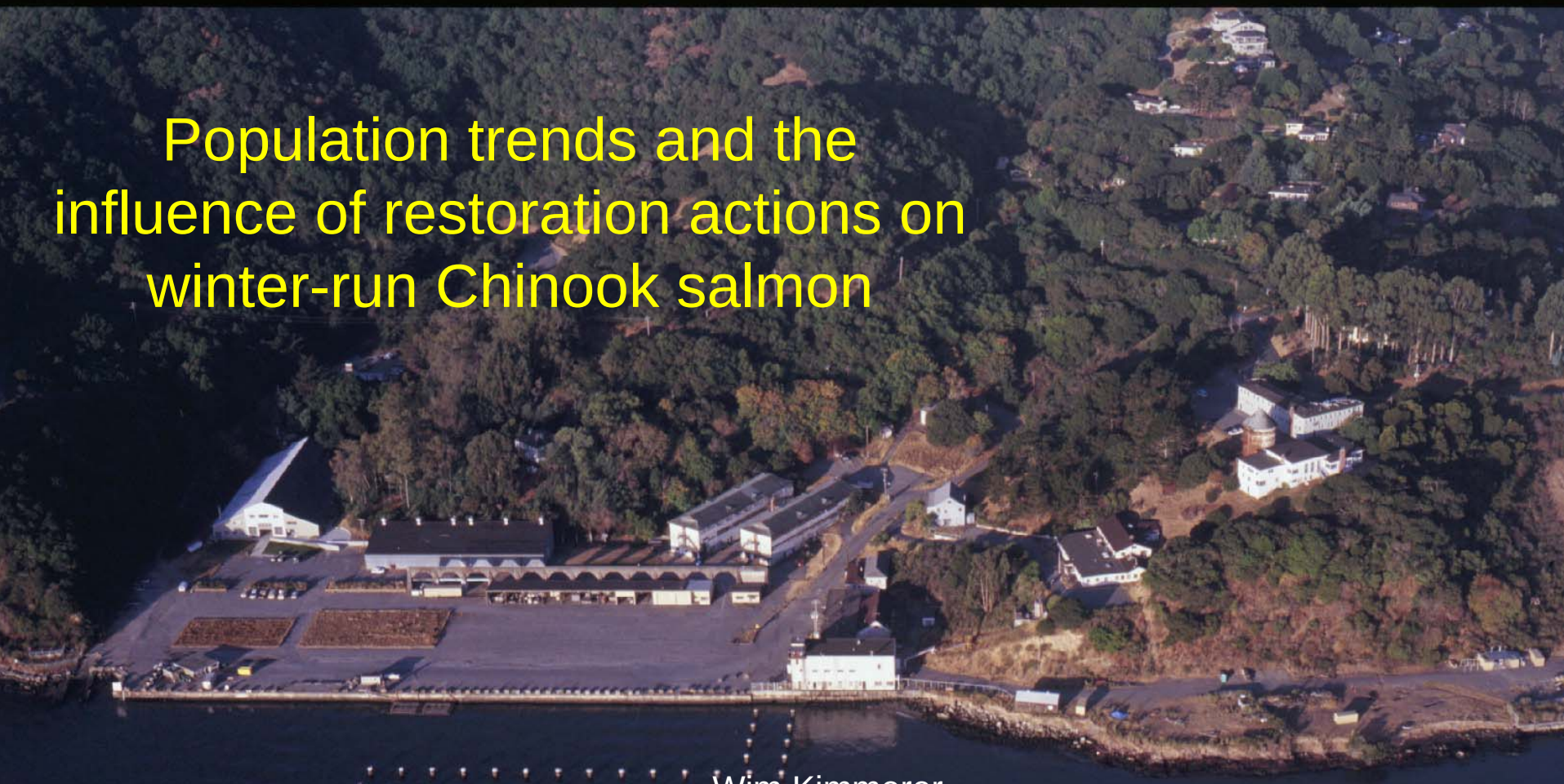
# Population trends and the influence of restoration actions on winter-run Chinook salmon



