WATER & POWER

Serving Central California since 1887

2016 Bay-Delta Plan Amendment & SED

Modesto
Public Hearing
Dec. 20, 2016

TID, Past and Present

WATER & POWER
Serving Central California since 1887

Carryover Storage Required

Sustainability Threatened

Turlock and Modesto subbasins not designated by DWR as "Critically Overdrafted"

If the SED were in place during the 1990-2015 period, TID would have been able to deliver a full amount of available water in only **5 out of 26 years**.

WATER & POWER
Serving Central California since 1887

Does the SED achieve its own stated goals?

Project Goals

1. **Maintain inflow conditions from the SJR Watershed sufficient to support and maintain the natural production of viable native fish populations migrating through the Delta**
2. Provide flows that more closely mimic the natural hydrographic conditions (including frequency, timing, magnitude, and duration of natural flows) in the LSJR and three eastside, salmon-bearing tributaries—the Stanislaus, Tuolumne, and Merced Rivers—to which these migratory native fish species are adapted
3. Provide flows in a quantity necessary to achieve functions essential to native fishes such as increased floodplain inundation, improved temperature conditions, improved migratory conditions, and promote other conditions that favor native fishes over nonnative fishes
4. Allow adaptive implementation of flows that will afford maximum flexibility in establishing beneficial habitat conditions for native fishes, addressing scientific uncertainty and changing conditions, developing scientific information that will inform future management of flows, and meeting biological goals, while still reasonably protecting the fish and wildlife beneficial uses
5. Promote transparency in decision-making and provide certainty to the regulated community by expressing flow requirements for the protection of fish and wildlife as a share of the total quantity of water available for all beneficial uses
6. In establishing flow water quality objectives to reasonably protect fish and wildlife, take into consideration all of the demands being made and to be made on waters in the LSJR and the three eastside, salmon-bearing tributaries and the factors to be considered for establishing water quality objectives in Water Code section 13241, including, but not limited to, past, present and probable future beneficial uses and economic considerations.
7. Provide for the development and implementation of an appropriate monitoring and evaluation program to inform adaptive implementation of LSJR flows and future changes to the Bay-Delta Plan
8. Provide for and encourage collaboration, coordination, and integration of regulatory, scientific, and management processes related to LSJR flows

SED, Page ES-9-10

Project Goal No. 1

The project goals related to establishing new LSJR flow objectives and an associated program of implementation are as follows:

1. **Maintain inflow conditions from the SJR Watershed sufficient to support and maintain the natural production of viable native fish populations migrating through the Delta**

SED, Page ES-9

The SED-Stated Benefit

Table 19-32. SalSim Annual Total Adult Fall-Run Chinook Salmon Production for Different Flow Cases. These results are the combined results for the Stanislaus, Tuolumne, and Merced Rivers, and are also illustrated in Figure 19-14.

SalSim Case	Total Adult Production by Year																Average
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	
SBBASE	5,365	10,250	14,328	28,745	8,433	21,001	33,753	17,892	14,289	11,075	6,613	1,129	461	161	3,812	4,665	11,373
SB20%UF	5,696	10,571	14,407	25,499	8,685	19,983	30,996	16,007	14,507	11,349	6,850	1,173	680	169	4,008	5,755	11,021
SB30%UF	6,334	10,460	14,843	26,121	9,357	20,253	33,125	16,984	15,289	11,983	7,436	1,278	952	185	2,587	5,922	11,444
SB40%UF	7,213	10,484	15,170	30,888	9,872	22,289	38,824	19,996	15,801	12,613	8,072	1,392	579	216	2,594	3,611	12,476
SB40%MaxFS	6,843	10,540	15,474	38,226	10,704	26,833	56,691	24,875	18,557	17,604	11,252	1,332	693	194	2,499	5,870	15,512
SB40%OPP	7,212	11,664	14,106	31,598	10,122	25,432	36,359	20,923	16,689	13,248	8,198	1,479	489	323	2,696	6,399	12,934
SB50%UF	7,462	10,791	14,632	29,908	8,959	22,803	36,206	19,362	15,411	13,252	8,486	1,517	671	219	2,681	3,460	12,239
SB60%UF	7,229	11,162	14,441	28,770	7,473	23,601	35,632	18,404	14,633	14,258	9,158	1,575	723	204	2,834	3,677	12,111

12,476 – 11,373 =

1,103 salmon

SED, Page 19-34

The SED-Stated Impacts

Table 20.2-1. Summary of Average Annual Cost and Beneficial Effects of LSJR Alternatives 2, 3, and 4, Relative to Baseline Conditions: Agricultural Production and Related Economics

