

Integrating genetic and demographic effects of dispersal on population response to a variable environment



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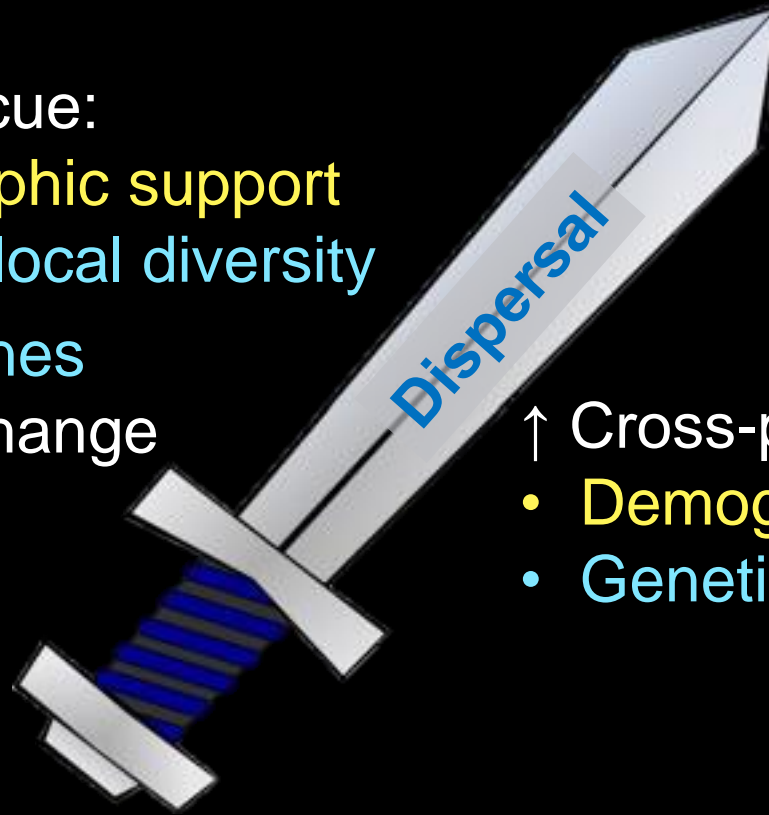


Dispersal is a double-edged sword

- ↑ Local rescue:
 - Demographic support
 - Increase local diversity

Mobilized **individuals** & **genes**

→ ↑ response to climate change



- ↑ Cross-population variability:
 - Demographic synchrony
 - Genetic homogenization

What is the relative role of **demographic** versus **genetic** dynamics in driving the effect of dispersal?

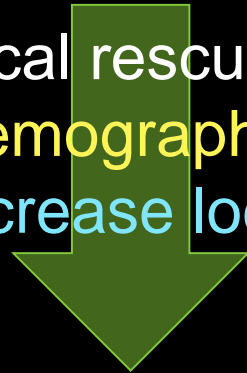
→ drivers of +/- roles in response to climate change

Humans are altering dispersal

Habitat fragmentation

↑ Local rescue:

- Demographic support
- Increase local diversity

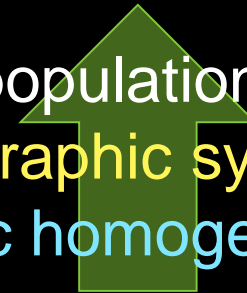


Transport

↑ Cross-population variability:

- Demographic synchrony
- Genetic homogenization

Including variability in returns
for a natural resource

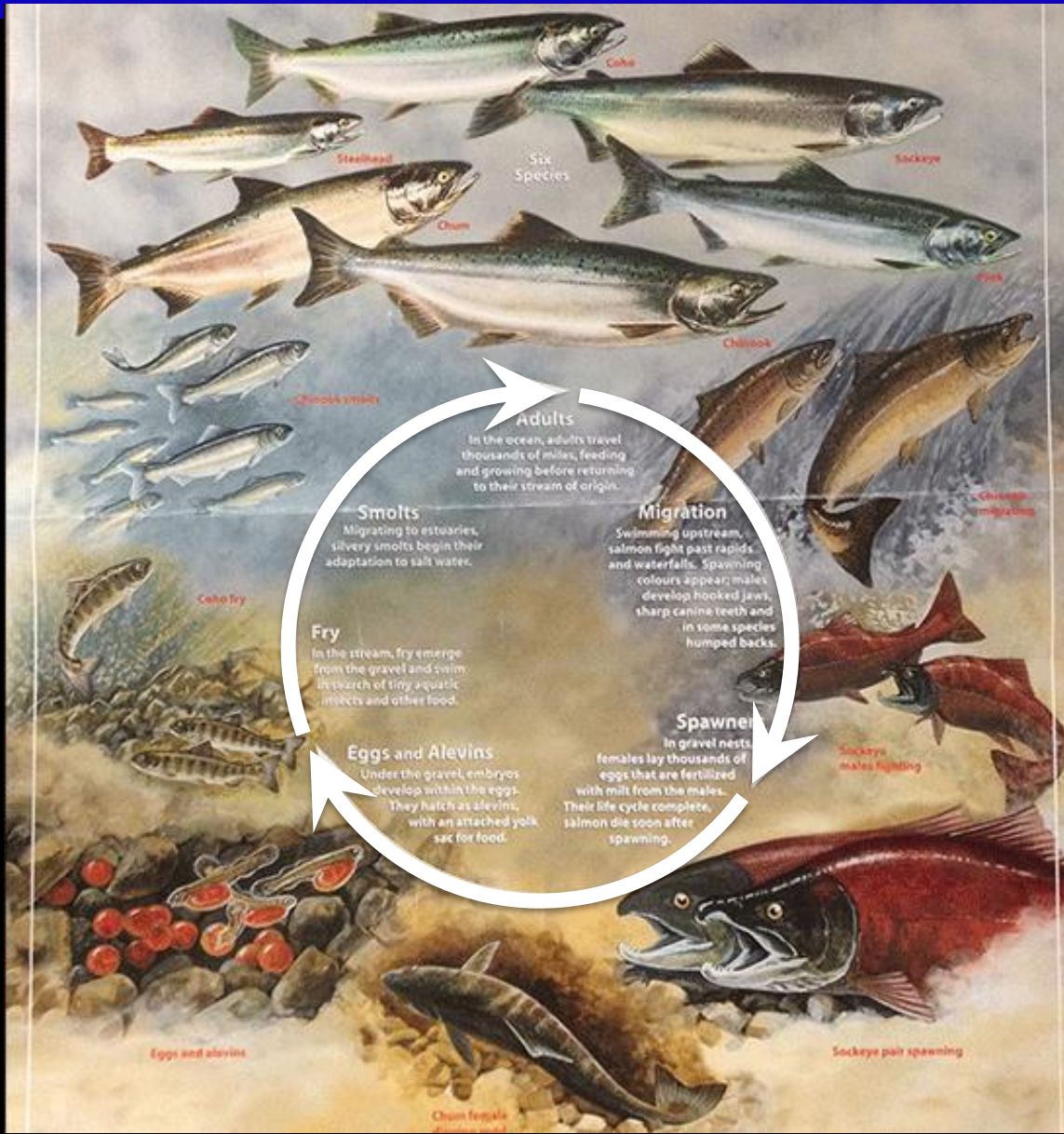


What is the relative role of **demographic** versus **genetic** dynamics in driving the effect of dispersal?
human [^]impacts on

