The Protected?, the Bad, and the Ugly:
Use of a Coupled Hydrodynamic-Particle Tracking Model & 3 Years of Low Outflow Hydrology to Evaluate Entrainment Risk for Longfin Smelt Larvae in the Delta

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Background to assess an invisible loss…

- Buoyant larvae hatch winter/spring
- Transported by prevailing flow
- Salvage high during low outflow years
- Salvage only counts fish ≥ 20 mm

- Concern: high loss of larvae could occur before 20mm size

Topics

- Approach to modeling entrainment & limitations
- "Population" scale results for entrainment
- What we learned along the way
- Concluding remarks

Approach

- Coverage for longfin smelt hatching – space and time – and duration as larva
- Coverage for State Water Project facilities
- Selected hydrology based on observed vulnerability, flow variability, and export variability

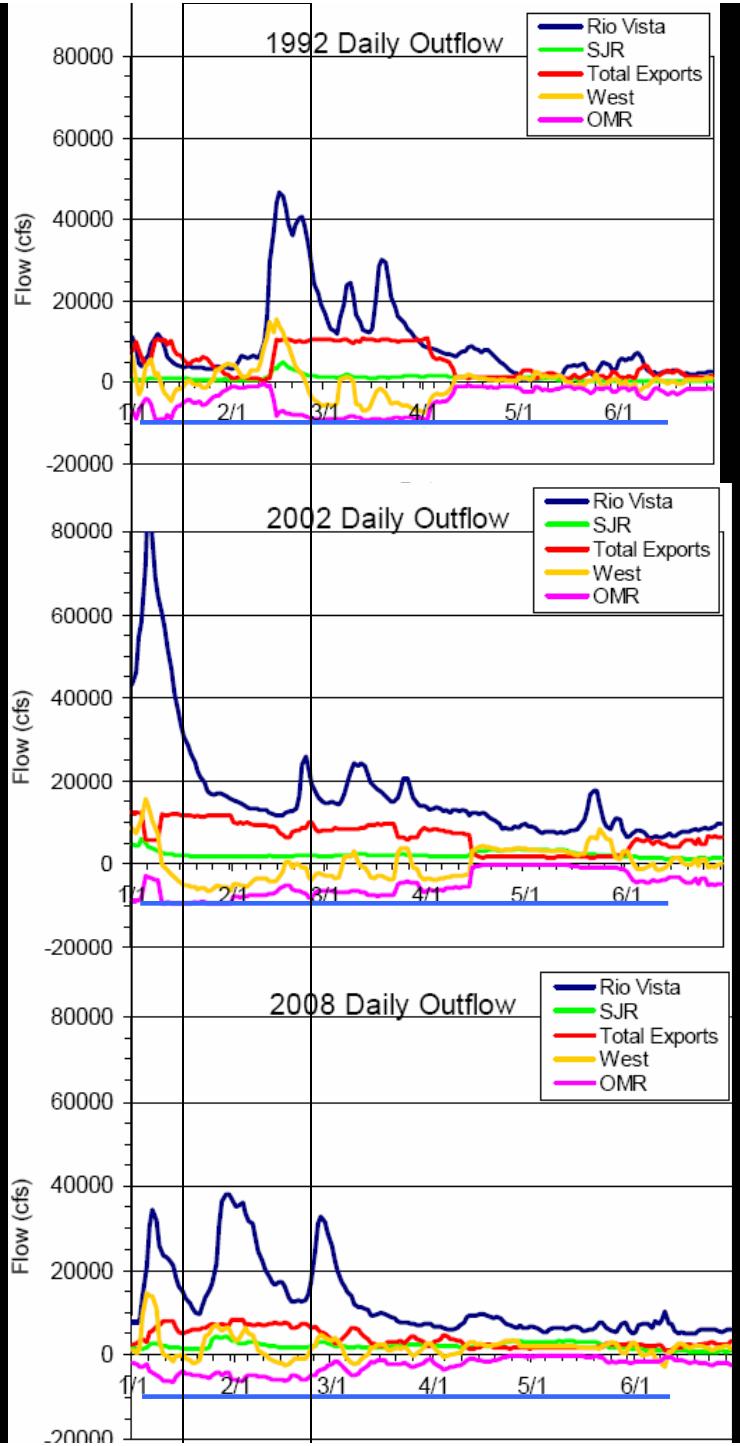
Approach cont.

