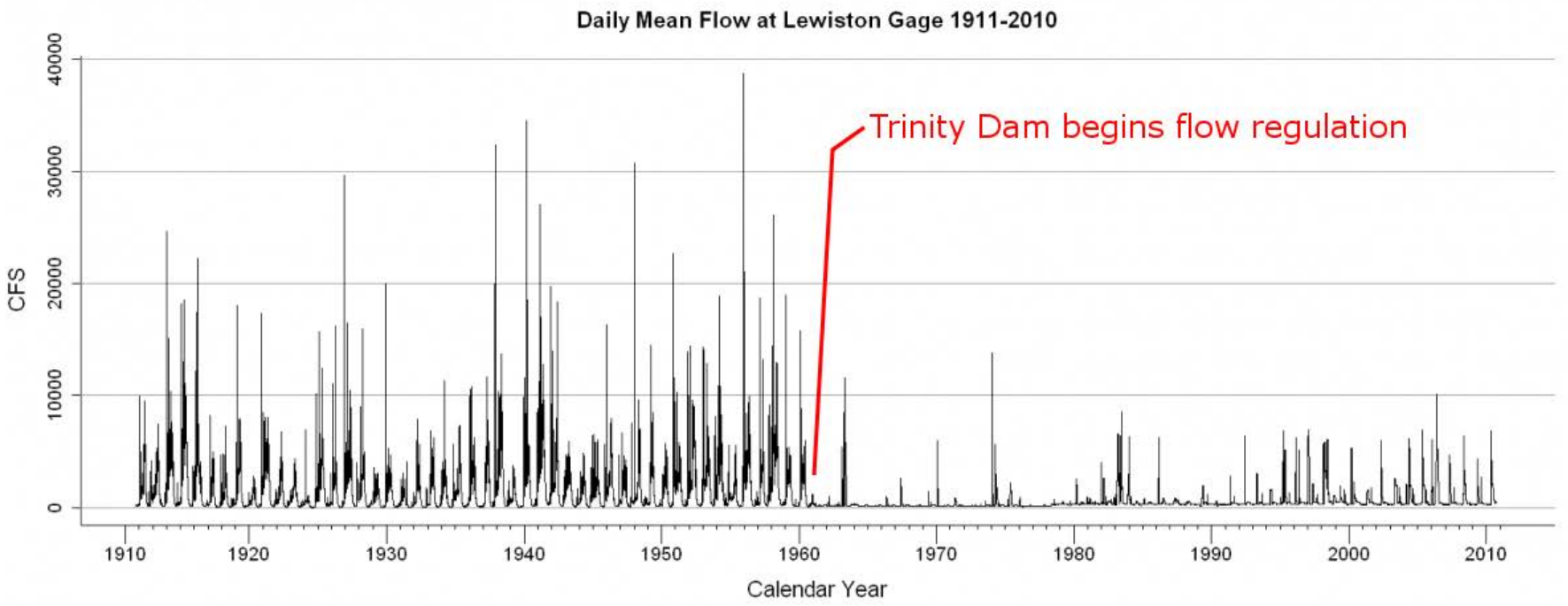
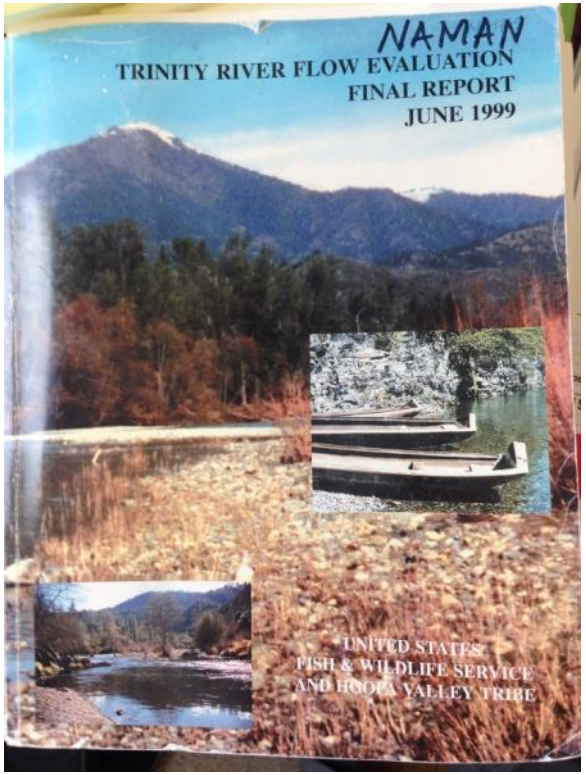
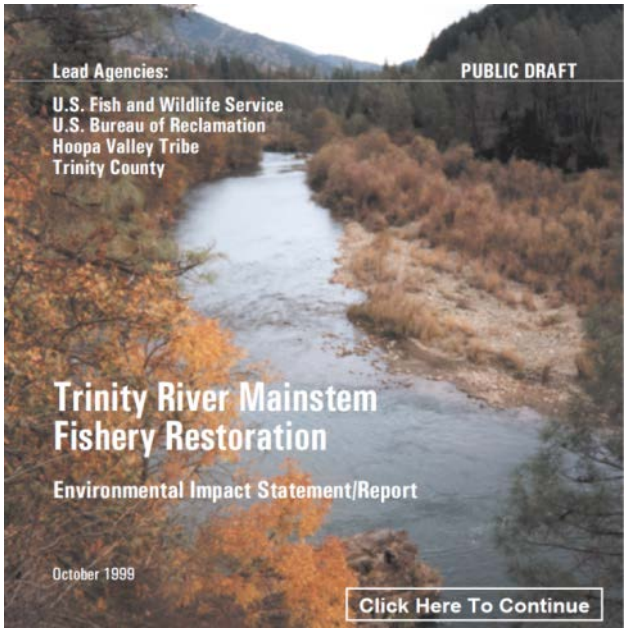
# Natural Flow Regime for the Trinity River

Seth Naman
NOAA
Trinity Management Council
12/4/19



- Groundbreaking studies in 1990s
- EIS in 1999
- ROD signed in 2000




**U.S. Department of the Interior**
**Record of Decision**
**Trinity River Mainstem Fishery Restoration**
**Final Environmental Impact Statement/Environmental Impact Report**
**December 2000**

**I. Introduction and Statement of Decision**

The Trinity and Klamath Rivers in northern California once teemed with bountiful runs of salmon and steelhead. Historically, hundreds of thousands of salmon and steelhead would enter the Klamath estuary and migrate upstream during several months of the year. After traveling through the lower 44 miles of the Klamath River, many of these fish would turn south at the confluence of the Trinity River and continue their journey to the middle and upper Trinity River. Adult salmon and steelhead would spawn in the clean gravels of the mainstem Trinity and several of its tributaries. Millions of young salmonids would then emerge from the gravel between January and June and rear in the diversity of habitats found in the river. The young of some species would begin their downstream migration to the Pacific Ocean within a few months of emerging from the gravel where they were spawned. Others remained in the river for a year or more before beginning their downstream migration. All of these fish would grow as they moved downstream through the Trinity, lower Klamath Rivers and Klamath estuary, undergoing physiological changes in preparation for life in the ocean. Suitable habitat and water quality were critical for the young salmon and steelhead during every stage of their outmigration in order for them to grow and become physically able to tolerate the transition to ocean life. After several years in the ocean fish return to the Klamath River as adults and once again begin the upstream migration to the Trinity River to spawn in their natal streams.

These impressive fish stocks defined the life and culture of the Hoopa Valley and Yurok Indian Tribes, and reservations were established along the Trinity and lower Klamath Rivers in the mid- to late-1800s based in large part on the Tribes' reliance on these resources. The abundance of the region's fishery resources also helped support the economy and way of life for the people of the region as a whole.

The once majestic runs in the Trinity River experienced significant declines following the construction and operation of the Central Valley Project's Trinity River Division (TRD) in the early 1960s. The TRD not only eliminated 109 miles of important salmonid habitat above Lewiston, California, but also exported to the Sacramento River as much as 90 percent of the waters flowing into the Trinity River at Lewiston, California. In authorizing the TRD, Congress believed water excess to the needs of the Trinity Basin could be diverted to the Central Valley

with its associated monitoring and mitigation measures, all practicable means to avoid or minimize environmental harm from the alternative selected have been adopted.

**VII. Tribal Concurrence**

In accordance with CPVIA Section 3406(b)(23)(B), this decision and the underlying recommendations were reviewed with the Hoopa Valley Tribe through the Tribal Chairman and the Tribal Council. By Tribal Resolution # 00-94 dated December 18, 2000, the Hoopa Valley Tribe formally concurred in and agreed with the underlying recommendations and this decision.

Duane Sherman, Sr. Chairman
Hoopa Valley Tribal Council

12/19/00
Date

**VIII. Secretarial Directive**

The Department's agencies are directed to implement this decision as outlined in this Record of Decision, and described in detail in the FEIS/EIR.

Bruce Babbitt
Secretary of the Interior

December 19, 2000
Date

Appendix A: Public Involvement and Responses to comments on the FEIS/EIR
Appendix B: Lewiston Dam Releases to the Trinity River
Appendix C. Measures to Minimize and Mitigate Impacts Associated with Implementation of the Preferred Alternative
Appendix D. Hoopa Valley Tribal Resolution # 00-94

# TRINITY RIVER FLOW EVALUATION

## Final Report

A report to the:

Secretary
U.S. Department of the Interior
Washington, D.C.

Prepared by:

U.S. Fish and Wildlife Service
Arcata Fish and Wildlife Office
1125 16th Street, Room 209
Arcata, CA 95521

and

Hoopa Valley Tribe
P.O. Box 417
Hoopa, CA 95546

In Consultation with:

U.S. Geological Survey
U.S. Bureau of Reclamation
National Marine Fisheries Service
California Department of Fish and Game

June 1999

# TRFES (Appendix O)

**Fall/Winter Flood Flows**

**Potential management Actions**

- All water years - November to late February
- No high-flow releases are planned, but sychronization of peak releases with stormflows should be evaluated through the adaptive management program to assess opportunities to maximize benefits of high-flow releases while conserving water.

**Hypotheses:**

- A single high-flow release each year will accomplish necessary geomorphic work (sediment transport, fine sediment deposition on floodplains, channel migration, bed mobility and scour, riparian vegetation scour, etc.).
- Preventing fall/winter peak flows in reaches nearest to Lewiston will reduce egg/embryo mortality associated with redd scour.

# TRFES (Appendix O)

**Competing hypotheses:**

- Synchronizing peak Lewiston releases with fall/winter peak flows in tributaries will transport fine sediment delivered by tributaries in suspension, deposit the fine sediment on floodplains, and will be less likely to reduce infiltration of mainstem alluvial deposits by fines.