Category	LSJR Alternative 2		LSJR Alternative 3		LSJR Alternative 4	
	Change from Baseline Conditions	% Change	Change from Baseline Conditions	% Change	Change from Baseline Conditions	% Change
Agricultural Production						
Irrigated acreage	-6,086	-1.2	-23,421	-4.6	-70,640	-13.8
Crop revenues ($M)	-$9	-0.6	-$36	-2.5	-$117	-7.9
Additional GW pumping cost ($M)	+$1.3	+8.5	+$6.2	+40.5	+$12.7	+83.0
Local Fiscal conditions, as measured by change in tax revenue ($M)	-$0.4	-0.7	-$1.5	-2.4	-$4.7	-7.9
Regional Agriculture-Related Effects						
Total regional output ($M)	-$17	-1	-$64	-3	-$206	-8
Total regional jobs	-117	-1	-433	-2	-1,474	-8

$M = millions of dollars

GW = groundwater

SED, Page 20-4

Changes in the Bay-Delta

The Bay-Delta is in ecological crisis. Fish species have not shown signs of recovery since adoption of the 1995 Bay-Delta Plan objectives intended to protect fish and wildlife. Several species of fish are listed as protected species under the California Endangered Species Act (CESA) and under the federal Endangered Species Act (ESA). The Bay-Delta is also in water supply crisis. Those dependent on the Delta for water supply have received much less water in recent years because of the drought.

The Bay-Delta is therefore at the center of the ongoing statewide debate about how to reasonably protect fish and wildlife uses of water without causing unreasonable negative effects on water supply for agriculture, drinking water, hydropower, and other competing beneficial uses. The southern Delta is at the center of a more local debate of how to reasonably protect irrigated agriculture.

