

Population trends and the influence of restoration actions on winter-run Chinook salmon

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Summary

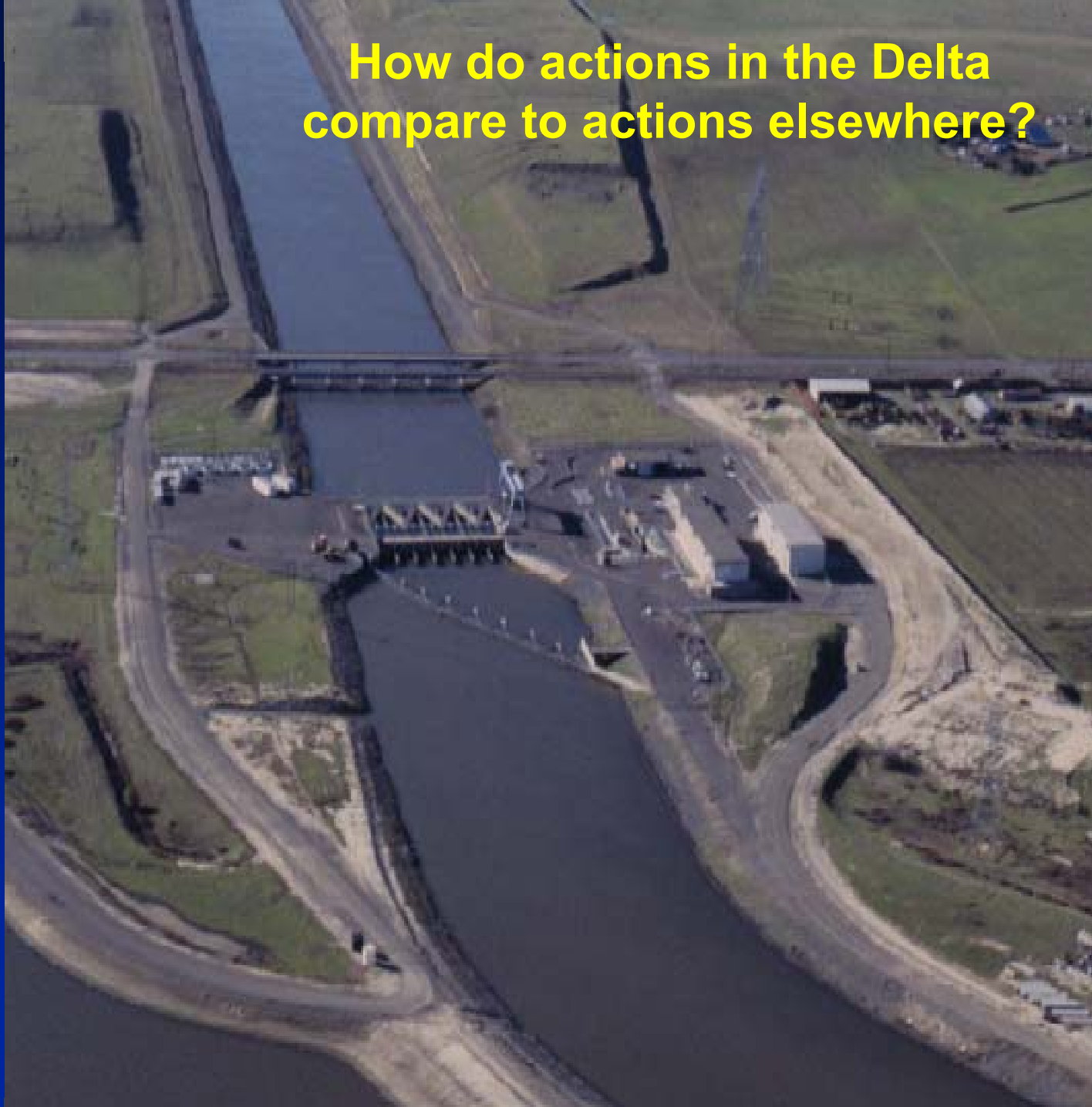
- Simple model of winter run life cycle
- Identify management-related variables
- Which have trends?
- Do these add up to the trajectory observed?



