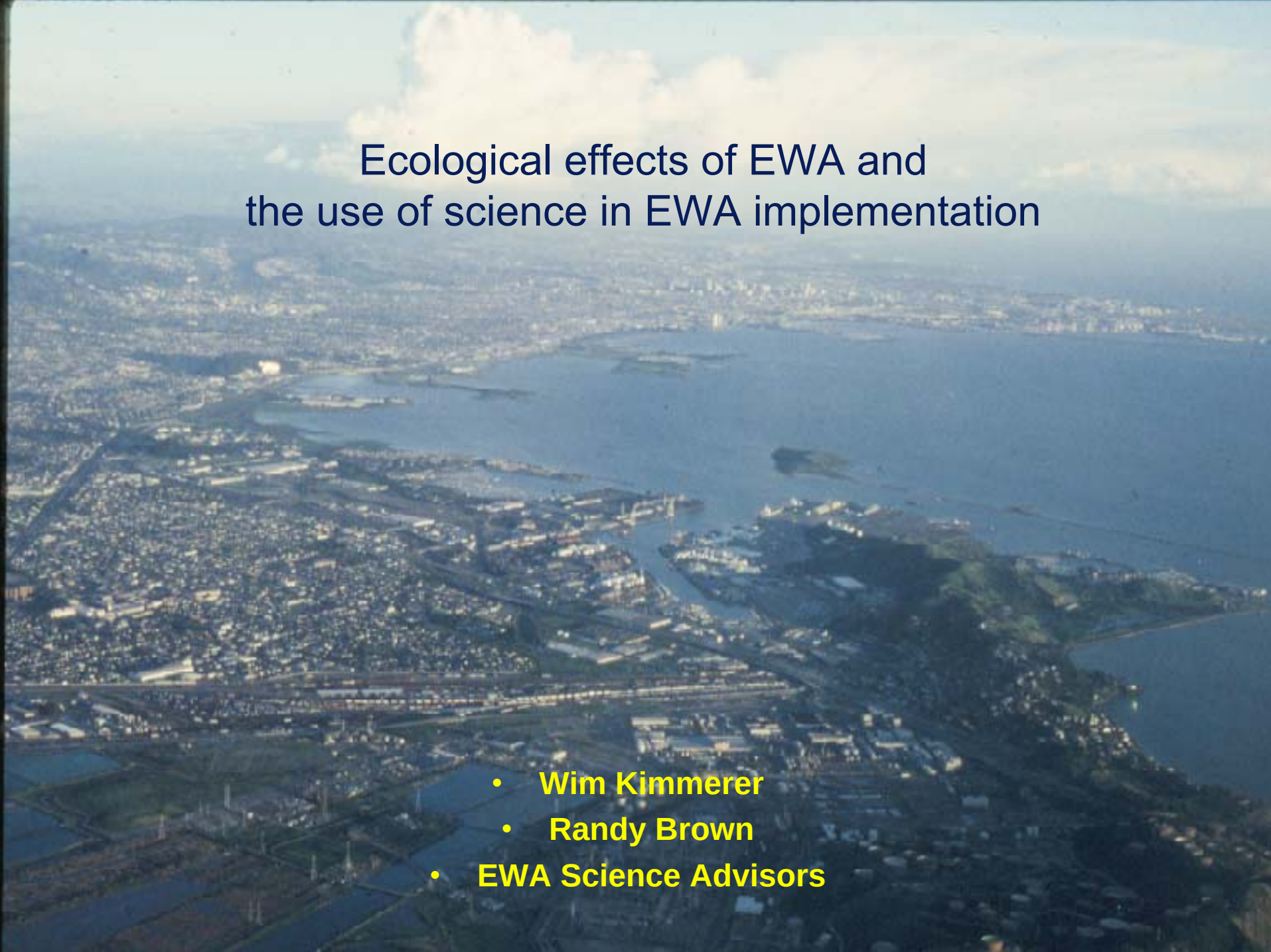

Ecological effects of EWA and the use of science in EWA implementation

- **Wim Kimmerer**
- **Randy Brown**
- **EWA Science Advisors**

Outline

- EWA purpose and goals
- Current state of science in the EWA
- Future of science in EWA
- A case study of winter-run salmon

EWA purpose and incremental benefits

- Purpose: to protect and restore listed species
- EWA is part of a package
  - Agency belief that package will work
- Need to examine incremental benefits
  - Maximize effectiveness
  - Consider and compare alternative actions
  - Clear analysis of benefits for future decisions
  - Pressure by those who pay
- Can be done if effects are independent
  - Percent gain in survival
  - Better for salmon than delta smelt

Is EWA a science-based program?

- Scientific thought pervades EWA
  - The need for an EWA
  - Sizing of EWA
  - Allocation of assets
  - Some efforts to understand benefits
  - Conceptual models (theories) mostly stated
- Scientific advances prompted by EWA
  - Revision of Juvenile Production Estimate
  - Relationship to Juvenile Production Index
  - Salmon life cycle modeling
  - Life history and vulnerability of delta smelt

Is EWA a science-based program?

What are the elements of a scientific approach?

- Develop theories about how things work
  - Testable hypotheses
  - Quantitative predictions
  - Need for parameter values
- Gather data to test hypotheses/answer questions
  - Experiment, monitoring data, model runs,…
  - Formal analysis
- Write up the results in a formal paper
- Obtain peer review
  - Self-correcting aspect of science
- Publish the results

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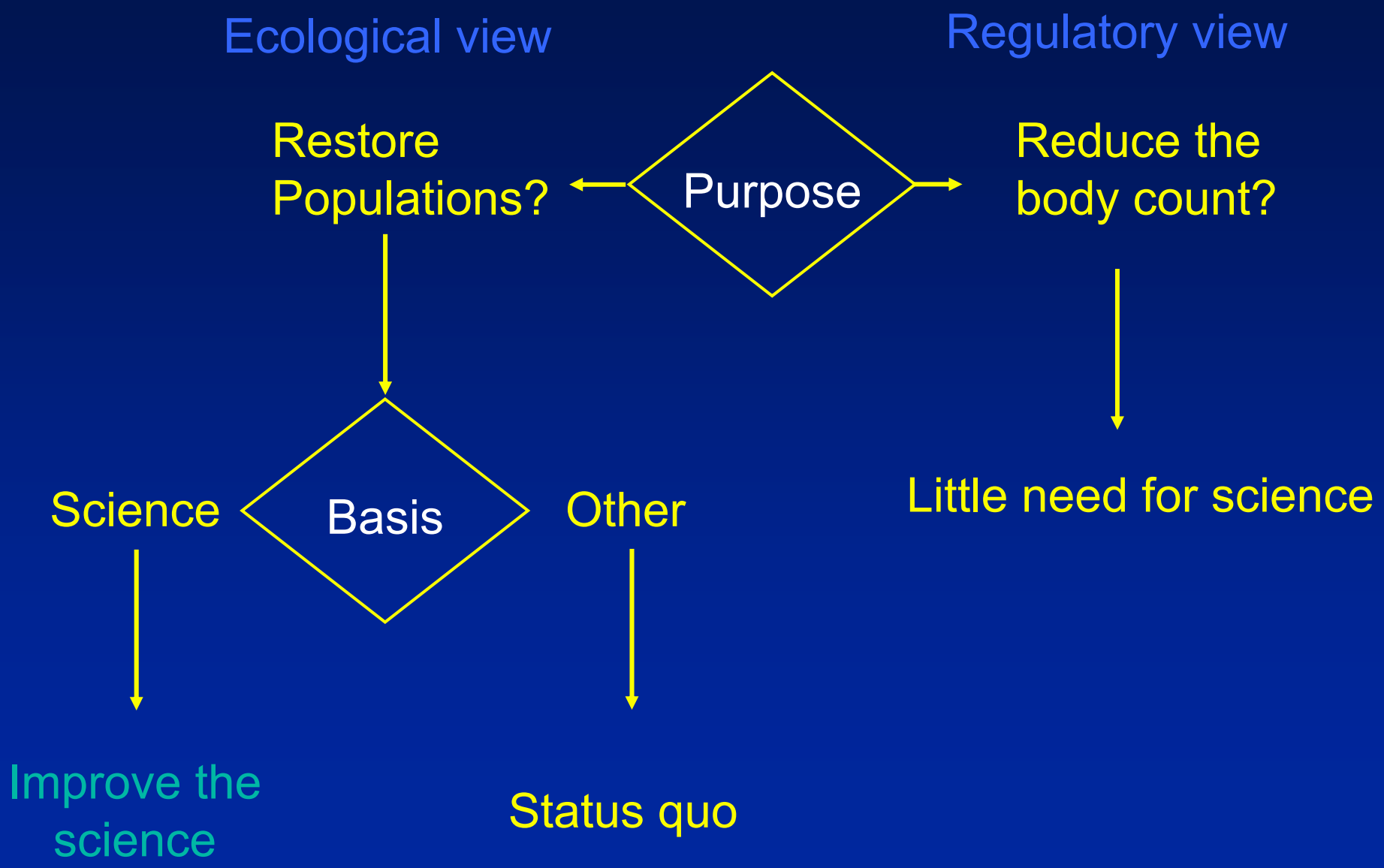
At this point it is just gossip