Hydrology chosen…

1992 - "dry" until mid-hatch

2002 - pulse flow then low outflow

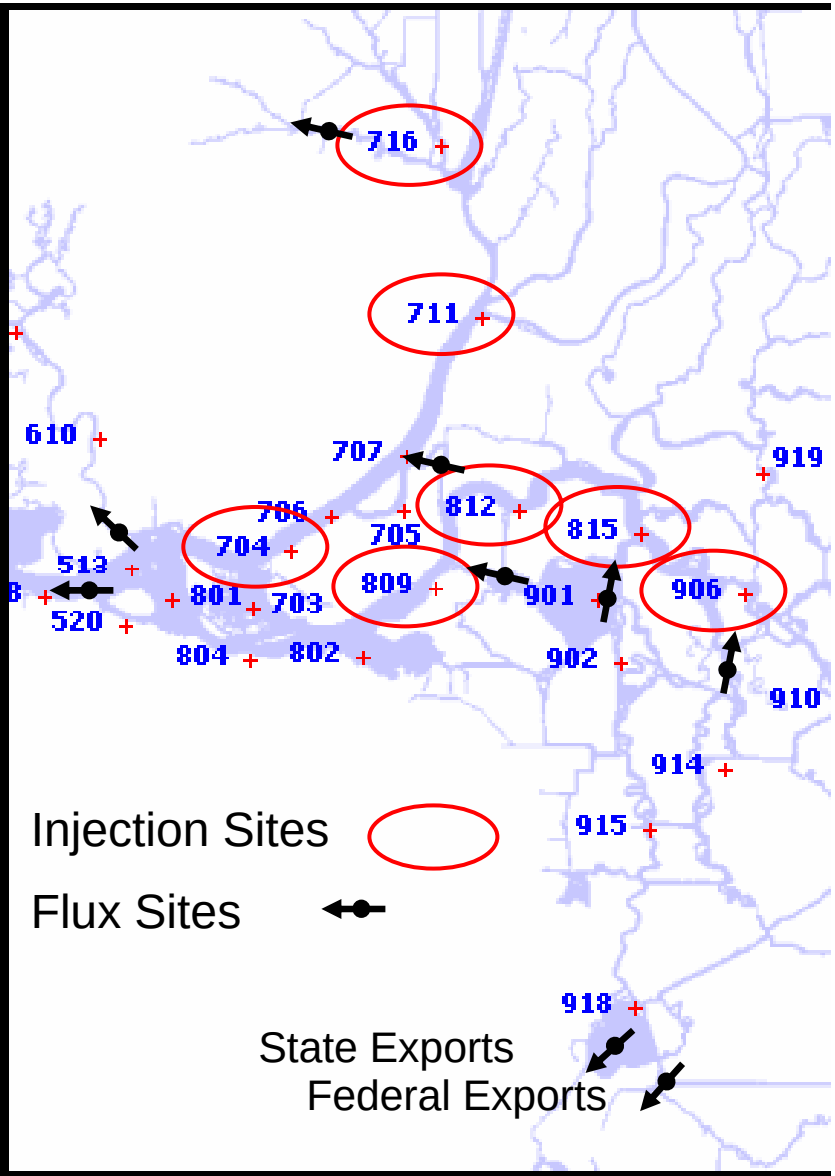
2008 - pulses thru hatch period, reduced exports



Approach cont.

Model used, injection sites selected…

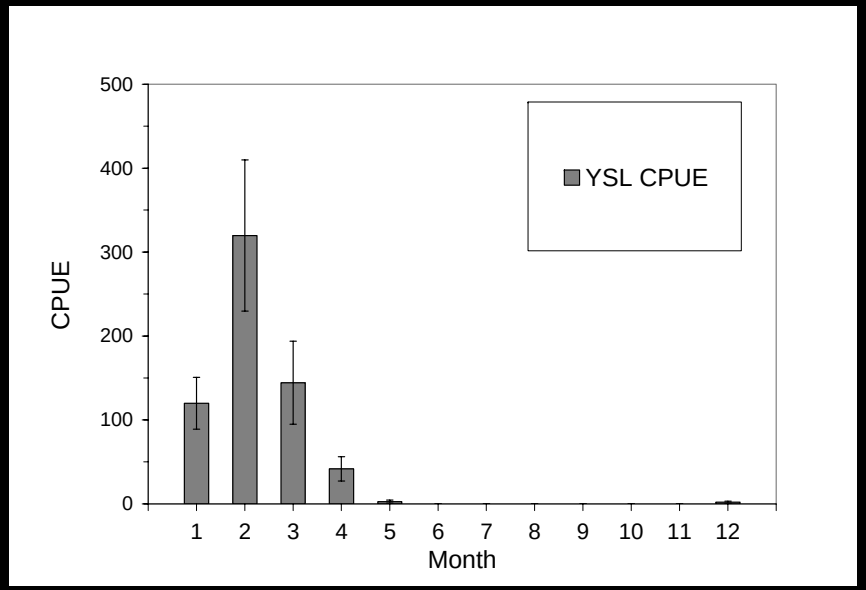
- DSM2 + particle tracking
- 7 injection sites
- 14 flux sites
- 5,000 particles per injection