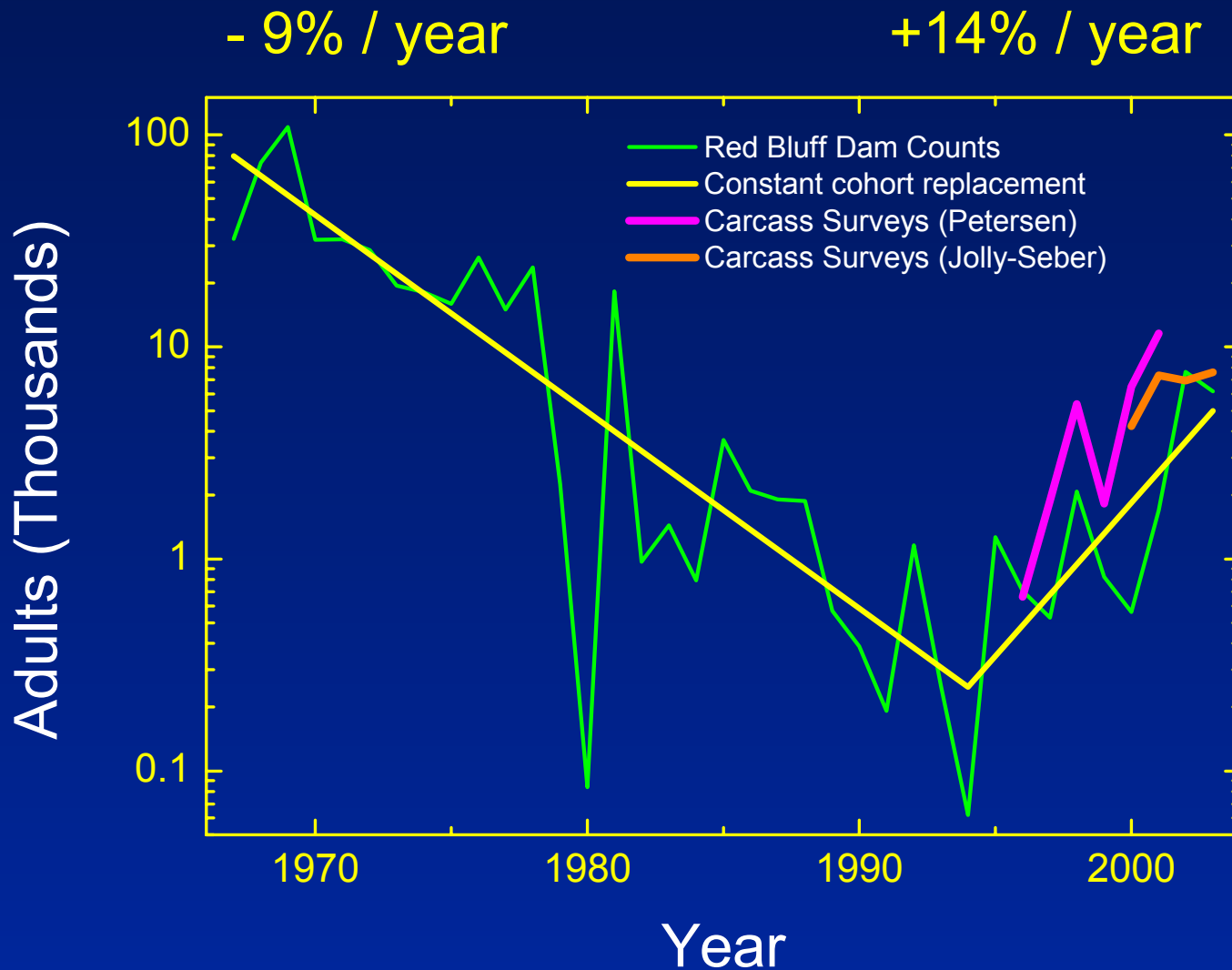
This is our perspective

Digital Map from
Dr. William Bowen
California State University
Northridge

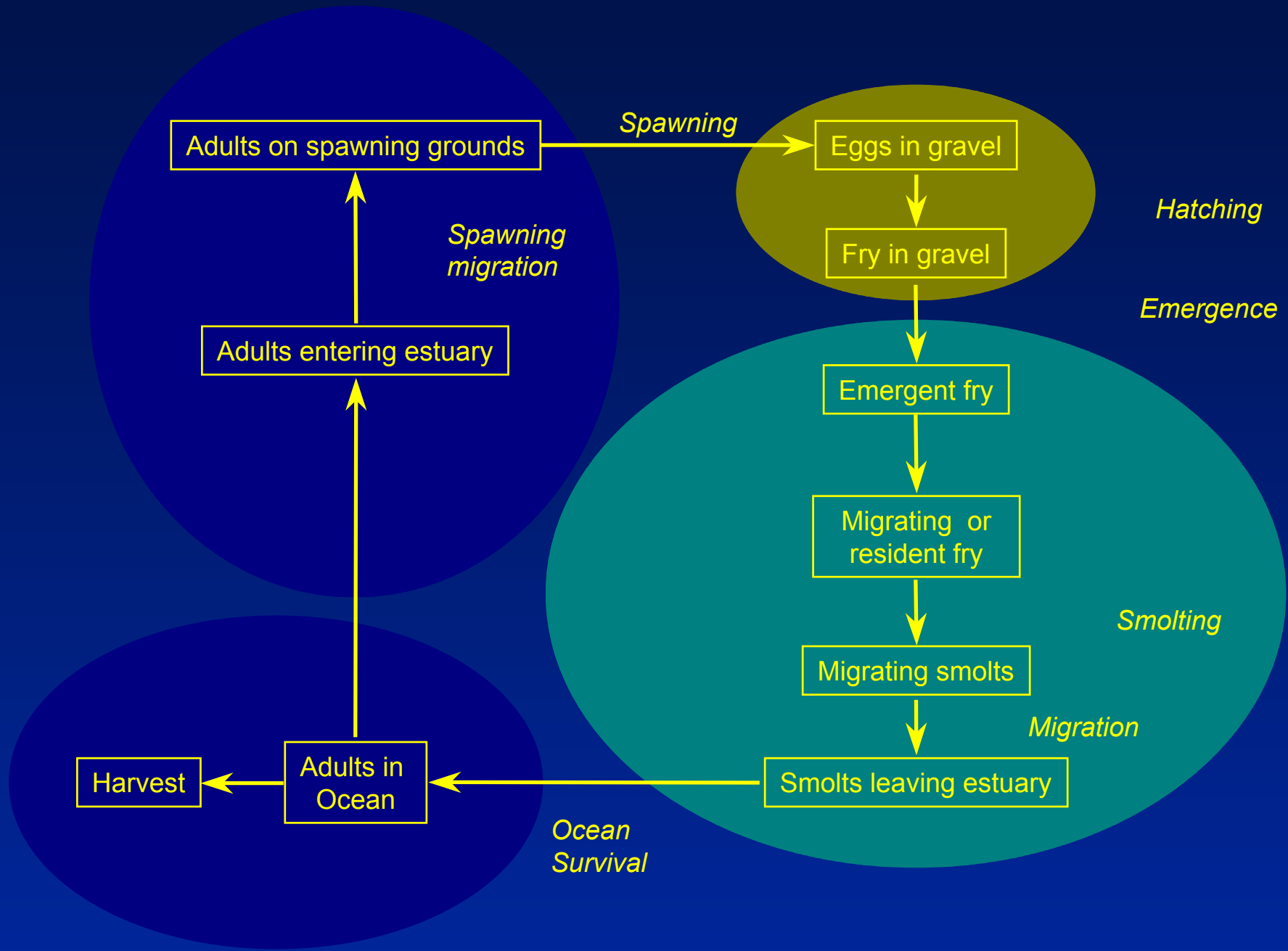
**How do actions in the Delta
compare to actions elsewhere?**