Can Adaptive Management be applied?

- Terminology
  - Adaptive Management ≠ managing adaptively
- Requirements
  - Explicit statements of hypotheses / models
  - Predictions of outcomes
  - Formal comparison to data
  - Refinement of models, practices
  - Periodic formal evaluation
- Opportunities
  - Actions for delta smelt ?

Science for a long-term EWA



If the basis is science…

we need to get serious about it!

- Integrate science into EWA
- Plan and funding for research and monitoring
- Minimum standards for statistical reporting
- Program for formal peer review of results
- Plan for publishing basis for actions

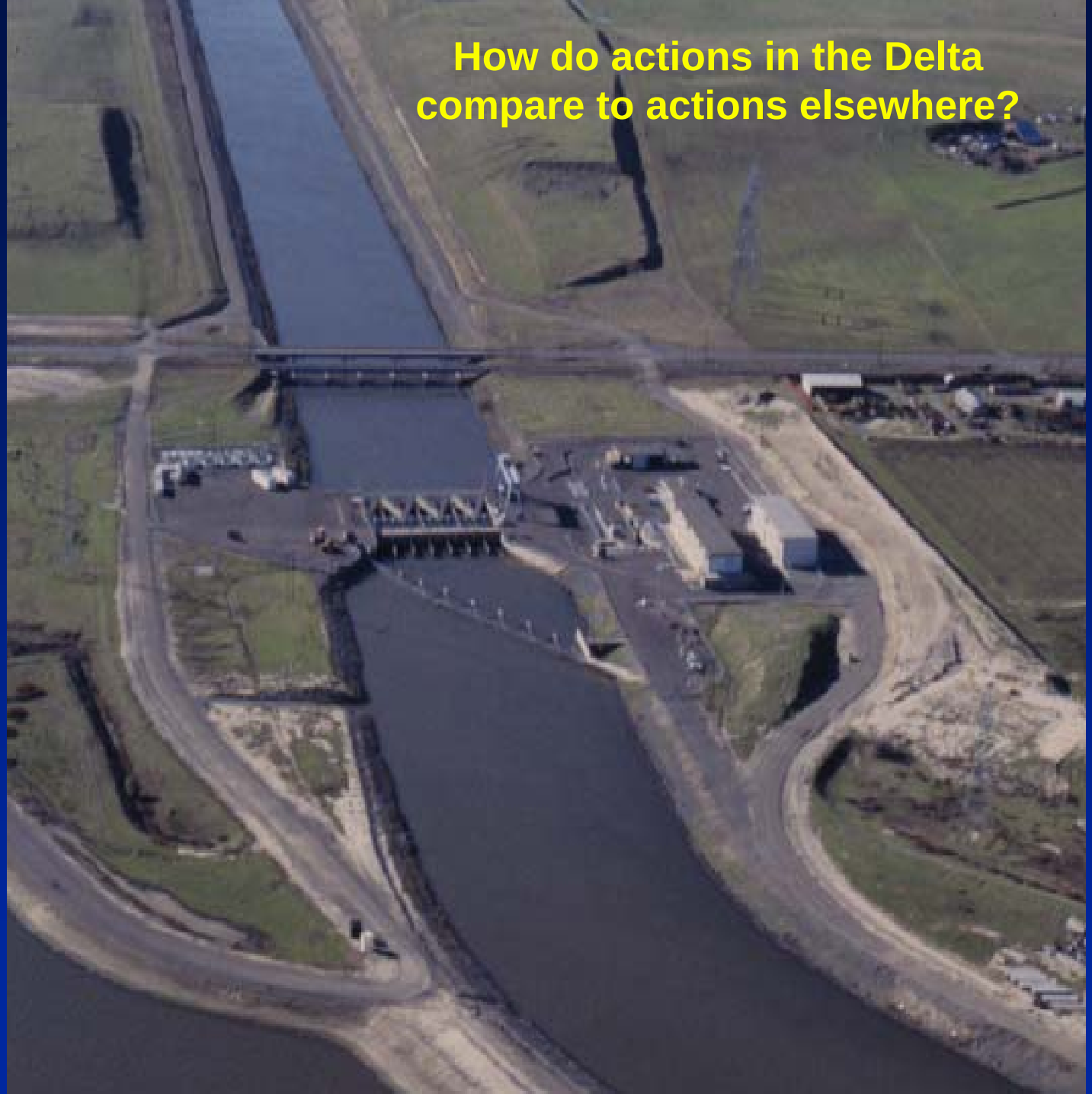
Science in the long-term EWA

- Focus on population-level effects
- Focus on alternative strategies
- Develop priorities with a 5- to 10-year horizon
- Continue developing simulation models
  - Framework for comparing actions
  - Method for examining alternative futures
- Consider Adaptive Management for EWA