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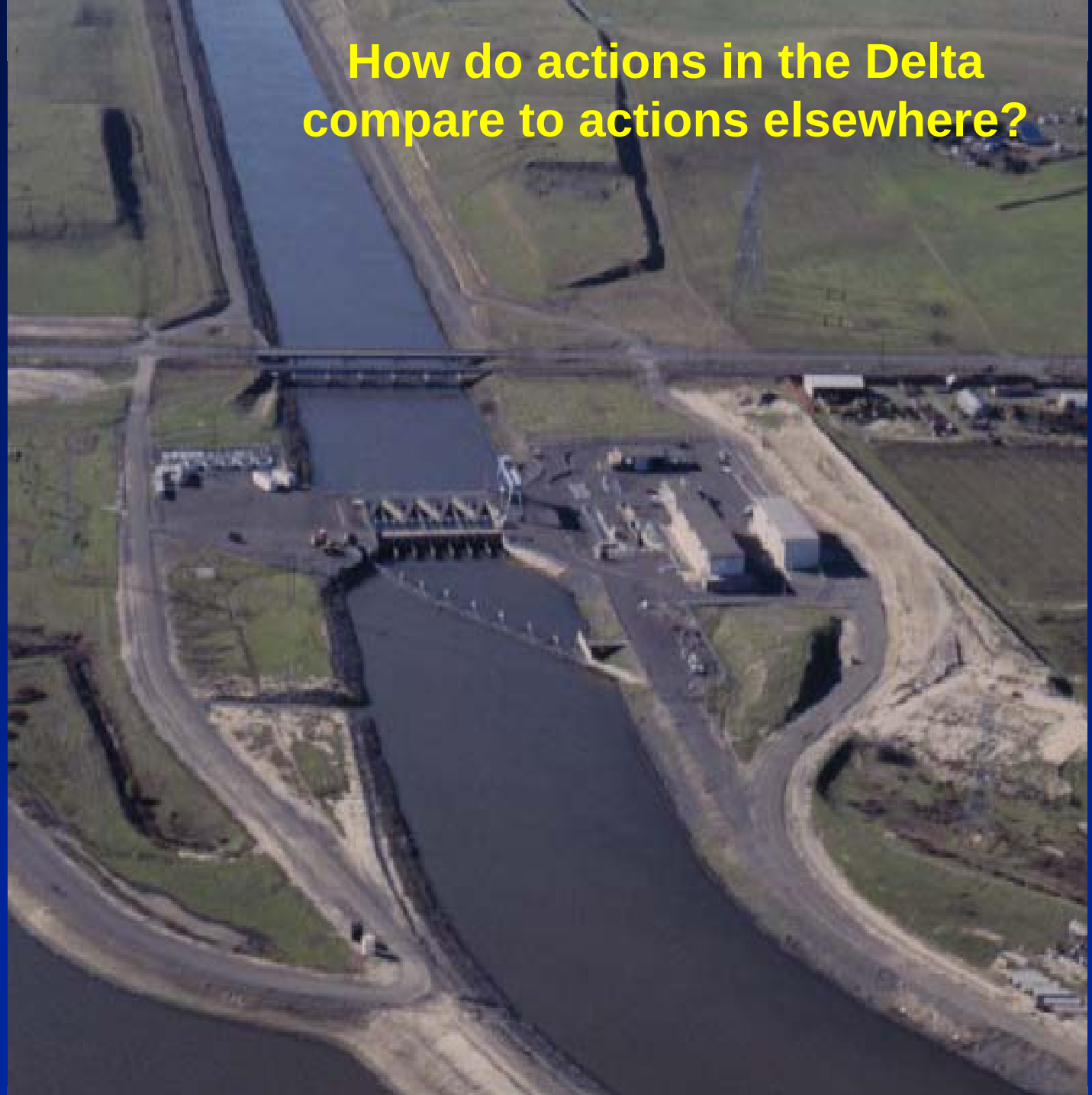
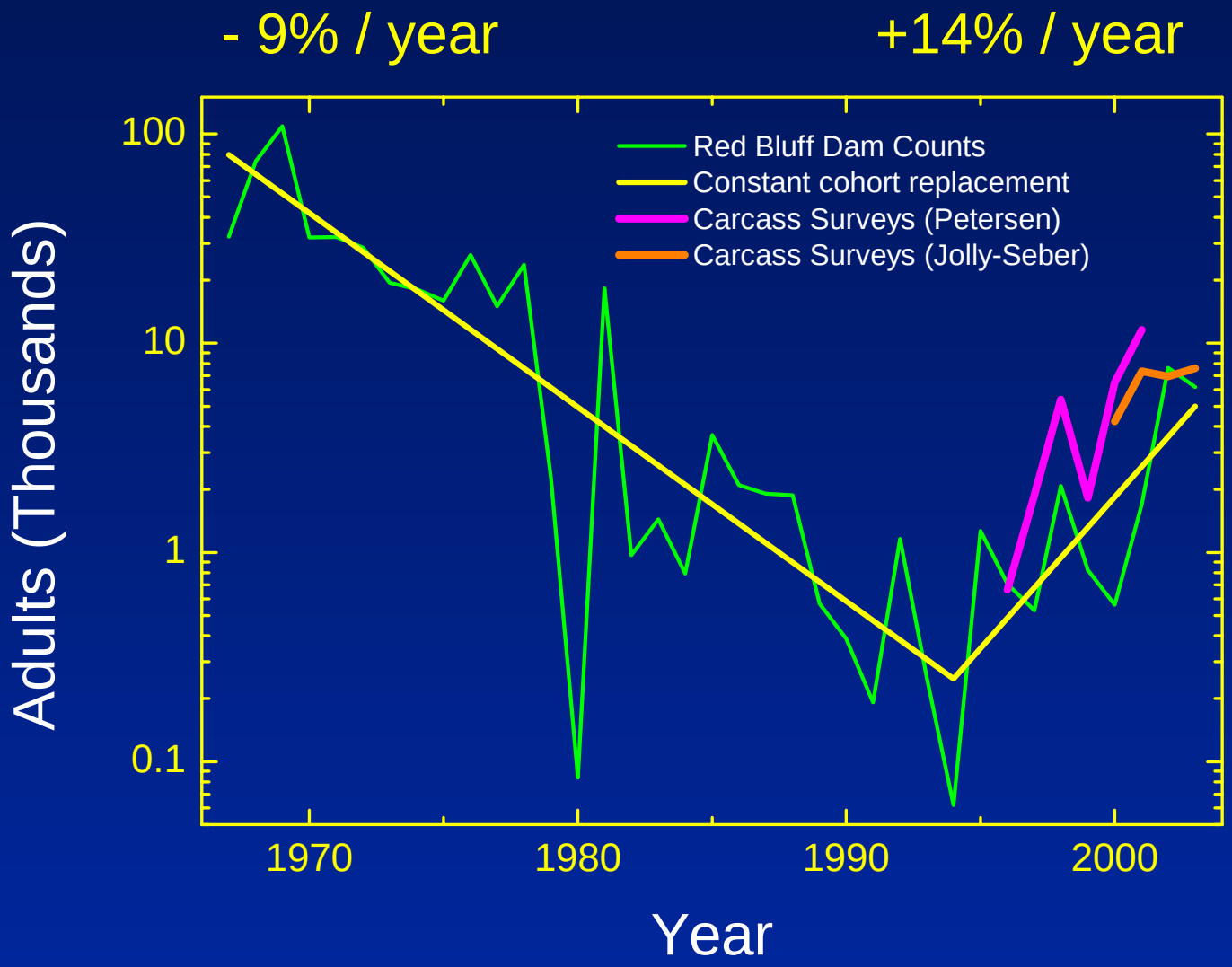
# Summary

- 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

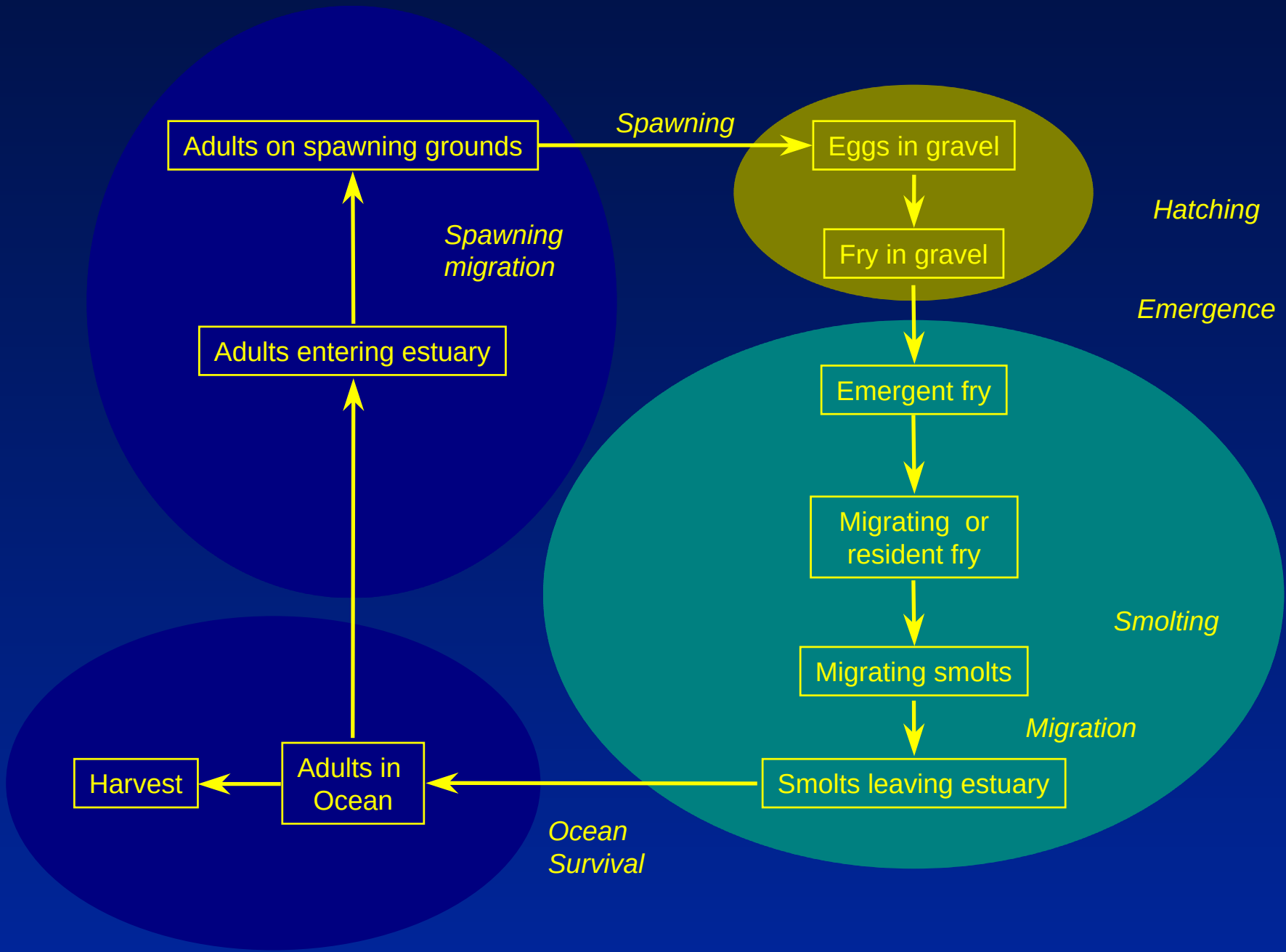

How do actions in the Delta
compare to actions elsewhere?