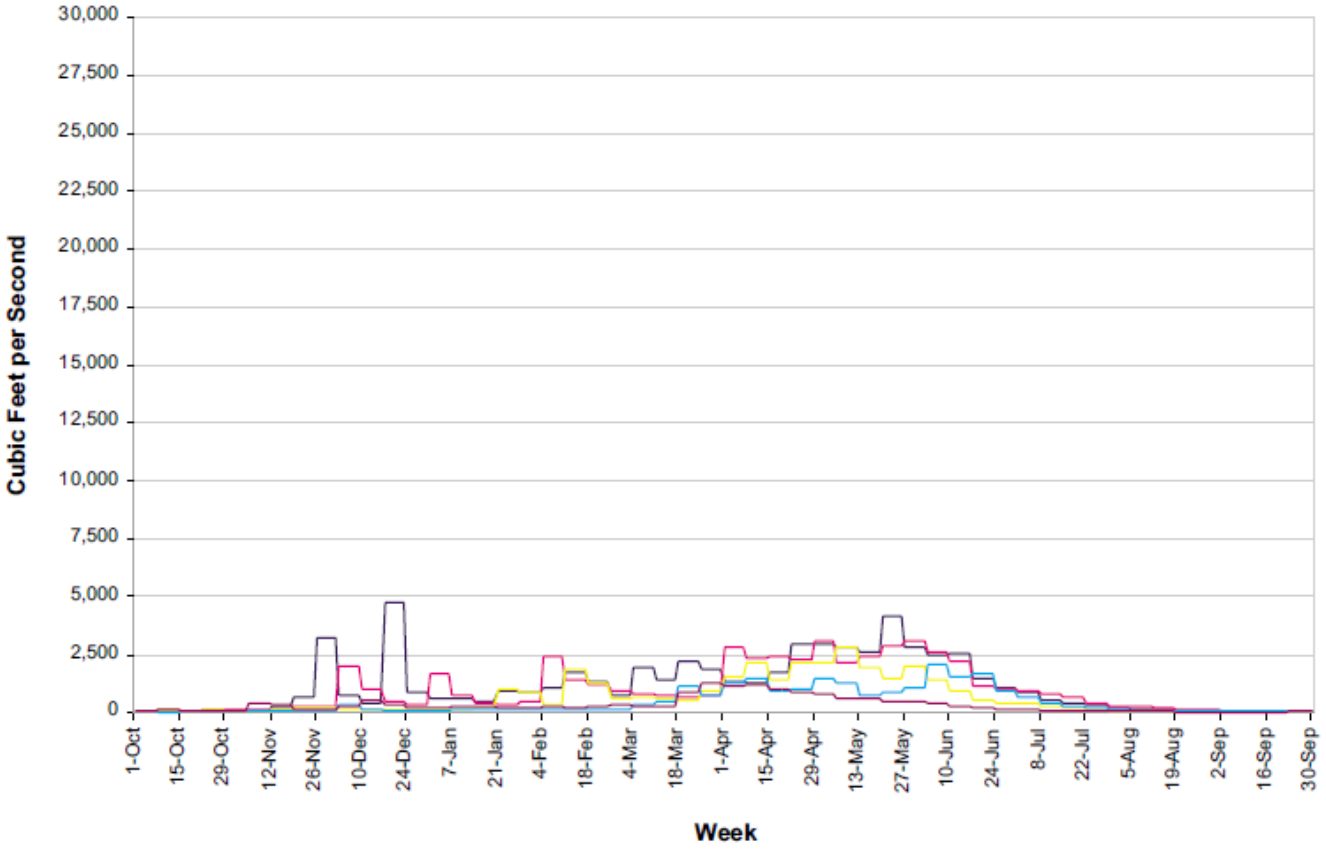




- Synchronizing peak Lewiston releases with tributary flood events increases downstream coarse sediment transport capacity, which allows us to better balance reach-wide coarse sediment budgets.
- Synchronizing peak releases with tributary stormflows would increase the magnitude and frequency of scour events, increasing riparian vegetation mortality and improving success with rehabilitation of riparian plant community diversity.

# Trinity River EIS, Percent Inflow Alternative

Synchronizing Lewiston Dam releases not analyzed




**NOTE:**
Water year in parenthesis. Weekly releases are 40 percent of modeled reservoir inflow for the previous week. This set of hydrographs presents releases that would have occurred in actual water years.

**FIGURE 2-5**
**PERCENT INFLOW HYDROGRAPH BASED ON REPRESENTATIVE YEARS**
TRINITY RIVER MAINSTEM FISHERY RESTORATION EIS/EIR

2655_420 (8/5/99)

# Trinity River ROD pg 12

- *"Based on subsequent monitoring and studies guided by the Trinity Management Council, the schedule for releasing water on a daily basis, according to that years' hydrology, may be adjusted but the annual flow volumes established in Table 1 may not be changed*."

# EIS Appendix C

APPENDIX C

## Implementation Plan for the Preferred Alternative of the Trinity River EIS/EIR

The proposed action consists of 6 components: 1) an increased flow regime and associated OCAP for managing releases and reservoir levels; 2) a channel rehabilitation program (mechanical rehabilitation); 3) a coarse and fine sediment management program; 4) infrastructure modifications; 5) upslope watershed restoration; and 6) an Adaptive Environmental Assessment and Management organization.

### 1. Increased Flow Regime and Trinity River Operating Criteria and Procedures

#### 1.1 Legal Principles Concerning TRD Operations

In section 3406(b)(23) of the Central Valley Project Improvement Act (CVPIA) (Public Law 102-575, 106 Stat. 4600, 4720), Congress called for the development of operating criteria and procedures (OCAP) for the Trinity River Division (TRD), along with recommendations for necessary instream fishery flow requirements, for the restoration and maintenance of the Trinity River fishery. Accordingly, this document describes the legal principles and scientific recommendations that apply to TRD operations and establishes OCAP required for the proper operation of the TRD consistent with those principles and recommendations.

This section briefly describes the legal principles that apply to the operations of the TRD. A detailed description can also be found in the FEIS/EIR, chapter 1.



#### 1.4 Operations Forecasting

Forecasting of hydrological conditions is an ongoing procedure that Reclamation uses to project water supply availability. This process is integral to the operations planning process whereby the current year is classified, river flow schedules are developed, and other beneficial uses of the water supply are determined.

Beginning in February, Reclamation begins forecasting the upcoming year hydrologic conditions and potential operations. Forecasts provide estimates of monthly information on water allocations, reservoir storage, instream releases, electrical generation and capacity. Forecasts are based upon precipitation and runoff conditions and snow course measurements. The runoff forecast in February is considered the first reliable forecast because more than one half of the precipitation year has occurred and snowpack measurements regularly occur. Runoff forecasts are updated in March, April, and May and are used in operational planning for the rest of the water year. Forecasts that occur later in the year are more reliable due to decreased variability of precipitation patterns. Forecasts are generally produced with 50 and 90 percent exceedence probabilities, but the 90 percent exceedence forecast is generally used for planning purposes and is required for CVP operational forecasts as a result of the 1993 Biological Opinion on Sacramento River winter run Chinook (NMFS, 1993).

#### 1.5 Water Year Designation

Normally the water year type can be reliably determined by April 1, when maximum snow pack has occurred. To determine the water year type, annual basin runoff above the Lewiston gage is determined. Annual basin runoff is calculated by summing the amount of runoff that has occurred from October until April 1 and a volume of water that Reclamation forecasters predict (90 percent probability of exceedence) will runoff during the months remaining in the water year (i.e., April through September) using the April 1 runoff forecast projection from the California cooperative snow surveys, California Department of Water Resources, Bulletin 120. Total water runoff is then compared to the ranges in Table 1 to designate the water year class.

#### 1.6 Dam Releases to the Trinity River

Beginning in early February, Reclamation will provide the Trinity Management Council (see the section Organizing to Implement the Trinity River Restoration Program) with a preliminary estimate of the water year classification. The Trinity Management Council (TMC) will formulate a preliminary instream fishery release schedule to the Trinity River and submit it to Reclamation for operational planning. Final decisions on the designation of the water year will be based on the April 1 runoff forecast. By April 15 of each year, Reclamation will request from the TMC, a final Lewiston Dam instream fishery release schedule. Reclamation will operate the TRD as closely to the proposed schedule as technically possible.

Initially, Lewiston Dam spring releases of 8,500 and 11,000 $ft^3/s$ that are recommended for Wet and Extremely Wet water years, respectively, will not be released into the Trinity River due to the need to modify 4 bridges and address other existing improvements in the floodplain that may be affected by releases in excess of 6,000 $ft^3/s$. Peak spring releases for Wet and Extremely Wet water years will be held to 6,000 $ft^3/s$ until sufficient construction

# Trinity River ROD pg 12

- *"Based on subsequent monitoring and studies guided by the Trinity Management Council, the schedule for releasing water on a daily basis, according to that years' hydrology, may be adjusted* ***within the time period analyzed in the EIS (April to July)****, but the annual flow volumes established in Table 1 may not be changed*."


2-385-19

Trinity River Restoration Program

P.O. Box 1300, 1313 South Main Street, Weaverville, California 96093
Telephone: 530-623-1800, Fax: 530-623-5944

**TO:** TODD BUXTON, FLOW WORKGROUP COORDINATOR

**FROM:** REAL-TIME FLOW MANAGEMENT SUBGROUP

SETH NAMAN (NOAA), KEN LINDKE (CDFW), TODD BUXTON (BOR), AARON MARTIN (YUROK TRIBE), ROBERT FRANKLIN (HVT), NICHOLAS SOM (USFWS)

