

Effects of high flows on salmon & steelhead *on the lower American River*

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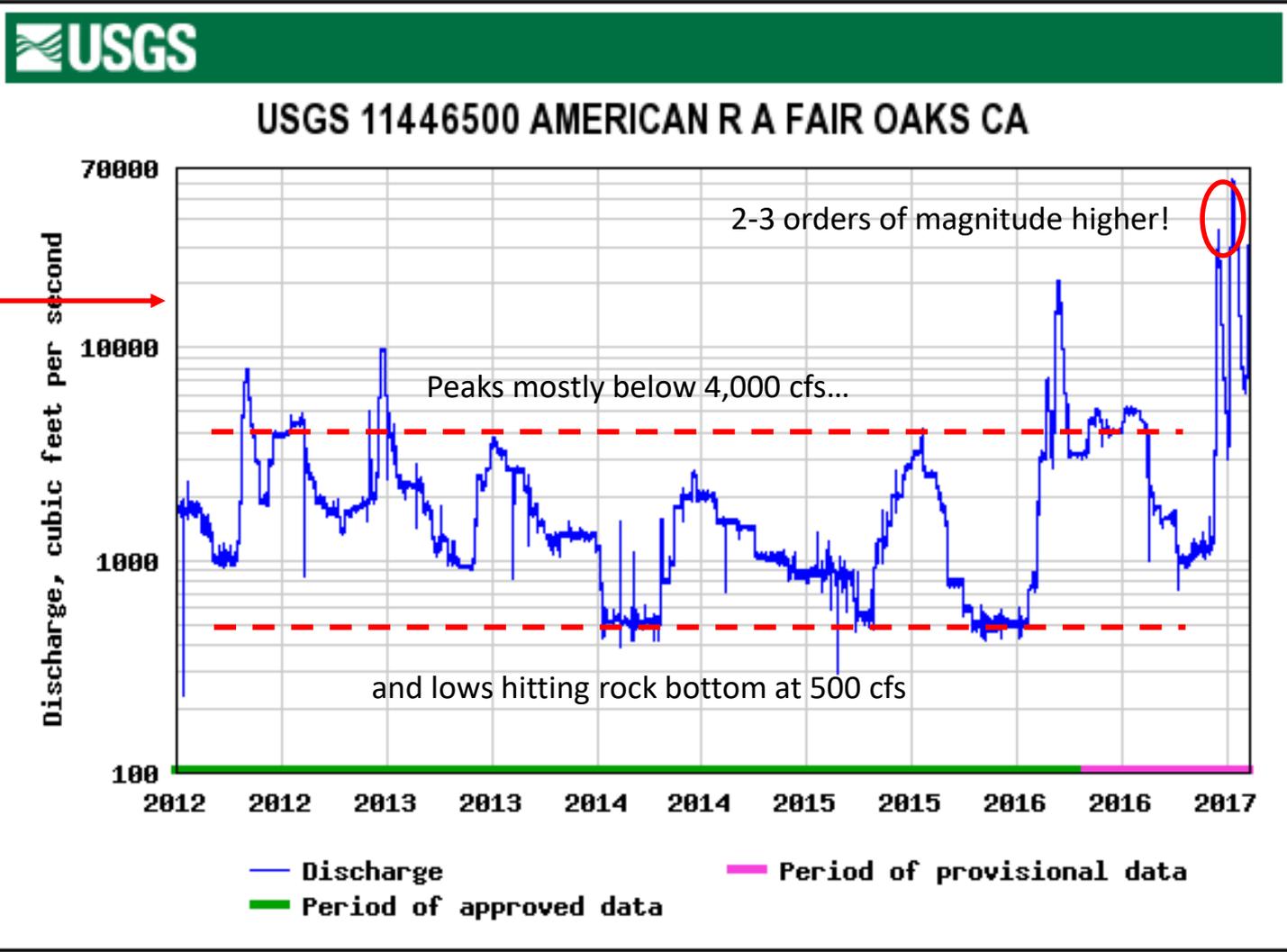
**California Department of Fish & Wildlife
Fisheries Branch, Sacramento**



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From famine to feast...