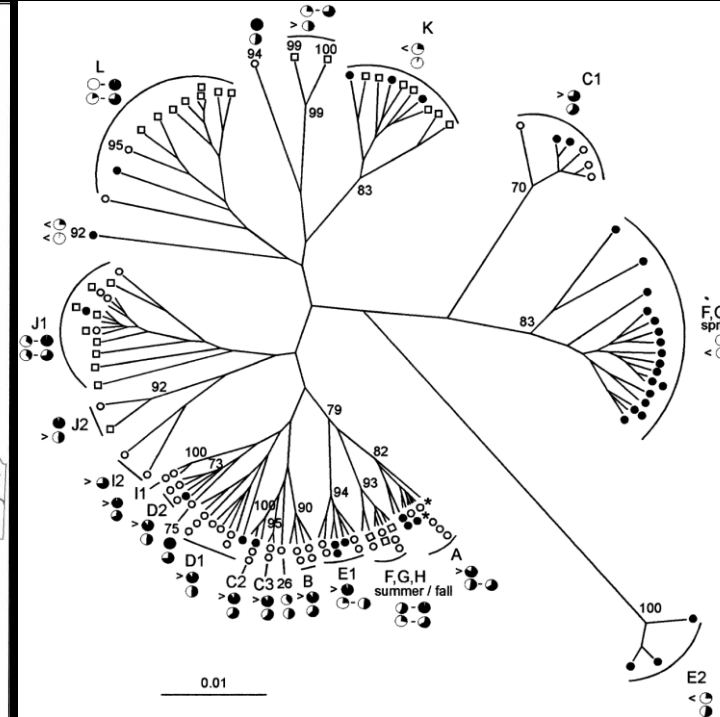
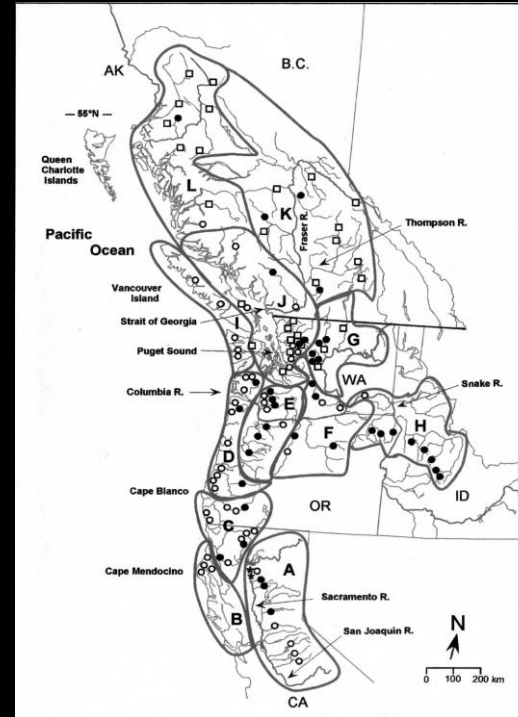
Study system: salmon

Ocean

River



→ naturally high genetic differentiation



Waples et al 2004

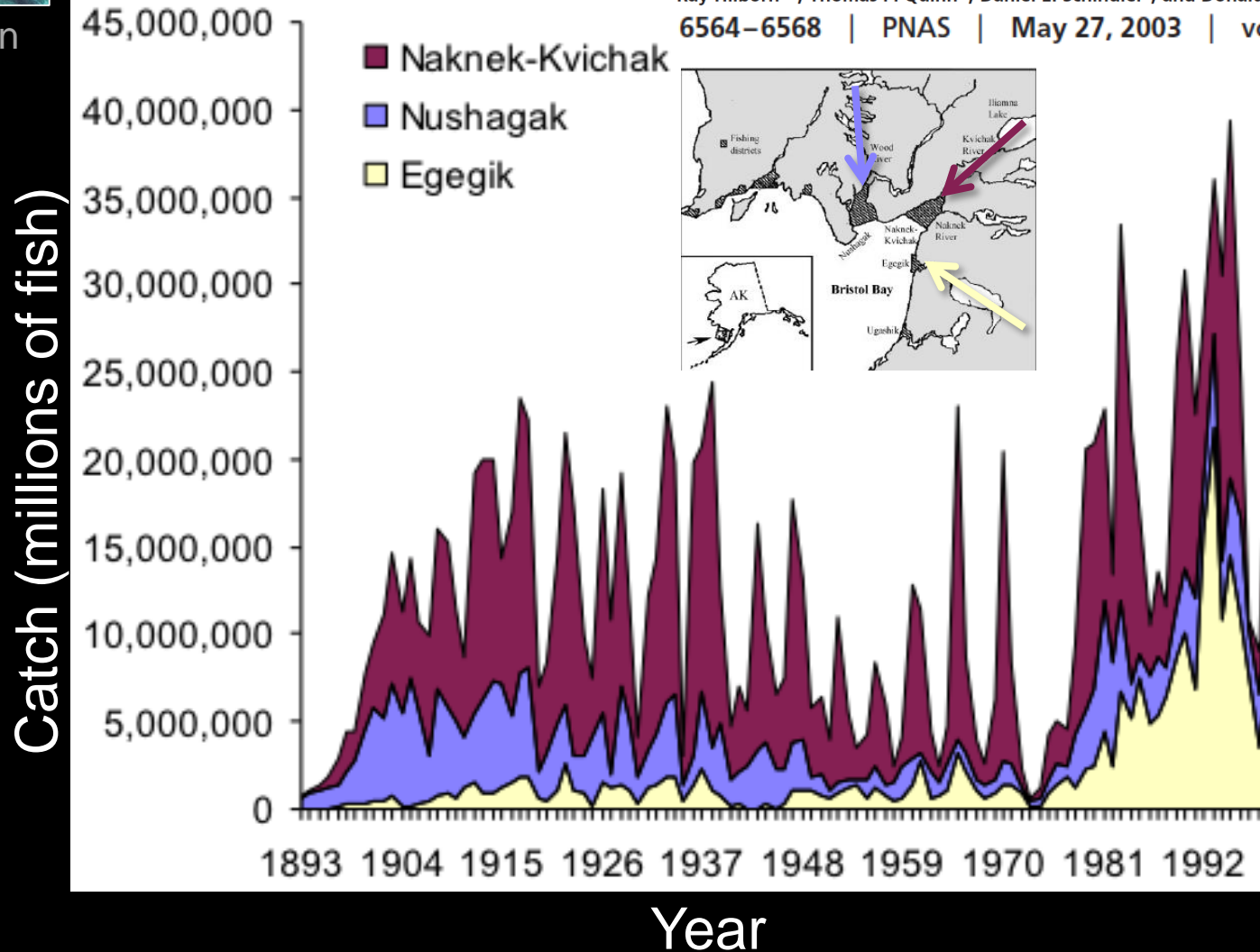
Independent & diverse populations stabilize returns