**SUBJECT: A PLAN TO MODEL THE EFFECTS OF SYNCHRONIZING LEWISTON DAM RELEASES AND TRIBUTARY FLOWS ON TRRP OBJECTIVES**

**DATE:** JANUARY 25, 2018

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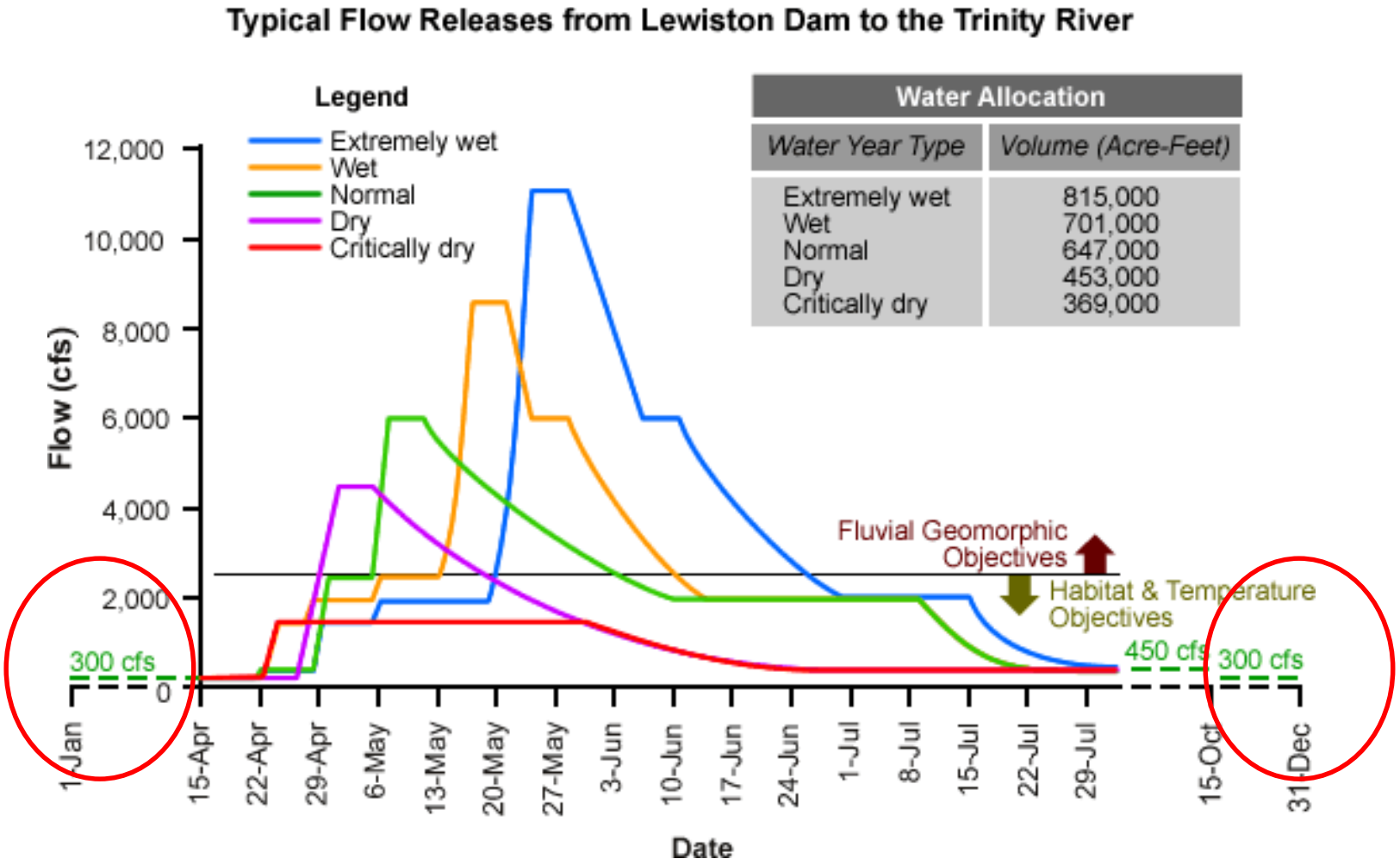
## 1. Introduction

There are currently two sub groups of the Flow Work Group, working in parallel on separate tasks aimed at developing methods that could be used to release water from Lewiston Dam in the winter months in order to increase the ecological effectiveness of dam releases. One group is

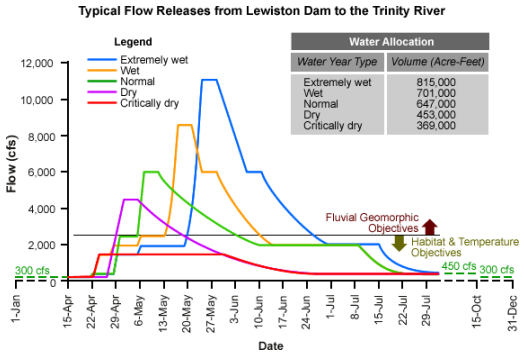
# Current typical flow schedule



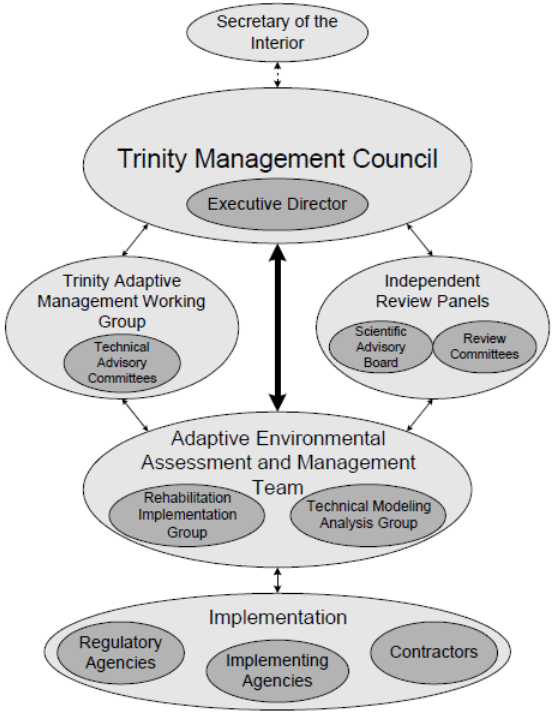

Source: trrp.net

# Problem: Administrative and procedural hurdles

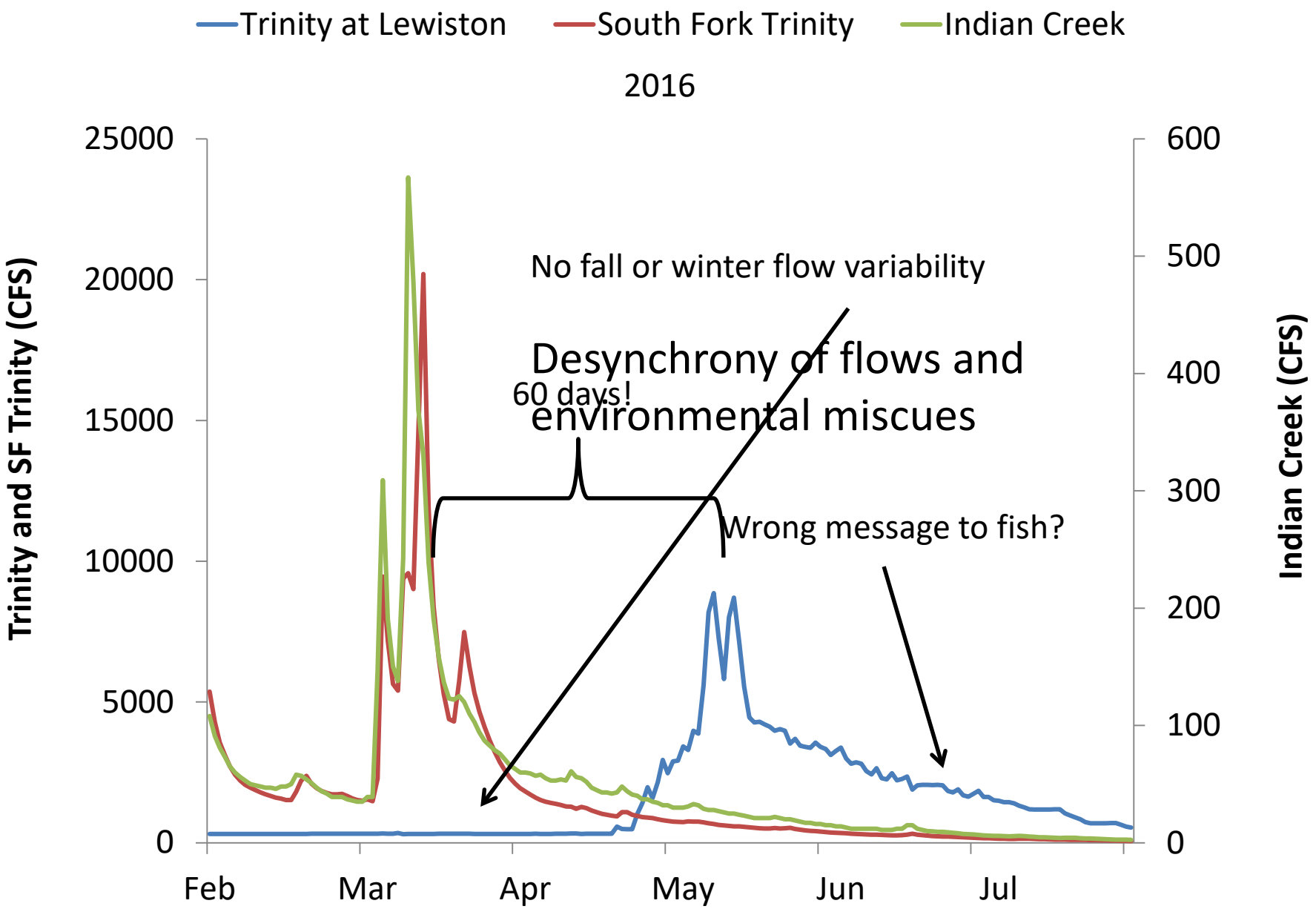
- Water year not determined until April, 7 months into the water year.