Conceptualizing high flow effects

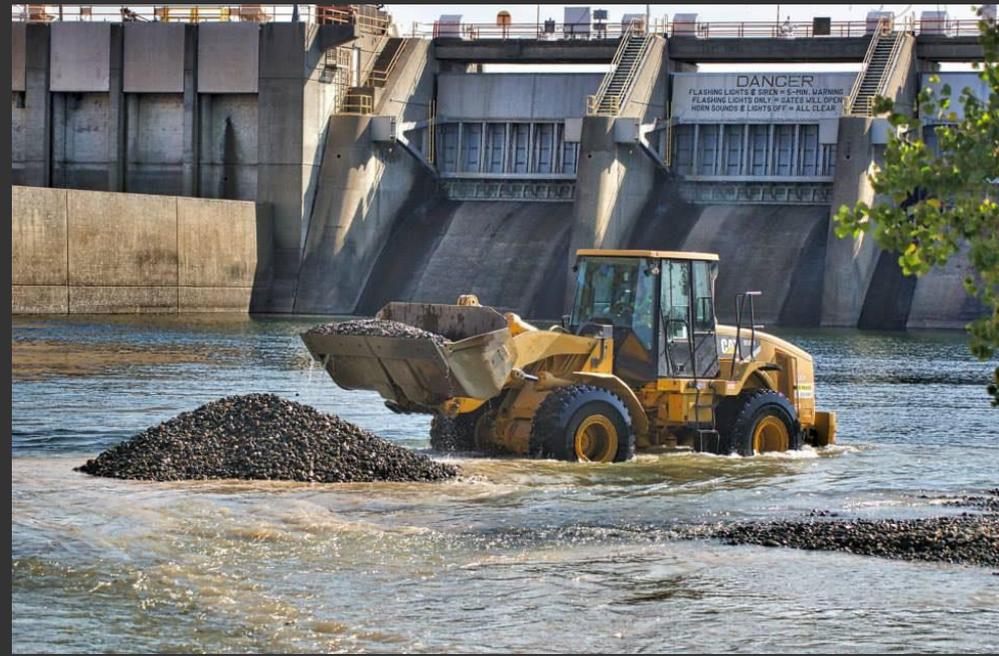
- High flow effects on salmonid habitat
 - Bedload movement, removal of fine sediment
- High flow effects on the fish themselves
 - As related to spawning, incubation, early rearing, emigration
- Inextricably linked
 - Some good, some bad effects





Habitat... rocks n' dirt

- Lots of focus on spawning gravel
- Fact of life: Rivers want to move gravel around
 - Channel forming, remove fines, dynamic equilibrium
- How much flow is needed to do this on the lower American River?
 - Hmmm...





