Bay-Delta Experiences

water quality, water quality, water quality

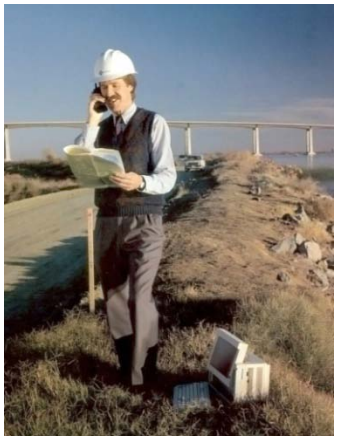
Richard A. Denton

Richard Denton & Associates

California Water and Environmental Modeling Forum
Asilomar Annual Meeting
Monterey, CA February 23, 2010

Overview of Presentation

- Pre-California Work
- UC Berkeley
- CCWD
  - ❖ Los Vaqueros Project
  - ❖ Salinity-Outflow Model
  - ❖ X2 Sliding Scale
  - ❖ Protecting CCWD water quality



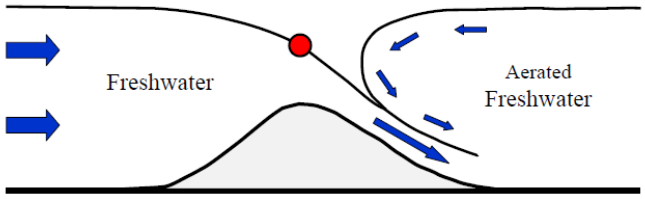
Earlier Work: Stratified Flow

- University of Canterbury, Christchurch, New Zealand (Doctoral research)
  - ❖ Vertical mixing in vertically stratified fluids (penetrative convection)
  - ❖ Buoyancy effects in fluids
- University of Karlsruhe, Germany (Post-doctoral research – 3 years)
  - ❖ Internal density currents on slopes
  - ❖ Thermal wedges behind skimmer walls

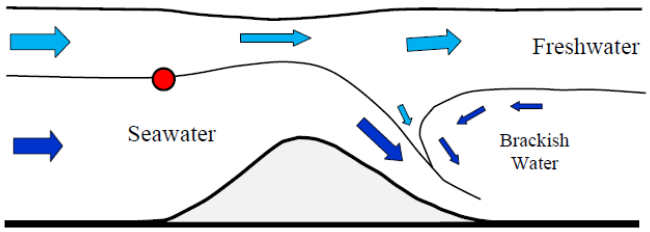
Academic Work at UC Berkeley

- **Teaching**
  - ❖ Fluid mechanics
  - ❖ Hydrology
    - ▪ rainfall-runoff models
    - ▪ stochastic ARMA models
  - ❖ Mixing in rivers, lakes and estuaries
- **Research**
  - ❖ Layered flow over fjord sills
  - ❖ Longitudinal dispersion in rivers with dead zones
  - ❖ Currents in San Francisco Bay (USGS field data)

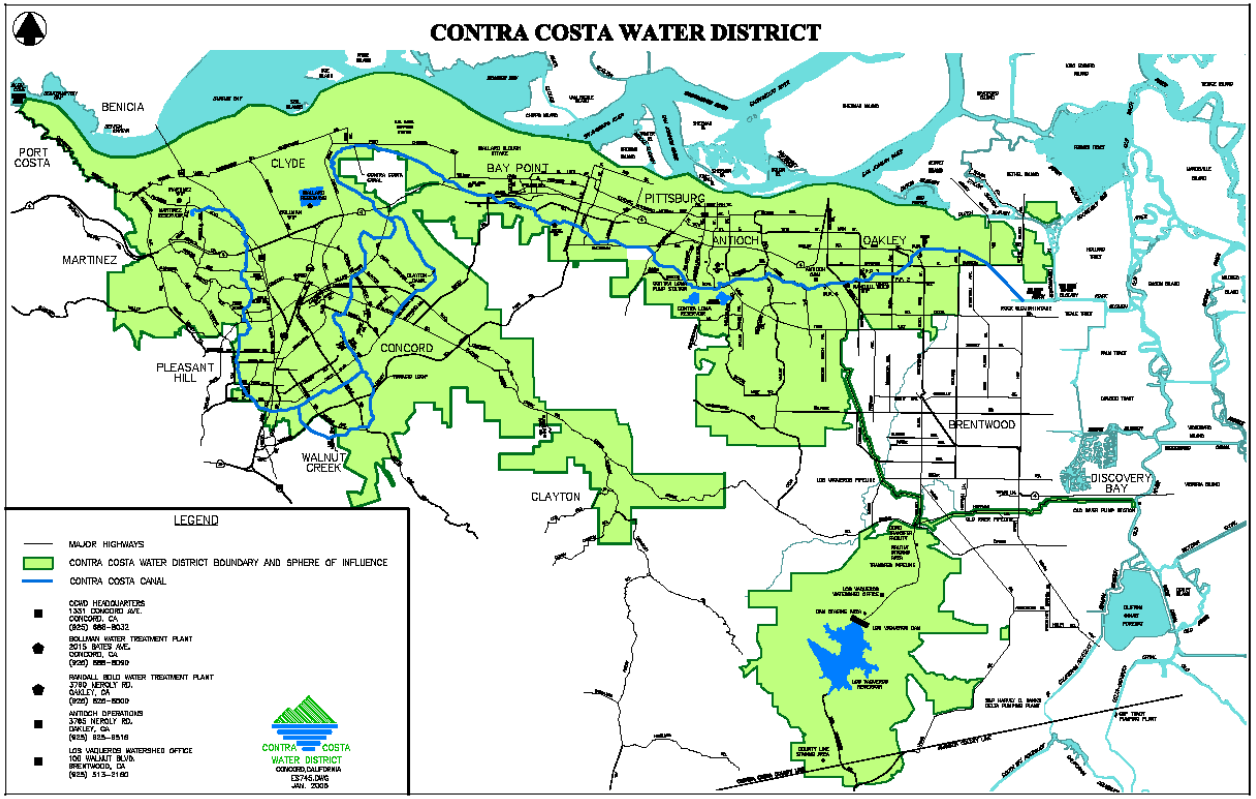
Hydraulic Control of Single-Layer Flow over a Hump