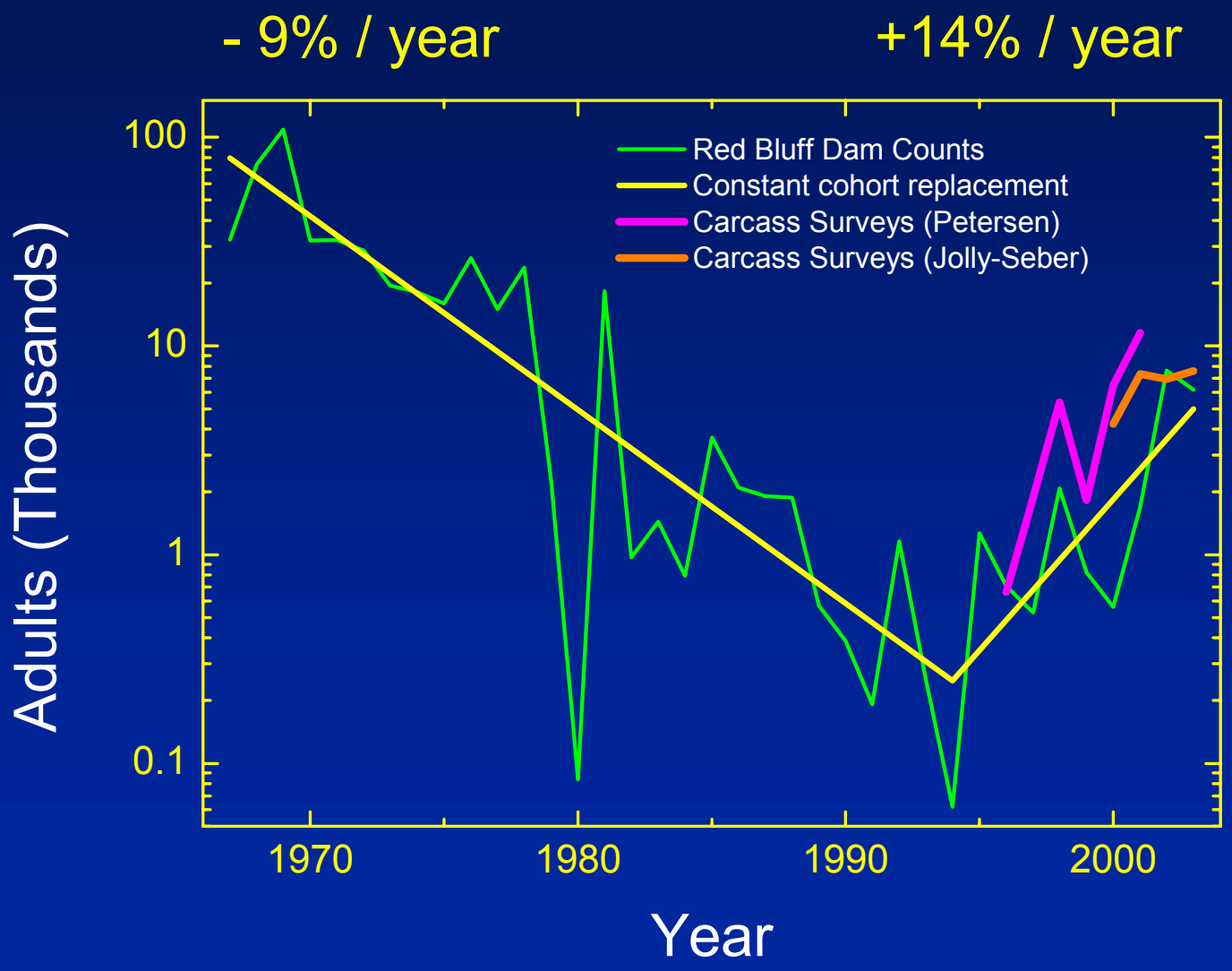
Summary so far

- Science is a significant part of EWA
- Science within EWA is incomplete
- Long-term EWA would need a firmer basis

Now for a stab at population dynamics of winter-run salmon…

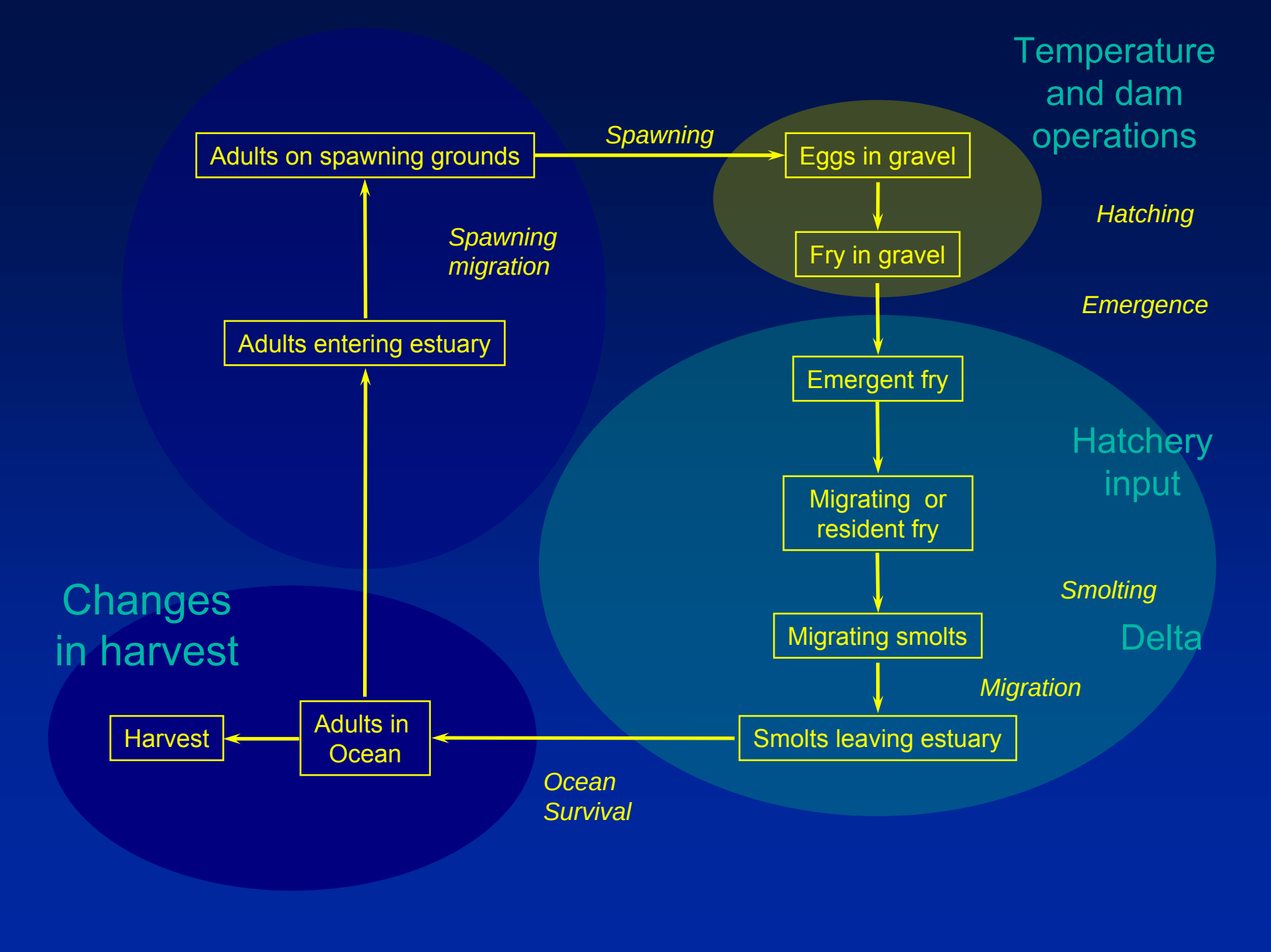

How do actions in the Delta
compare to actions elsewhere?

Time series of winter run escapement



Why did the cohort replacement rate change from 75% to 148%?

Source:
Snider et al. 1998-2002, CDFG reports


Temperature and dam operations
Adults on spawning grounds
Spawning
Eggs in gravel
Hatching
Fry in gravel
Spawning migration
Emergence
Adults entering estuary
Emergent fry
Hatchery input
Migrating or resident fry
Smolting
Migrating smolts
Delta
Changes in harvest
Migration
Harvest
Adults in Ocean
Smolts leaving estuary
Ocean Survival

A simple exploratory model of winter run survival

$$N_{\text{📖}3} = N_{\text{📖}0}\ F\ S_1\ S_2\ S_3\ S_4\ S_5 \ldots$$

$N_{\text{📖}0,\ 3}$	Female population at age 0 or 3
F	Average fecundity
S_i	Survival through life stage or event i