Approach cont.

- 7 injection dates – January 1 thru April 1
- 2 particle "behaviors": neutrally buoyant & surface-oriented
- 90-day tracking

Yolk-sac Larva #s approximate hatching



Approach cont.

Model Output

For each Year and Behavior

-> files by injection location (7) for every injection date (7)

-> 90 daily records % flux at 14 locations

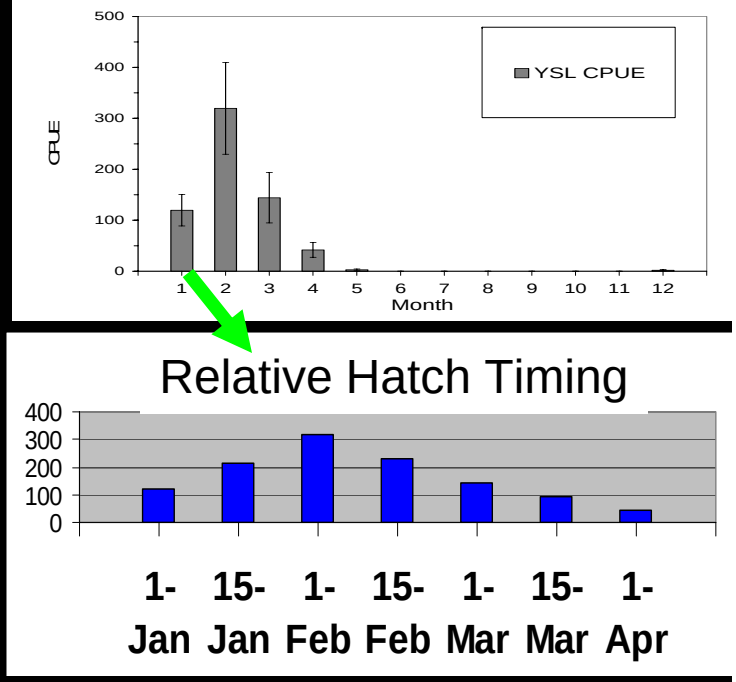
Created file of final particle fates (i.e. last record)

… but 5000 particles were injected at each location and date, not how larvae hatched

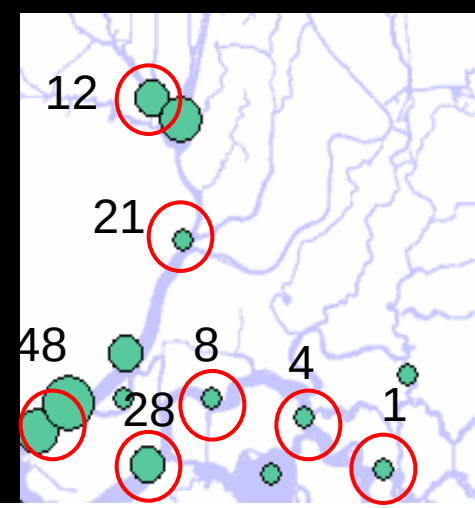
Approach cont.