Approach Control of Two-Layer Flow over a Fjord Sill



Contra Costa Water District

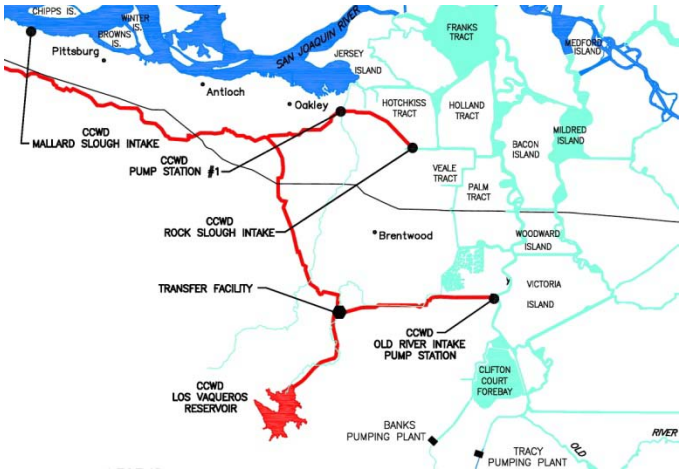


- Serves water to approximately 550,000 people in Central and Eastern Contra Costa County (municipal & industrial)
- Relies entirely on Delta for its water supply ➔ focus on protecting Delta water quality

CCWD Water Resources Group Activities

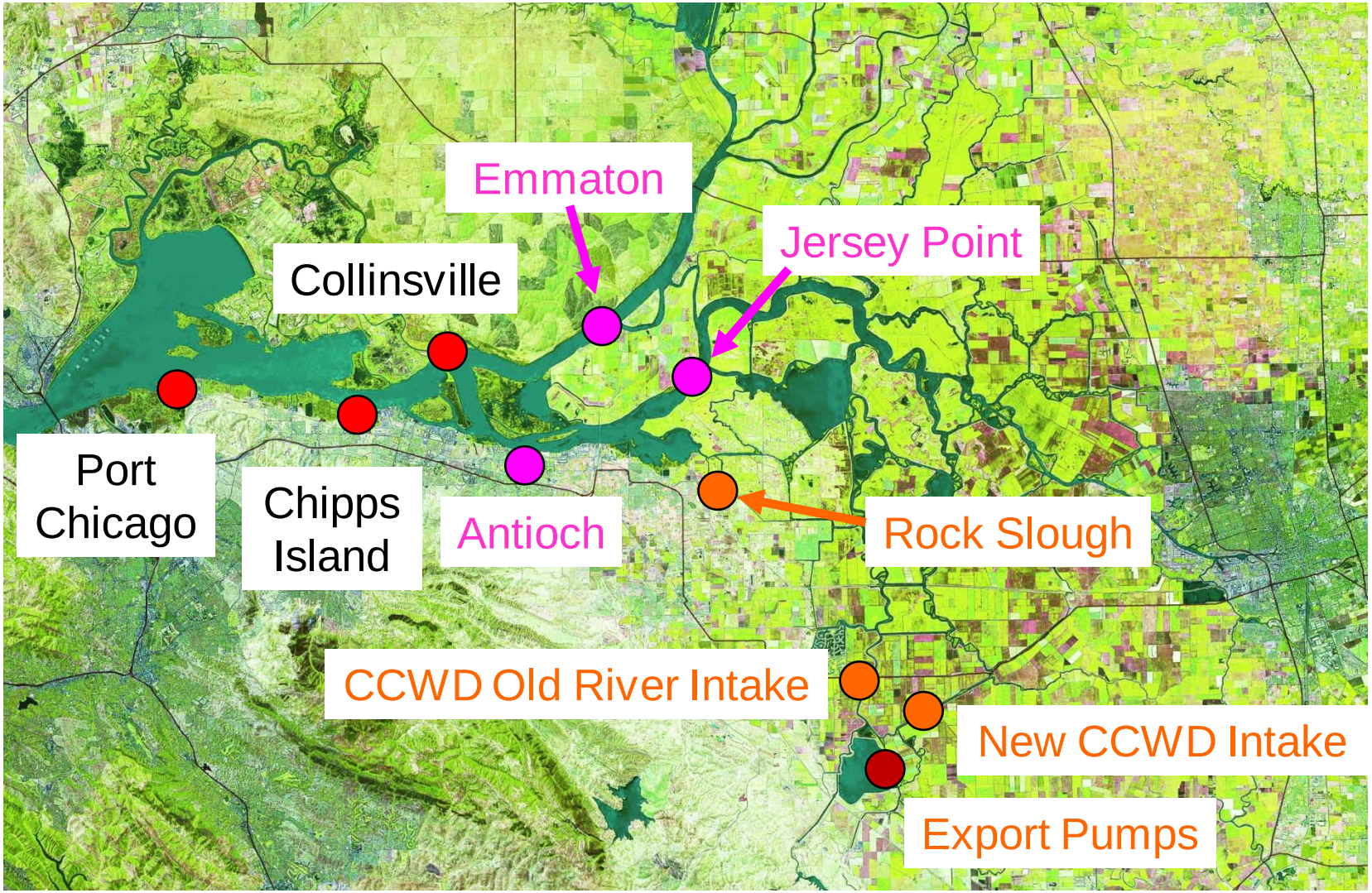
- SWRCB Water Quality Control Plans and Water Rights Hearings
- Los Vaqueros Project EIR/EIS and Water Rights
- Salinity-Outflow Model (G-Model)
- Estuarine Habitat Standard (X2) Sliding Scale
- Protection of Delta Drinking Water Quality
- Multi-Agency Activities