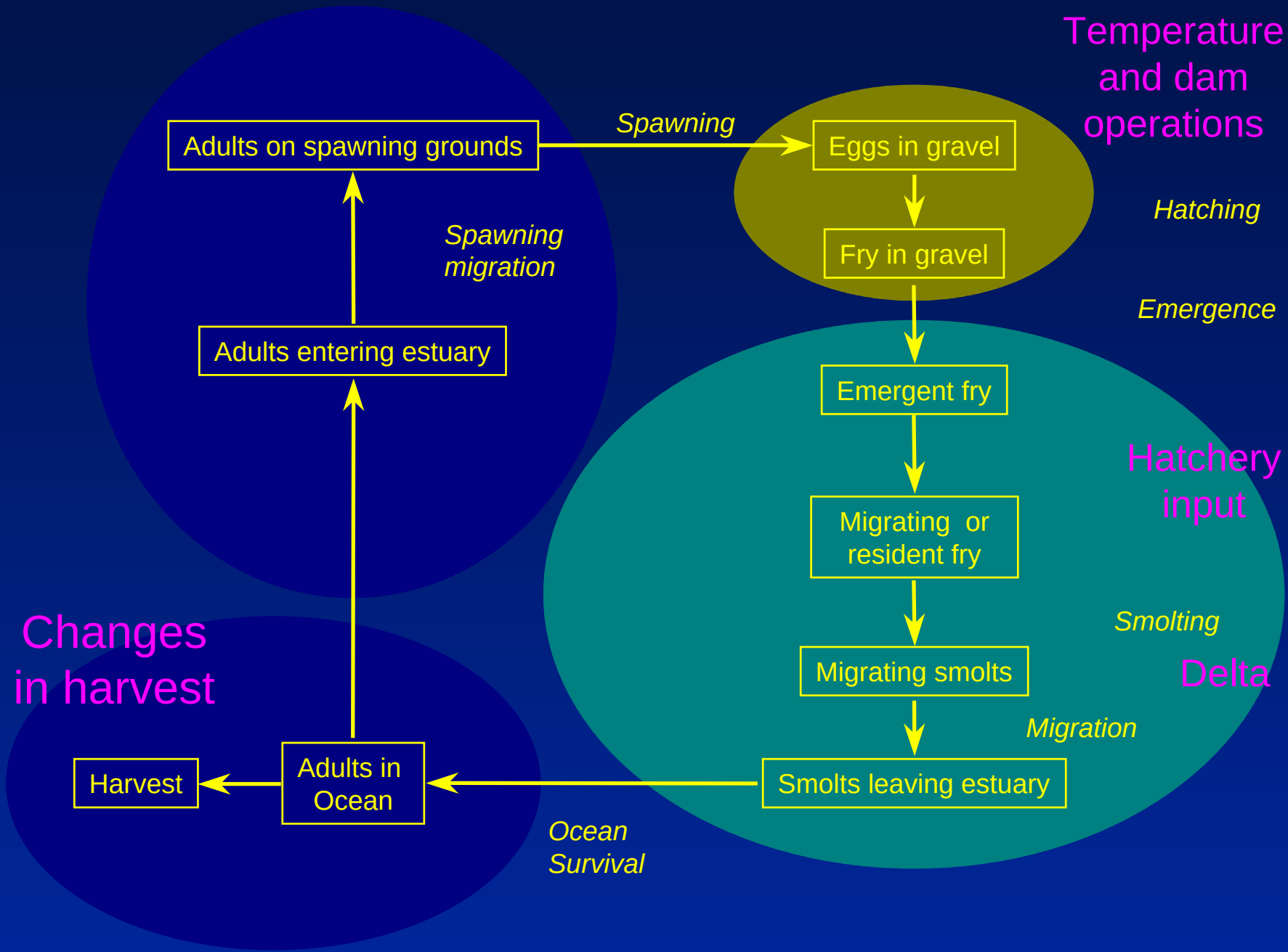
# Time series of winter run escapement




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

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


Adults on spawning grounds
Spawning
Eggs in gravel
Hatching
Fry in gravel
Spawning migration
Emergence
Adults entering estuary
Emergent fry
Migrating or resident fry
Smolting
Migrating smolts
Migration
Harvest
Adults in Ocean
Smolts leaving estuary
Ocean Survival


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
Changes in harvest
Smolting
Migrating smolts
Delta
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

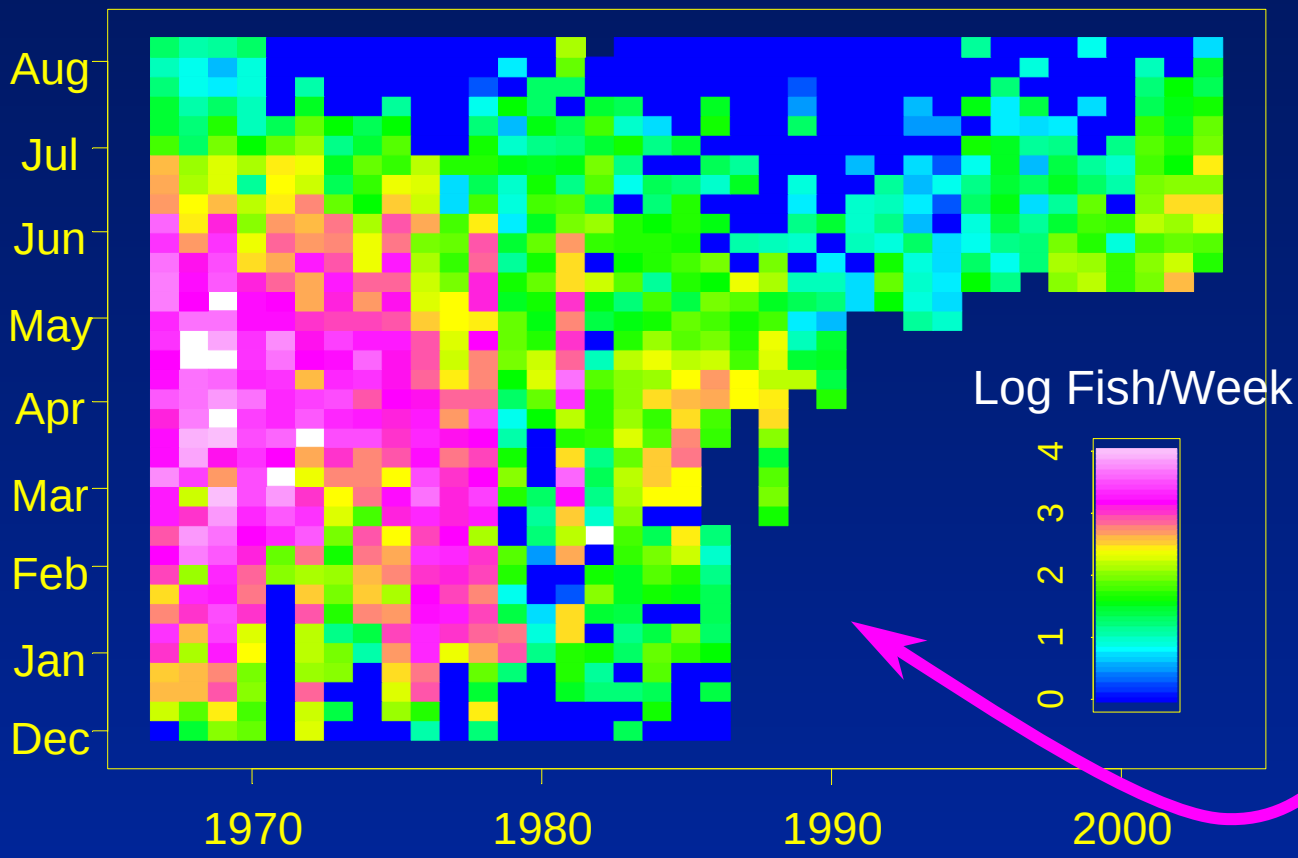
- No density dependence
- All reproduction is at age 3
- Sex ratio is constant
- Survival fractions are independent