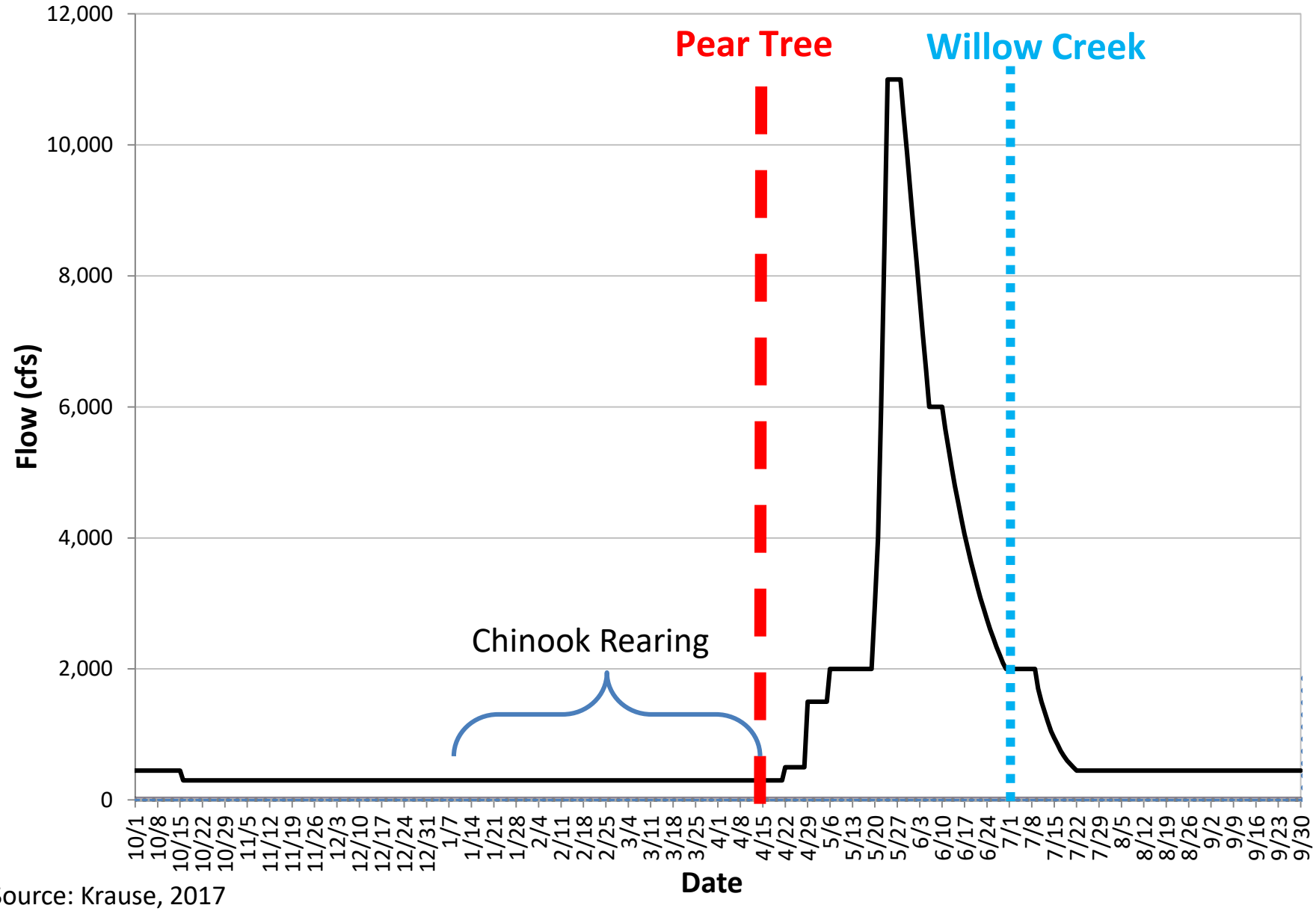

- Administrative process for flow scheduling cumbersome




- Leading to…


Trinity at Lewiston
South Fork Trinity
Indian Creek
2016
Trinity and SF Trinity (CFS)
Indian Creek (CFS)
25000
20000
15000
10000
5000
0
600
500
400
300
200
100
0
Feb
Mar
Apr
May
Jun
Jul
No fall or winter flow variability
Desynchrony of flows and environmental miscues
60 days!
Wrong message to fish?

# 80% Chinook Outmigration




Source: Krause, 2017

# “Simplistic, static, environmental flow rules are misguided and will ultimately contribute to further degradation of river ecosystems”-Arthington et al 2006

DOI: 10.1007/s002670-002-2737-0

## Basic Principles and Ecological Consequences of Altered Flow Regimes for Aquatic Biodiversity[1]

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ANGELA H. ARTHINGTON
Cooperative Research Centre for Freshwater Ecology
Centre for Catchment and In-Stream Research
Faculty of Environmental Sciences
Griffith University
Nathan, Queensland, Australia 4111

regimes; Thirdly, maintenance of natural patterns of longitudinal and lateral connectivity is essential to the viability of populations of many riverine species; Finally, the invasion and success of exotic and introduced species in rivers is facilitated by the alteration of flow regimes. The impacts of flow change are manifest across broad taxonomic groups including riverine plants, invertebrates, and fish. Despite growing recognition of these relationships, ecologists still

 *Mar. Freshwater Res.*, 1998, **49**, 55–72

## Flow variability and the ecology of large rivers

J. T. Puckridge[A], F. Sheldon[AB], K. F. Walker[A] and A. J. Boulton[C]

[A]*Cooperative Research Centre for Freshwater Ecology, Department of Zoology, University of Adelaide, SA 5005, Australia. email: jpuckrid@zoology.adelaide.edu.au*
[B]*Cooperative Research Centre for Freshwater Ecology, University of Canberra, Belconnen, ACT 2616, Australia*
[C]*Department of Ecosystem Management, University of New England, Armidale, NSW 2351, Australia*

**Abstract.** Ecological processes in large rivers are controlled by their flow variability. However, it is difficult to find measures of hydrological variability that characterize groups of rivers and can also be used to generate hypotheses about their ecology. Multivariate analyses of the hydrographs of 52 rivers worldwide revealed distinctive patterns of flow variability that were often correlated with climate. For example, there were groups of rivers that corresponded broadly with ‘tropical’ and ‘dryland’ climates. However, some rivers from continental climates occupy both extremes of this range, illustrating the limitations of simple classification. Individual rivers and groups of rivers may also have different

COMMUNICATIONS

*Ecological Applications*, 16(4), 2006, pp. 1311–1318


THE CHALLENGE OF PROVIDING ENVIRONMENTAL FLOW RULES

## The Natural Flow Regime

*A paradigm for river conservation and restoration*

N. LeRoy Poff, J. David Allan, Mark B. Bain, James R. Karr, Karen L. Prestegaard, Brian D. Richter, Richard E. Sparks, and Julie C. Stromberg

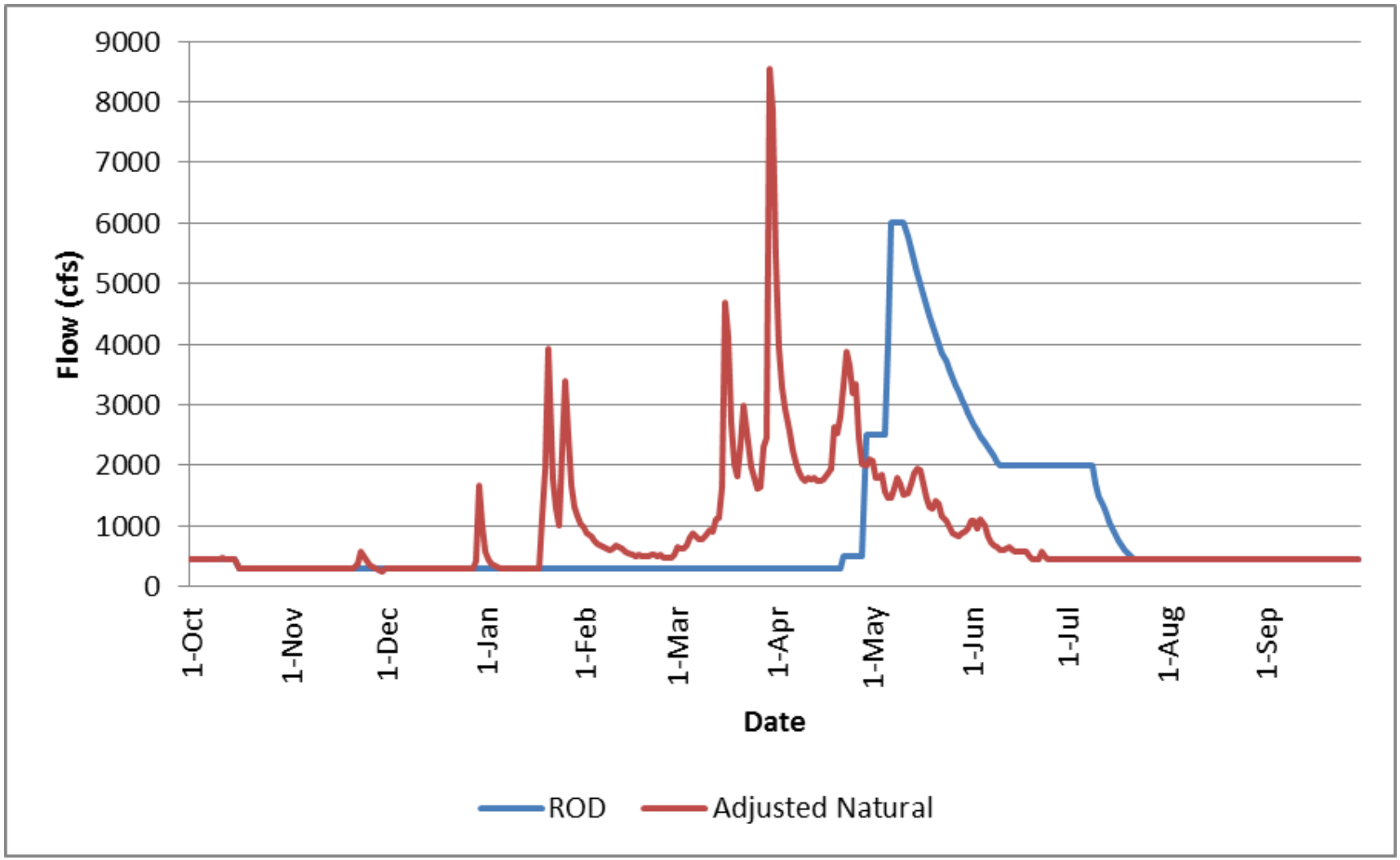
Humans have long been fascinated by the dynamism of free-flowing waters. Yet we have expended great effort to tame rivers for transportation, water supply, flood control, agriculture, and power generation. It is now recognized that harnessing of streams and rivers comes at great cost: Many rivers no longer support socially valued native species or sustain healthy ecosystems that provide important

**The ecological integrity of river ecosystems depends on their natural dynamic character**

The extensive ecological degradation and loss of biological diversity ing. However, current management approaches often fail to recognize the fundamental scientific principle that the integrity of flowing water systems depends largely on their natural dynamic character; as a result, these methods frequently prevent successful river conservation or restoration. Streamflow quantity and timing are critical components of water supply, water quality, and the ecological integrity of river systems. In-

# TRRP DSS Exercise – Alternative Hydrographs

## Trinity  Natural vs ROD Hydrograph – WY2012

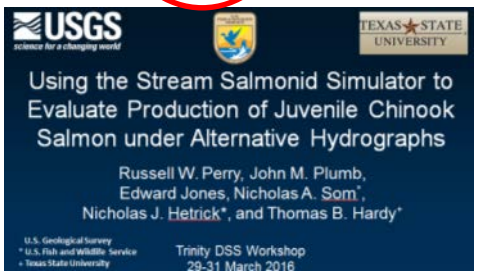



Source: Polos 2016

# TRRP DSS Exercise-Chinook salmon production

| | Natural | ROD | Difference (Natural – ROD) | Difference (%) |
|---|---|---|---|---|
| N - tot (millions) | 5.0 | 5.0 | 0.0 | 0.8 |
| N - Fry (millions) | 3.8 | 4.2 | -0.4 | -8.0 |
| N - Parr (millions) | 1.2 | 0.8 | 0.4 | 46.6 |
| Fry - FL (mm) | 34.0 | 33.0 | 1.0 | 3.0 |
| Parr - FL (mm) | 83.0 | 76.0 | 7.0 | 9.2 |
| Fry - Mass (g) | 0.4 | 0.4 | 0.0 | 0.0 |
| Parr - Mass (g) | 5.9 | 4.6 | 1.3 | 28.3 |
| Fry - BioMass (Metric ton) | 2.5 | 2.2 | 0.3 | 12.3 |
| Parr - BioMass (Metric ton) | 4.9 | 3.3 | 1.6 | 48.1 |