Los Vaqueros EIR/EIS and Water Rights

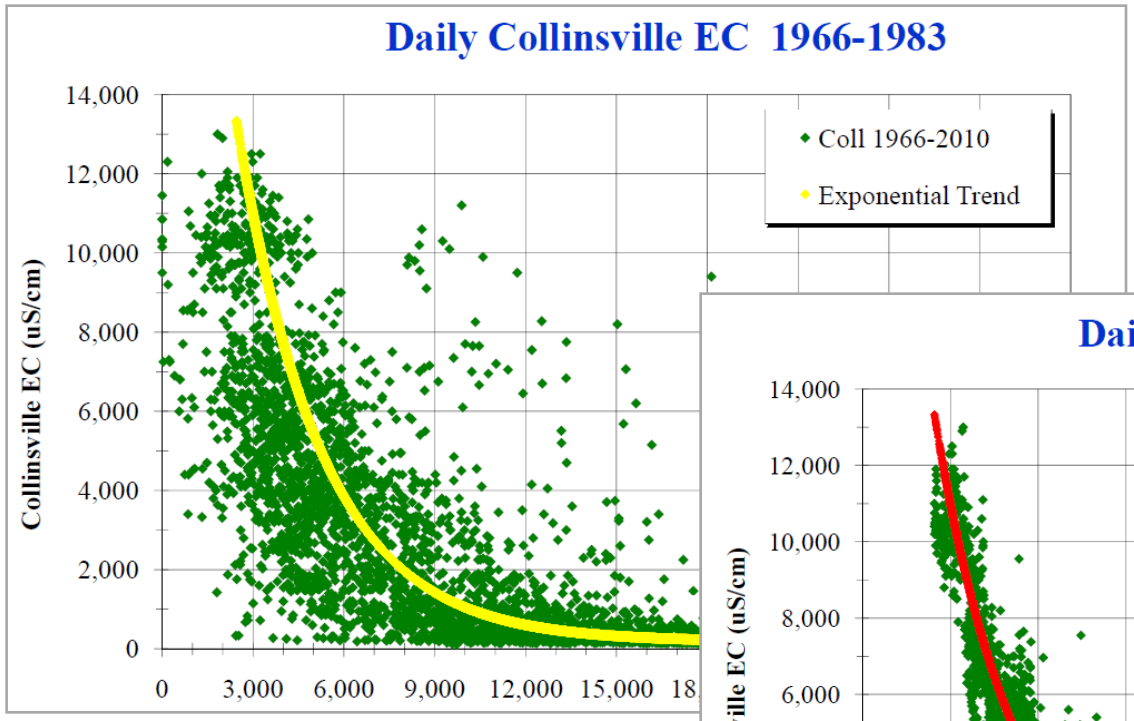


- Modeling Central Valley ops, Delta wq and LV operations
  - ❖ monthly DWRSIM ➔ daily Fischer Delta Model + daily LVOPS ➔ monthly DWRSIM, etc.
- Biological opinions, EIR/EIS, SWRCB water rights exhibits and testimony
- June 1994 – SWRCB WR D-1629
- January 1998 – First reservoir completed in California in 10 years
- July 1999 – LV Project received ASCE Outstanding Civil Engineering Achievement Award

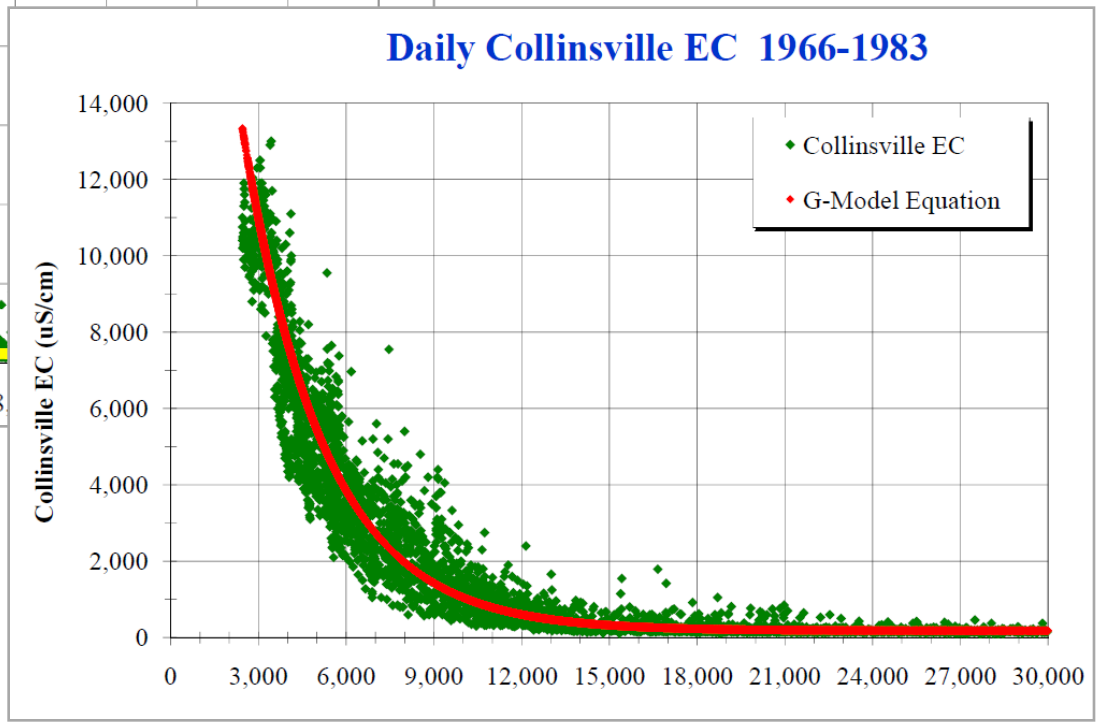
Salinity-Outflow Model (G-Model)