Sockeye salmon (*Oncorhynchus nerka*)

Biocomplexity and fisheries sustainability

Ray Hilborn^{*†}, Thomas P. Quinn^{*}, Daniel E. Schindler[‡], and Donald E. Rogers^{*}
6564–6568 | PNAS | May 27, 2003 | vol. 100 | no. 11



Aggregate returns to Bristol Bay were 41-77% more stable than individual stocks (Schindler et al. 2010)

Increased variability in California



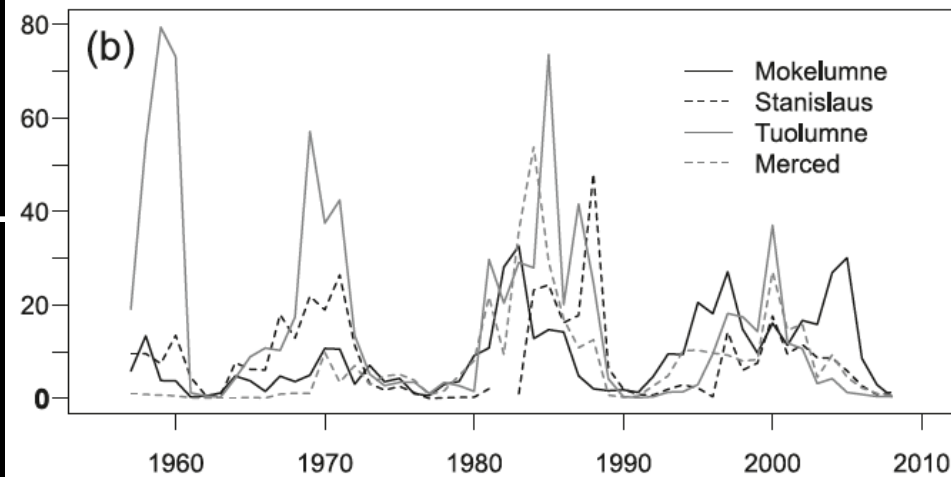
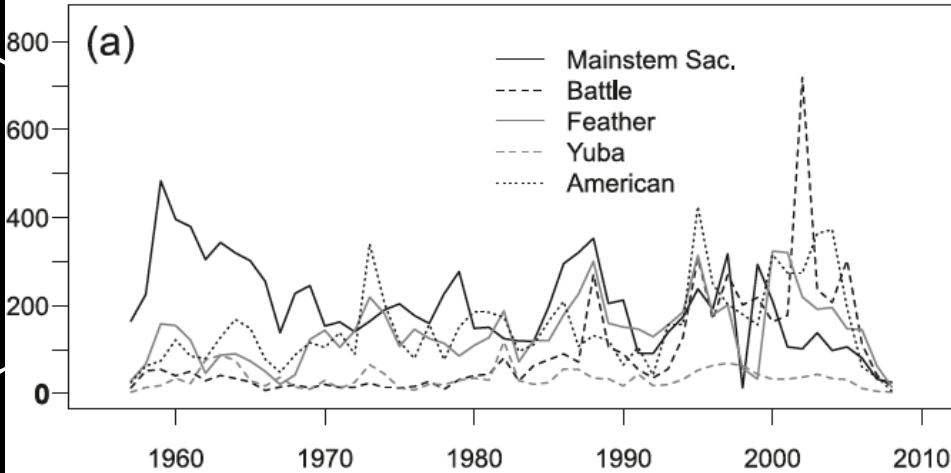
Chinook
(*Oncorhynchus tshawytscha*)

Adult production (thousands)

Weakened portfolio effect in a collapsed salmon population complex

Can. J. Fish. Aquat. Sci. 68: 1579–1589 (2011)

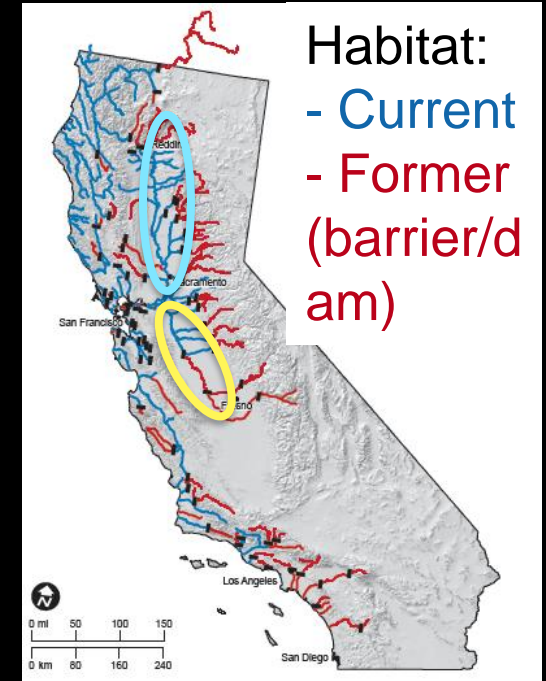
Stephanie Marie Carlson and William Hallowell Satterthwaite



Year

Sacramento Basin:
8/10 + pairwise
correlations
4 significant

San Joaquin Basin:
6/6 + pairwise
correlations
4 significant



Habitat:
- Current
- Former
(barrier/dam)