Source: Perry et al 2016



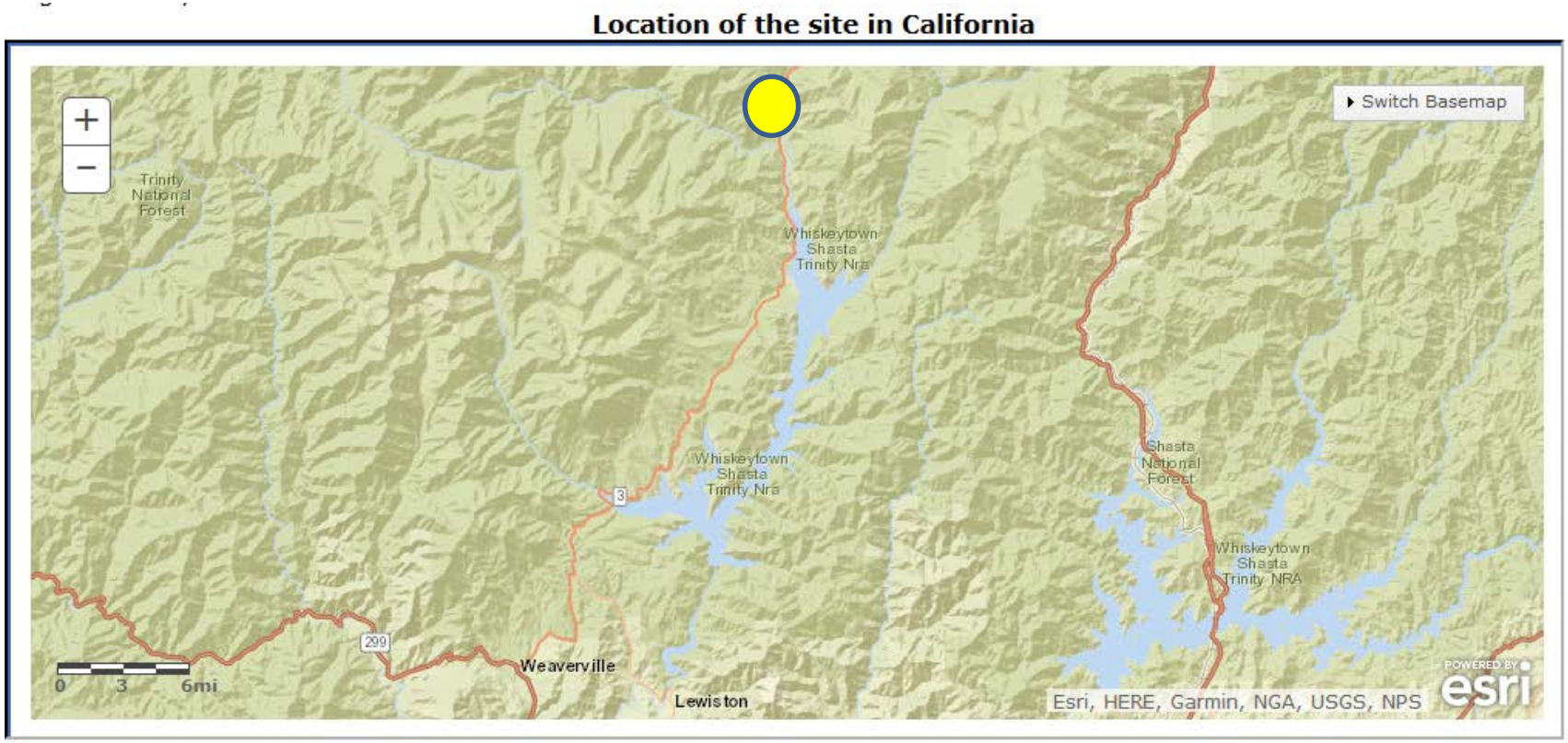
# Algorithm Development

# Goals

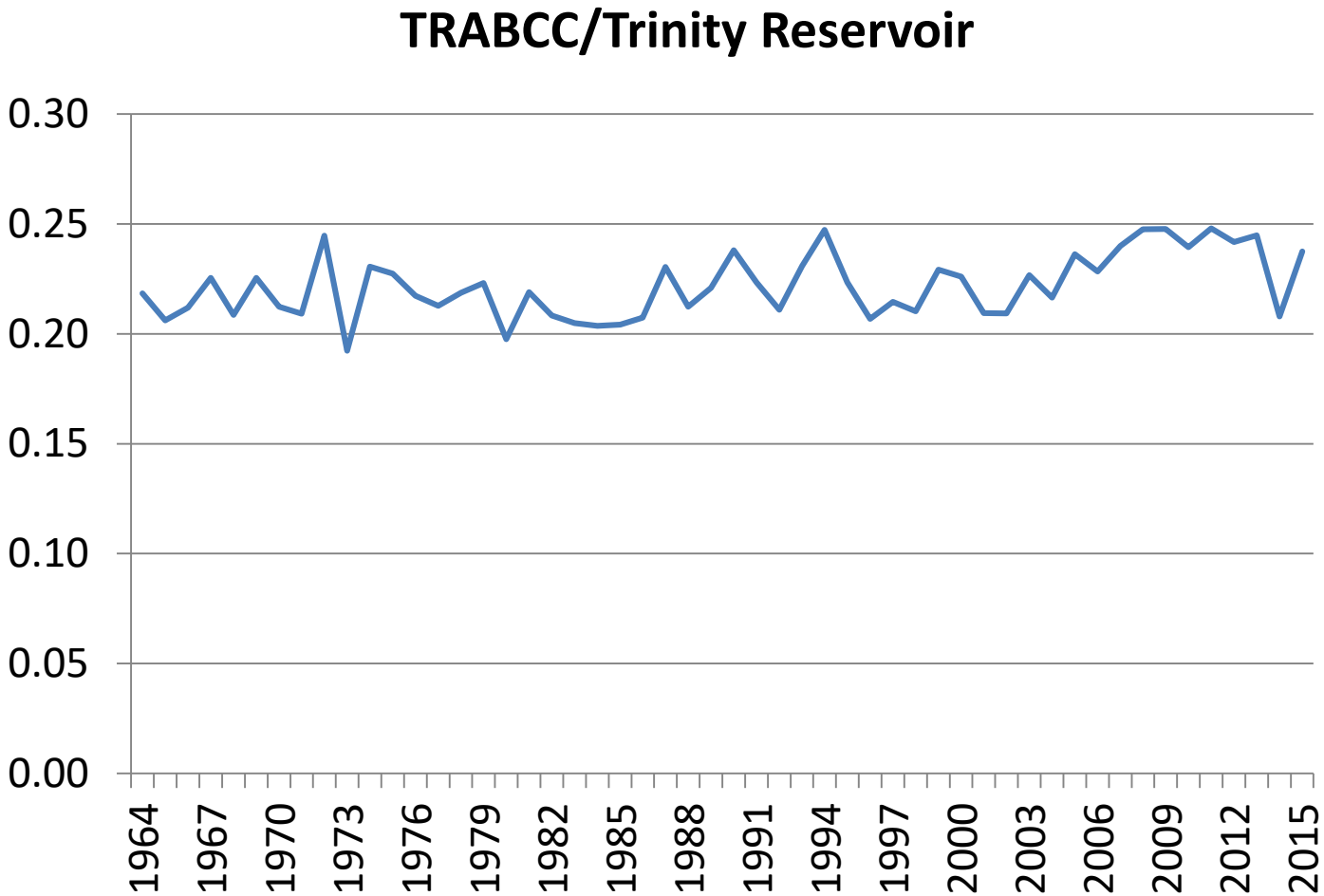
1. Mimic natural flow regime of nearby rivers
2. Meet mandates of the Trinity River ROD*

# Gage

**USGS 11523200 TRINITY R AB COFFEE C NR TRINITY CENTER CA (1958-Present)-TRABCC**



Trinity River above Coffee Creek ≈ 22% of Trinity Reservoir inflow




Targeting 47% inflow volume inflow ≈ 2 x TRABCC

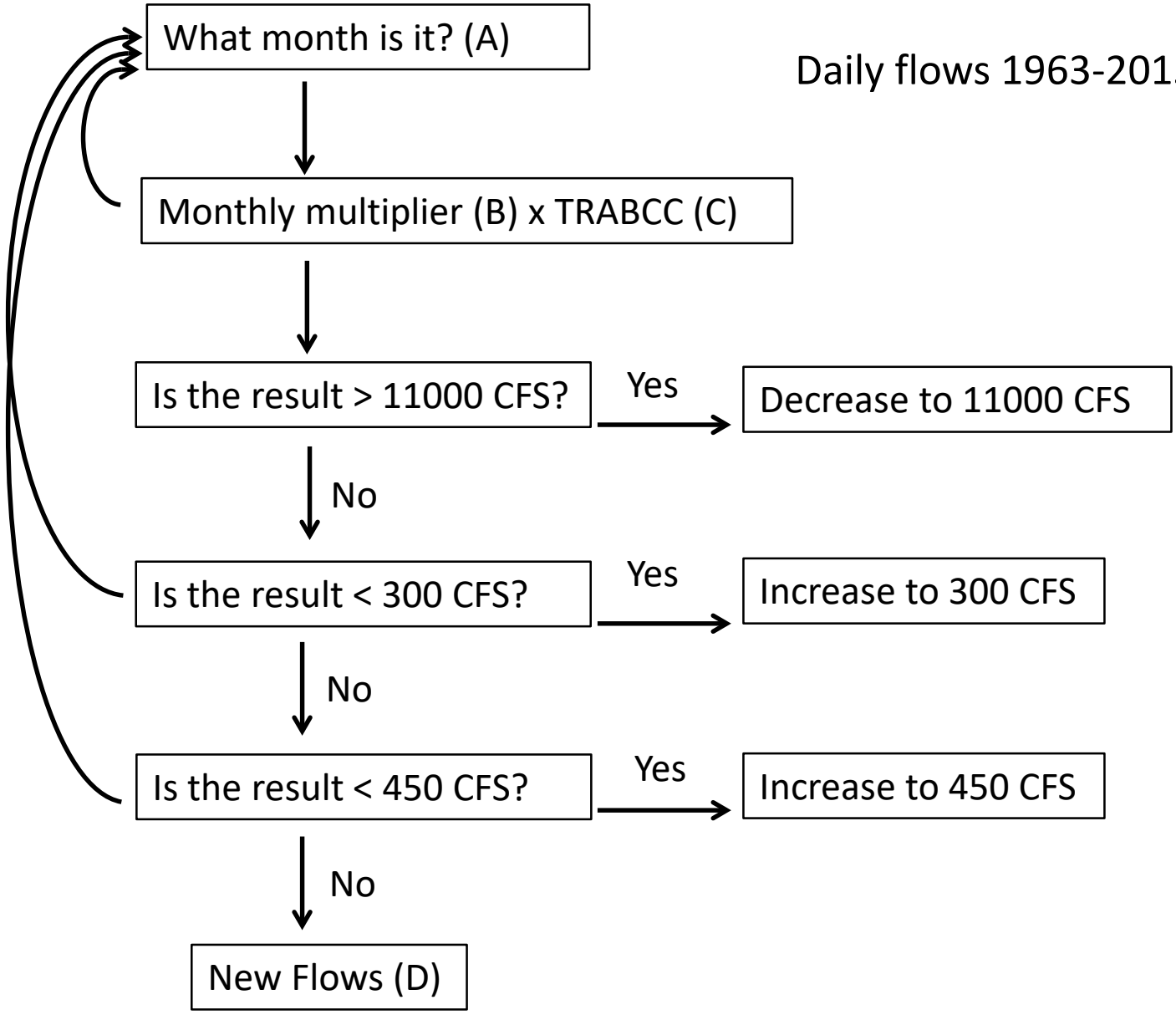
# Daily flows 1963-2015

$$A \rightarrow B$$
$$B \times C = D$$

Where:
A is month of each daily record
B is month specific multiplier
C is daily flow at TRABCC
D is new flow to be implemented