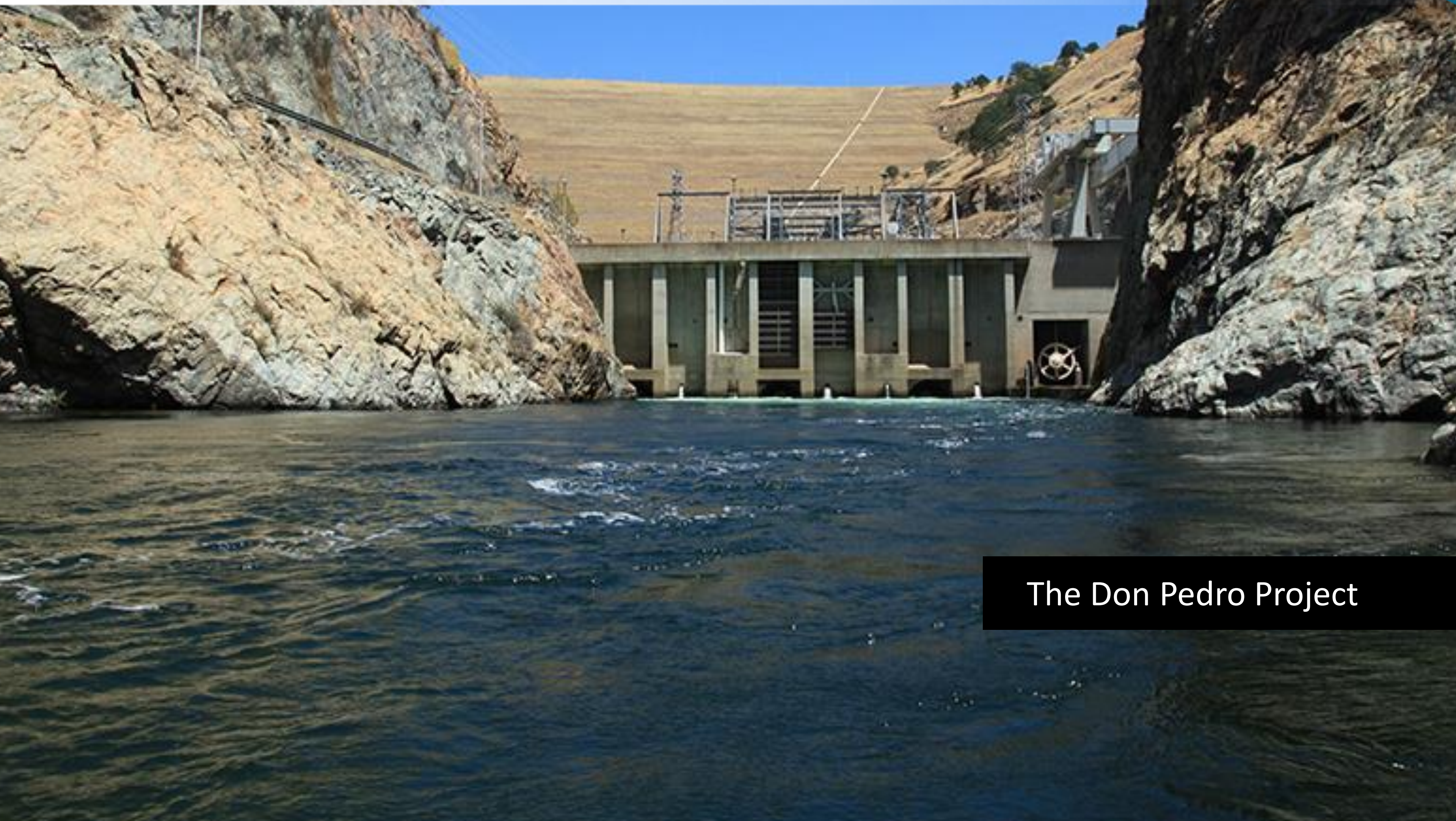
SED, Page ES-1

Balancing Questions

- Does 1,103 new fish = a viable population?
- How many of the 11,373 baseline salmon are native?
- Do 1,103 new salmon support commercial fishing improvements?
- Does the SED consider the effects predation on those fish through the tributaries?
- Does the SED consider the effects predation on those fish through the Delta?
- Is this a reasonable protection of fish and wildlife without causing unreasonable impacts?

WATER & POWER
Serving Central California since 1887

FERC Relicensing



The Don Pedro Project

Comments on SED and proposed Plan Amendments

Examining Flow and Predation impacts on Chinook salmon productivity in the Tuolumne River

Noah Hume PE, PhD
Stillwater Sciences
December 20, 2016

Background

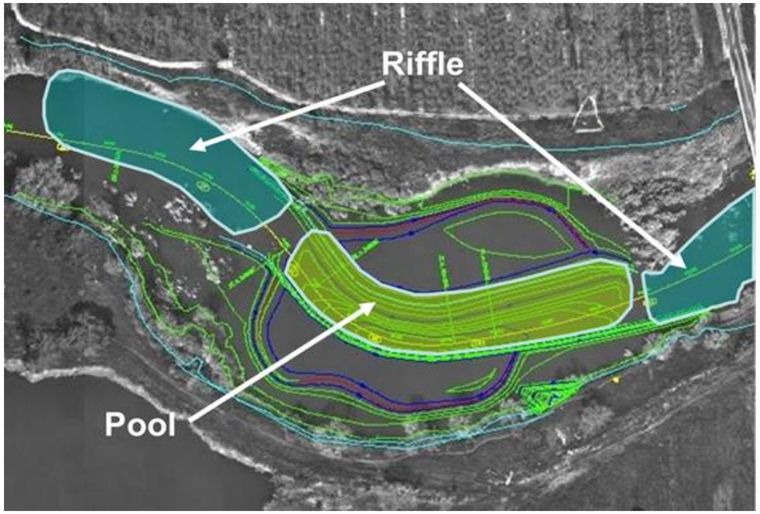
- **FERC license requirements for Don Pedro Project**
  - Article 37 – Fishery Flows (spawning, rearing, outmigration)
  - Article 39 – Cooperative Study Program (TID/MID/CDFW/USFWS)
  - Article 58 – Monitoring Program (e.g., escapement, RST sampling)

- **Numerous studies filed with FERC and CALFED to identify factors that may limit Chinook salmon production in the lower Tuolumne River**
  - Spawning escapement (monitoring, modeling), habitat (gravel quality, quantity, and redd superimposition)
  - Insect food availability (benthic, terrestrial drift, consumption)
  - Water temperature and Water quality
  - Smolt outmigration survival (Tuolumne, LSJR, Delta)

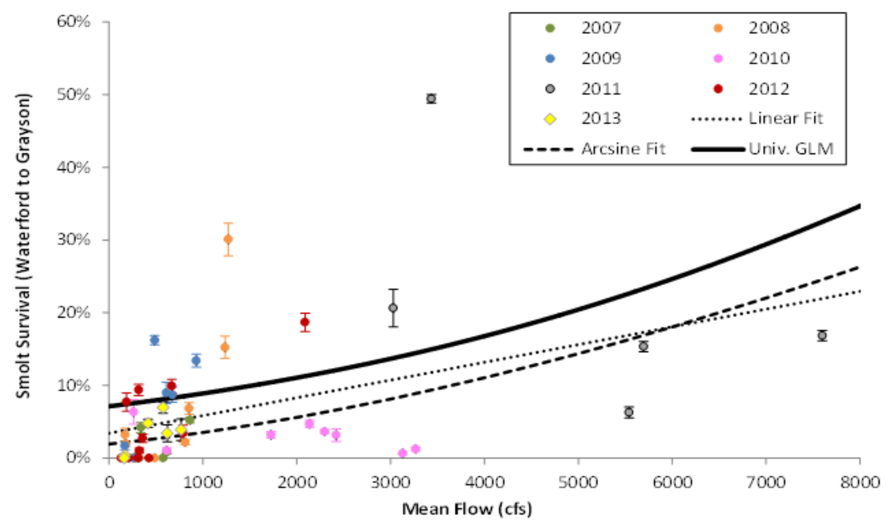
Salmon Survival vs Flow

- **Predation is a primary factor limiting Tuolumne River salmon survival based on CDFG (1989) and studies by the Districts from the 1990s to present**
  - Legacy mining pits represent predator “hot spots”
  - Weak relationship (r2=0.15 to 0.18) between Tuolumne River in-river survival and spring discharge