Increased variability in California



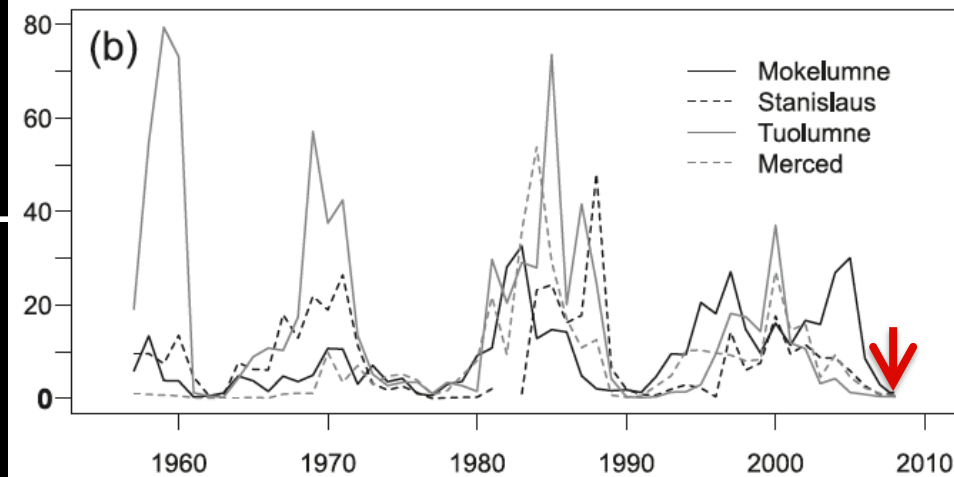
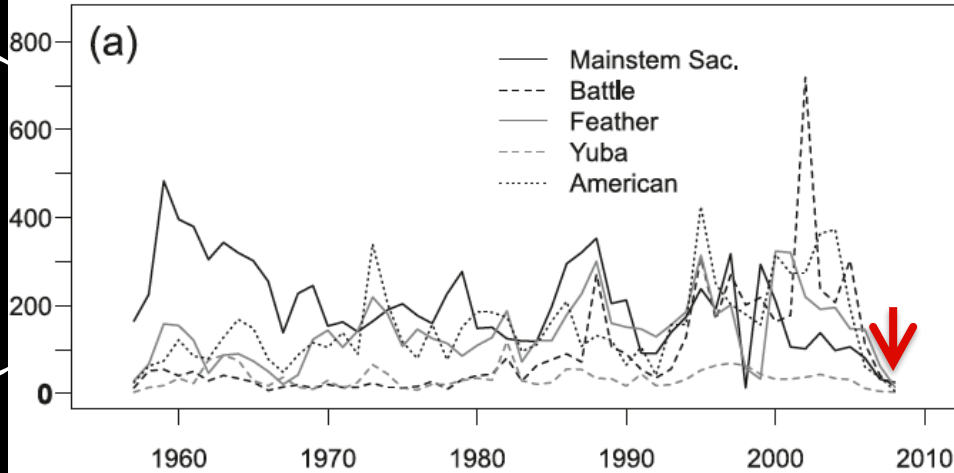
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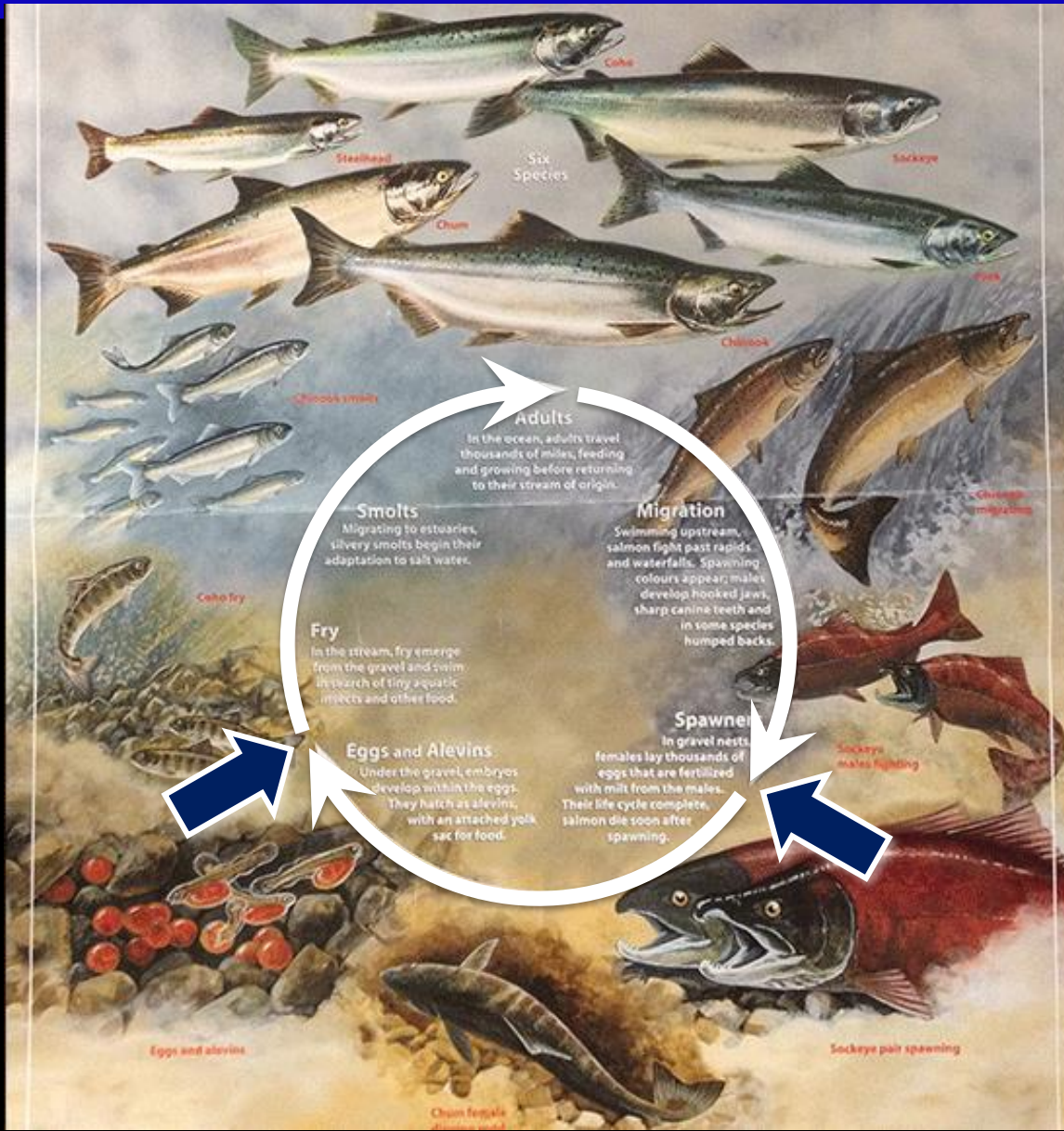
Year