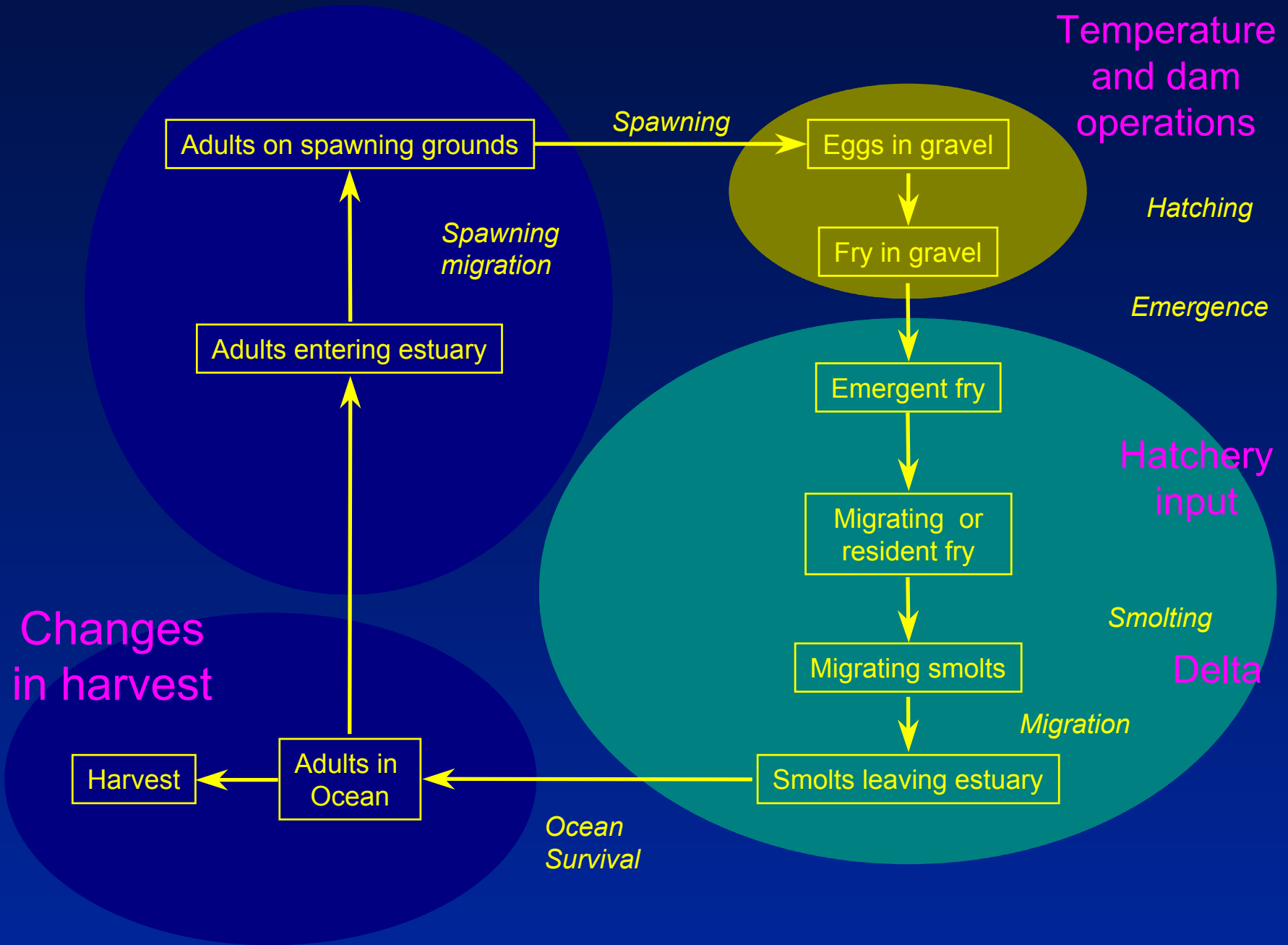


Time series of winter run escapement



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





Temperature and dam operations

Hatching

Emergence

Hatchery input

Smolting

Delta

Migration

Ocean Survival

Changes in harvest

Spawning migration

Spawning

Harvest

Adults in Ocean

Adults entering estuary

Adults on spawning grounds

Smolts leaving estuary

Migrating smolts

Migrating or resident fry

Emergent fry

Fry in gravel

Eggs in gravel

A simple exploratory model of winter run survival

$$N_{\text{book}3} = N_{\text{book}0} F S_1 S_2 S_3 S_4 S_5 \dots$$

$N_{\text{book}0, 3}$	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

$$N_{\text{book}}3 = (N_{\text{book}}0 FS_{\text{Egg} - \text{RBDD}} + H) S_T S_F S_O$$

$N_{\text{book}}0 FS_{\text{Egg} - \text{RBDD}}$ = Juvenile production index

H = Hatchery production

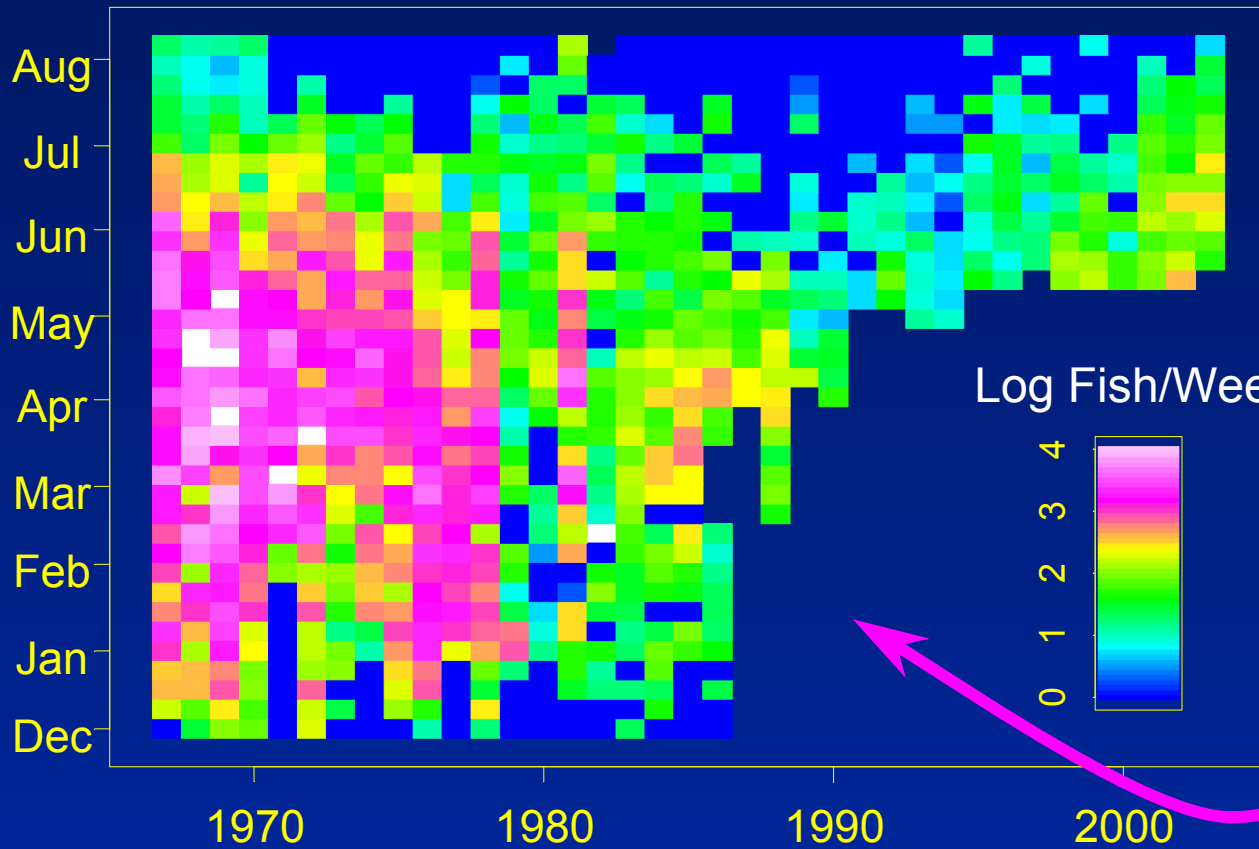
S_T = Survival: high temperature

S_F = Survival: fishing

S_O = Survival: Other

(can be treated as a single unknown parameter)