Assumptions

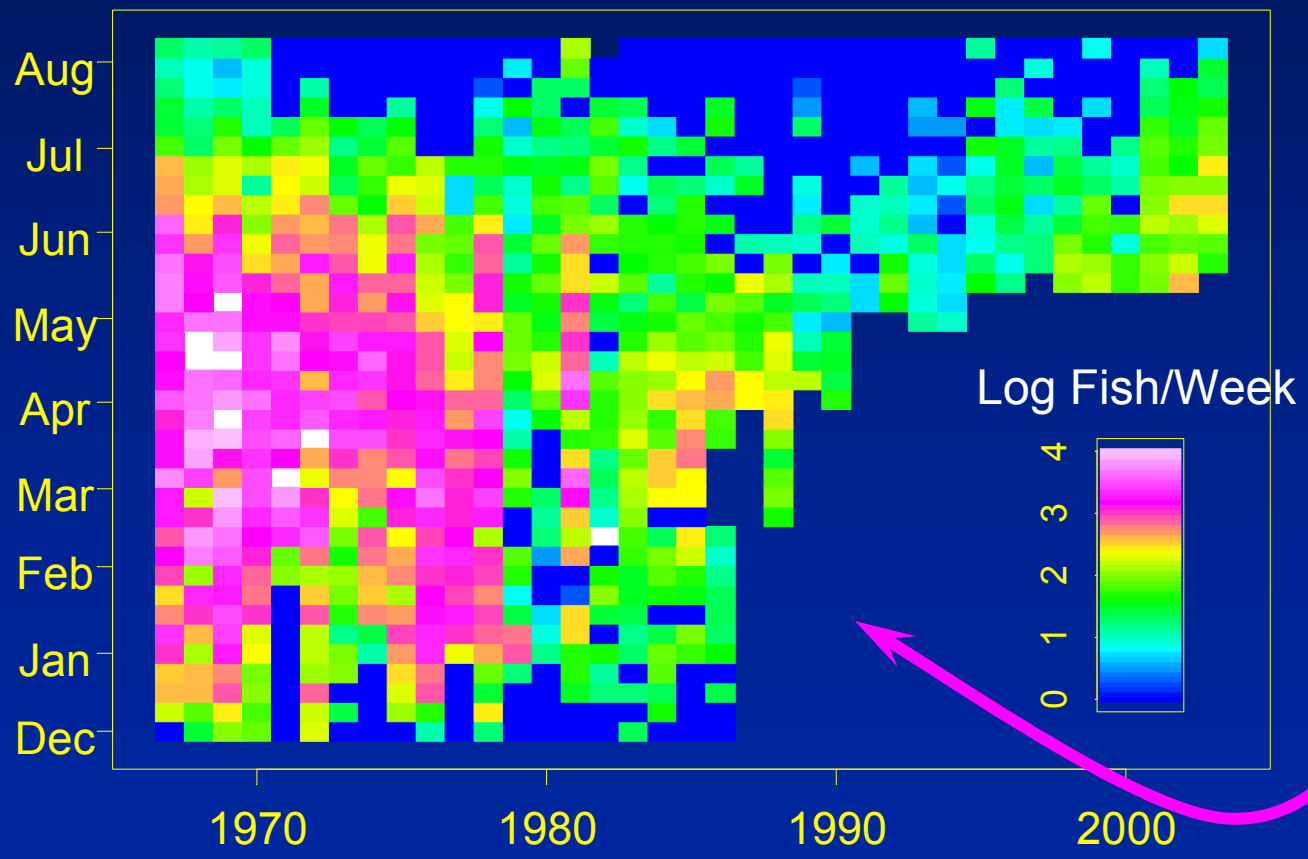
- No density dependence
- All reproduction is at age 3
- Sex ratio is constant
- Survival fractions are independent

A simple exploratory model of winter run survival

$$N_{\text{📖}3} = (N_{\text{📖}0}\, FS_{Egg-RBDD} + H)\, S_T\, S_F\, S_o$$

$N_{\text{📖}0}FS_{Egg\text{ - }RBDD}$ = Juvenile production index
H = Hatchery production
S_T = Survival: high temperature
S_F = Survival: fishing
S_O = Survival: Other
(can be treated as a single unknown parameter)

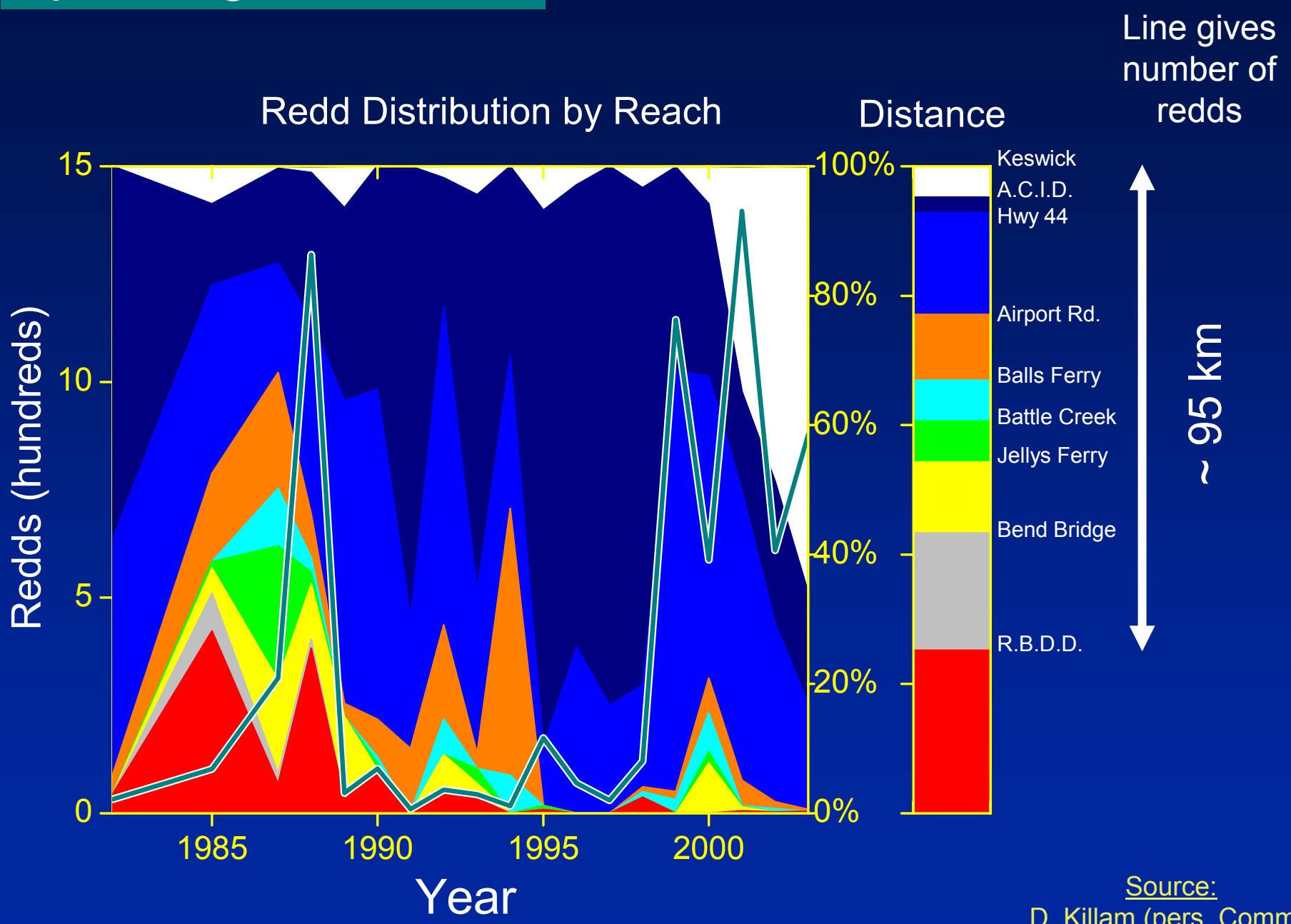
Migration Timing at Red Bluff Diversion Dam