Salmon hatcheries

Ocean

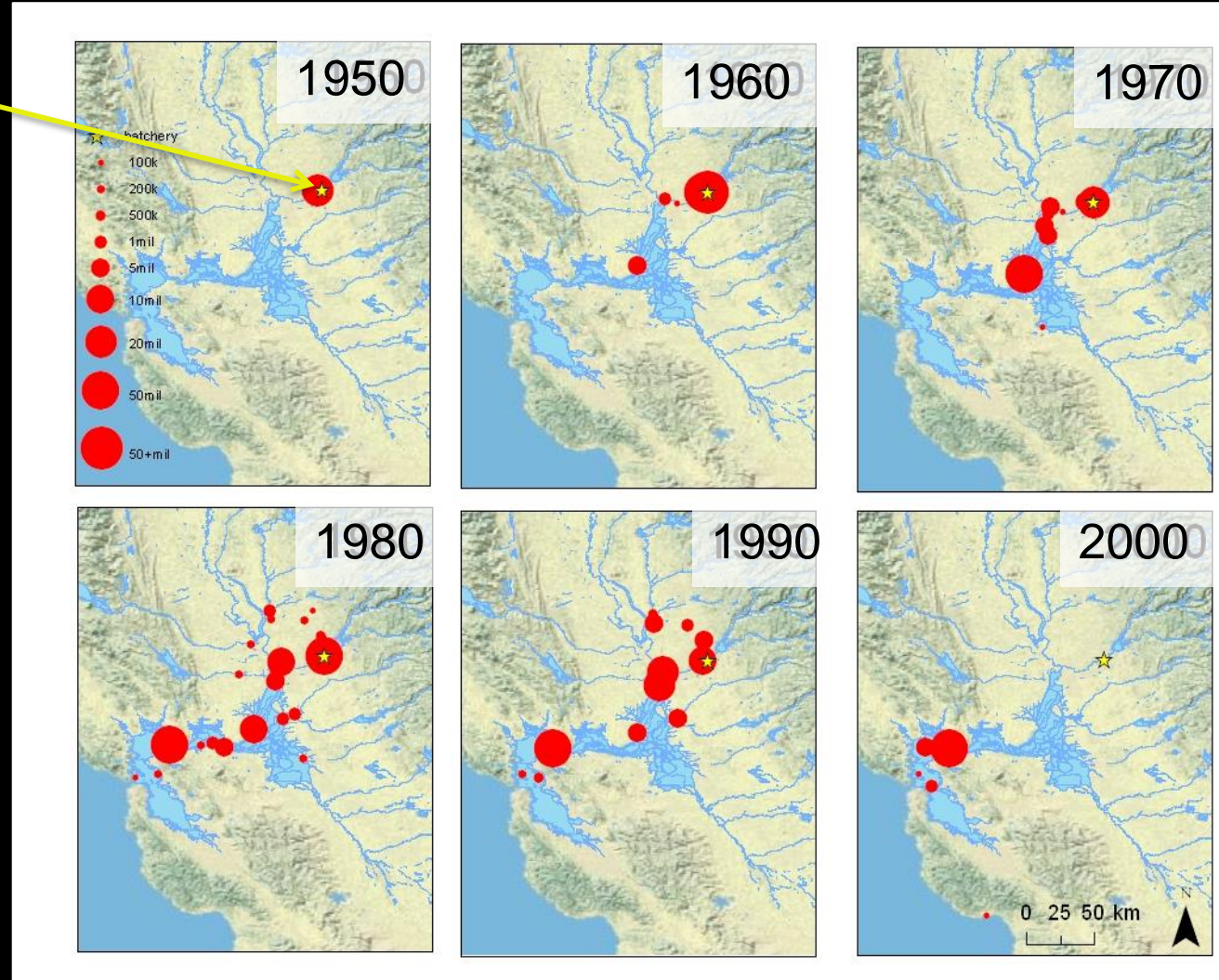
River



Salmon hatcheries: trucking

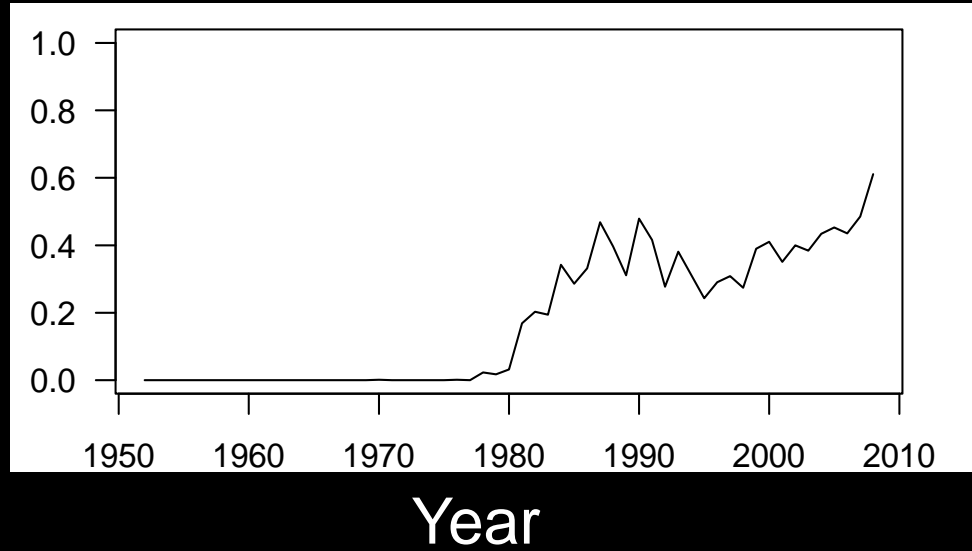


Hatchery