Salinity-Outflow Model (G-Model)



Delta Outflow (cfs)



Antecedent Outflow G-average (cfs)

Salinity-Outflow Model (G-Model)

- EC assumed only a function of antecedent Delta outflow

$$EC = Sb + (So - Sb) * Exp(- \alpha * G(t)^{n})$$

where Sb is background (high outflow) salinity,
So is downstream boundary salinity, and
α and n are fitting factors.

- Antecedent outflow G(t) calculated from

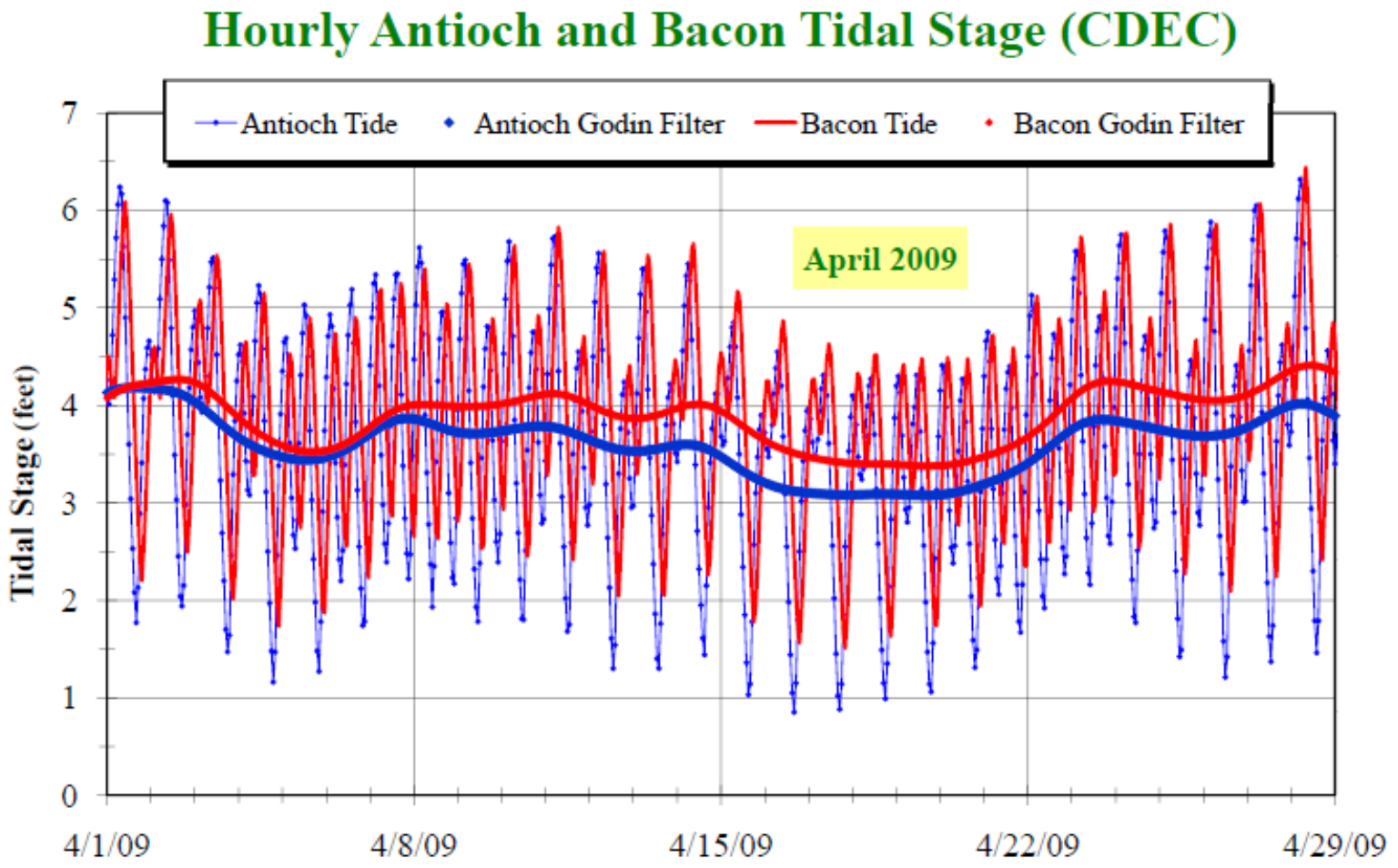
$$\mathbf{dG/dt = (Q - G)*G / \beta}$$

where Q(t) is Delta outflow, and
β is constant response rate coefficient
(collapses data to single EC versus G curve)