Weighting data to represent the larval population…

- Hatching pattern – monthly data interpolated



- Hatching varies by location



Longfin smelt relative larva densities

Also weighted data for differing channel size and site number…

Results

Data weighted to represent the larval population…

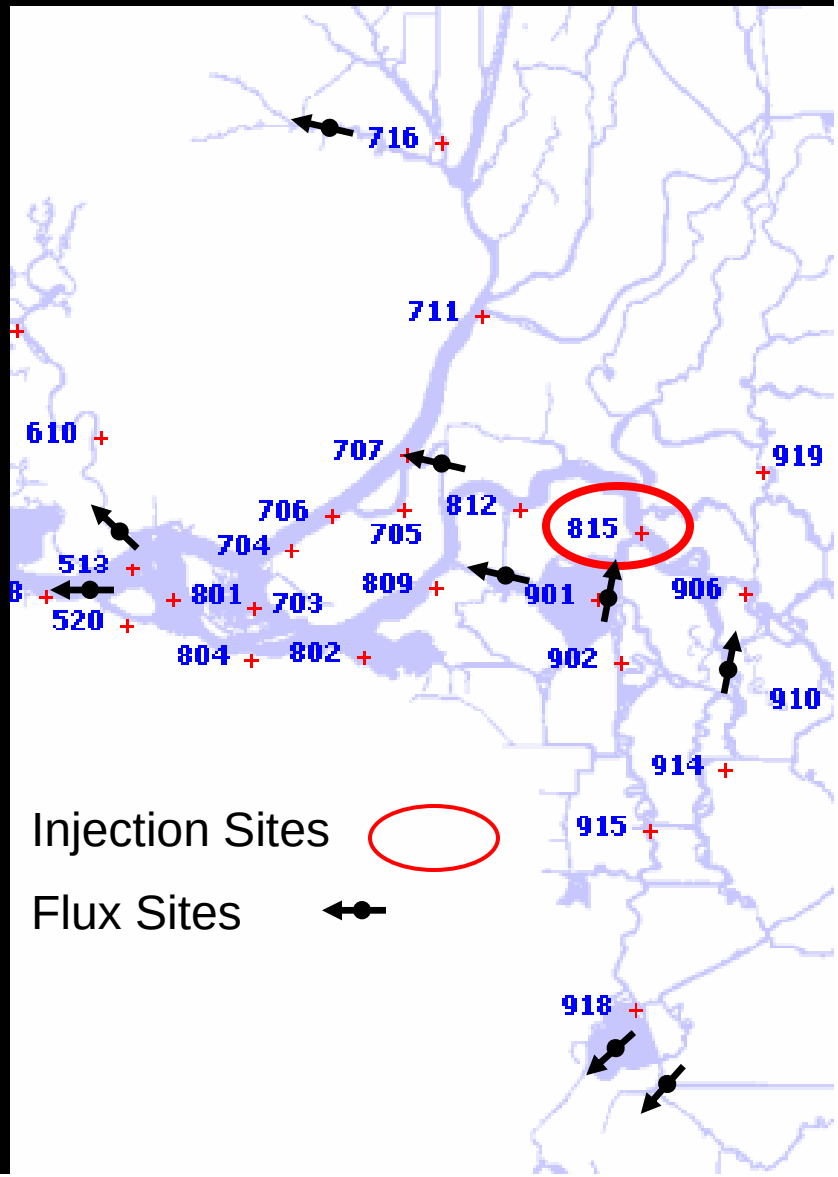
Percent of "population" past or entrained for "typical" low outflow larva distribution

Year	Behavior	Chipps%	SWP%	CVP%	SWP+CVP%
1992	neutral	82.02	3.49	2.06	5.55
1992	surface	79.43	4.91	2.91	7.82
2002	neutral	85.19	7.12	4.44	11.56
2002	surface	82.15	9.18	5.72	14.90
2008	neutral	94.52	1.56	1.10	2.66
2008	surface	93.69	2.17	1.54	3.71