Mining Pit Restoration



RST passage survival index



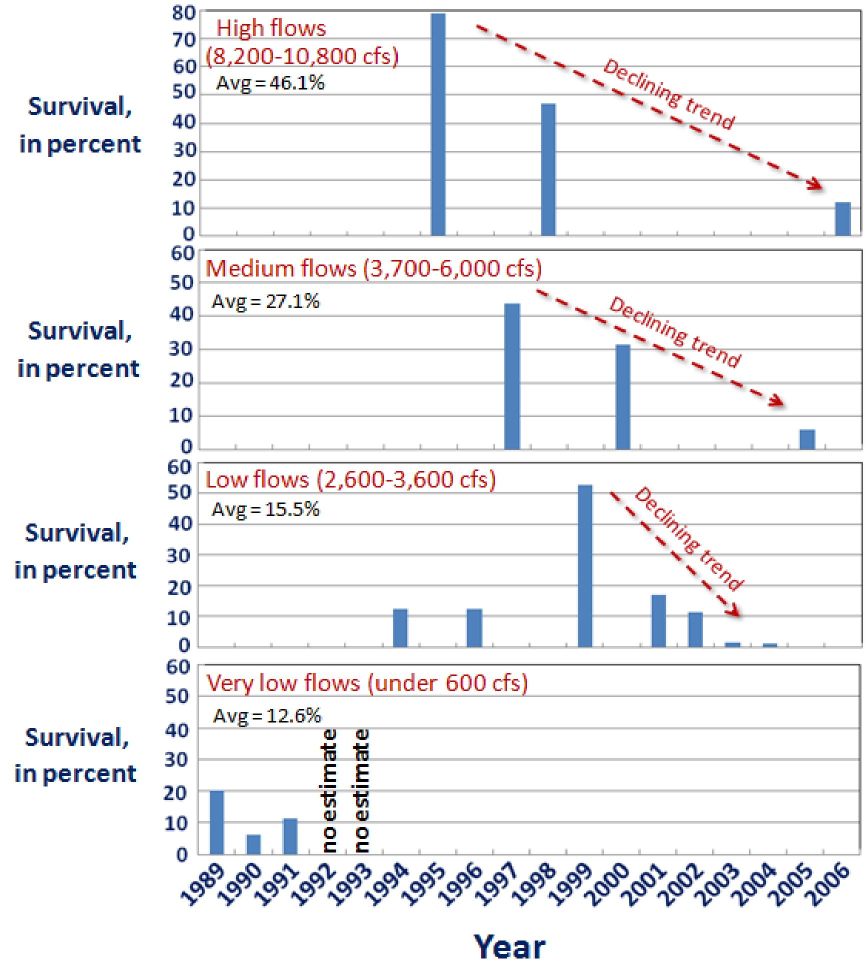
Assessing In-River Predation

- **Predator abundance sampling (1990, 1998-2001, and 2012)**
- **Predation rate sampling (1990 and 2012)**
- **Predator movement tracking (2005 and 2013)**

- **Rotary Screw Trapping (1999 to present)**
  - Predation mortality between Waterford (RM 29.8) and Grayson (RM 5.1) can exceed juvenile salmon abundance (up to 100% mortality)
  - Heavy predation losses in all water year types (76%-98% mortality during 2007-2012)

