Estimating population level effects in Delta

Delta smelt, salmon, X2 species

Direct and indirect mortality

Conclusions

- Population level effects of exports can be estimated for delta smelt, salmon, and X2 species
- Estimates of such effects for delta smelt would require additional modeling, costing in the range of $350-400K/yr.
- For salmon, estimates of indirect mortality population effects have considerable uncertainty.
- **Population effect estimates could have considerable effect on SDFF decisions.**

Population level effects delta smelt, direct mortality

Current method: Problems

- Sampling for delta smelt not efficient for all life stages entrained
  - No sampling for larvae
  - 20 mm sampling, smaller life stages not caught
- Stations not located to best determine smelt density in exported water
- Salvage efficiency differs from sampling efficiency--not comparable

Kimmerer method

- For each smelt survey, estimate fractional entrainment mortality (FEM)

  = smelt entrained per smelt in Bay-Delta
- Graph FEM for each survey
- Interpolate between surveys for daily estimates of FEM
- Sum daily FEMs for total over period of interest (including entire year)

Kimmerer method

estimating fractional entrainment mortality

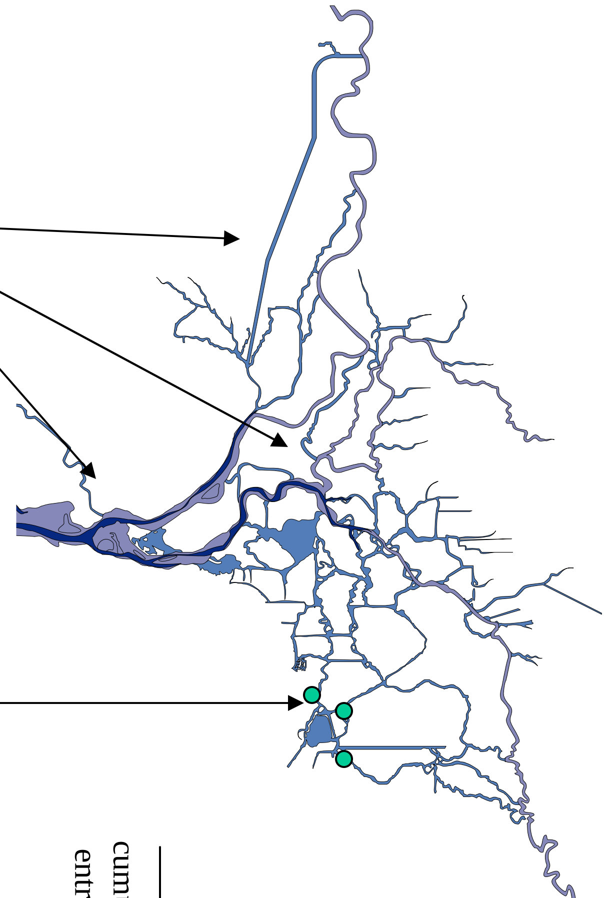
- From stations near pumps, total smelt caught / water passing through nets

  = smelt density in exported water
- Density (smelt/AF) x Export rate (AF/day

  = smelt entrained/day
- From all stations, estimate total smelt in system (various methods)
- For each survey, divide smelt entrained/day by total smelt = FEM

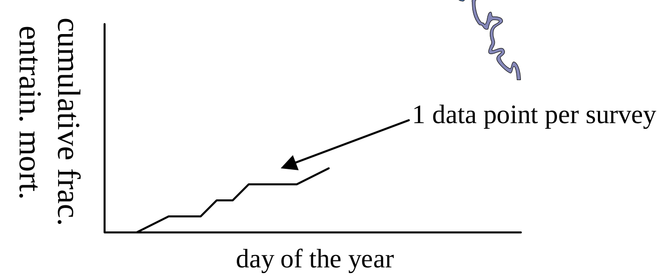
fractional entrainment mortality

Samples for
population
estimate,
Smelt present/day



Samples for density
in exported water
Density*export rate
=flux (smelt/day)