Migration Timing at Red Bluff Diversion Dam



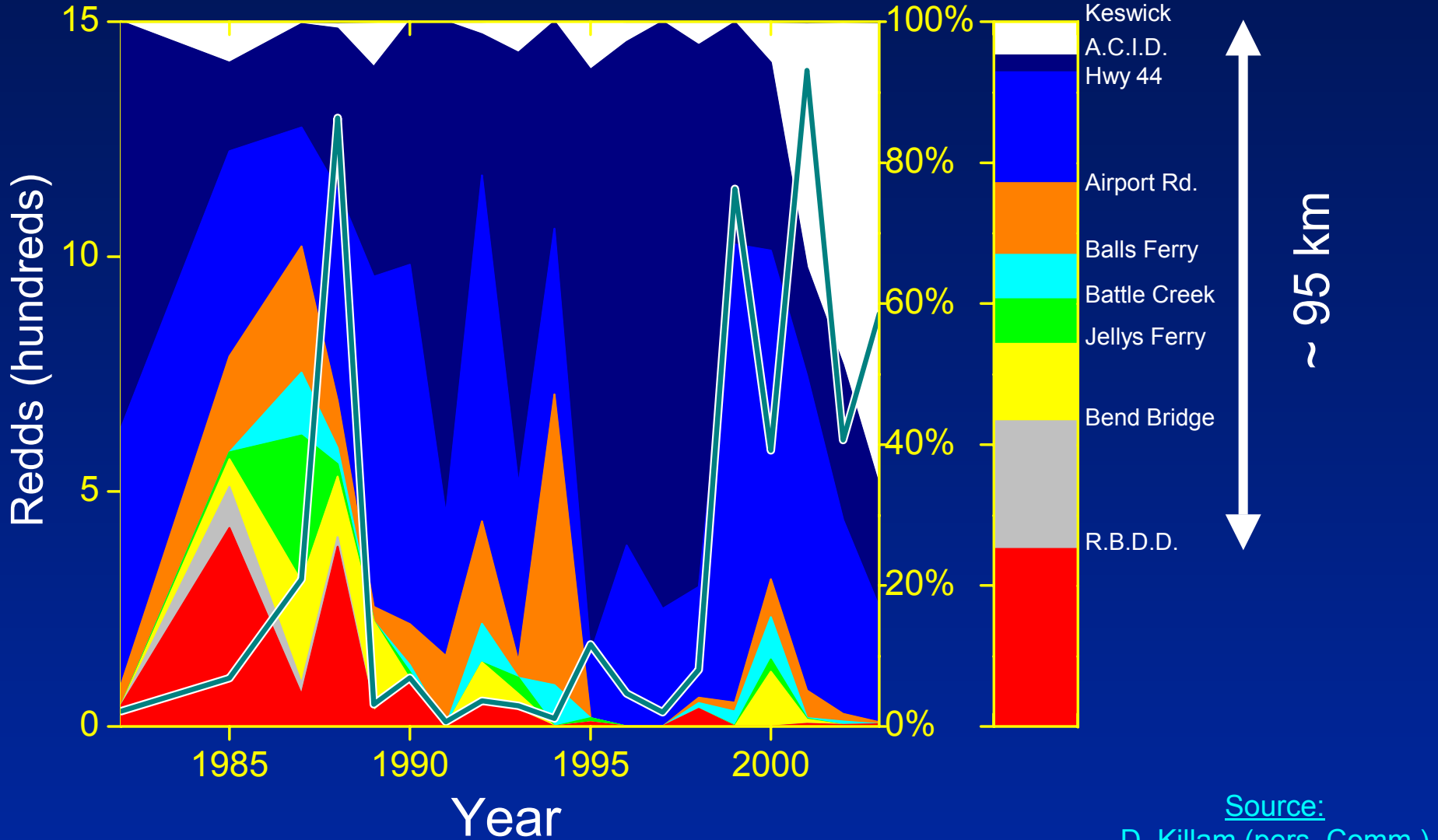
RBDD gates out during migration = No blockage