# A simple exploratory model of winter run survival

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

$N_{\text{📖}0}FS_{\text{Egg - RBDD}}$ = 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)

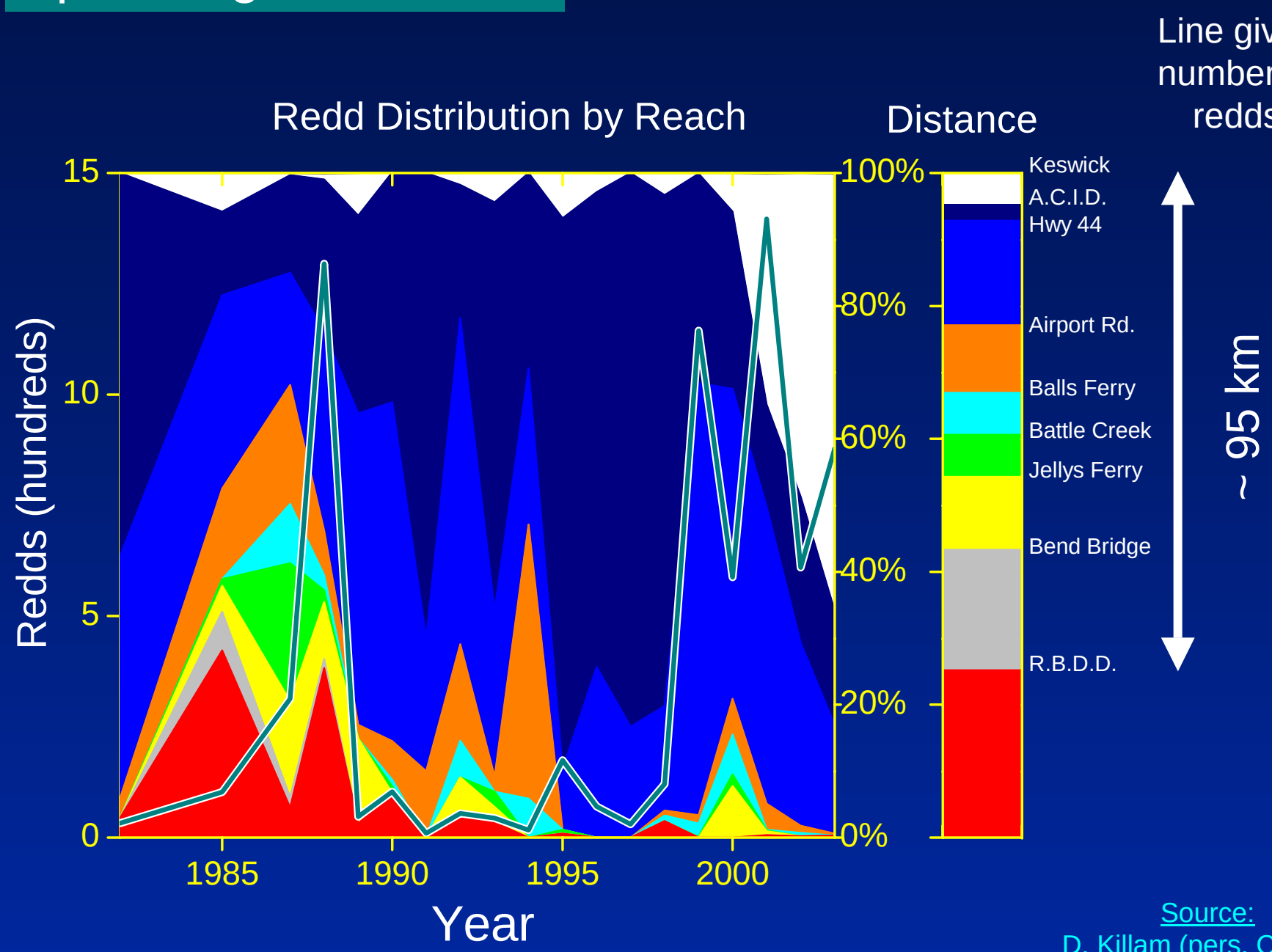
# Migration Timing at Red Bluff Diversion Dam