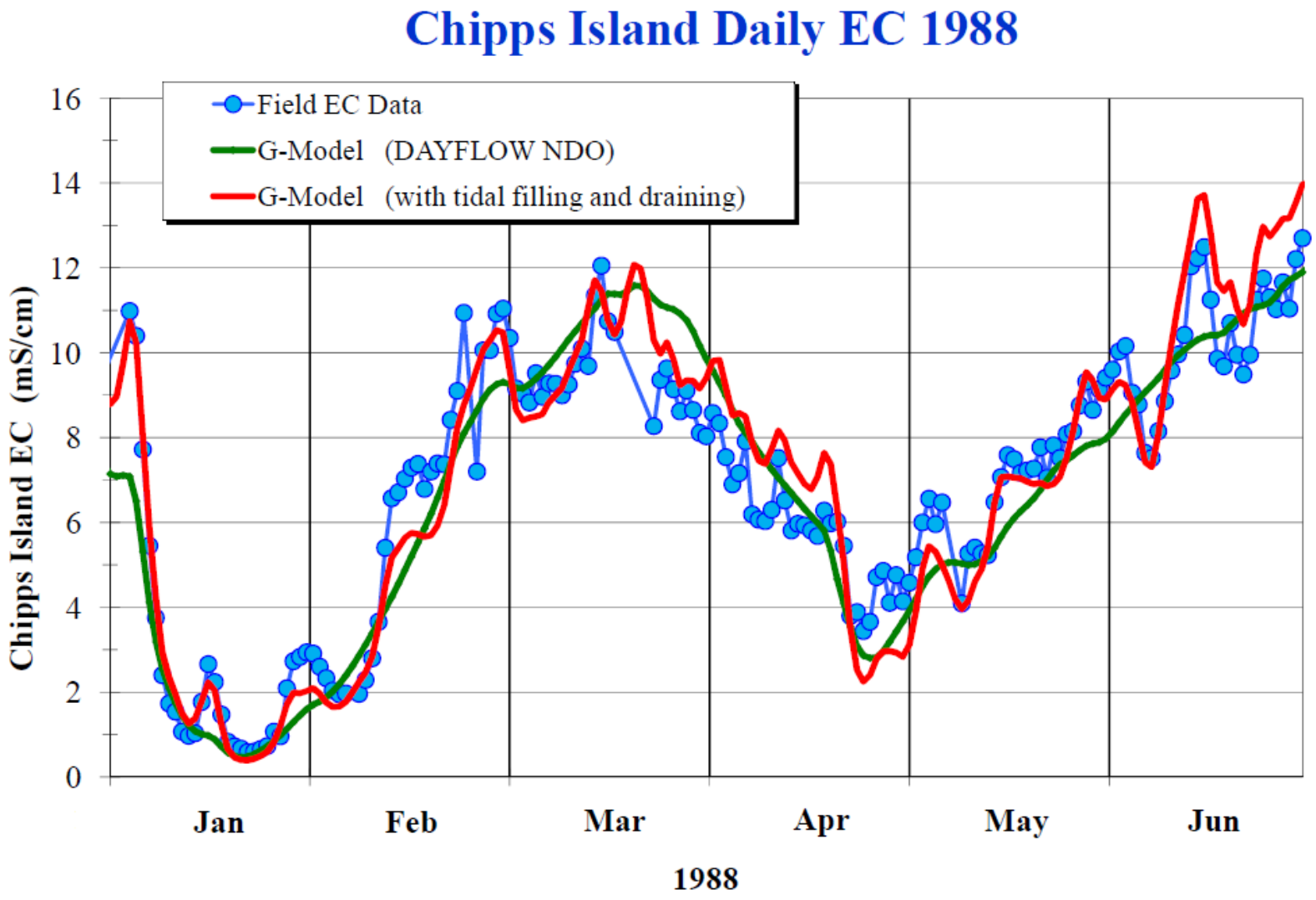
- G and EC change faster at high flows than at low flows
- Kimmerer-Monismith X2 equation has fixed response rate