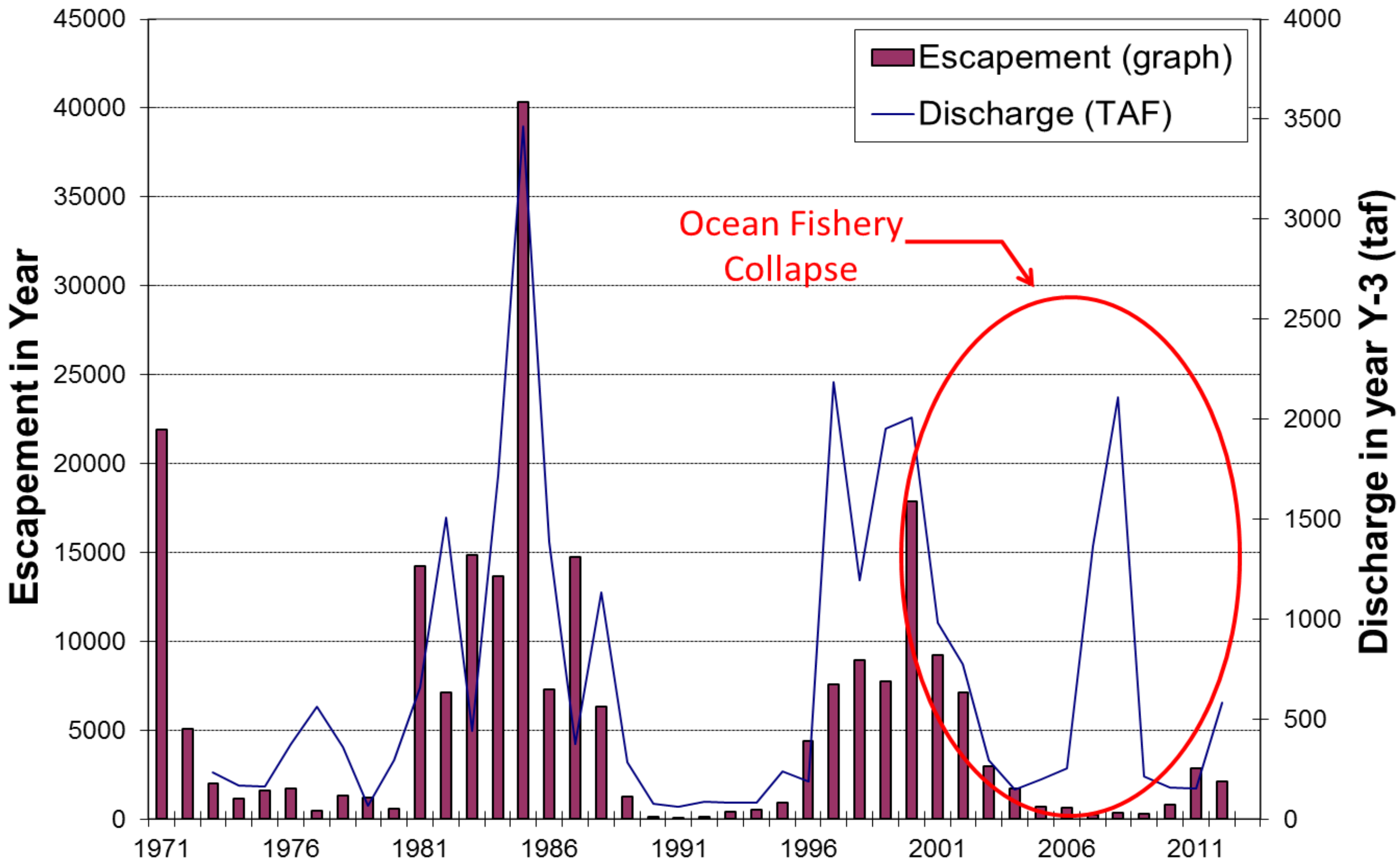
Assessing Delta Predation

- **Emigration through LSJR and South Delta**
  - VAMP Survival vs Flow experiments showed recent declines in survival at all discharge levels
  - Acoustic tracking studies identified predator hot spots at Head of Old River and other locations with 100% mortality in some years