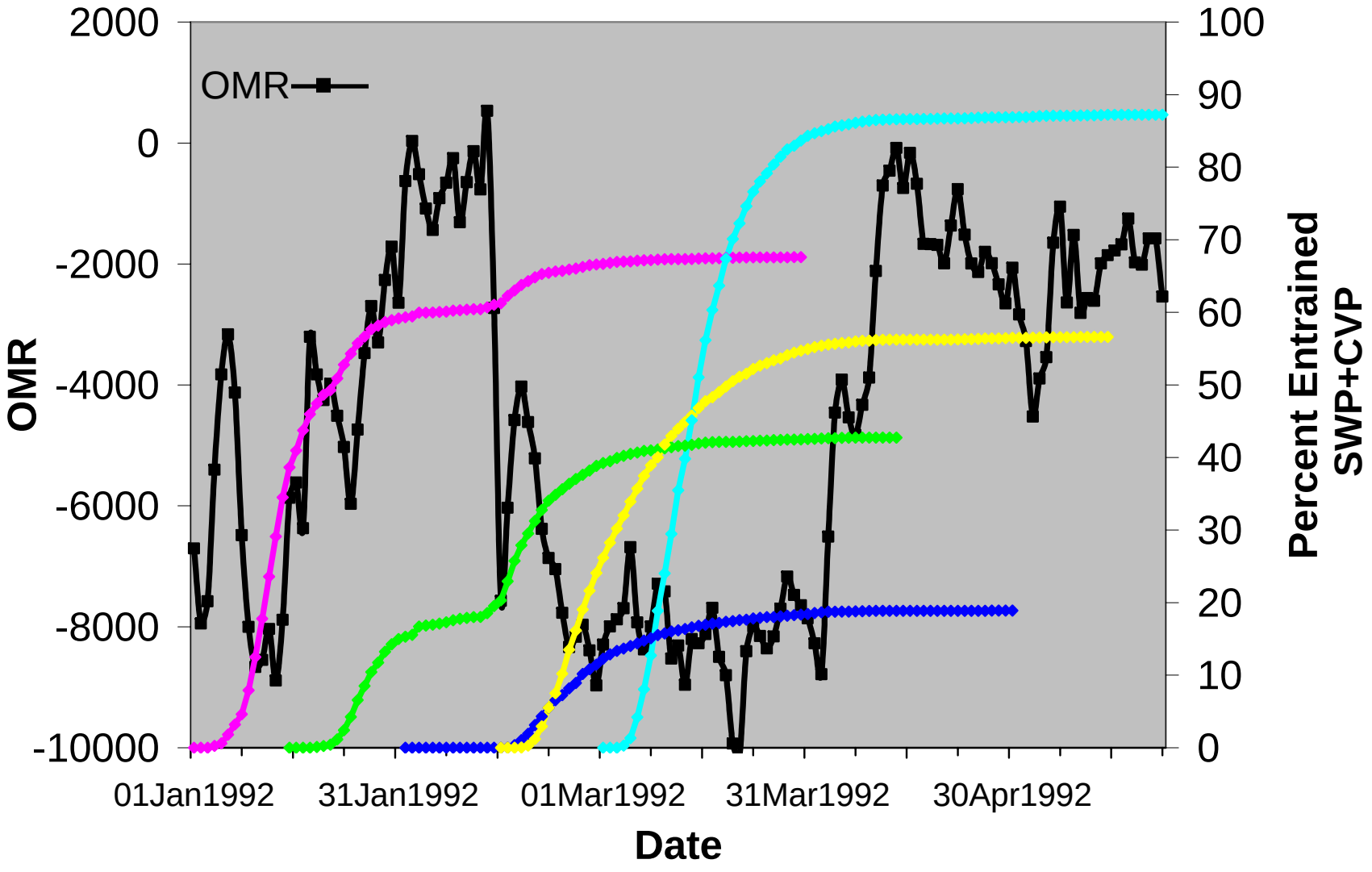
Results – what we learned along the way…