Nimbus
hatchery
release
sites

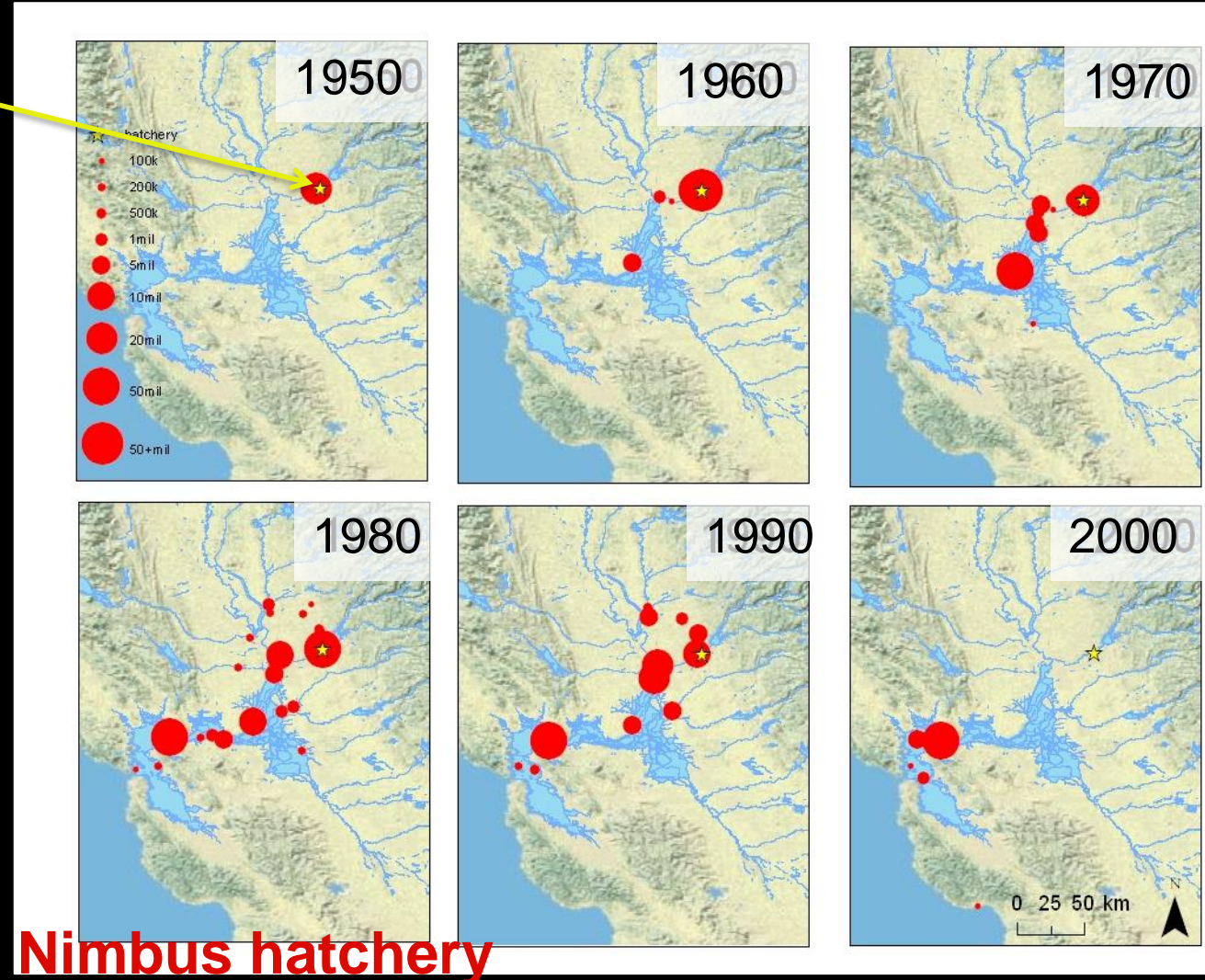


Salmon hatcheries: trucking

Proportion released to Bay
(all 5 hatcheries)