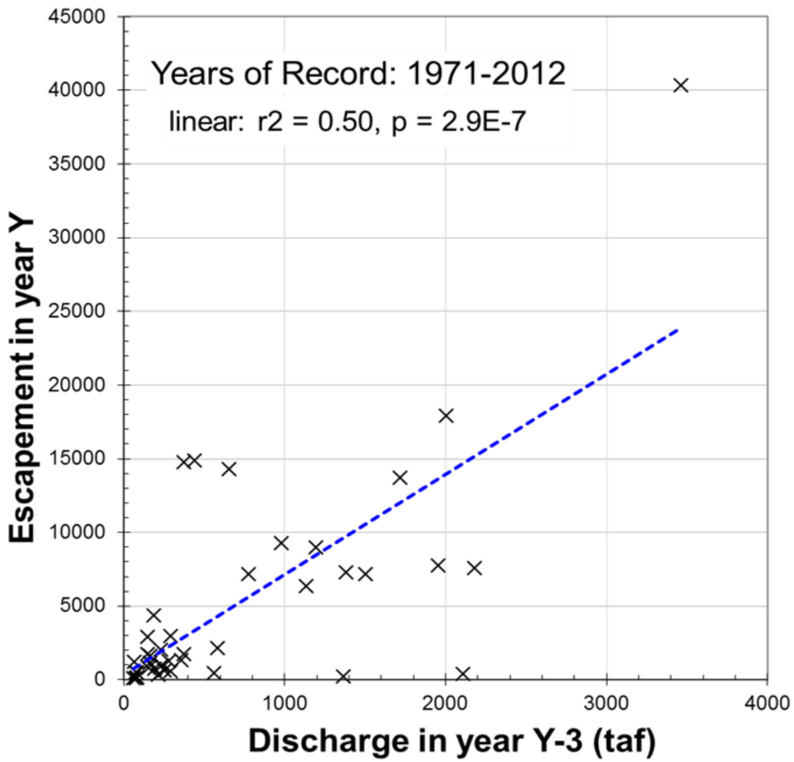
Tuolumne Spawners vs Flow

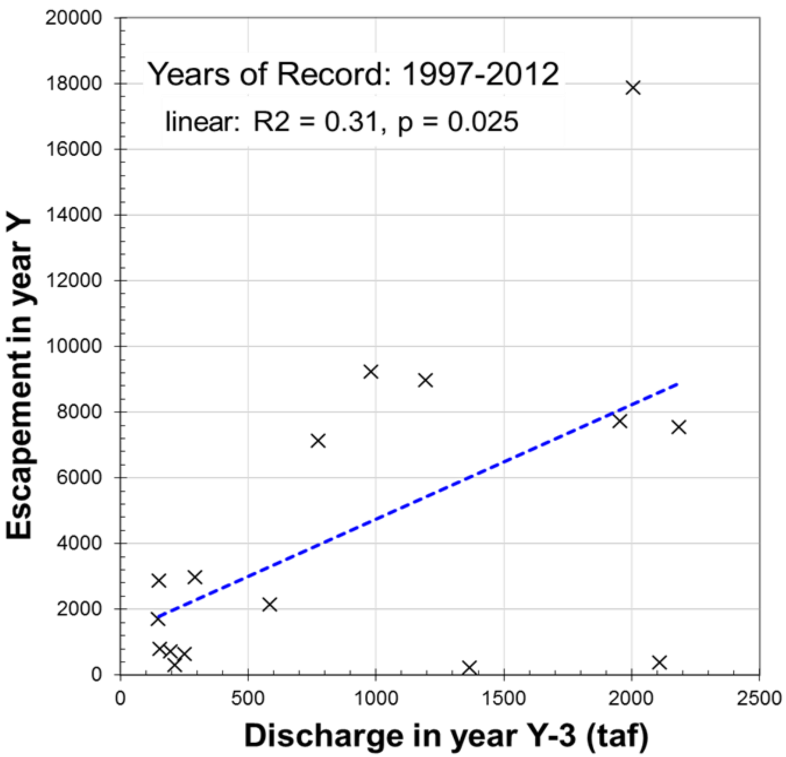
- General relationship between time lagged outflow but prior flows do not consistently explain escapement



Tuolumne Spawners vs Flow

- Relationship between time lagged outflow and salmon returns growing weaker in recent years





Key In-River Issues Affecting Tuolumne River Salmonids

Chinook salmon Spawning, Egg Incubation, & Fry Emergence

- Historical habitat changes, gravel quality
- Redd superimposition
- Seasonal water temperatures

Chinook salmon In-River Rearing & Outmigration

- Historical habitat changes, and predation
- Flow & temperature effects on salmon habitat, smolt outmigration, and vulnerability to predation

Review of Prior Population Models

- EACH population model (TID/MID 1992, App 1)
- State-Space model (TID/MID 1992, App 2; TID/MID 1997, Report 96-5)
- Oak Ridge Chinook Salmon model (Jager and Rose 2003)
- CDFG (2005) San Joaquin River Salmon Population Model
- SalSim Version 2.0

Tuolumne River Chinook salmon (TRCh) model approach to address in-river issues affecting juvenile production (TID/MID 2013)

- Uses individual-based multi-stage stock-production approach
- Explicit representation of habitat and individual movement and mortality
- Seasonal RST passage used for calibration (2010-2013) and validation (1999-2009)

Modeling In-River Factors Affecting Chinook salmon

Processes/Parameters included in TRCh Model

- Adult Upmigration
  - Run timing
  - Run size and composition
- Spawning
  - Spawning habitat (location, gravel area, quality, suitability based on water depth, velocity, and temperature)
  - Egg Deposition
- Egg Incubation and Fry Emergence
  - Incubation rate and mortality (water temperature)
  - Redd superimposition mortality
  - Survival to emergence (gravel quality)
- In-River Rearing and Smolt Emigration
  - In-channel and floodplain rearing (suitability based upon water depth, and velocity)
  - Juvenile migration/ movement (flow)
  - Growth rate (temperature)
  - Mortality (predator flow relationship, temperature)
  - Smoltification (size and temperature thresholds)