RBDD gates out during migration = No blockage

Source:
D. Killam, CDFG

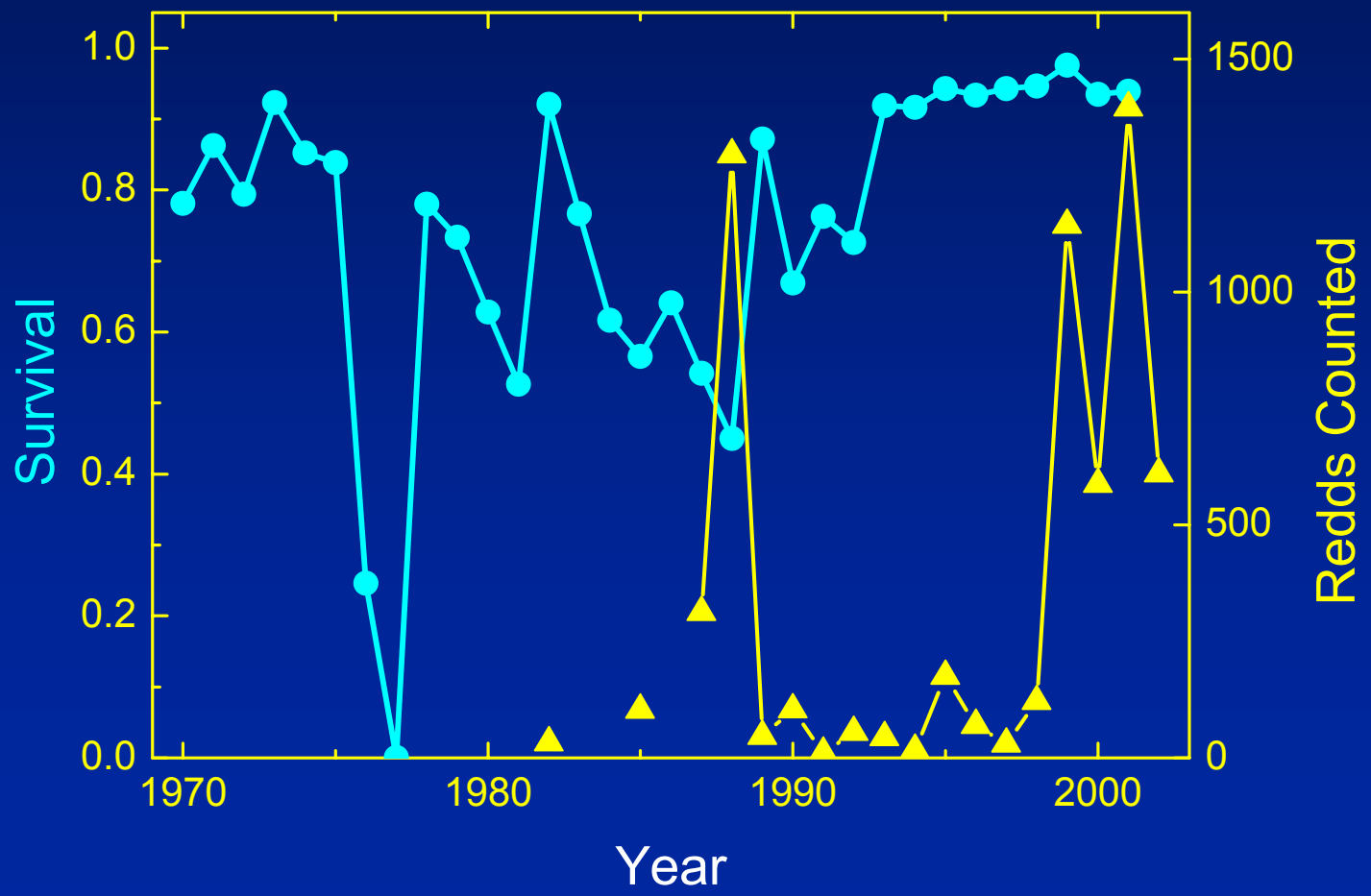
Spawning Distribution



Source:
D. Killam (pers. Comm.)