Spawning Distribution

Redd Distribution by Reach

Distance

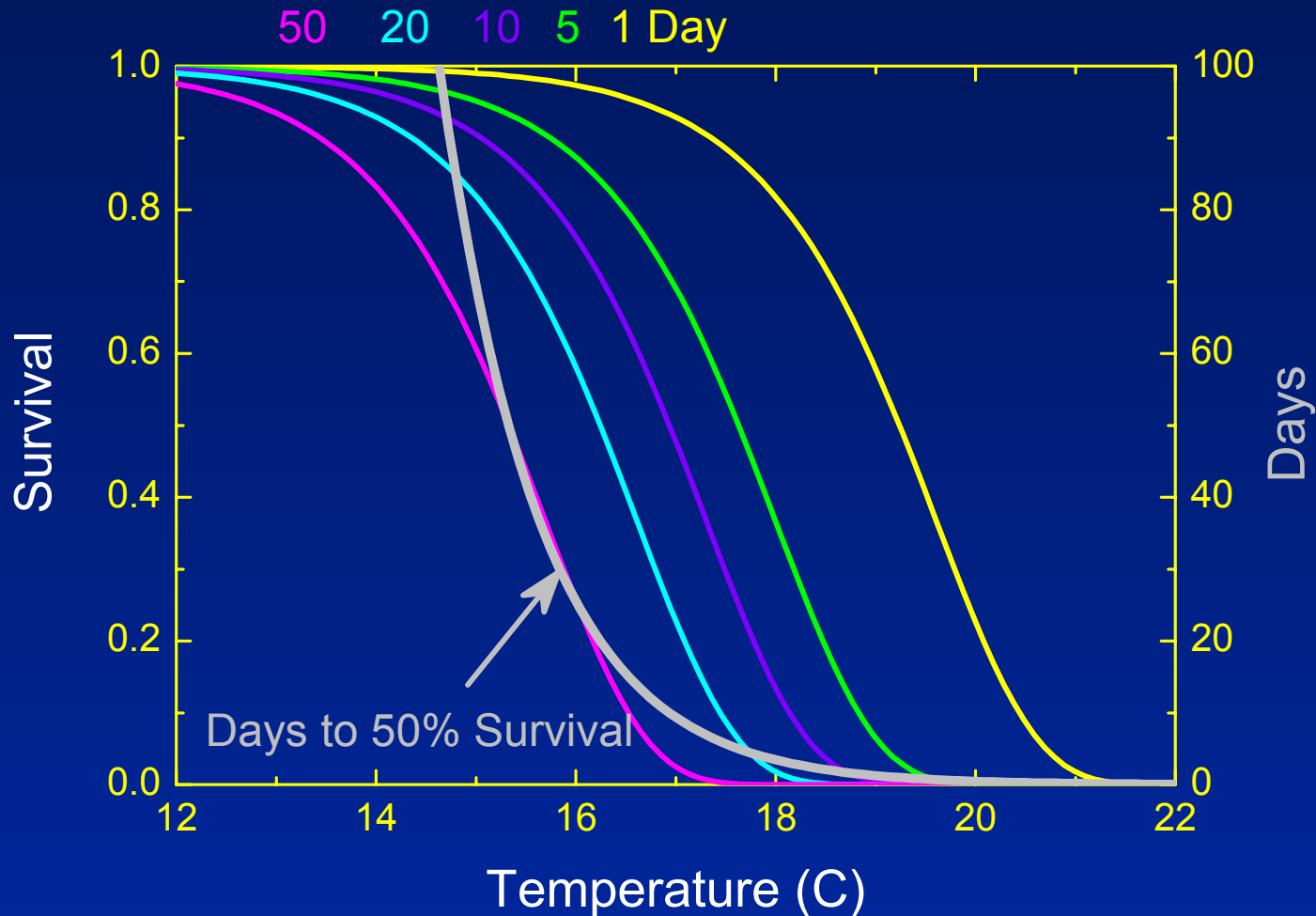
Line gives number of redds



~ 95 km

Source:
D. Killam (pers. Comm.)