Accounting for tidal filling and draining of Delta

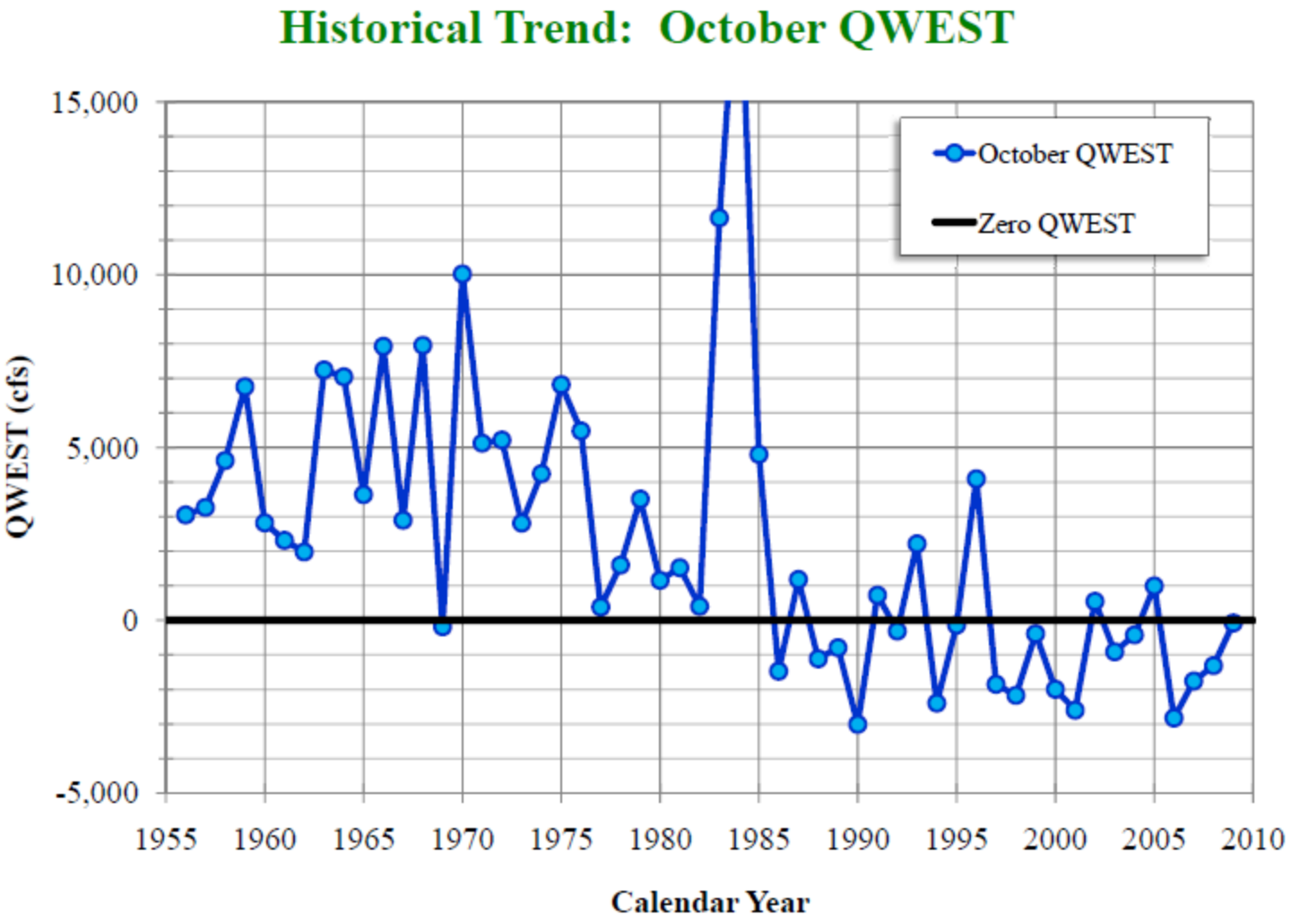
- NDO actual = DAYFLOW NDO – c . dH/dt



Salinity-Outflow Model (G-Model)