The Number

30,000 cfs

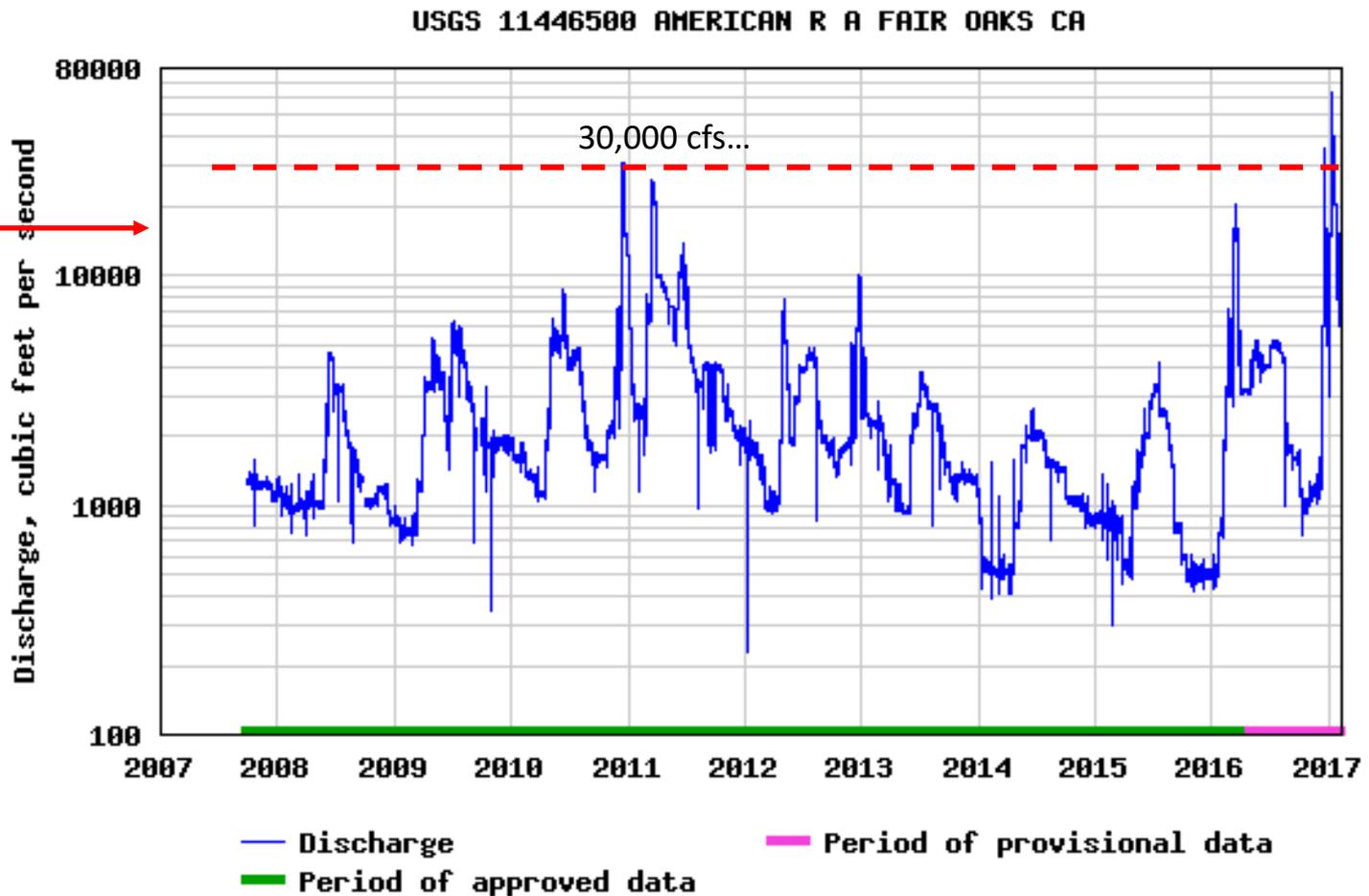
The Legend of Barry Hecht

When and how often does The Number occur?



The Number does not appear often

Note that the y-axis is on a log scale!

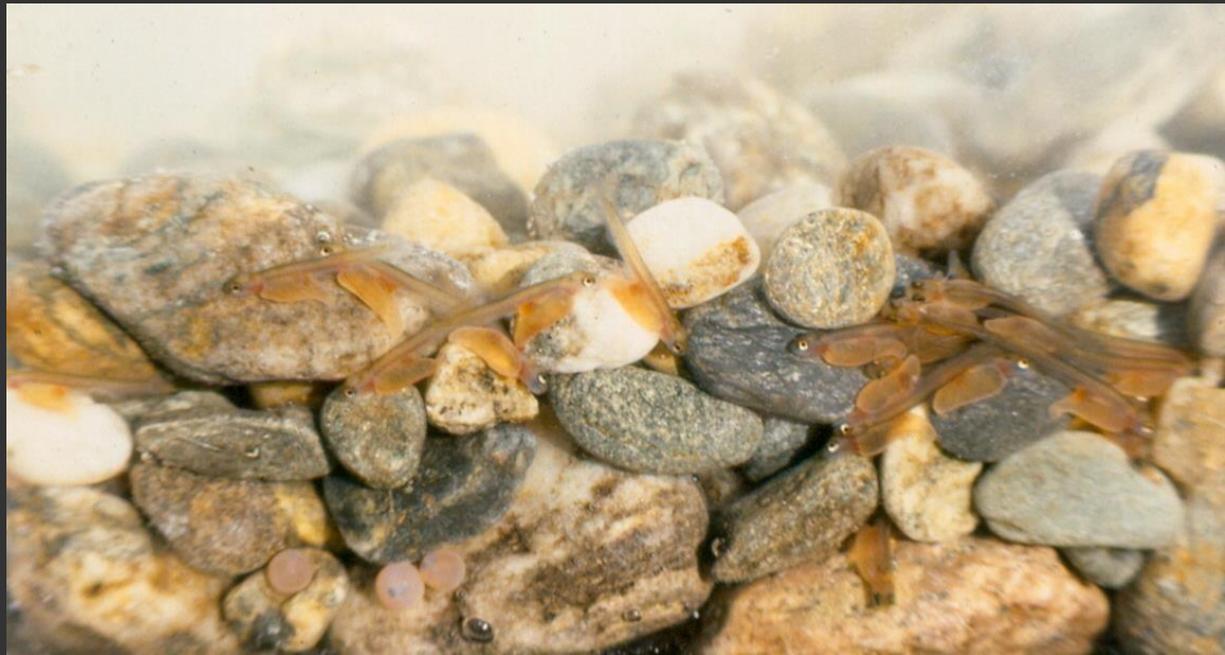


Graph courtesy of the U.S. Geological Survey



High flows => scouring of eggs & fry

- Salmon and steelhead have this figured out
 - Construct *redds*
 - Bury eggs in pockets 12 in to 18 in deep
- But eggs lost when scour reaches 6 in depth
 - Emerging fry even more vulnerable





High flows => population level effects?