Temperature survival model for eggs/alevins

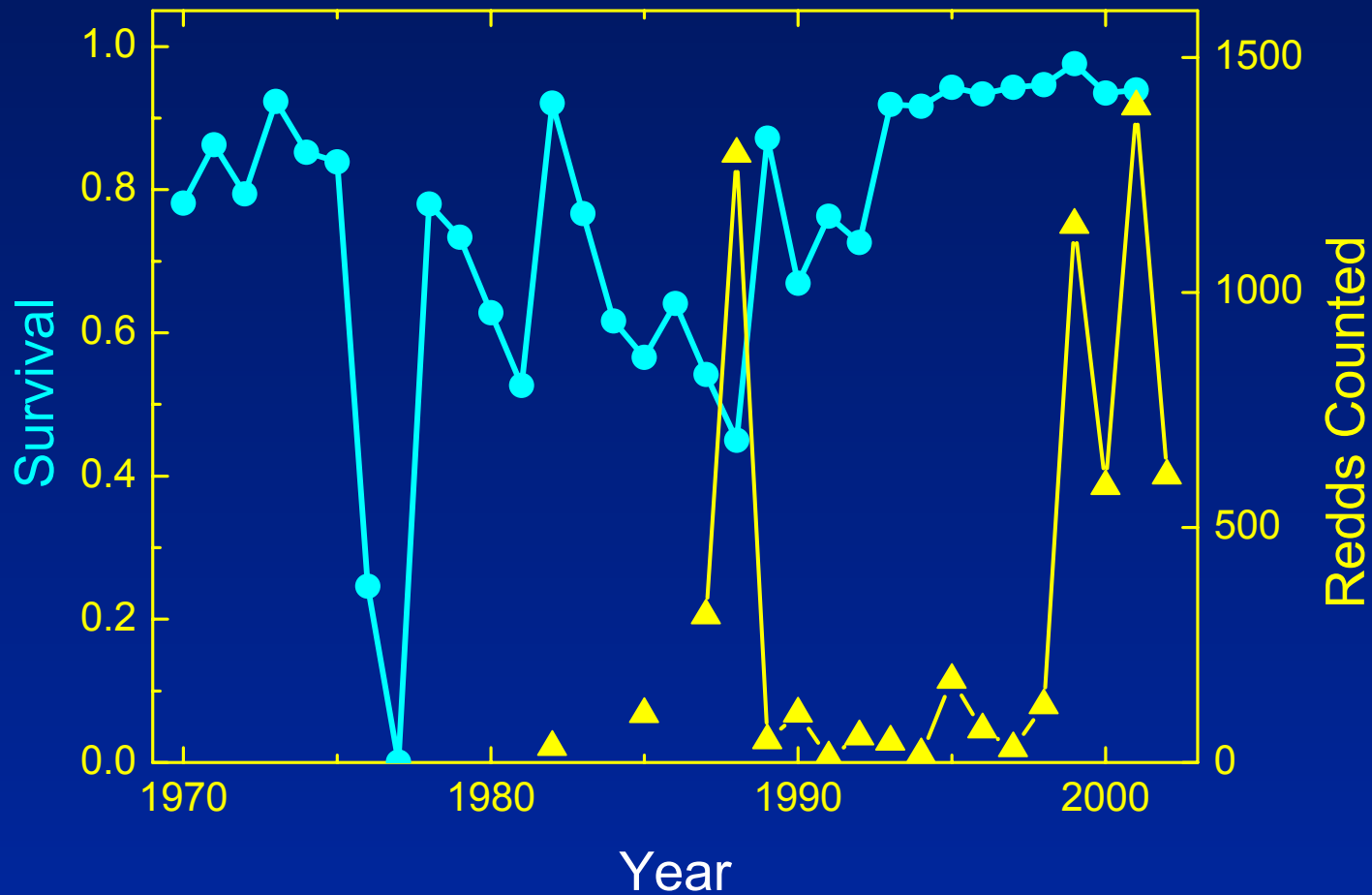


Problem:
reports don't
specify time
of exposure

Source:
Various reports

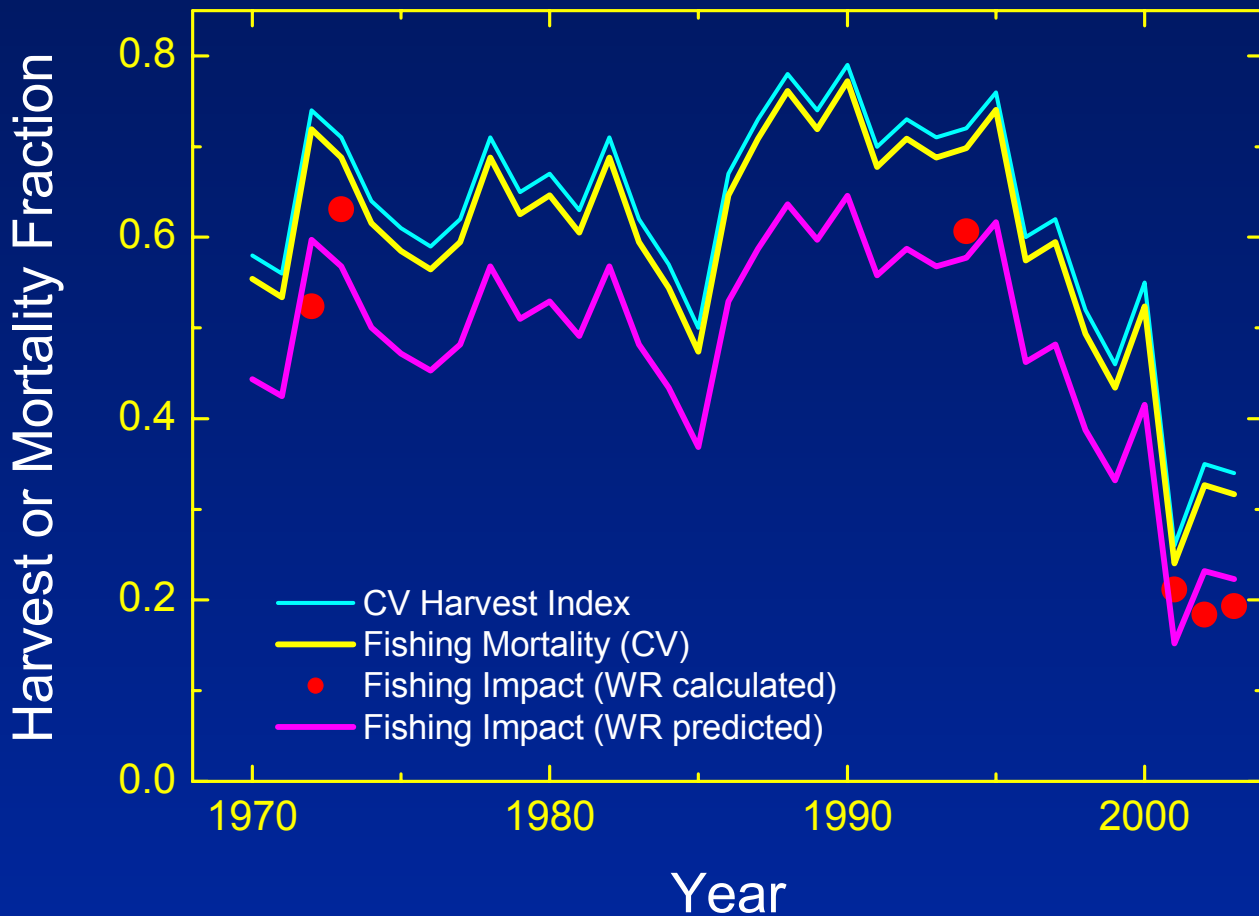
Temperature effects on survival

Temperature effects
based on spawning
location



Source:
D. Killam CDFG
USGS, DWR

Ocean Harvest

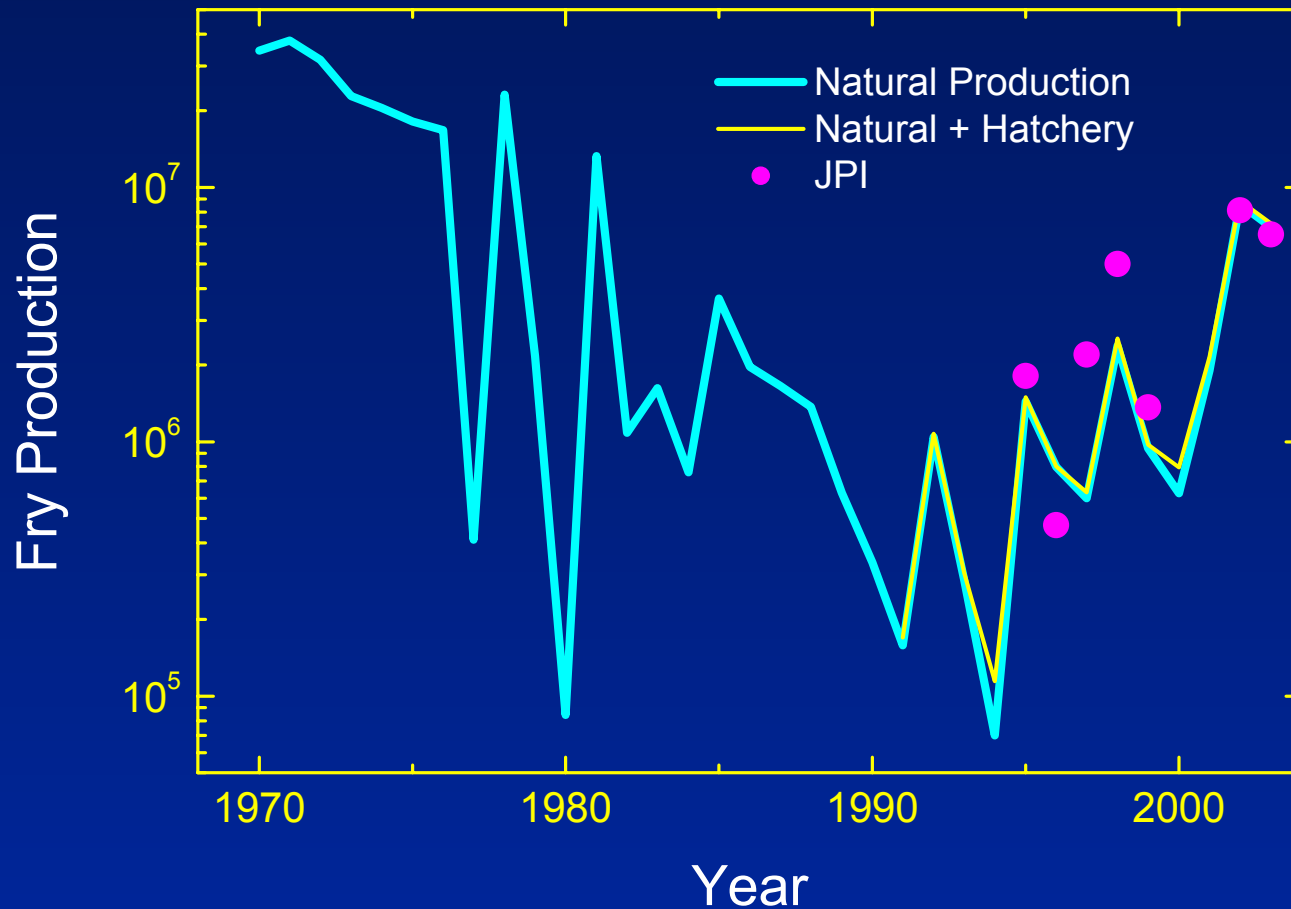


Harvest rate of winter-run tracks that of all Central Valley stocks

Both have declined substantially in recent years

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