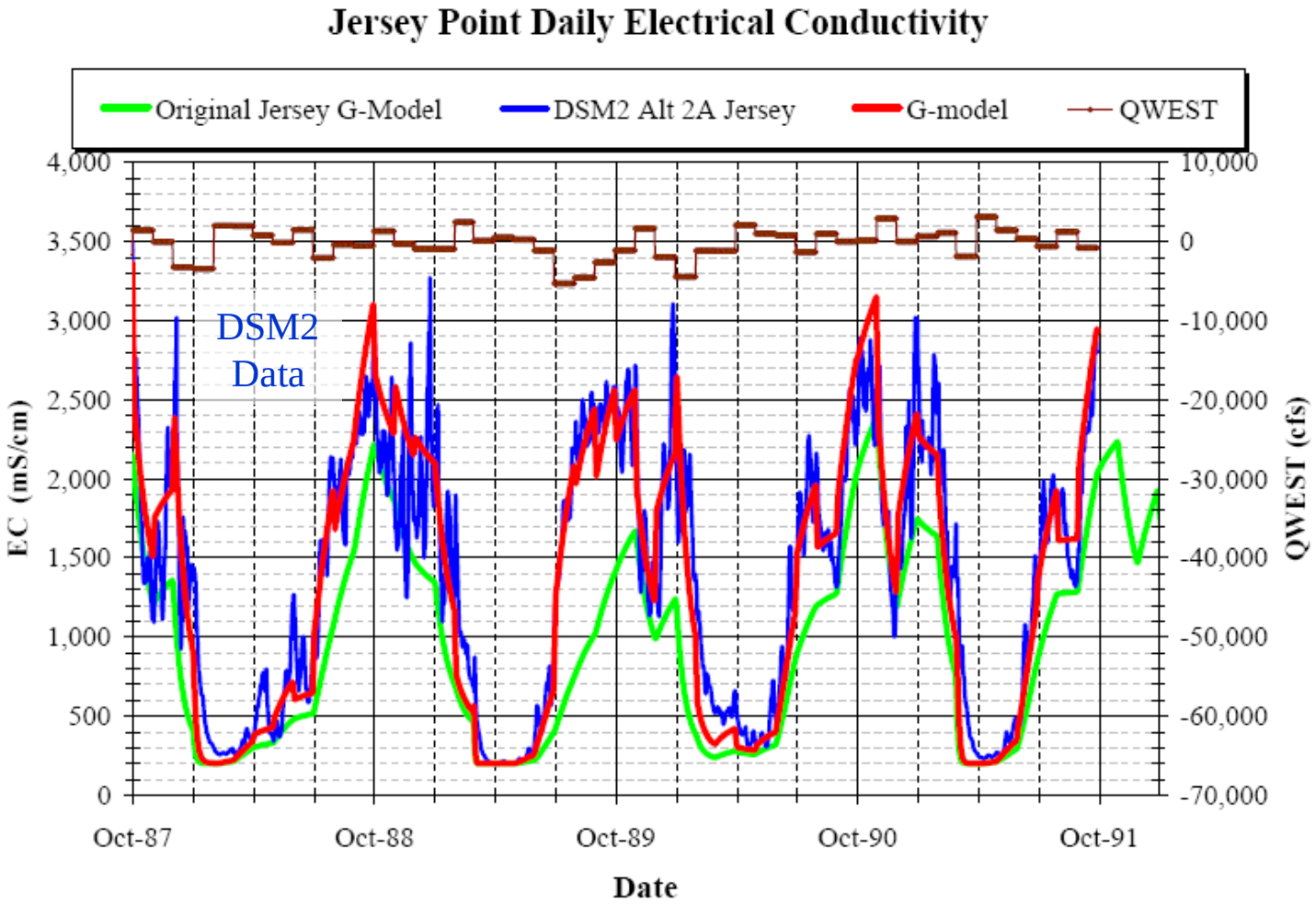


Fall QWEST is now regularly negative



Updated G-Model for Jersey Point

- Includes potential effect of reverse flows (QWEST)

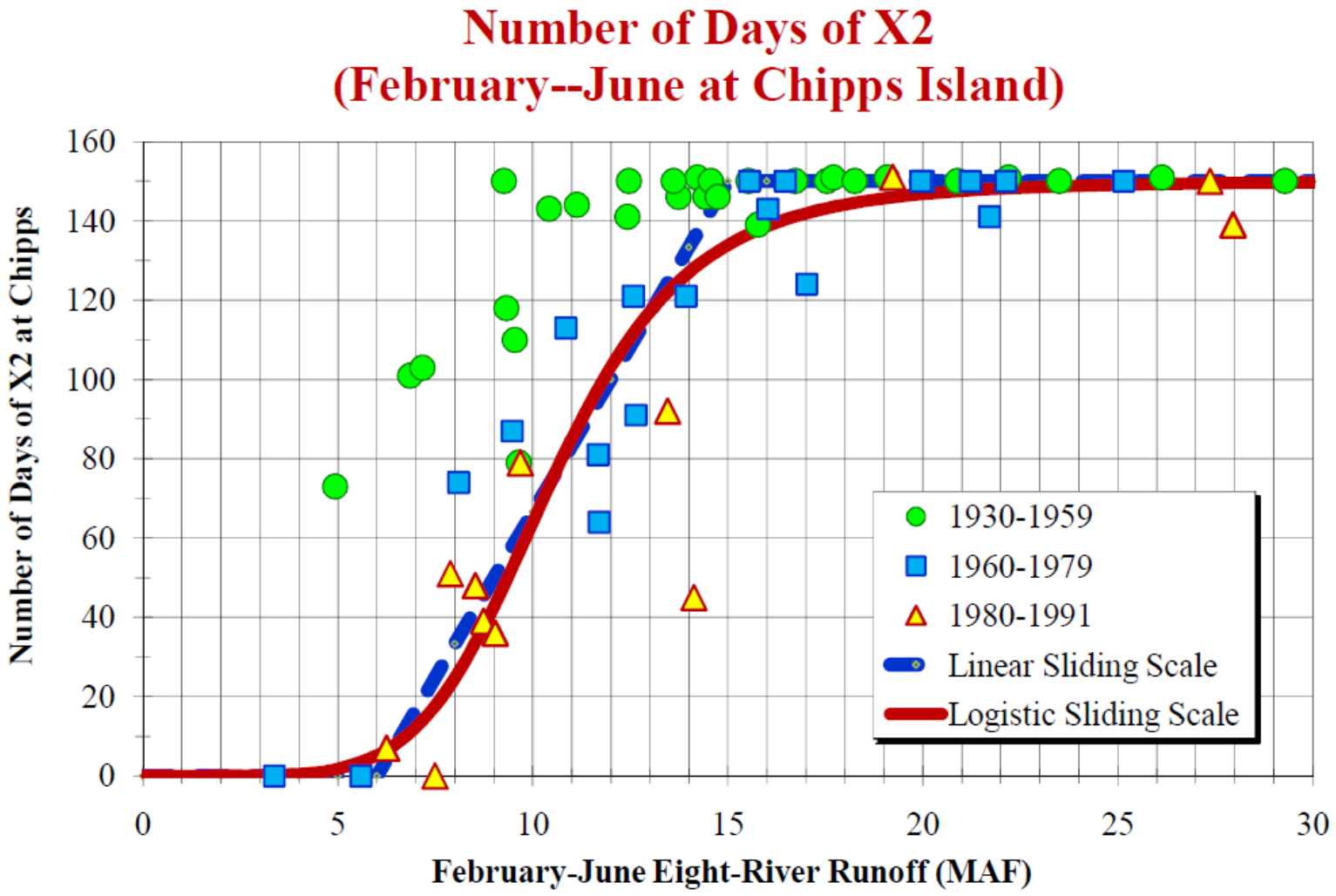


X2 Estuarine Habitat Sliding Scale

- X2 objective proposed in 1993 by USEPA
  - ❖ Numbers of days, Feb-June, 2ppt bottom salinity must be downstream of three western Delta locations
  - ❖ Roe Island, Chipps Island and the confluence
  - ❖ Number of days varied by water year type, e.g. 2 ppt isohaline downstream of Chipps for 90 days in critical years and 148 days in wet years
- Reformulated by SWRCB and CCWD ➔ number of days varies as function of Sacramento water year runoff and Feb-June 4-River runoff, respectively
- **Bay-Delta Modeling Forum** (CWEMF) held a number of workshops to refine proposal

April 1994 BDMF X2 Workshop

X2 Estuarine Habitat Sliding Scale



X2 Estuarine Habitat Sliding Scale (cont.)