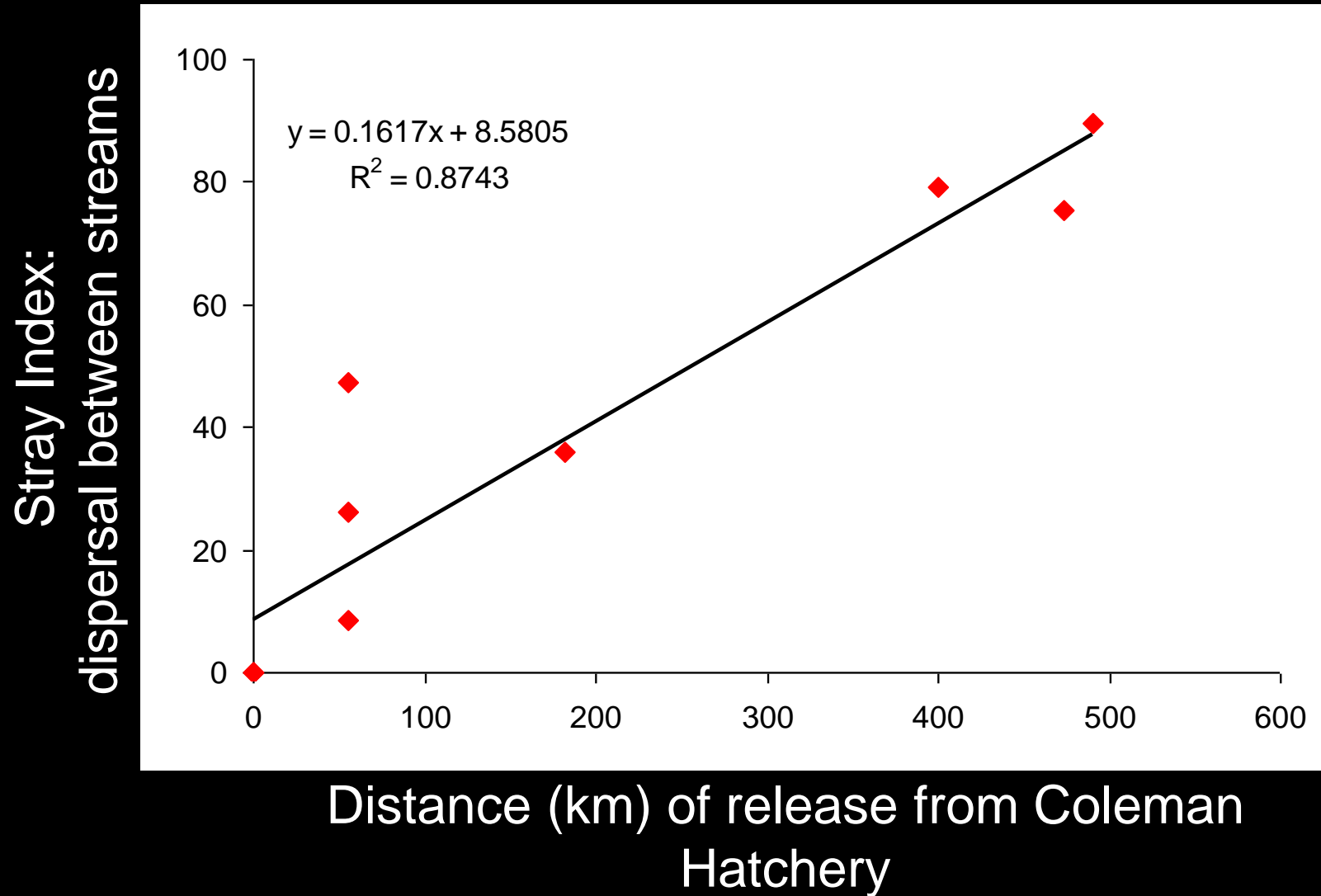


Hatchery



Nimbus hatchery

Trucking increases dispersal between streams

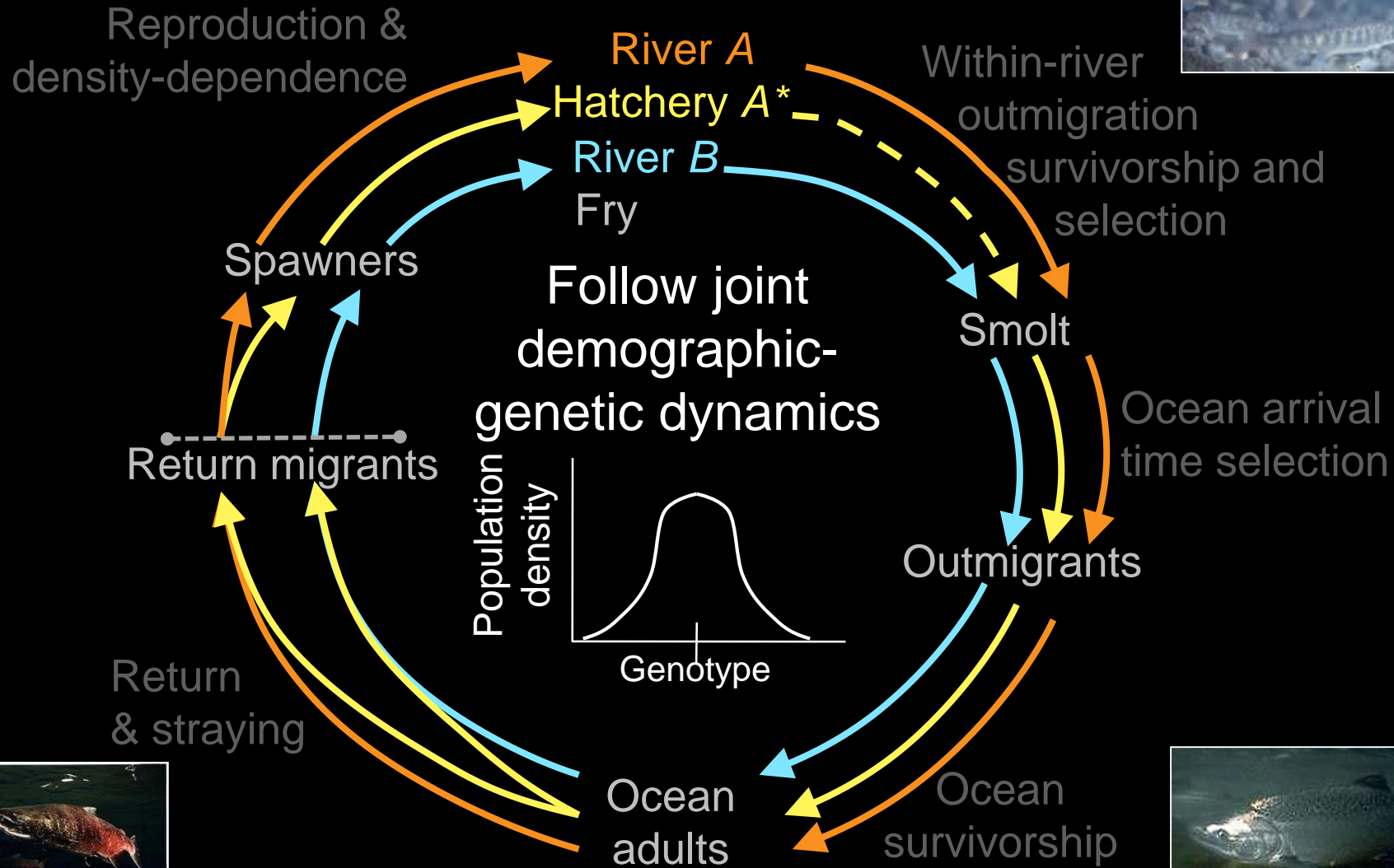


Central questions

- Can increased dispersal (through trucking) explain the increased variability in California's salmon?
 - What is the relative contribution of demographic synchrony versus genetic homogenization to increased variability?

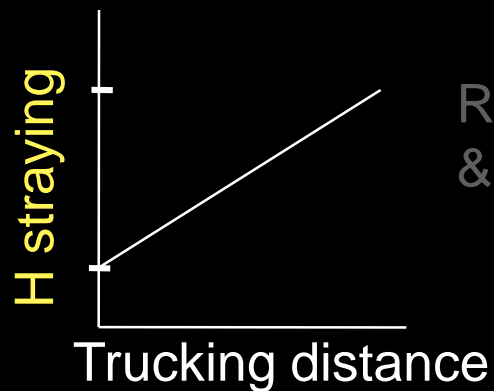
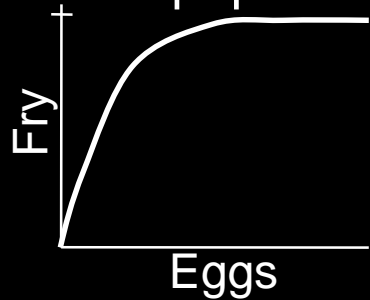