Juvenile Production



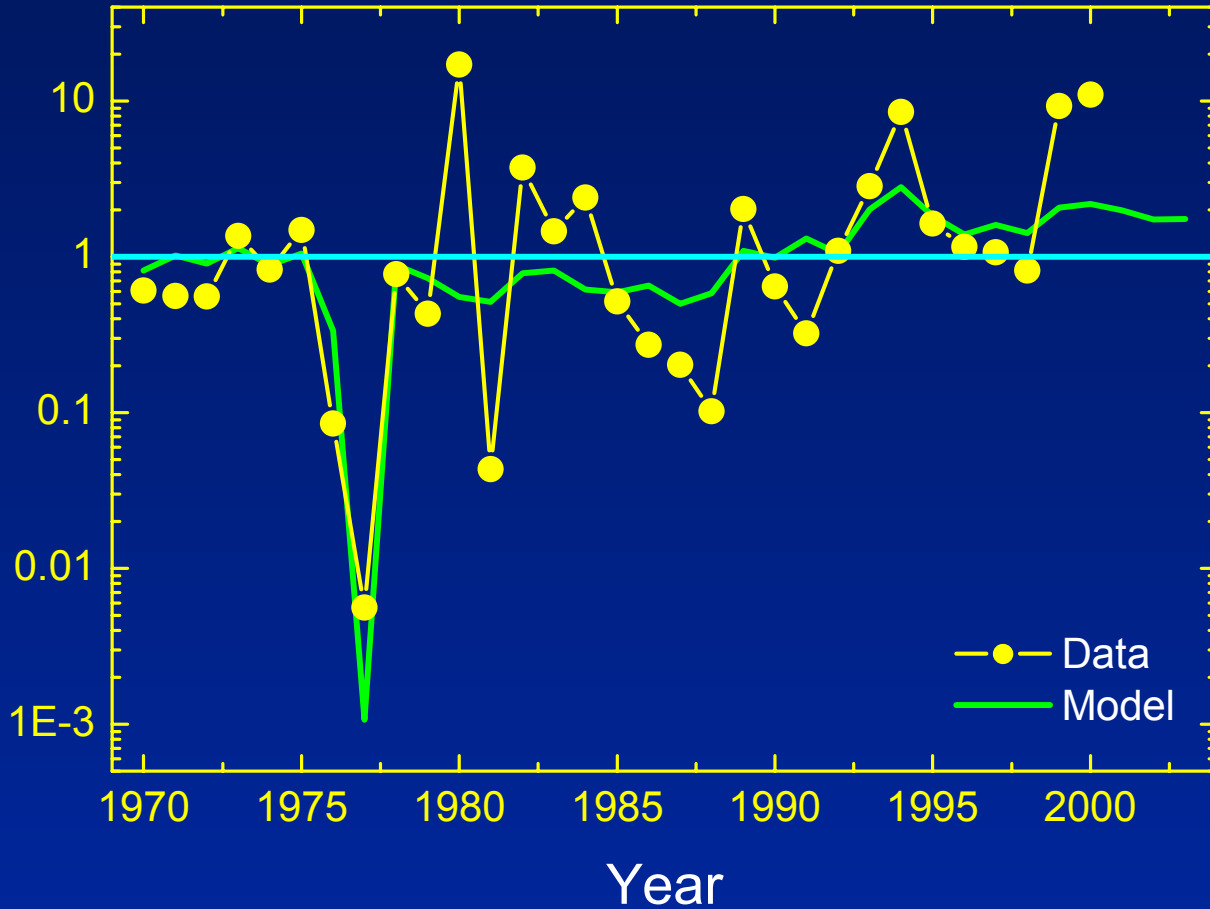
Natural production calculated assuming 1200 fry per adult

Juvenile Production Index (JPI) includes natural production only

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

Model of winter run escapement

Cohort Replacement Rate



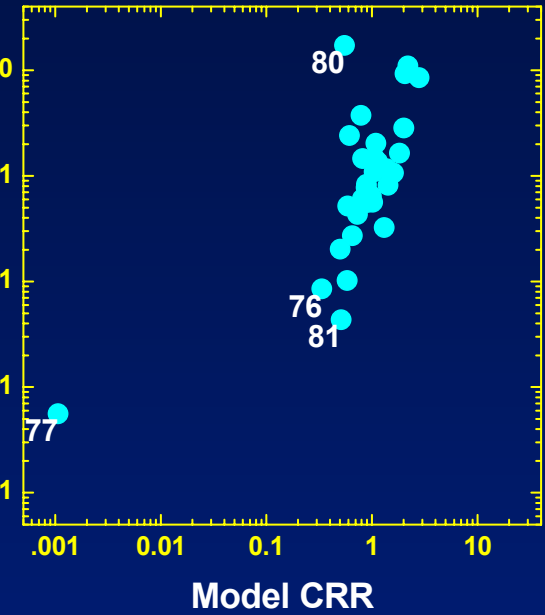
Data CRR

0.01

0.1

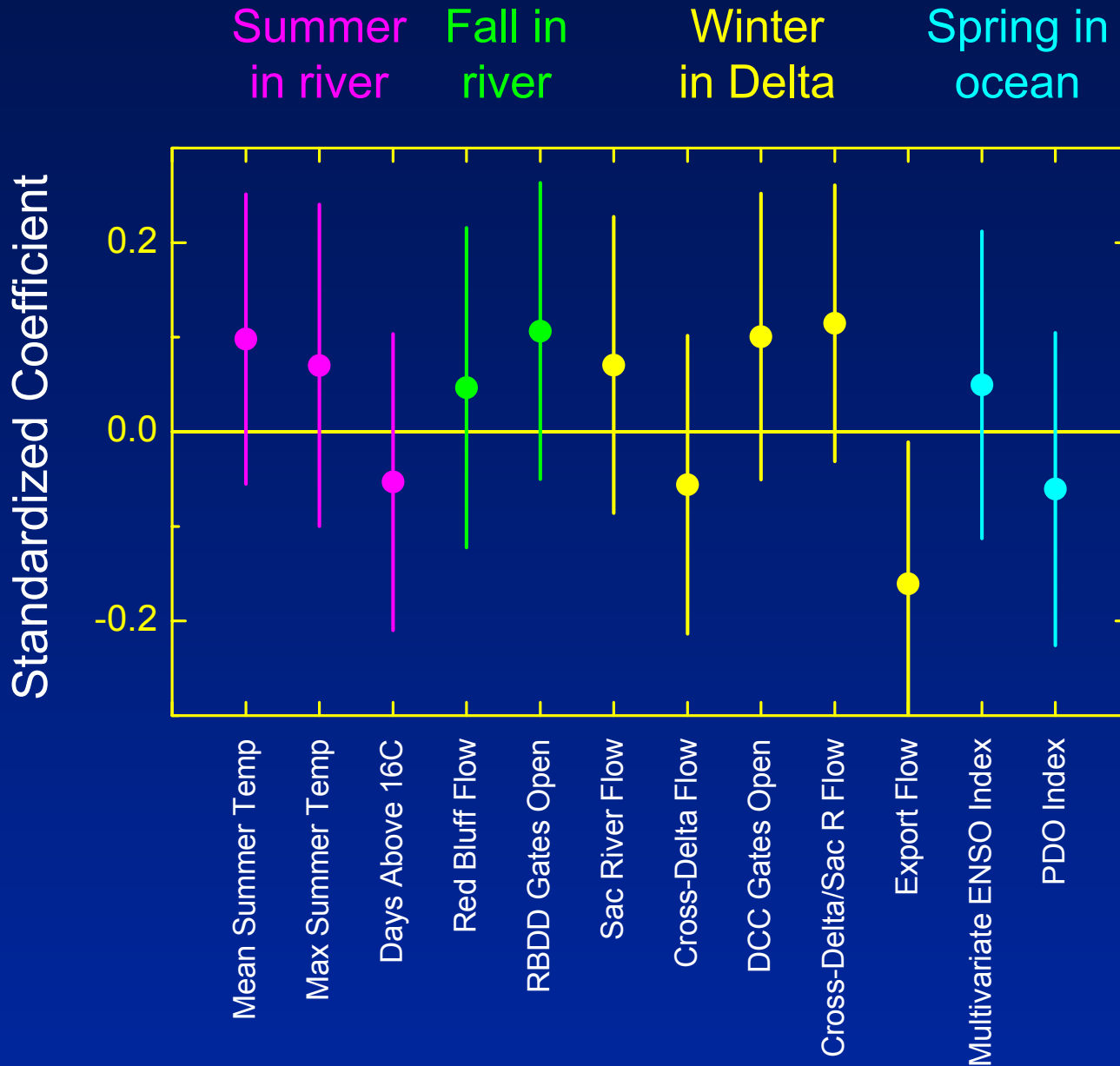
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Agreement is fair:
note 76-77 low
values, and long-
term trend.