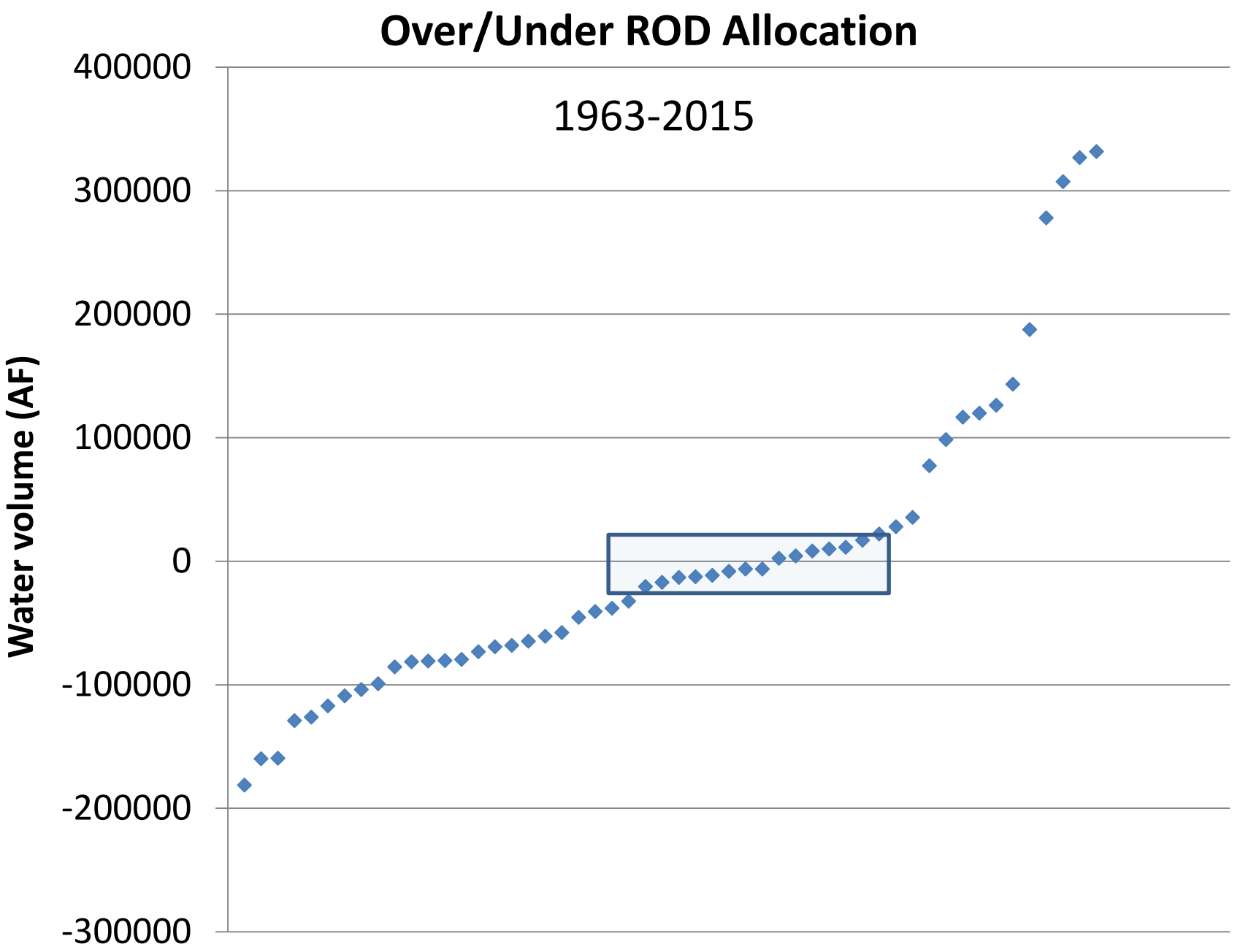
| Period | B |
|---|---|
| Nov-Dec | 2.1 |
| Jan-Feb | 1.3 |
| Mar-Apr | 1.3 |
| May-June | 2.3 |
| Jul-Aug | 2.0 |
| Sep-Oct | 2.0 |

# Algorithm Basics

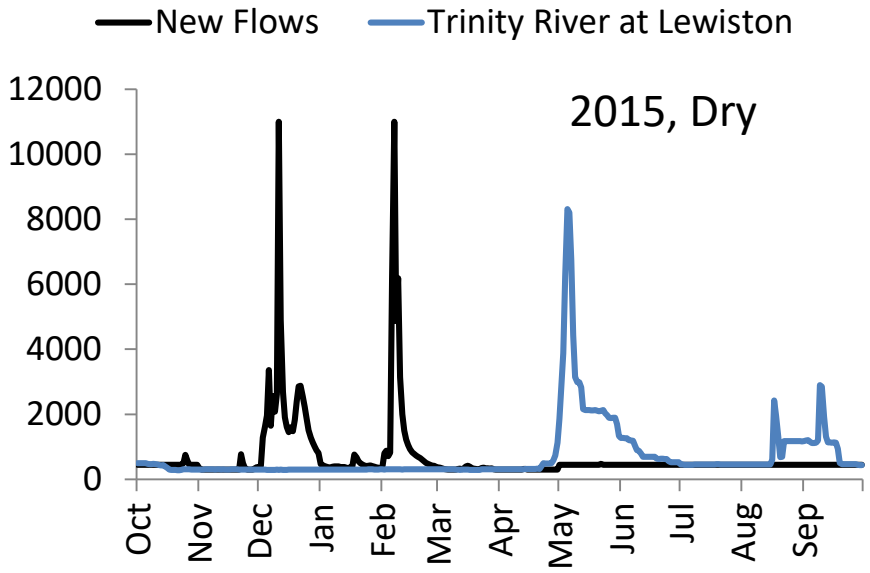


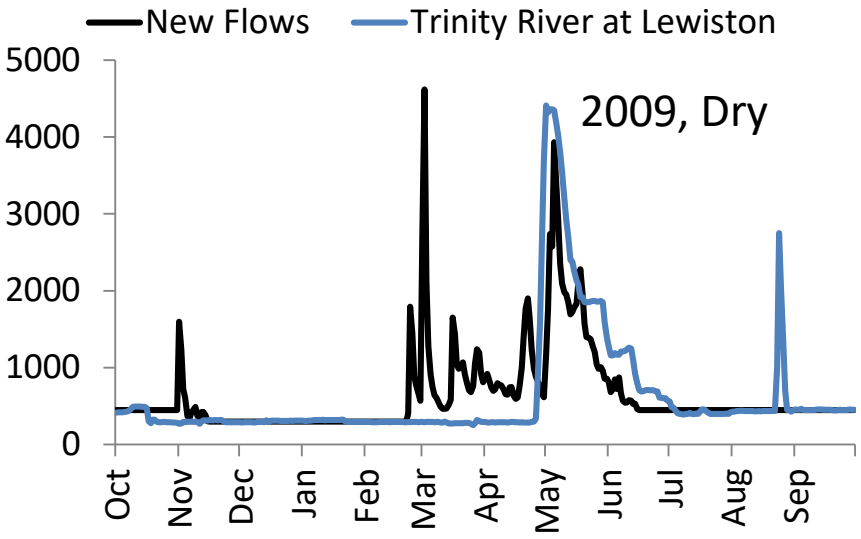

Daily flows 1963-2015

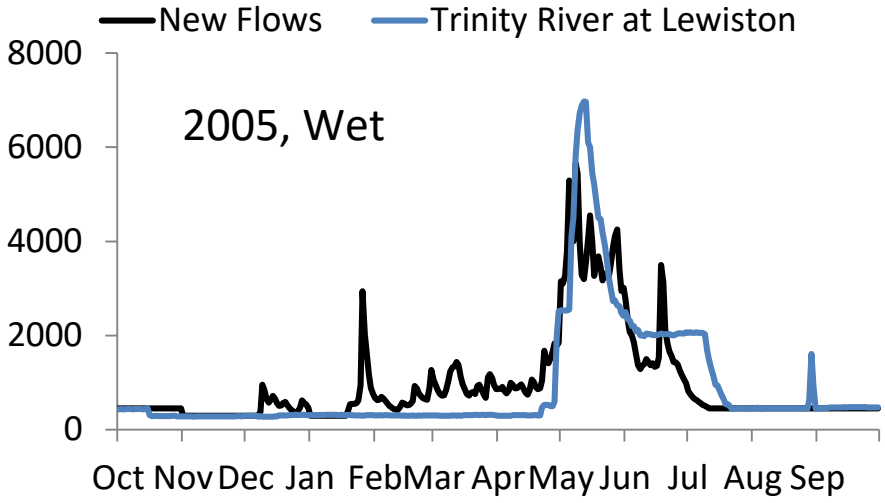
# Results

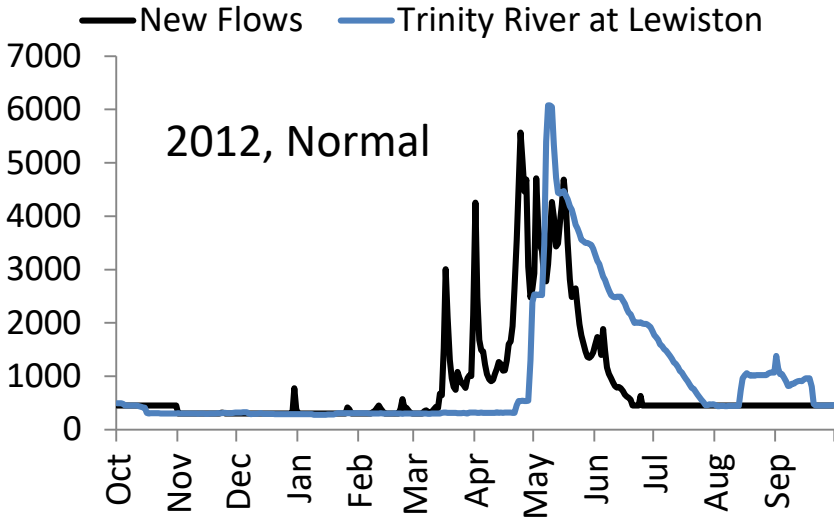

Over/Under ROD Allocation
1963-2015
Water volume (AF)
400000
300000
200000
100000
0
-100000
-200000
-300000