RBDD gates out during migration = No blockage

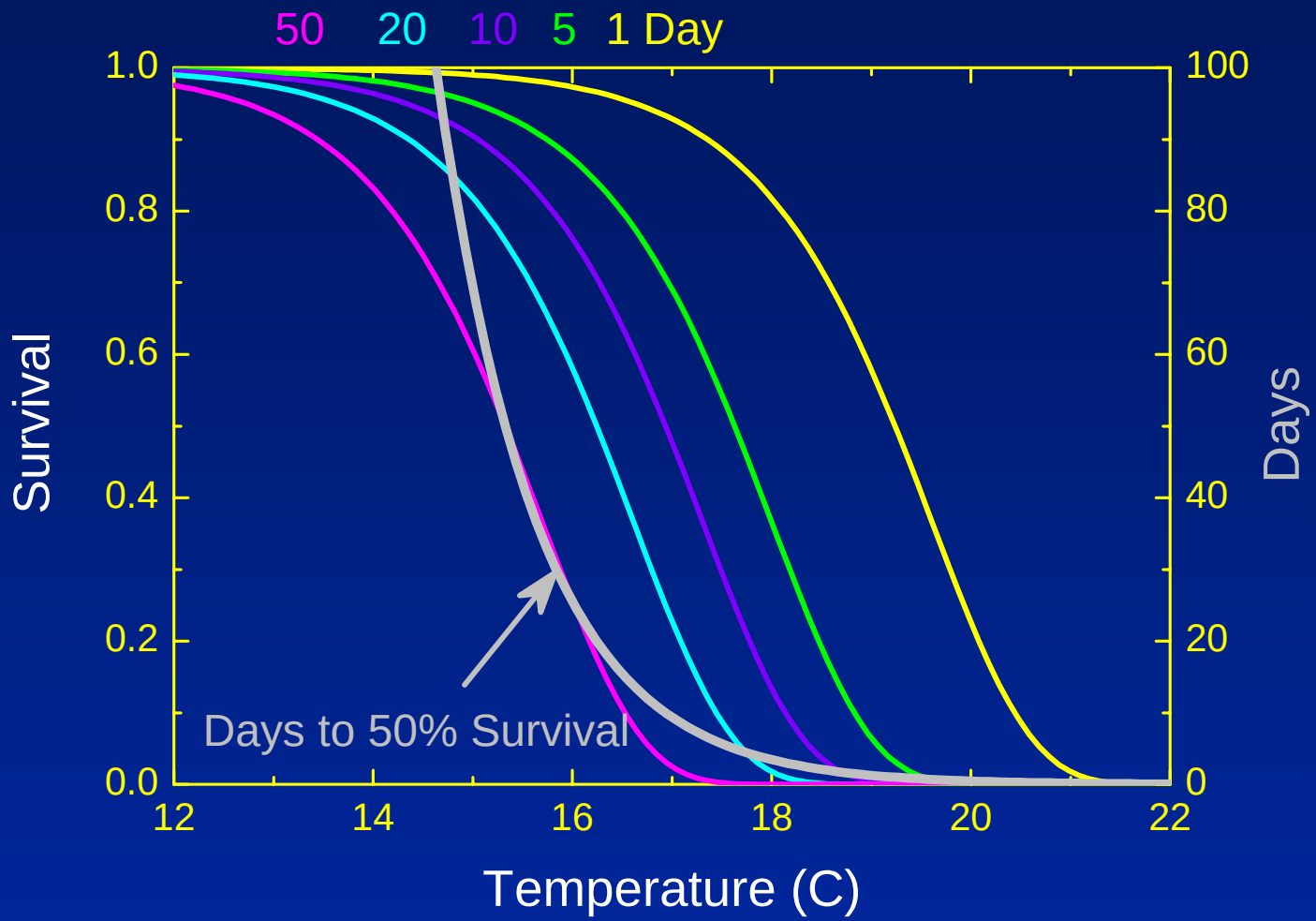
Source:
D. Killam, CDFG

# Spawning Distribution




Source:
D. Killam (pers. Comm.)