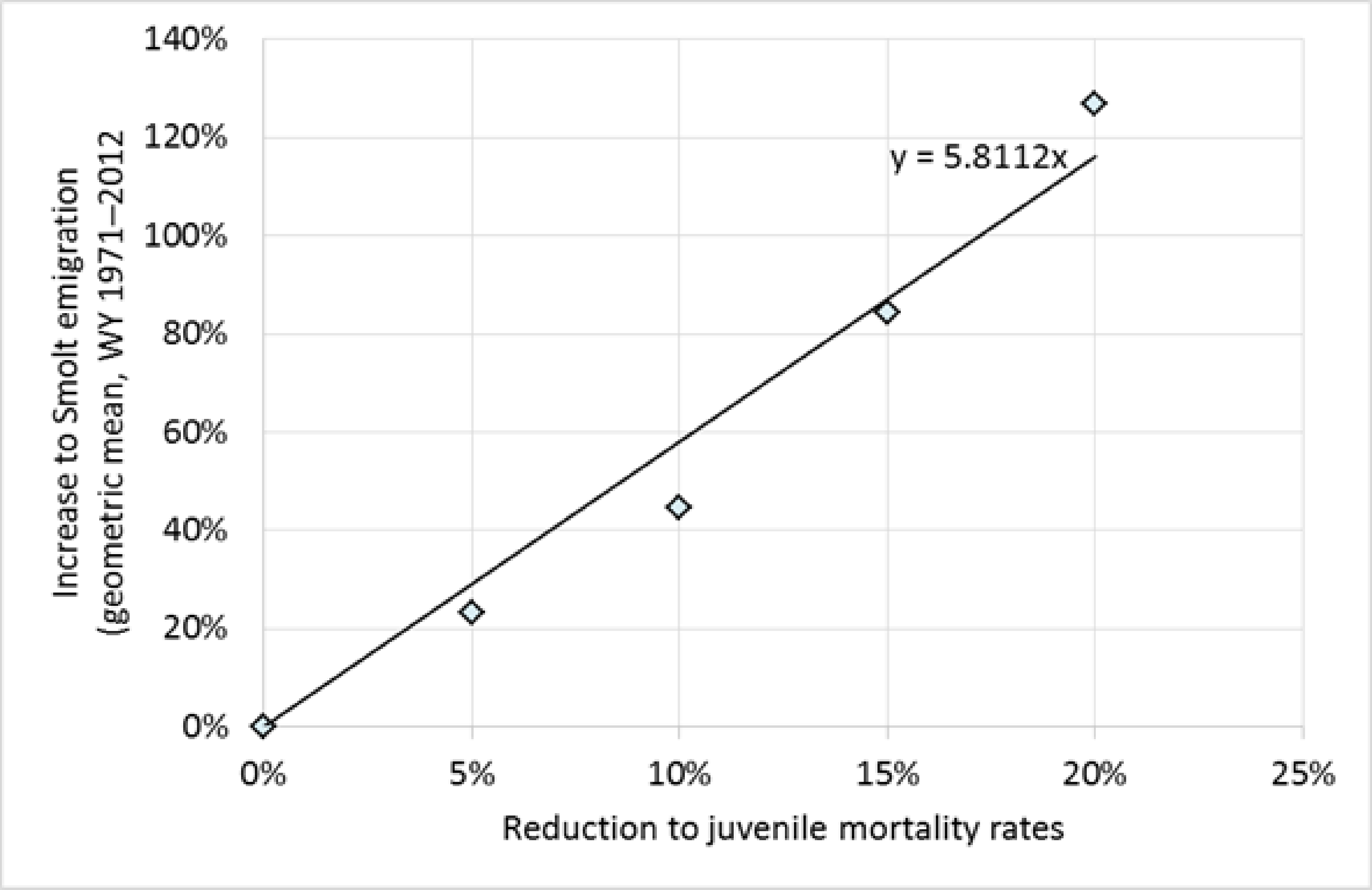
Considering Predator Removal

- **In 2013, largemouth and smallmouth bass are most abundant predators (> 10,000 individuals estimated in 2012); striped bass (> 500 individuals) are least abundant but had high consumption rates**
- **A 10–15% reduction in abundance of the 3 major salmon predators in the lower Tuolumne River (those > 150 mm) could save 12,840–19,260 salmon from predation each year**

Species	10% Removal Target	15% Removal Target	Potential Reduction in Salmon Predation (salmon/day)	Potential Annual Reduction in Salmon Predation
Largemouth bass	301	452	30–45	4,500–6,750
Smallmouth bass	363	544	40–60	6,000–9,000
Striped bass	24	35	26–39	2,340–3,510