# Hydrograph examples



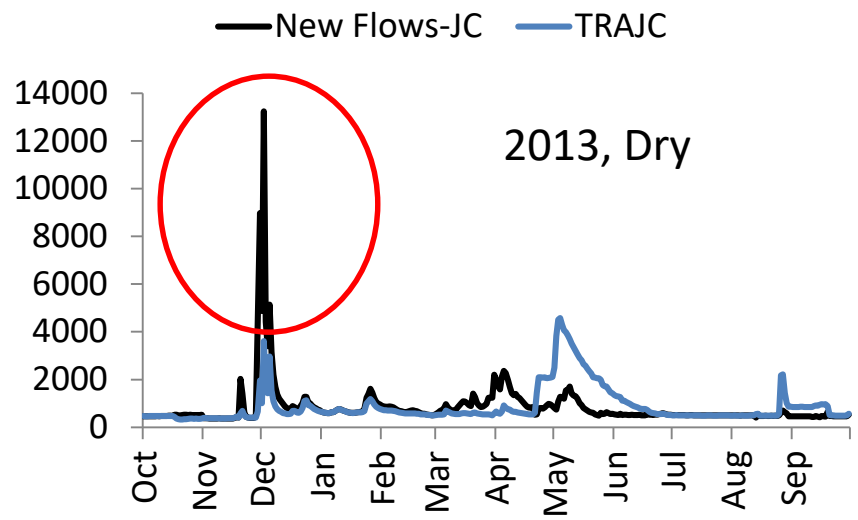



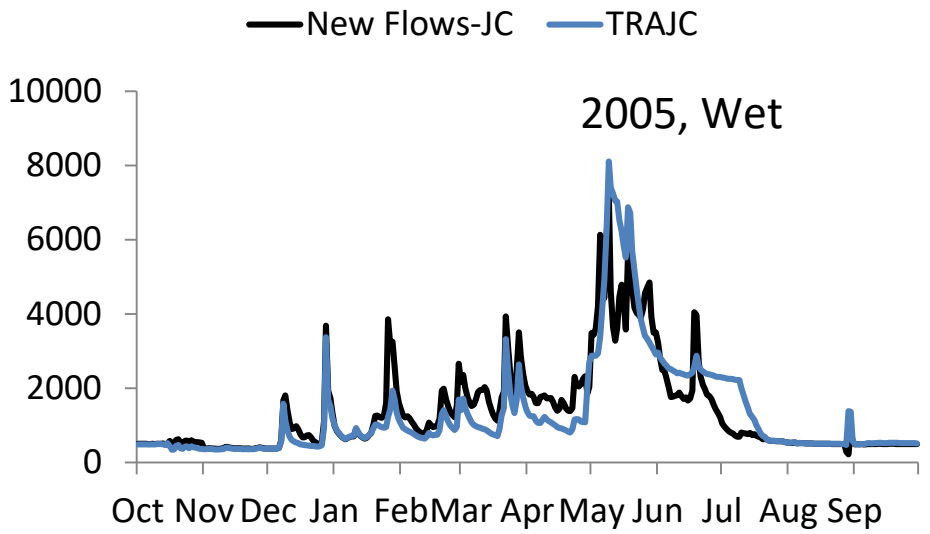



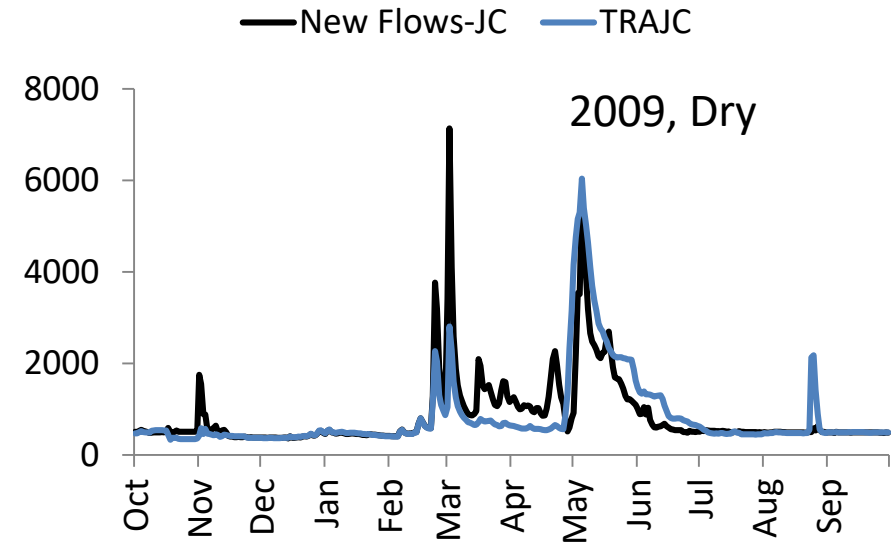



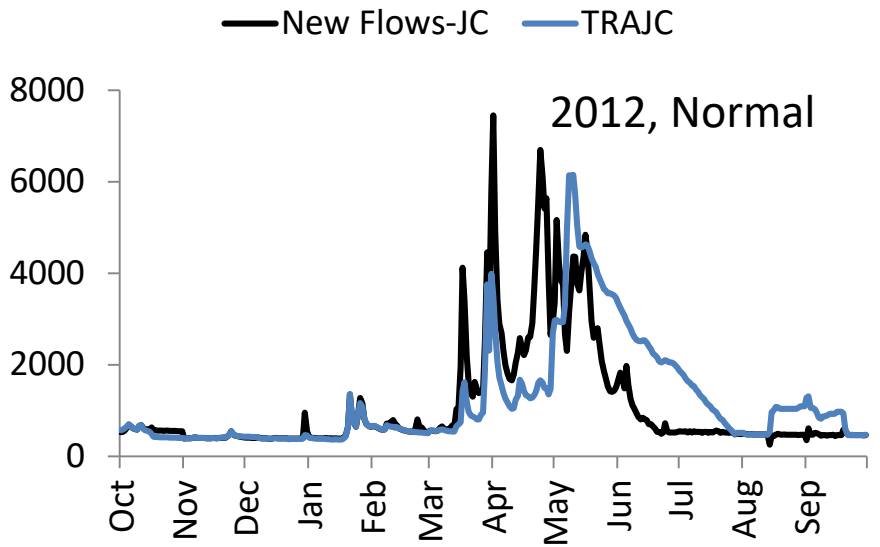
# Geomorphology

## Streamflow peaks greater than 5,000 CFS at Junction City



# Geomorphology

Streamflow peaks greater than 5,000 CFS at Junction City

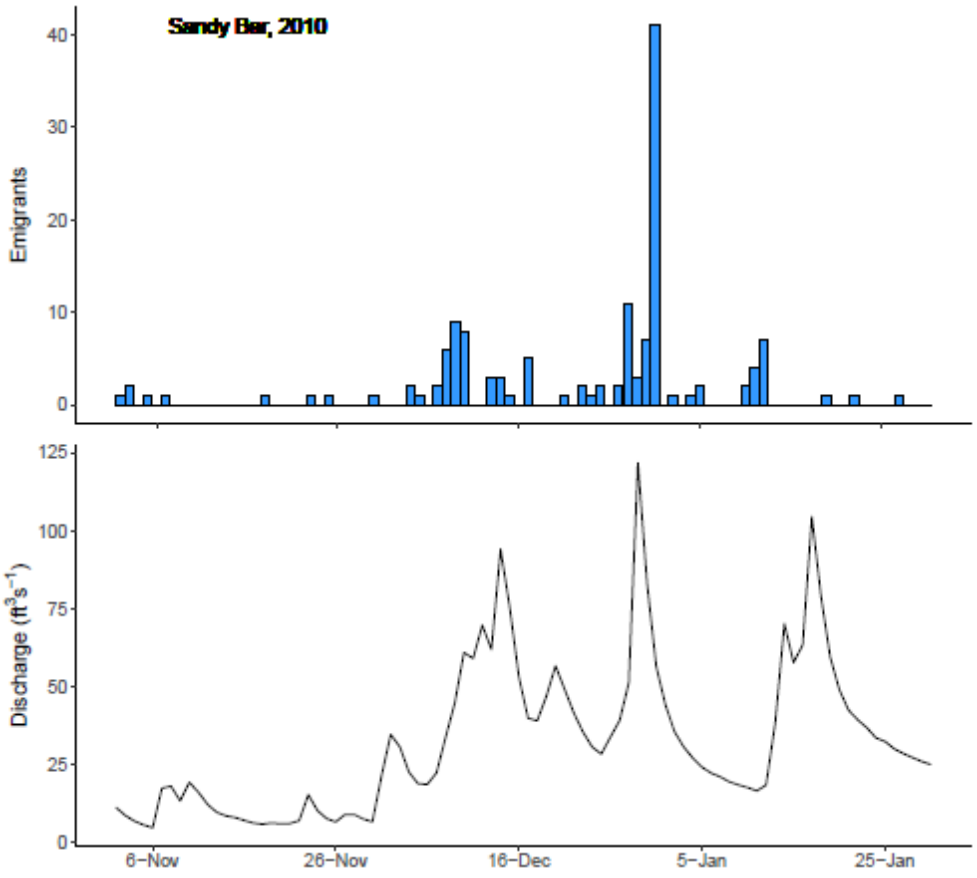
| Year | New Flows | ROD flow |
|---|---|---|
| 2005 | 2 | 2 |
| 2009 | 2 | 1 |
| 2012 | 3 | 1 |
| 2013 | 2 | 1 |
| Total | 9 | 5 |