# Temperature survival model for eggs/alevins

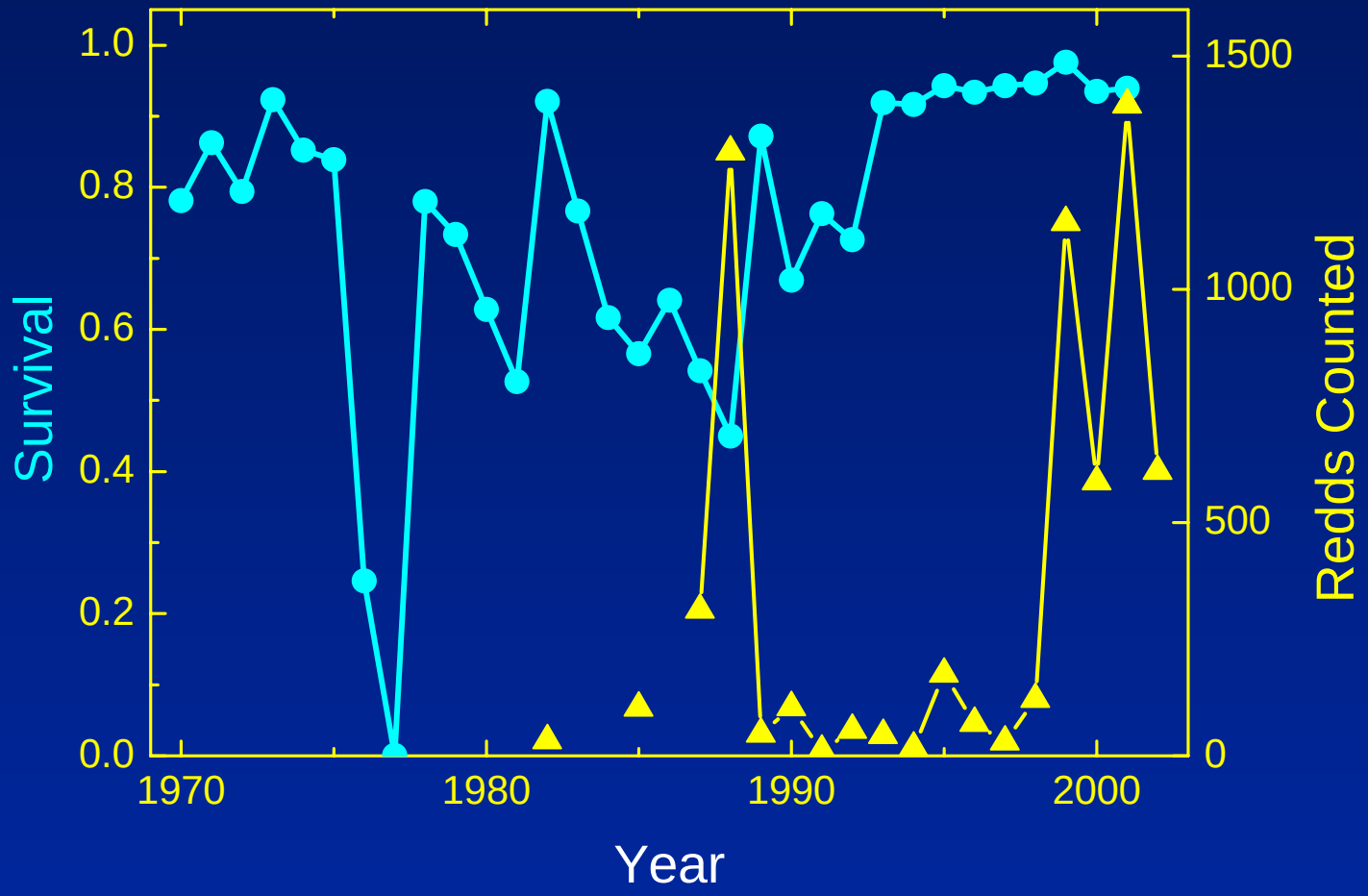



Problem: reports don't specify time of exposure

Source:
Various reports

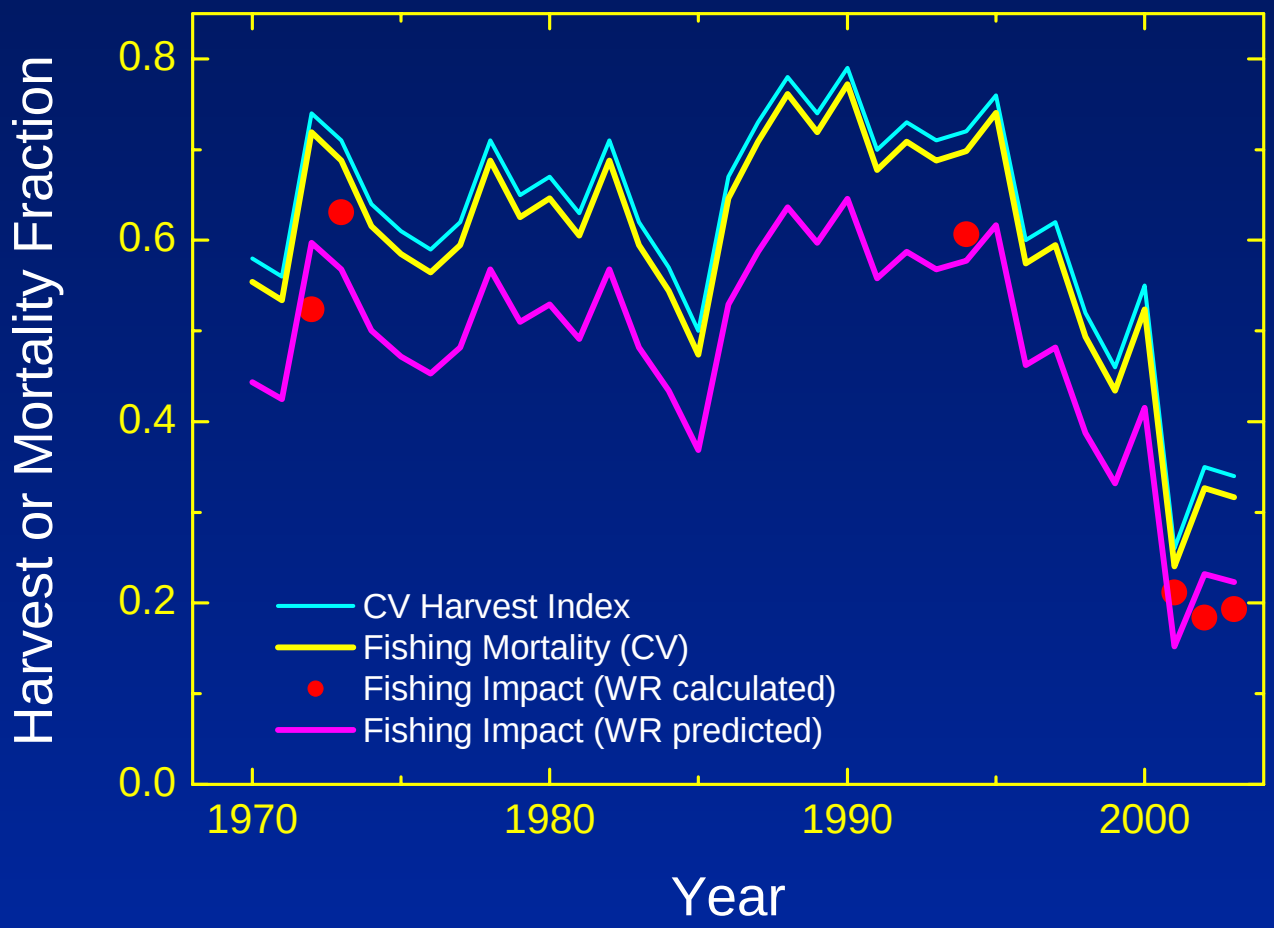
# Temperature effects on survival

Temperature effects based on spawning location




Source:
D. Killam CDFG
USGS, DWR

# Ocean Harvest

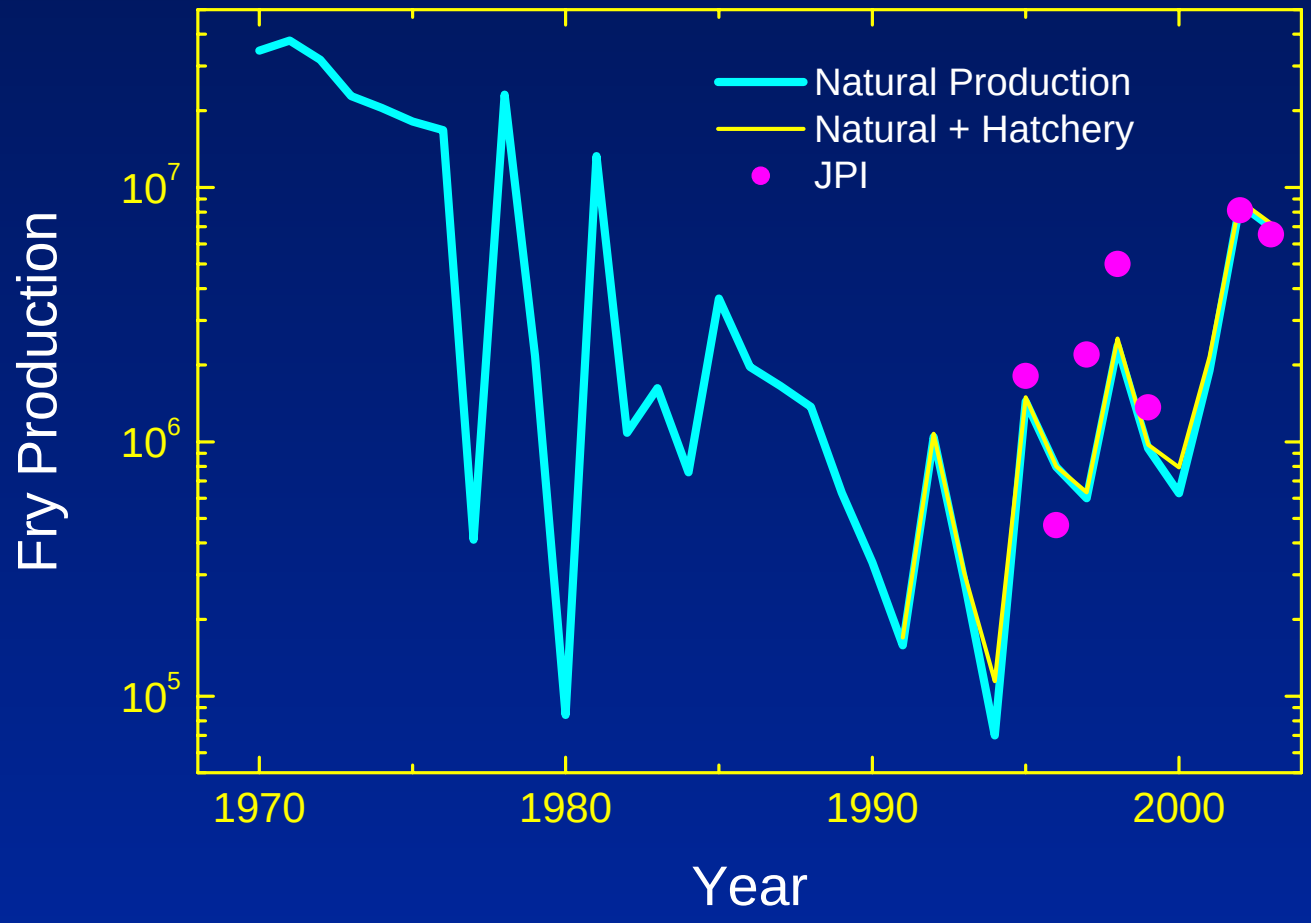