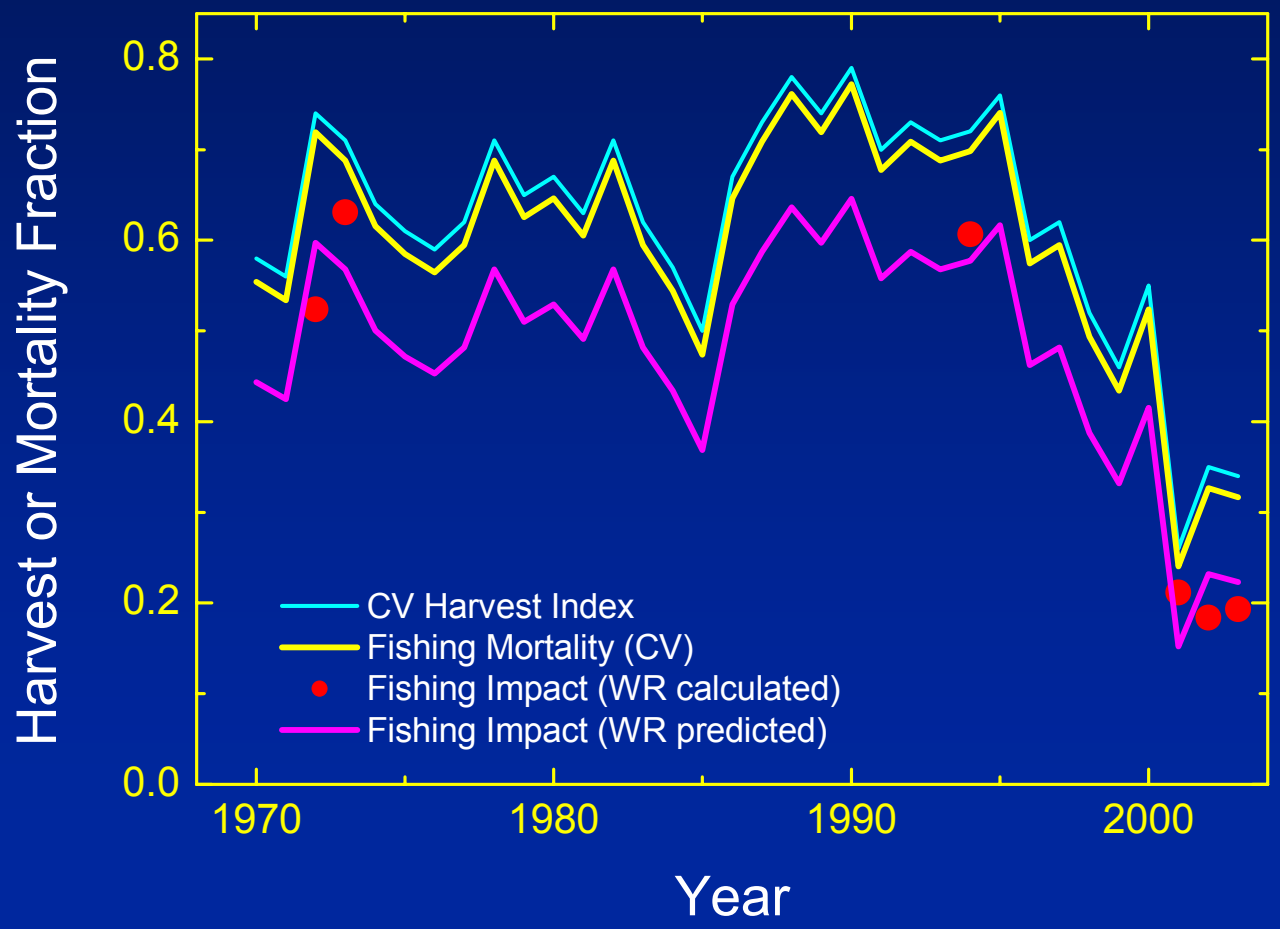
Temperature effects on survival

Temperature effects based on spawning location



Source:
D. Killam CDFG
USGS, DWR

Ocean Harvest

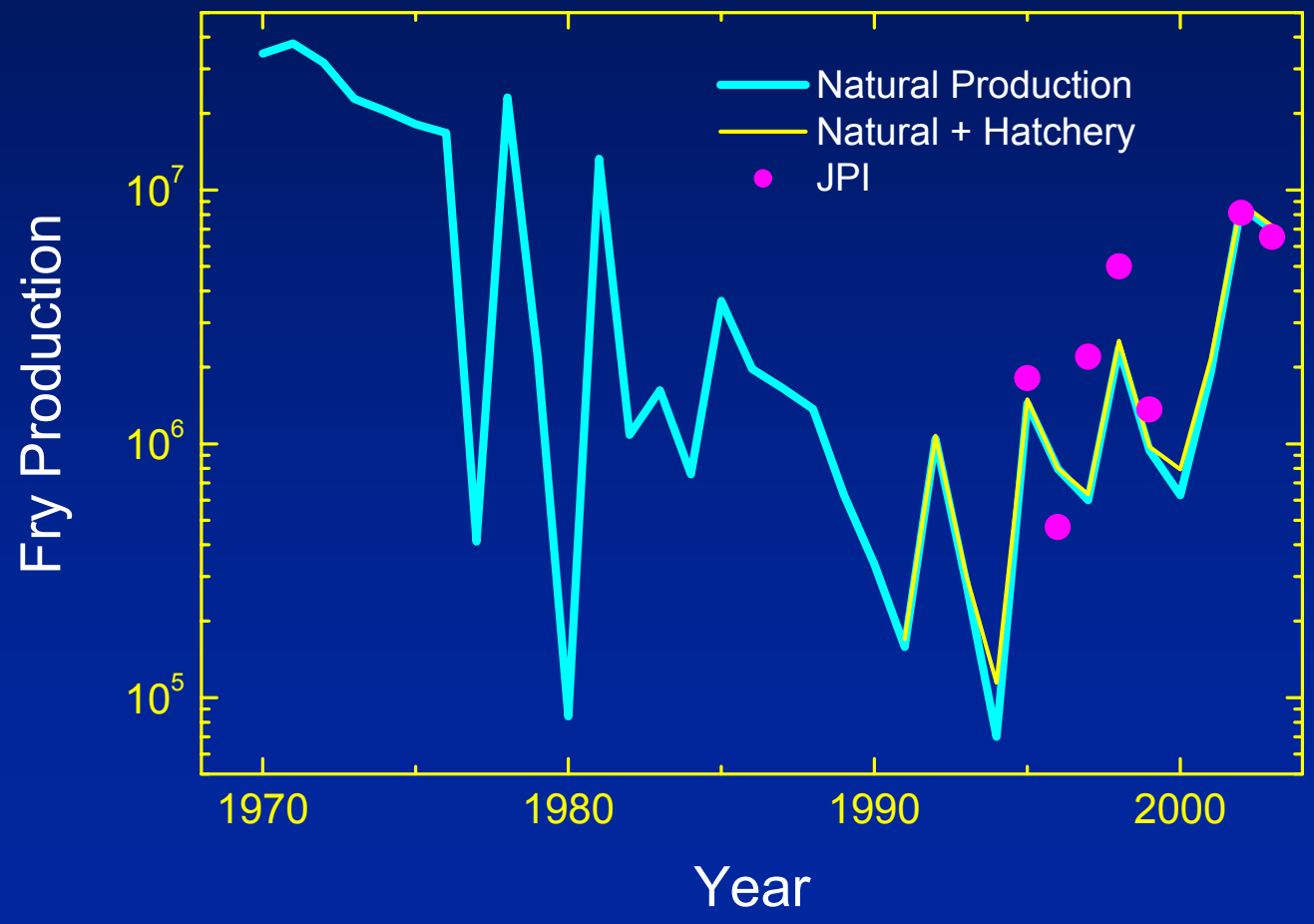


Harvest rate of winter-run tracks that of all Central Valley stocks

Both have declined substantially in recent years

Source:
PFMC, Grover et al. 2004 (report)