- There is evidence
 - Cal. Fish & Game screw trap data, 1994 – 1999

	1994	1995	1996	1997	1998	1999
Emigration estimate (millions)	18.2	5.9	20.3	4.3	18.9	12.4
Spawner escapement (thous)	28.7	27.7	66.0	67.0	46.9	43.0
Emigration survival index	633	213	308	64	405	287





High flows => isolation & stranding

- Cal. Fish & Game flow fluctuation study
 - For BOR, 1996 – 2000 (Snider, Titus, Vyverberg 2001)
- Estimated losses due to isolation

Year	Chinook Salmon	Steelhead
1997	1,467,339	283,073
1998	13,652,218	42,979
1999	5,420,938	10,893
Total	20,540,495	336,945



The good news: higher fry survival to the Delta

Souce: Brandes and McLain (2001)

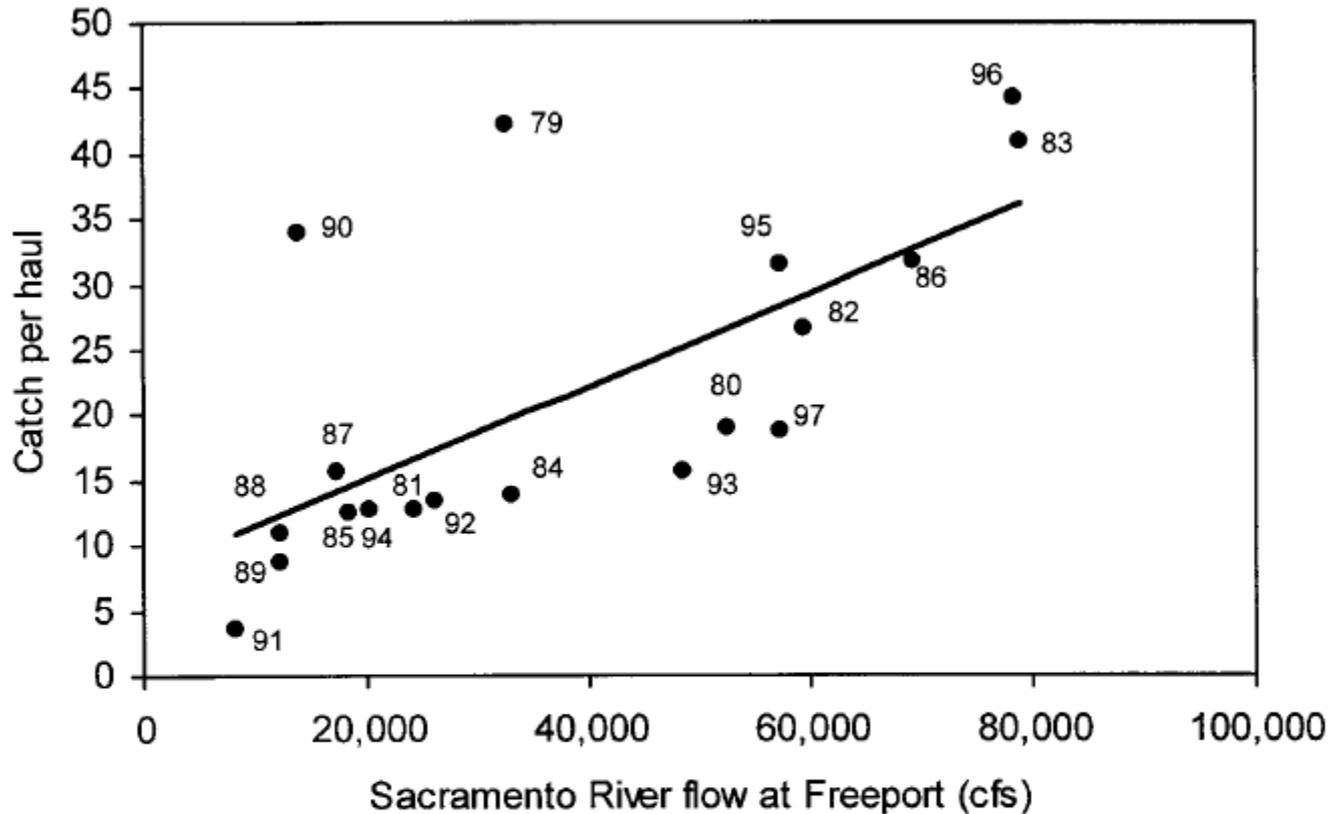


Figure 8 Catch per haul of juvenile chinook salmon in the North Delta beach seine between January and March versus mean February flow on the Sacramento River at Freeport from 1979 to 1997