Harvest rate of winter-run tracks that of all Central Valley stocks

Both have declined substantially in recent years

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

# Juvenile Production

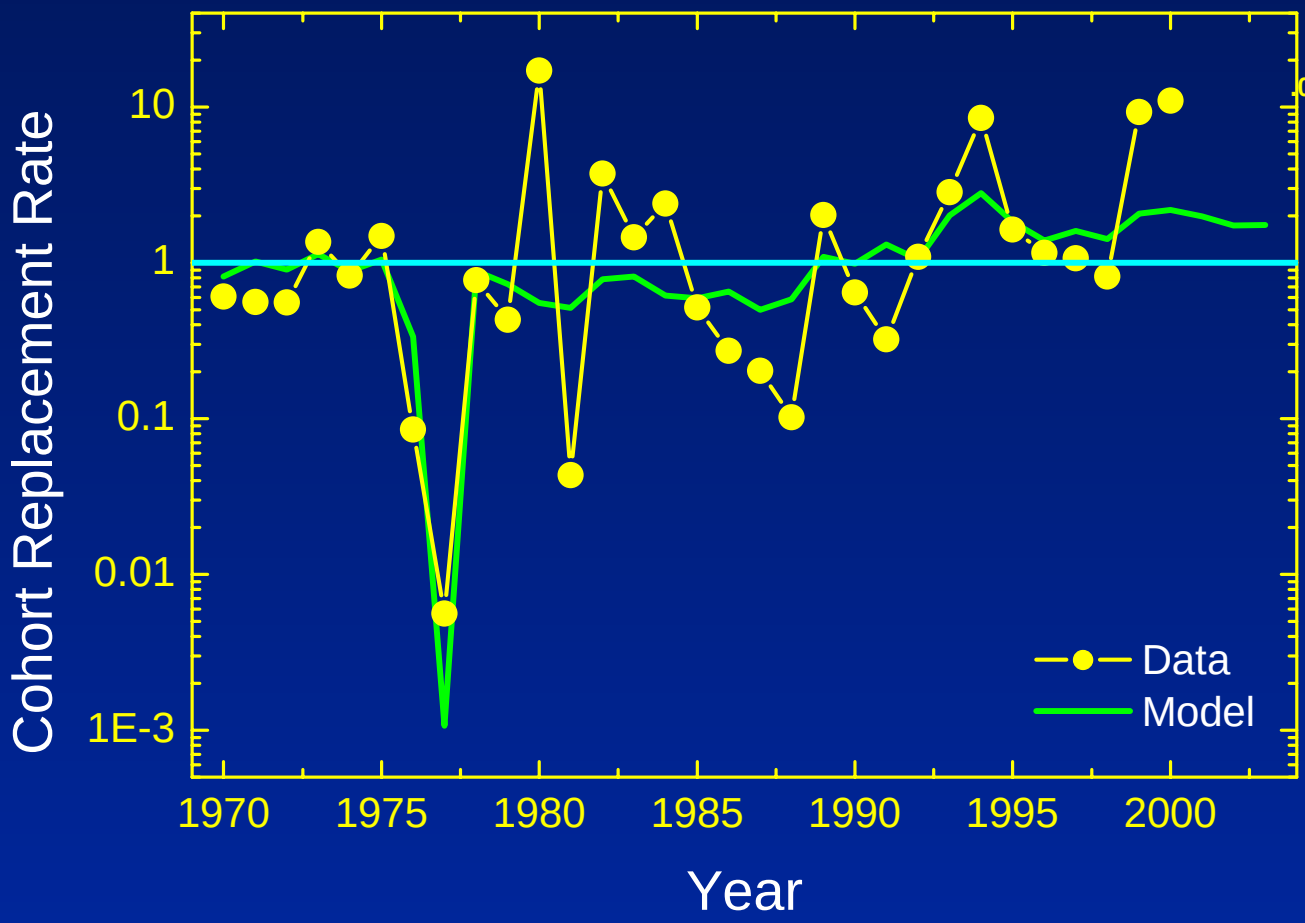


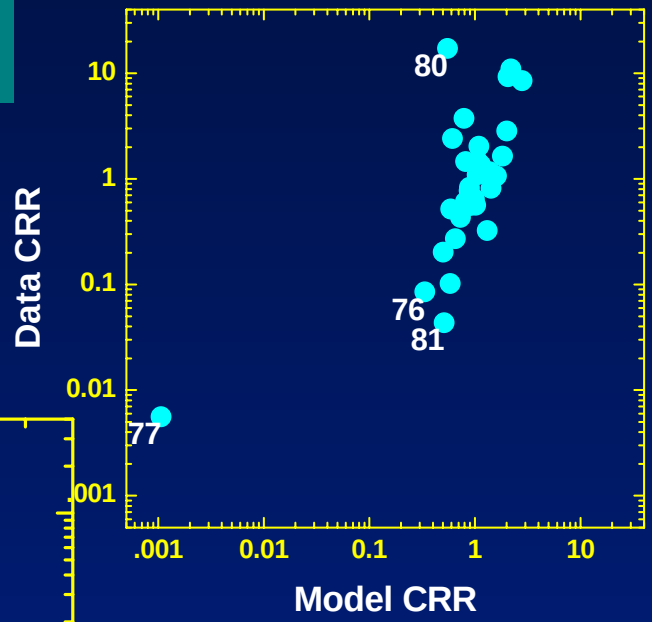

Natural production calculated assuming 1200 fry per adult

Juvenile Production Index (JPI) includes natural production only