- CCWD used **linear sliding scale** (Wim Kimmerer ➔ continuous logistic function)
- Dave Fullerton and Bruce Herbold recognized number of days decreased somewhat linearly from 1969-1994
  - ❖ Standard set at **1971.5** (average of 1968-1975)
- Bruce Herbold suggested setting number of days for each month based on previous month's 8-River index
- **G-Model** used to calculate water costs and determine equivalent outflows to comply with X2 standard, i.e., 29,200, 11,400 and 7,100 cfs
- Feb-June bottom salinity objective ended up as month-by-month surface EC standard

Protection of Delta Water Quality

- MacMillan Bloedel Paper Recycling Plant (West Sacramento)
  - ❖ organic carbon, salinity, arsenic, mercury and temperature
- Delta Wetlands Project
- South Delta Barriers
- Grassland Bypass Project (Westside San Joaquin Valley)
  - ❖ selenium, salinity
- Sacramento County Regional Wastewater Treatment Plant Expansion
- CALFED drinking water program
  - ❖ bromide, organic carbon ➔ disinfection byproducts

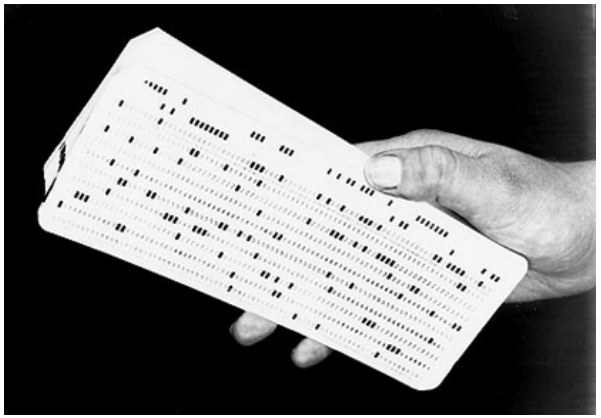
Protection of Delta Water Quality

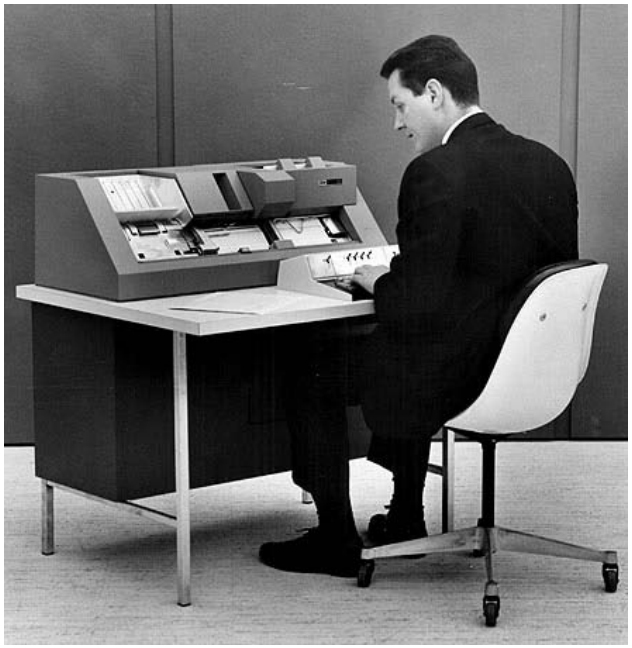
- Bay-Delta Conservation Plan
  - ❖ Other Stressors: pesticides, ammonia, temperature ➔ fish impacts
  - ❖ increased salinity ➔ more clams ➔ less food for fish
  - ❖ will proposed isolated tunnel and reduced South Delta exports cause accumulation of contaminants in south and central Delta and warmer temperatures?

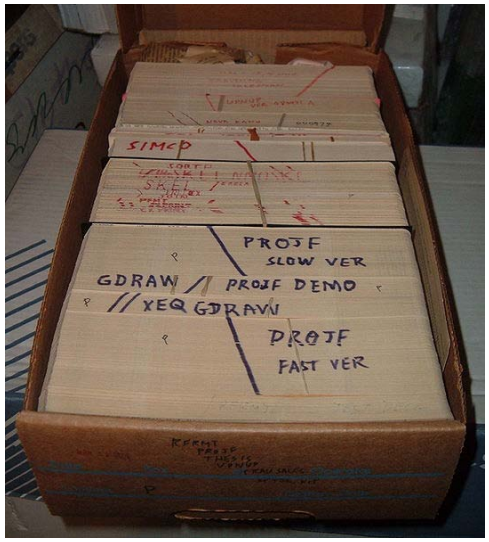
Multi-Agency Activities

- Operations and Fish Forum (CALFED Ops)
  - ❖ DCC experiments ➔ water quality impacts ➔ water supply impacts
  - ❖ Roe Island X2 trigger ➔ Folsom releases ➔ American River fish spawning impacts
  - ❖ CVPIA Section 3406(b)(2) issues [*800 TAF*]
- California Urban Water Agencies
- Association of California Water Agencies
  - ❖ Blueprint for California Water (2005)
- CWEMF (formerly BDMF)

Do You Remember When?







Contact Information

Richard A. Denton

Richard Denton & Associates

Water Resources Engineering

Oakland, CA 94611

Email: rdenton06@comcast.net