The good news: higher smolt survival to the Bay

Souce: Brandes and McLain (2001)

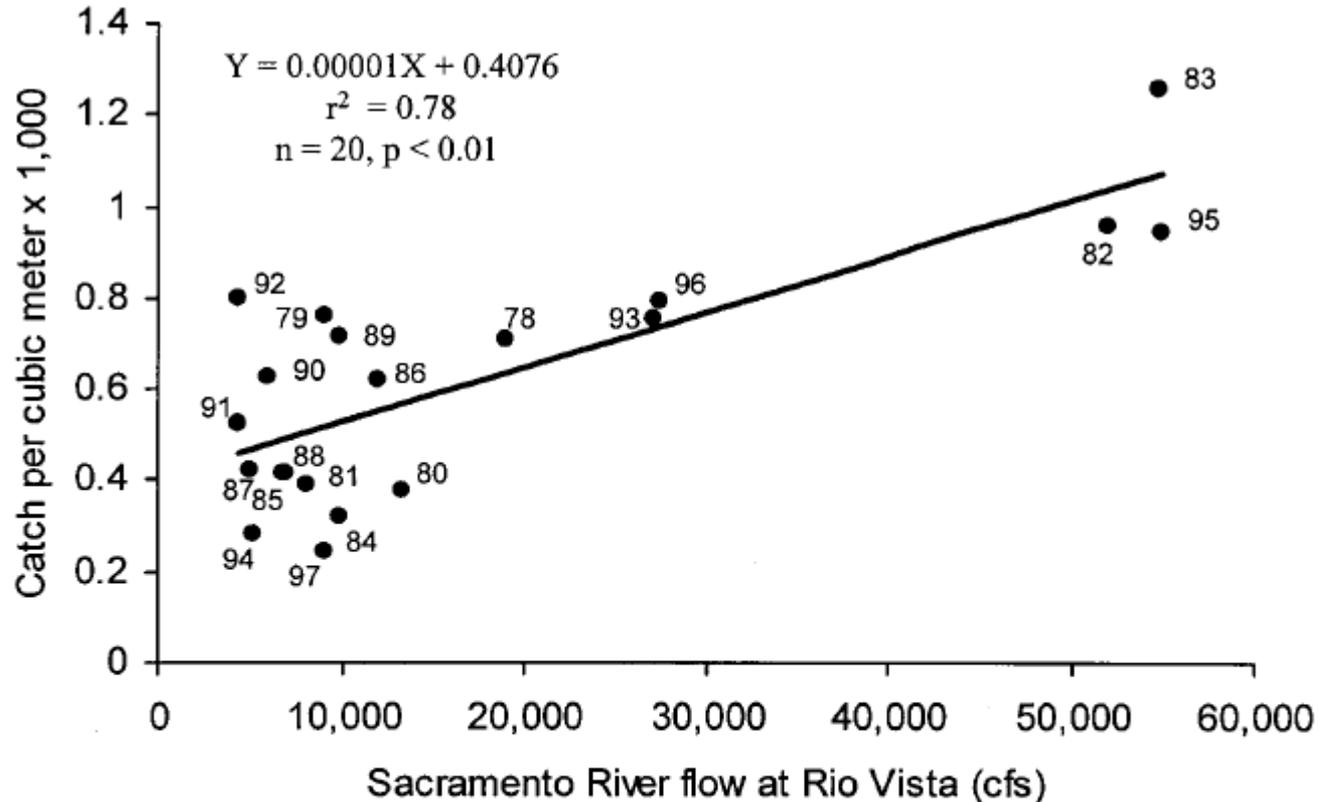


Figure 13 Mean catch of unmarked chinook salmon smolts per cubic meter (x 1,000) in the midwater trawl at Chipps Island between April and June from 1978 through 1997 versus mean daily Sacramento River flow (cfs) at Rio Vista between April and June



Salmon & steelhead and high flows

- Salmon and steelhead evolved with high flows
- Resiliency
 - Overlapping generations
 - Hatcheries
- Historic habitat was more diverse
- So, impact of high flows now likely greater than pre-development





Final thoughts...

- Validate The Number?
- Fish aspects difficult to study directly
 - Redd capping, isolation & emigration monitoring
- Modeling may help



Salmon anglers on the American River at Sailor Bar. Photo: Terry Linton