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

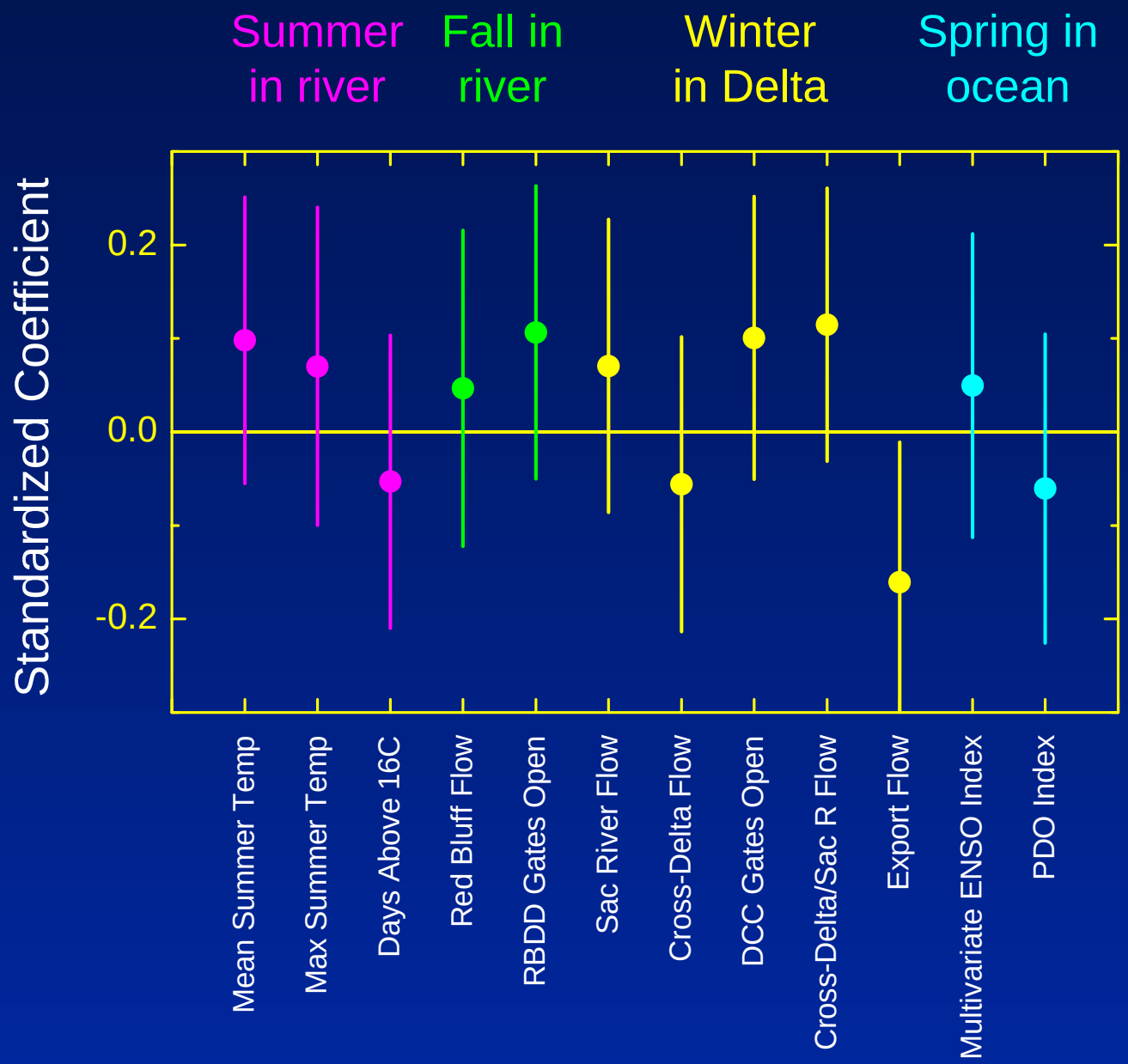
# Model of winter run escapement




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

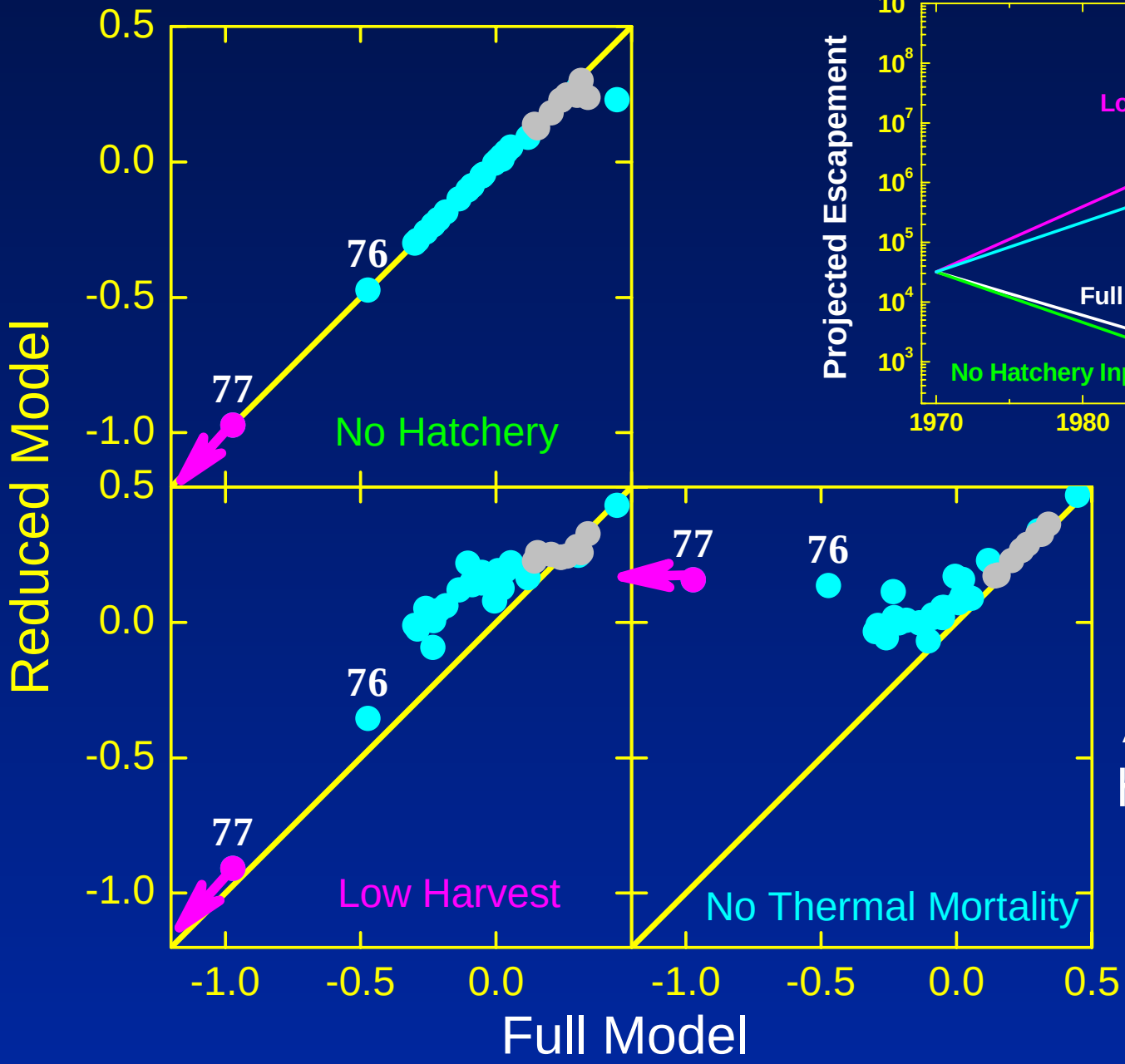
# Environmental variables have little effect

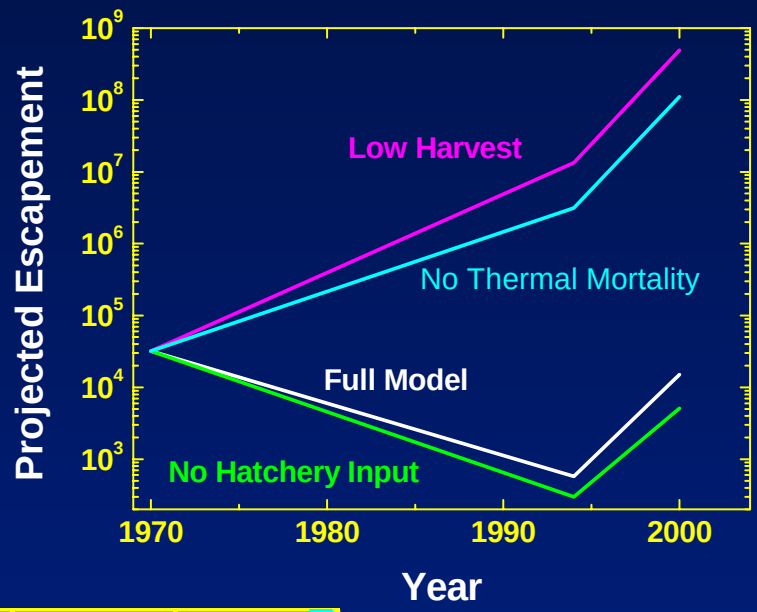



Regression parameters with 90% confidence limits

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