(Smelt/day)/(smelt present/day)
=fractional mortality



Advantages of Kimmerer Method

- Avoids efficiency differences, salvage vs. surveys
- Gear inefficiencies tend to cancel out (in numerator and denominator of FEM)
- Improved surveys better estimates $350-400K)
  - More stations near pumps
  - More surveys
  - Survey gear tailored to life stage
  - Larval sampling
- Produces estimate of population level effect of entrainment, esp. using Bennett proposal

Using Kimmerer method to manage export curtailments

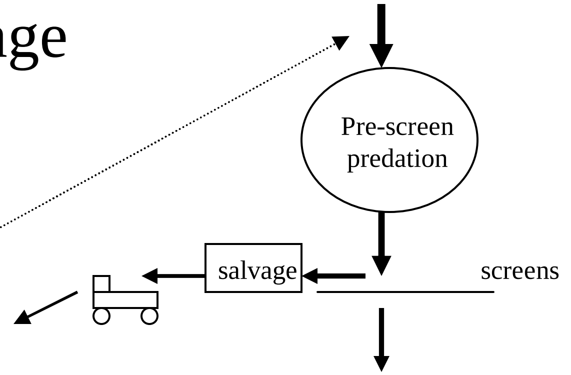
- Track cumulative FEM
- Use Particle Tracking Model and Herbold methods to predict and avoid high FEM events
- Manage exports to stay below a desired FEM
- Use cumulative FEM to adjust VAMP export rate

Disadvantages of Kimmerer Method

- Estimates of total smelt per survey difficult to achieve accurately (where in water column do they reside?)
- Expense of more sampling and more efficient gear (exporter funding?)
- Need period of transition to test against current system
- Gaming would be desirable

Population level effects salmon, direct mortality

- Estimate direct losses starting with salvage
  - Back-calculate fish approaching screens
    - Number salvaged
    - Species-size-approach velocity
    - Screening efficiency
  - Back-calculate fish approaching facilities
    - Number approaching screens
    - Pre-screen predation rate
  - Estimate number returned to Delta
    - Number salvaged
    - Trucking & handling loss rate
  - Estimate loss =
    Fish approaching screens - number returned to Delta
- Divide direct losses by number of smolts
  - Entering Delta or
  - Leaving Delta



Population level effects salmon, indirect mortality

- From CWT experiments

  Survival = f(export rate, XCG closure, etc.)

- N smolts enter Delta, S*N survive to Chipps
- Popn effect of export curtailment =

  Change in survivors/original survivors =

  $(S_2*N - S_1*N)/S_1*N = (S_2 - S_1)/S_1$

- Estimate S_2 & S_1 from correlation equations

Population level effects salmon, indirect mortality

- Estimates are “expected” values, based on past CWT experiments, not “real time” as with winter run direct mortality. Can estimate uncertainty.
- Must estimate fraction of outmigrants affected by action ??
- Three correlations
  Sac. fall run: Newman-Rice and Newman using older CWT data
  Sac. Late fall, winter, spring: Brandes using Dec-Jan data
  SJR fall run: Brandes using VAMP and selected pre-VAMP data
- Correlations with export rate are questionable for now
- Indirect mortality estimates include direct mortality (indirect estimates must be > direct)

Population level effects X2 species

- Same principle as for salmon
- Correlations, abundance vs. X2 (or Delta outflow)

  $A = f(Q_{out})$
- For any change in outflow, popn effect =

  $(A_2\text{-}A_1)/A_1$, estimate A from correlations
- Outflow is averaged over months, requires outflow prediction for real time decisions
- Also "expected" rather than real time effect, and uncertainty can be estimated

Cautions

- All of these estimates are fractional population changes of <u>affected life stage.</u>
- Implicitly assume that all effects on later life stages are equal on % basis; i.e., 20% more smolts = 20% more adults; therefore, conservative.
- Assume no density dependence (e.g., 20% more smolts = 2% more adults), although this could be accounted for.
- If above implicit assumption is true, life stage population effects are essentially fractional adult equivalent effects.

On the other hand

- Fractional life stage population effects can be useful for comparisons, (e.g., export curtailments vs. harvest regs) especially if differences between actions are large (x10 or x100).
- “All other things being equal” is implicit in how data on early life stage effects are now used.