# Emmigration Cues at Lewiston Dam

## Lamprey and Salmonids

## Streamflow peaks

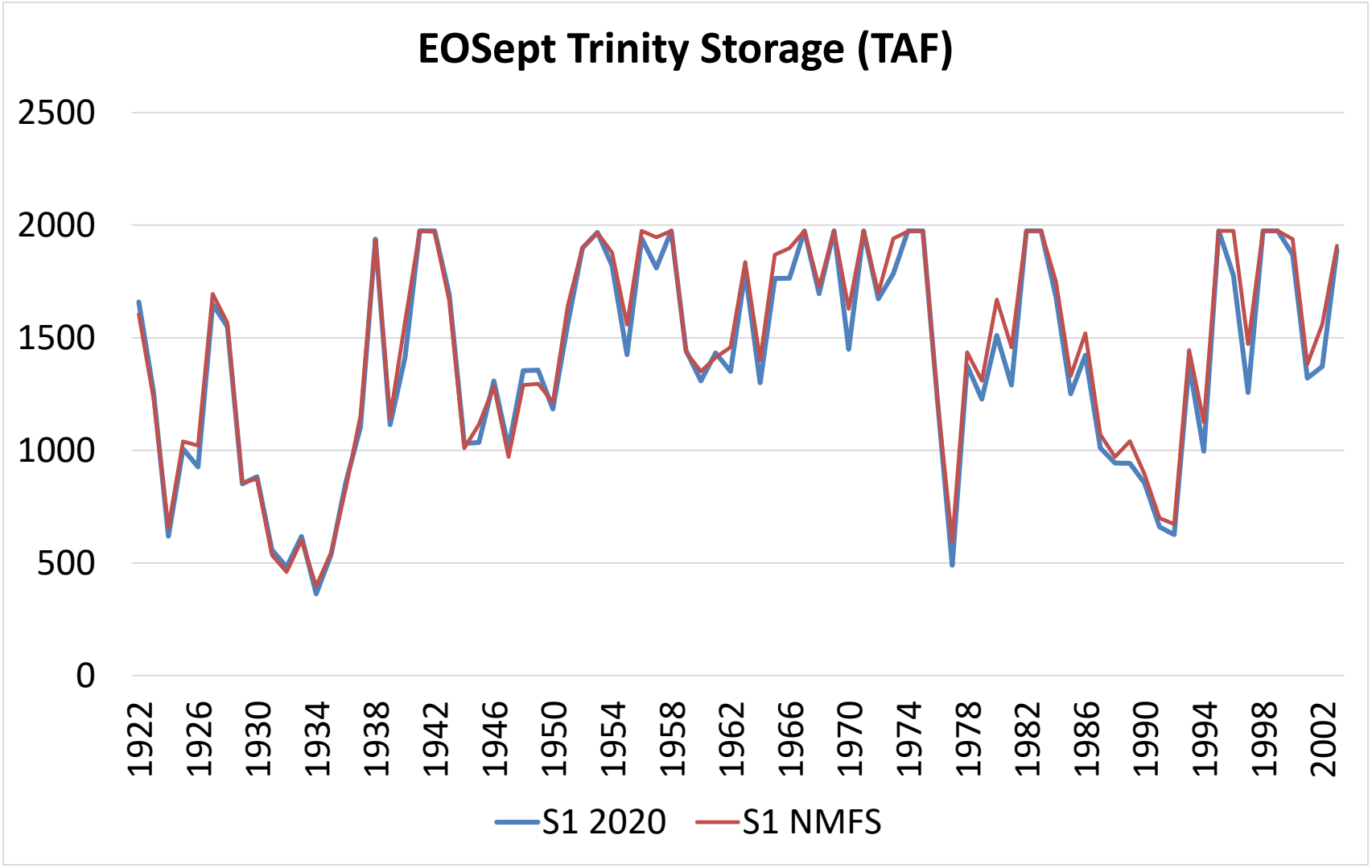
| Year | New Flows | ROD flow |
|---|---|---|
| 1971 | 10 | 1 |
| 1982 | 8 | 1 |
| 1987 | 4 | 1 |
| 1988 | 4 | 1 |
| 1992 | 5 | 1 |
| 1994 | 6 | 1 |
| 1999 | 8 | 1 |
| 2000 | 8 | 1 |
| 2005 | 6 | 1 |
| 2013 | 4 | 1 |
| Total | 63 | 10 |




Source: Manhard 2017

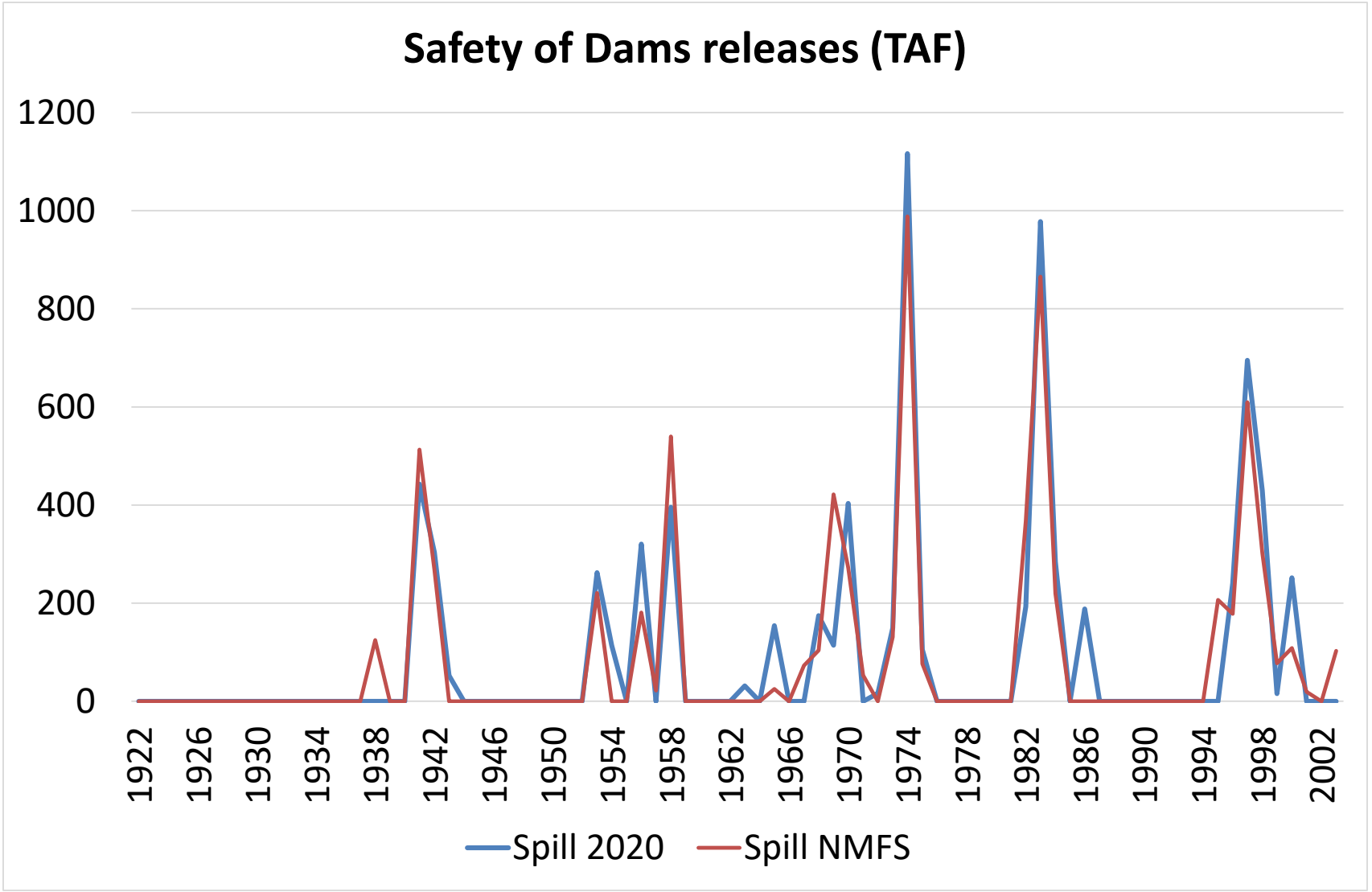
# Reservoir Operations-CalSim

(water volume neutral)



# Reservoir Operations-CalSim

(water volume neutral)

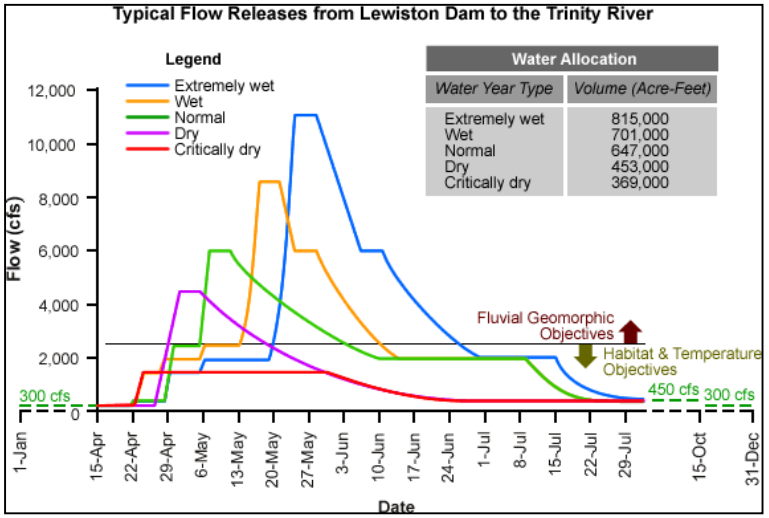


# Conclusions

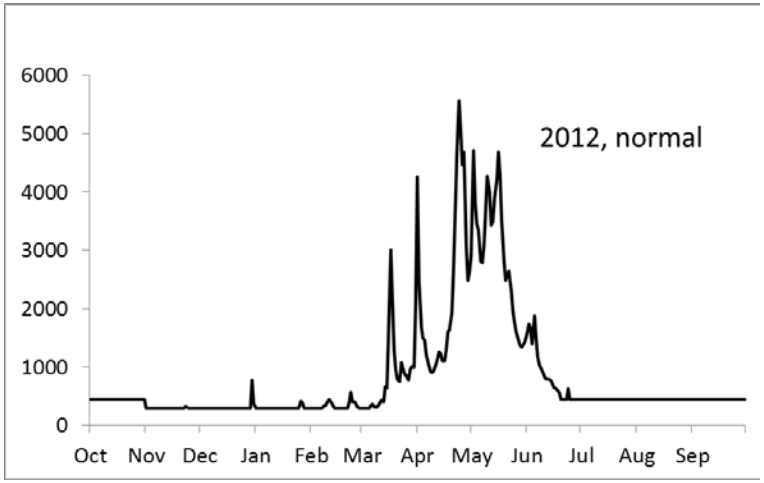
- Modified natural flow regime meets several metrics from initial investigations
- Has multiple benefits to fish, geomorphology, reservoir operations, etc
- Well supported in the peer reviewed literature

# Using computer algorithms improves system performance

1990s-Environmental flow targets, monthly (less objective)




Tomorrow-Formulaic, hourly (more objective)

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## References


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# Recommendation

- TMC should consider directing TRRP to initiate studies to support development of environmental documents to analyze the effects of synchronizing Lewiston Dam flows with tributary flow events on TRRP goals.