of the flow schedule by USDI, the USBR issued a news release on April 19, 2014, with the flow schedule and graph included. The news release includes contact information to the TRRP. The news release was forwarded to: local newspapers in Weaverville, Hoopa, Eureka, and Redding; the env-trinity list server; the automated Trinity River release notification list server. The marinas located along Lewiston Reservoir were notified of the high flow release schedule so docks can be adequately secured against the increased water velocity. The TRRP also updated the Program's web home page to provide electronic access to the news release and posted the schedule with graph on the Current Release Schedule page. Flow schedules were also posted at numerous locations between Lewiston and Hoopa, California.

USBR sends out automated notifications via phone or email of flow releases changes to the Trinity River. The public can sign up to receive these notifications at: <http://www.trrp.net/restore/flows/release-email/>. USBR also maintains call-in recorded phone message (530-246-7594) with the current release, and any scheduled changes. For significant flow releases, USBR also contacts the Trinity County Sheriff's Office and the USFS (Weaverville & Big Bar), as they are the primary agencies tasked with public safety.

4.3. Emergency Preparedness

The TRRP continues to work with the USBR and Trinity County to develop an emergency response plan in case an unforeseen emergency arises. Additionally, staff from the TRRP conducts field-monitoring between Lewiston Dam and the North Fork Trinity River for releases greater than 8,500 cfs (not required for this water year's restoration flow release). Staff are equipped with radios to communicate any unforeseen issues to the appropriate authorities.

5. REFERENCES

Peterson, E. (ed.) 2013. *Abbreviated Restoration Flow Release Portfolio* [internal DRAFT dated 9/23/2013]. Trinity River Restoration Program, Weaverville, CA.

USDI (2000) Record of Decision, Trinity River mainstem fishery restoration final environmental impact statement/environmental impact report. Decision by the U.S. Department of Interior, December 2000. Available online at <http://odp.trrp.net/Data/Documents/Details.aspx?document=227>

USFWS, USBR, HVT, and TC (1999) Trinity River mainstem fishery restoration environmental impact statement/report public draft. Lead agencies are U.S. Fish and Wildlife Service, U.S. Bureau of Reclamation, Hoopa Valley Tribe, and Trinity County. Available online at <http://odp.trrp.net/Data/Documents/Details.aspx?document=1238>

USFWS and HVT (1999) Trinity River flow evaluation final report. Report to the U.S. Department of the Interior, June 1999, from U.S. Fish and Wildlife Service, Arcata, CA and Hoopa Valley Tribe, Hoopa, CA. Available online at <http://odp.trrp.net/Data/Documents/Details.aspx?document=226>