Example – cumulative entrainment from injections at 815 in 1992

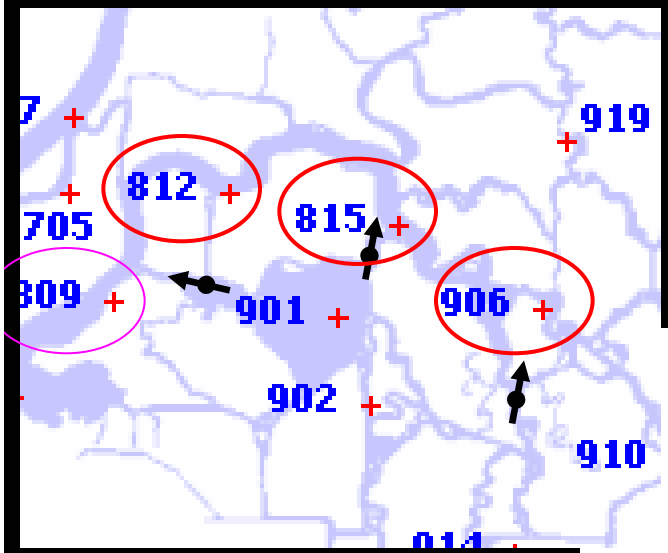
3 paths to entrainment

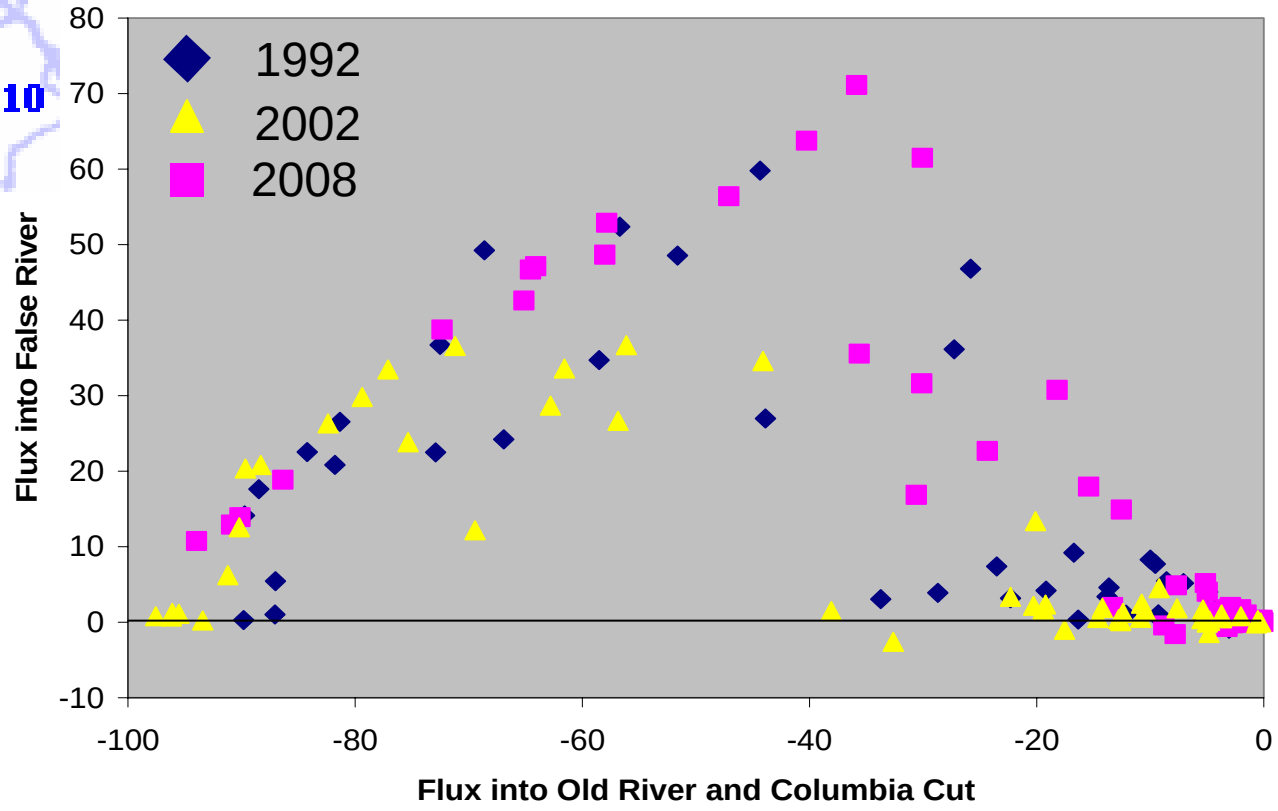


Conditions right after hatch determine fate…



Flux into south Delta not synonymous with entrainment…





Concluding remarks

- Best estimate of SWP+CVP entrainment – a hybrid of behaviors
- Water Project effects substantial in 2002, much less so in 2008
- Entrainment or escape in the San Joaquin River strongly dependent upon conditions at and soon after hatch

Acknowledgements

Tara Smith, Kijin Nam and Min Yu (DWR) conducted particle tracking model runs, provided data and assistance with interpretation

Dave Contreras, Virginia Afentoulis and Omid Ebrahimi (DFG) organized and summarized particle tracking model output

Rene Reyes took photos of larval longfin smelt used in this presentation

Read more about it:

http://www.dfg.ca.gov/delta/

Longfin smelt link -> Incidental Take Permit SWP link -> Effects Analysis links