Juvenile Production

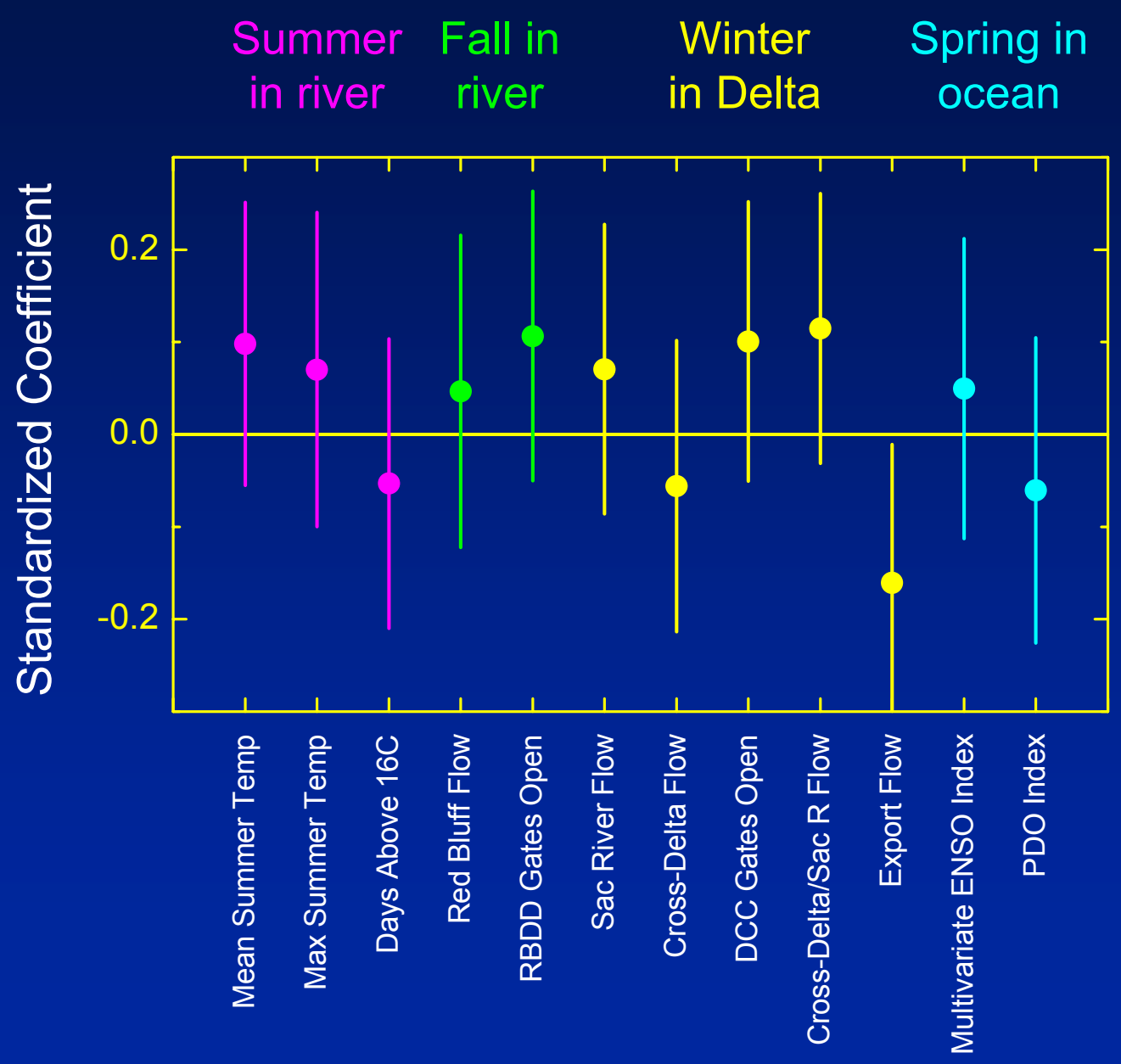


Natural production calculated assuming 1200 fry per adult

Juvenile Production Index (JPI) includes natural production only

Source:
Model estimate, Gaines and Poytress 2004 and agency reports

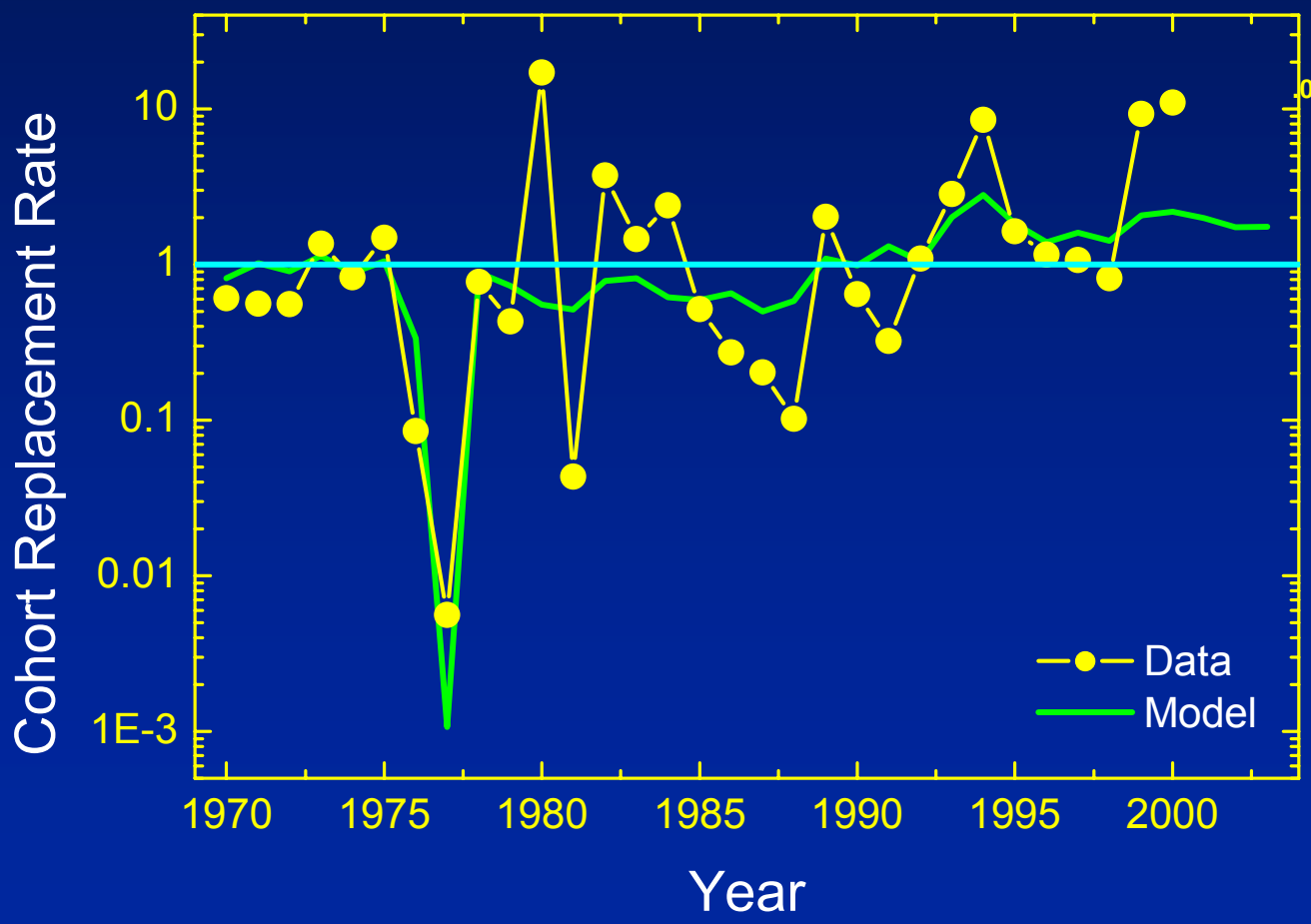
Environmental variables have little effect