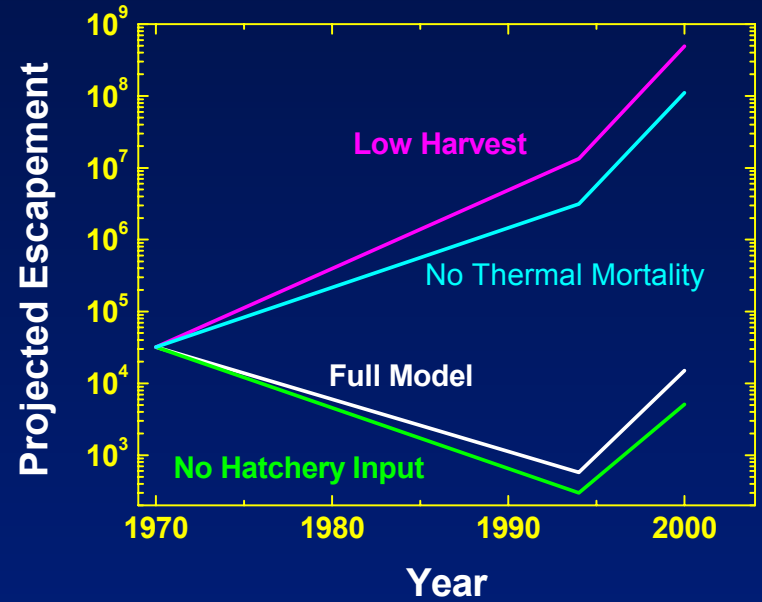
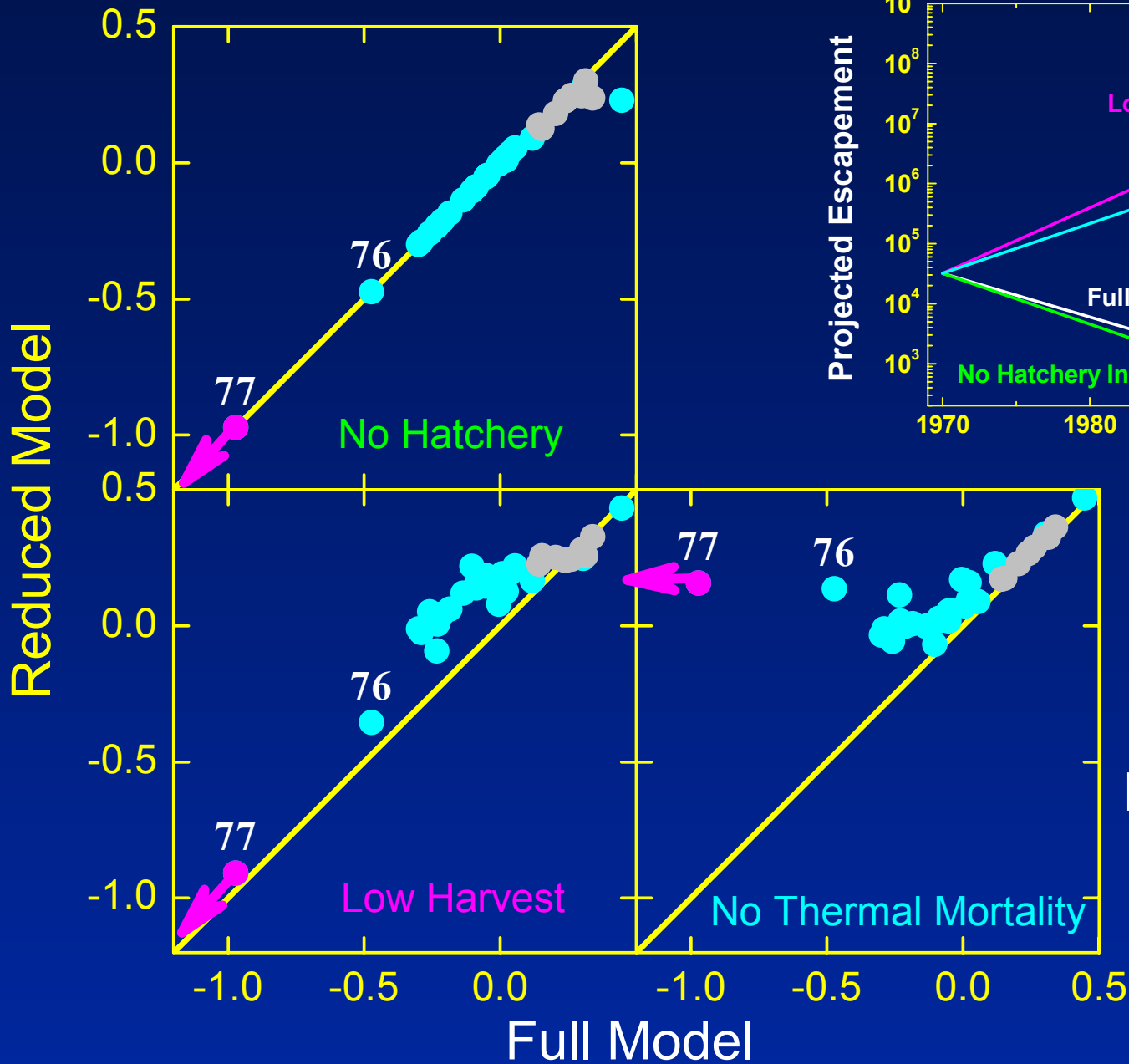
Environmental variables have little effect



Regression parameters with 90% confidence limits

Positive = expected direction of effect

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