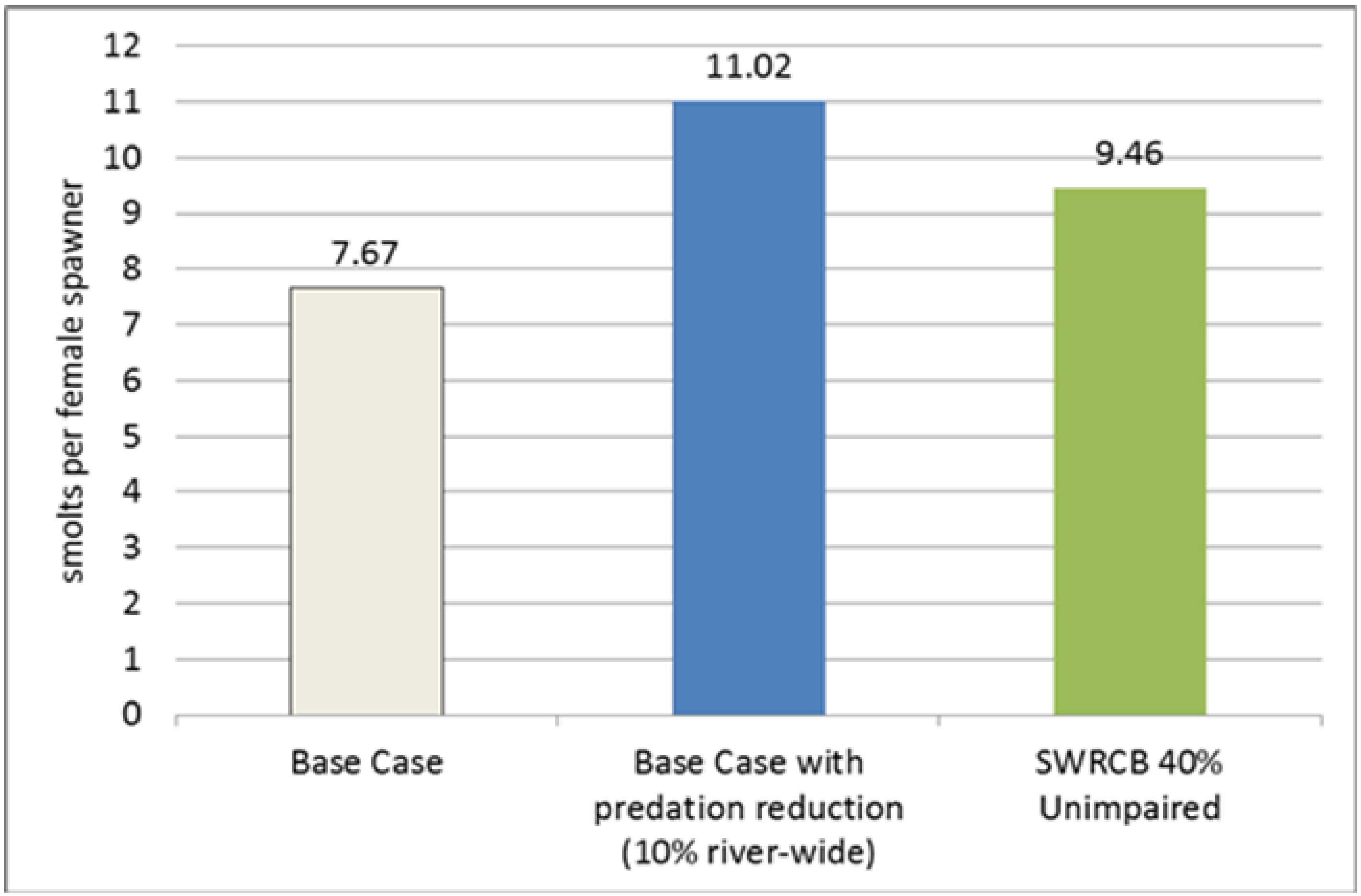
Considering Predator Removal

- **A modeled 10% reduction in daily predation rate would increase smolt production by almost 60% (TRCh modeling)**



Modeling predator removal vs flow benefits

- **Modeled effect of a 10% predator reduction on smolt production is substantially greater than the effect of 40% Unimpaired flow**



Summary and Closing

- **Available Tuolumne River studies not reviewed by SED preparers**
- **Flow explains only partially explains salmon productivity, with non-flow factors such as predation unaffected by flow in many years.**
- **Modeled predator reductions can potentially achieve comparable benefits to unimpaired flow measures proposed in SED at no additional water costs**

Summary and Closing

- **Other General Comments on SED Analysis**
  - Other factors do not appear to be accounted in the salmon vs flow relationships used in the SED models (e.g., HEC-5Q, SalSim, Floodplain models)
  - Of factors shown to be relevant to salmon ecology, annual diversions from the Tuolumne River are unchanged since 1926 and seasonal discharges from other LSJR tributaries have remained stable or have increased in recent decades, whereas Delta survival and Ocean returns have declined.

21st Century Approach

"We propose a functional flow approach to managing heavily modified rivers. The approach focuses on retaining specific process based components of the hydrograph (Functional Flows) rather than attempting to mimic the full natural flow regime. Simply stated, the design of a more natural flow regime without consideration of the implications for sediment transport and channel – is likely to have a limited success in river management and restoration."

Yarnell, SM, AA Whipple, E Beller, C Dahm, C Enright, P Goodwin, G Petts, JH Viers. 2014. Functional Flows in Modified Riverscapes: Hydrographs, Habitats and Opportunities.

Let's end "Era of Conflict"