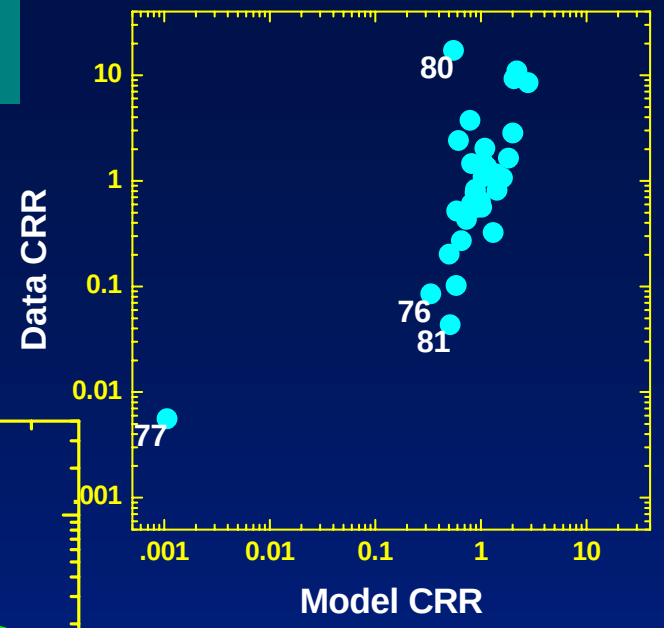


Regression parameters with 90% confidence limits

Positive = expected direction of effect

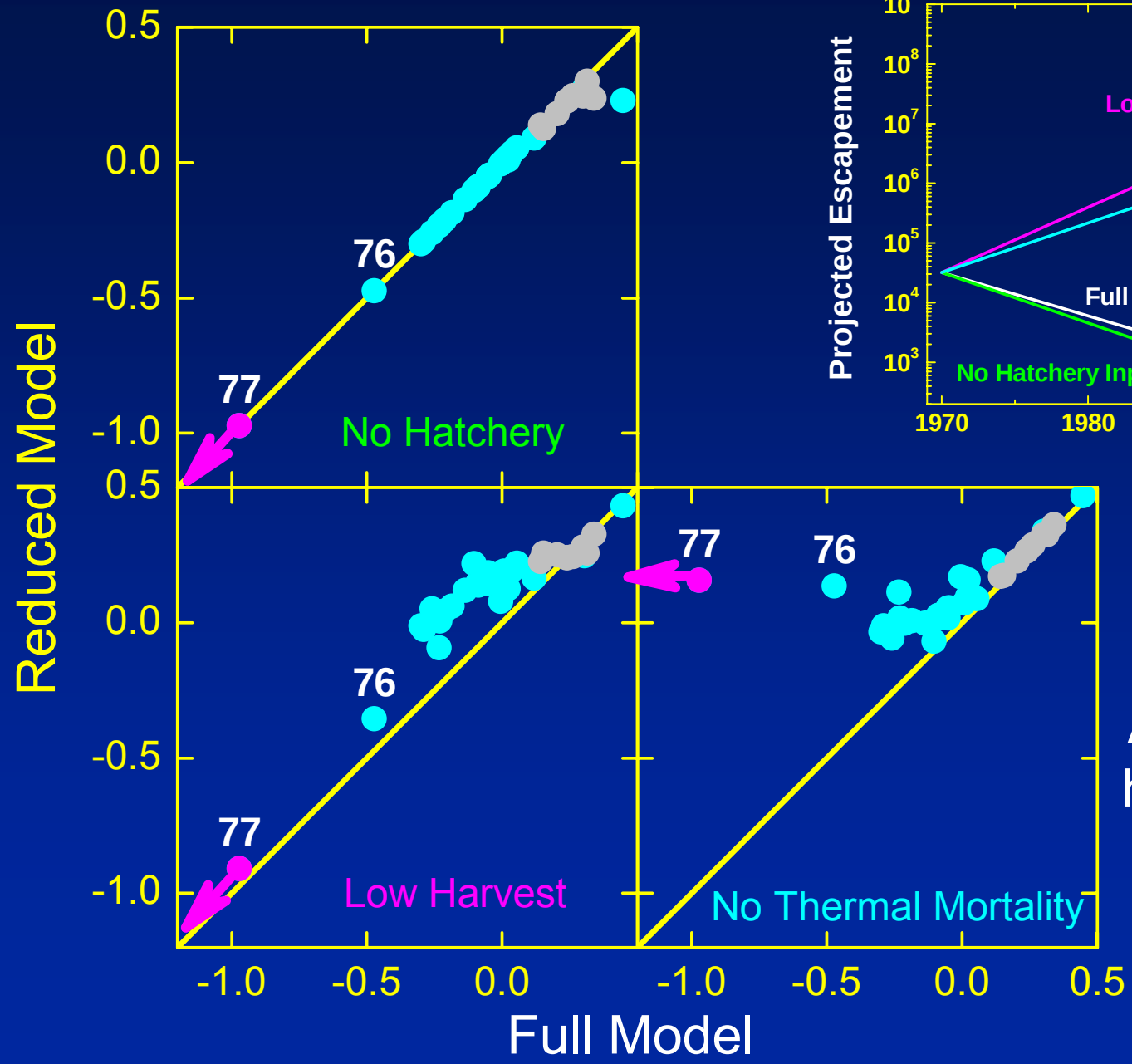
Model of winter run escapement

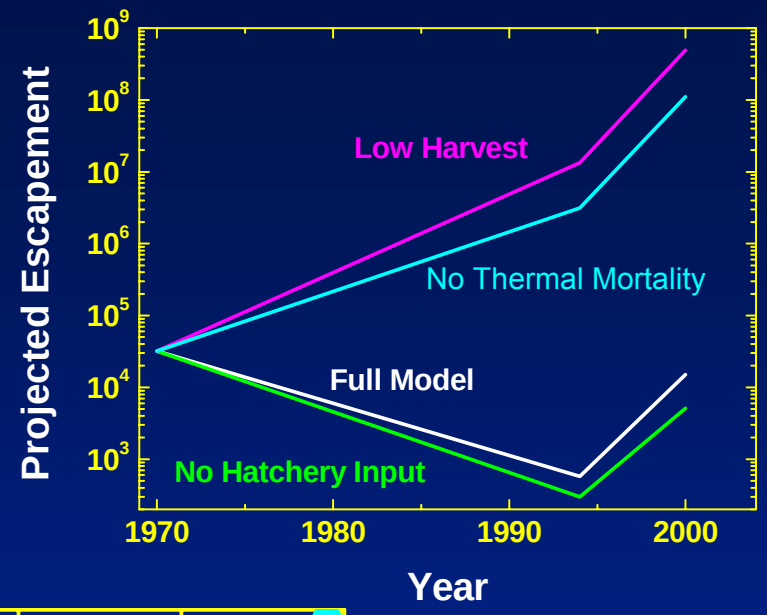




Agreement is fair: note 76-77 low values, and long-term trend.

Model projections





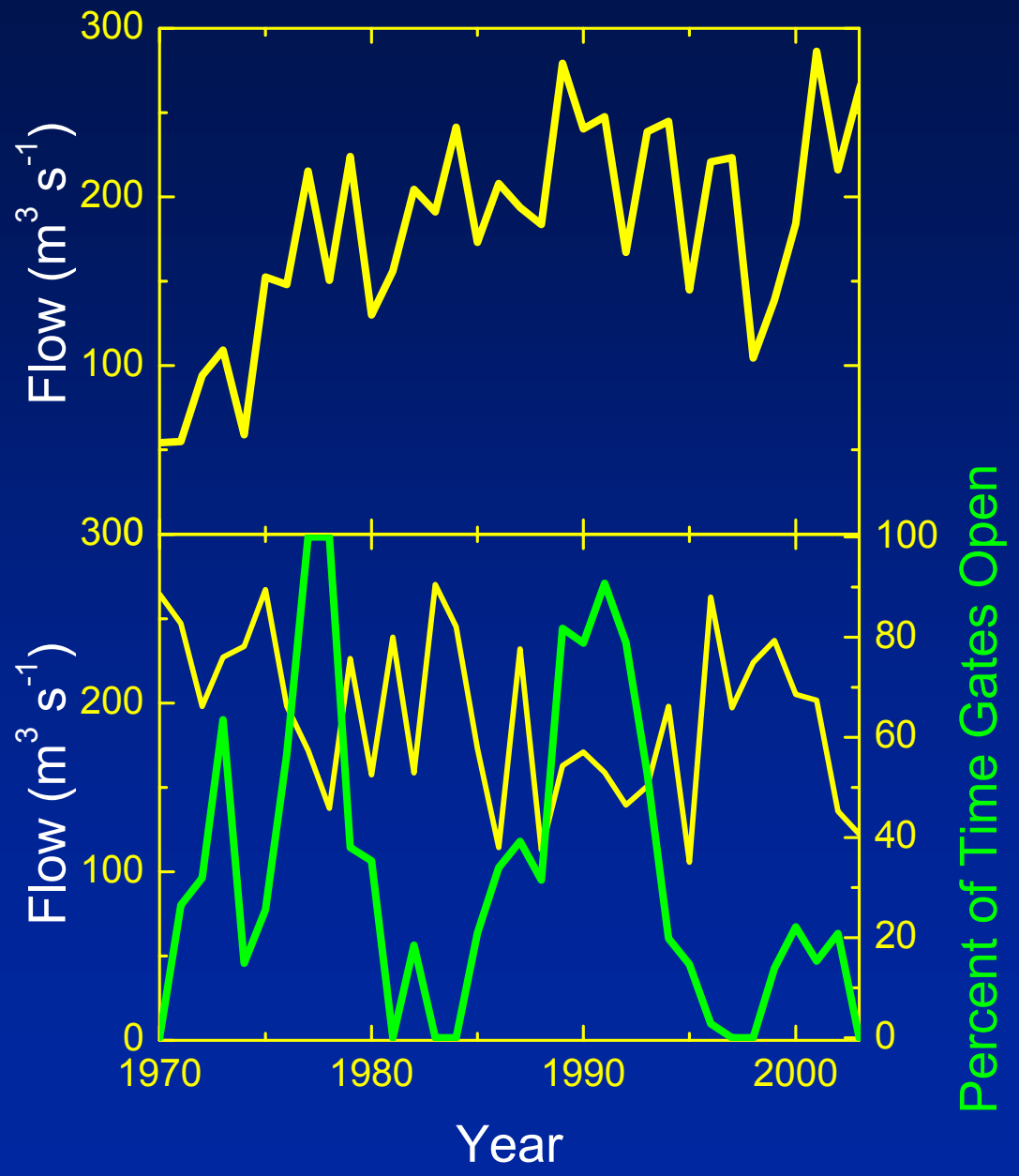
All three factors had an effect on the model.

Summary: Winter-run model

- Preliminary results
- Strong effects of harvest and temperature (?)
- Weak effect of hatchery
- No effect of other environmental variables

Thanks to: Jerry Boles, Pat Brandes, Steve Cramer, Tom Haltom, Doug Killam, Bill Poytress, and Ryan Martin

Flow conditions in the Delta



Time period: Dec - March

Export flow increased through late 1970s, then little change

Cross-Delta flow had a slight downward trend

Source:
Dayflow