Model

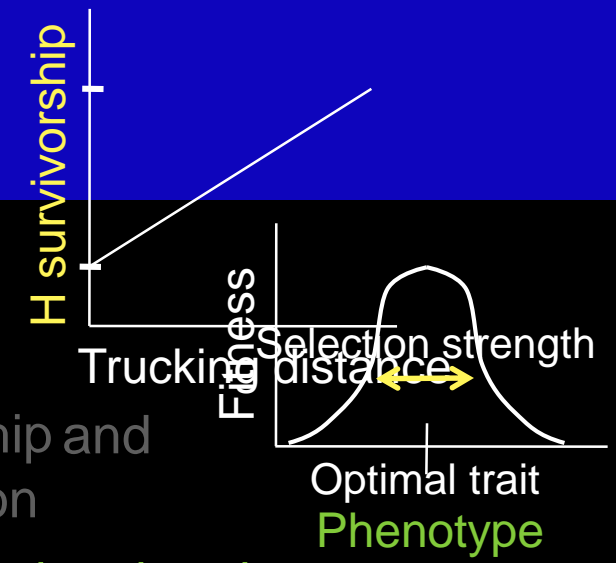
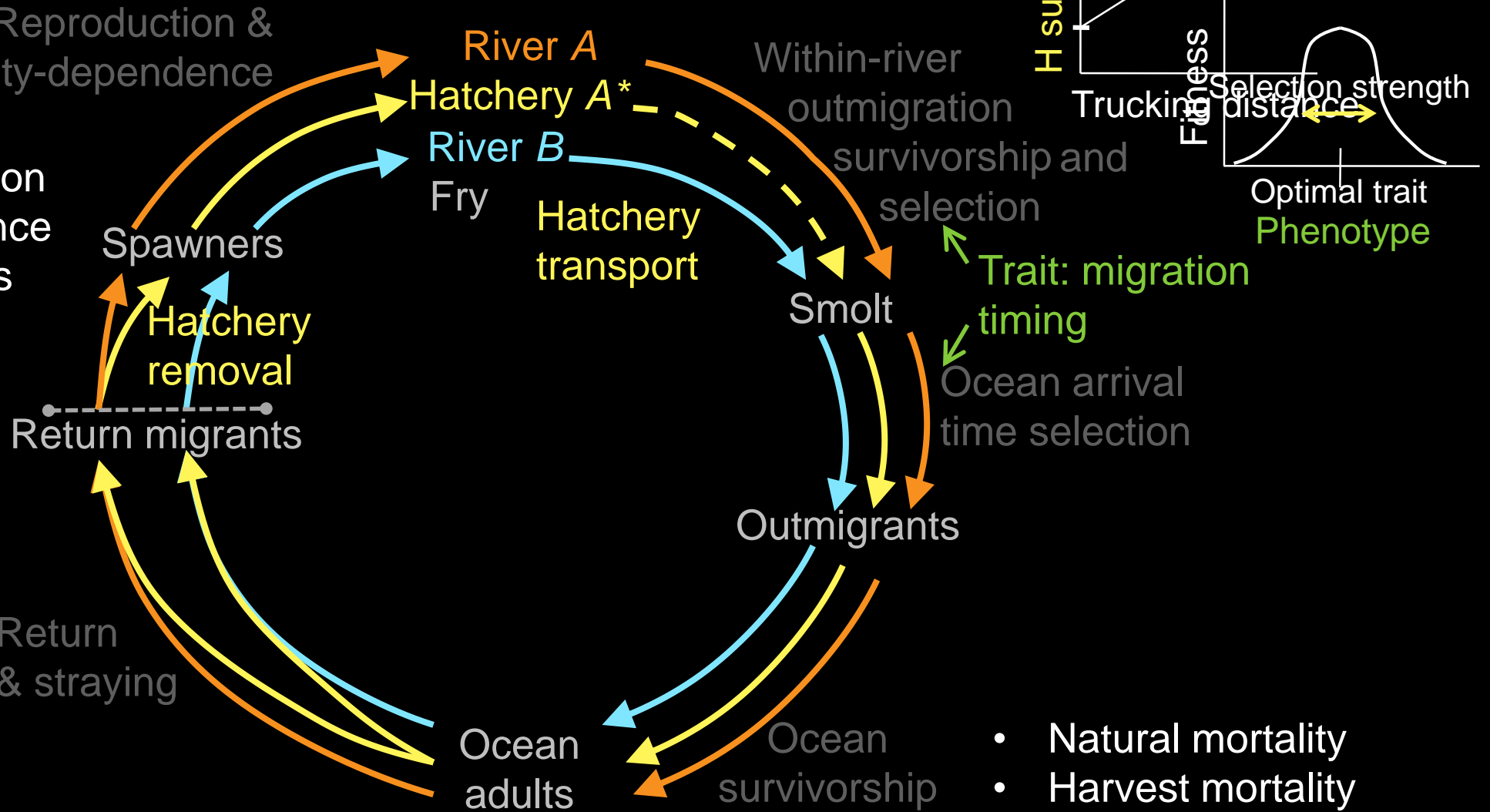


Model

- Random mating
- Offspring production
- Density dependence in wild populations



Reproduction & density-dependence

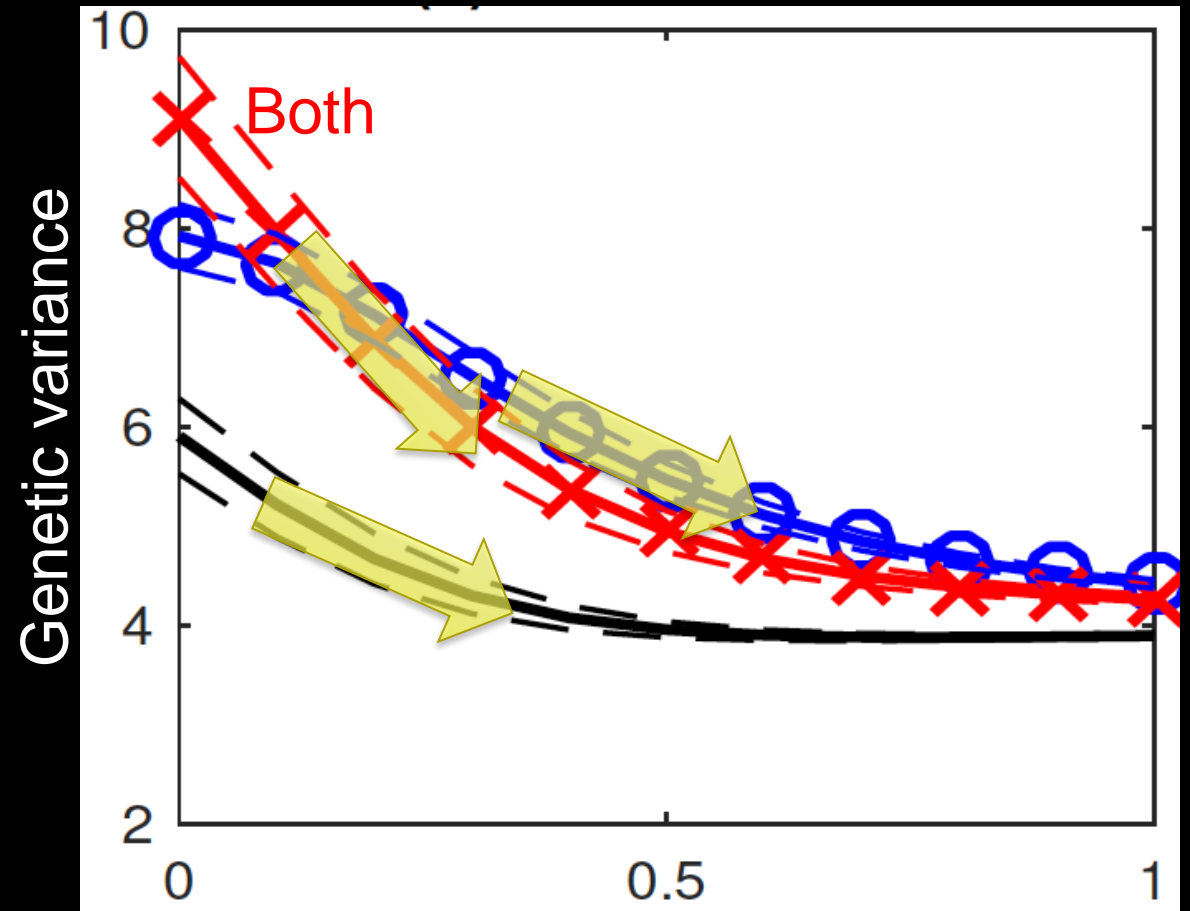
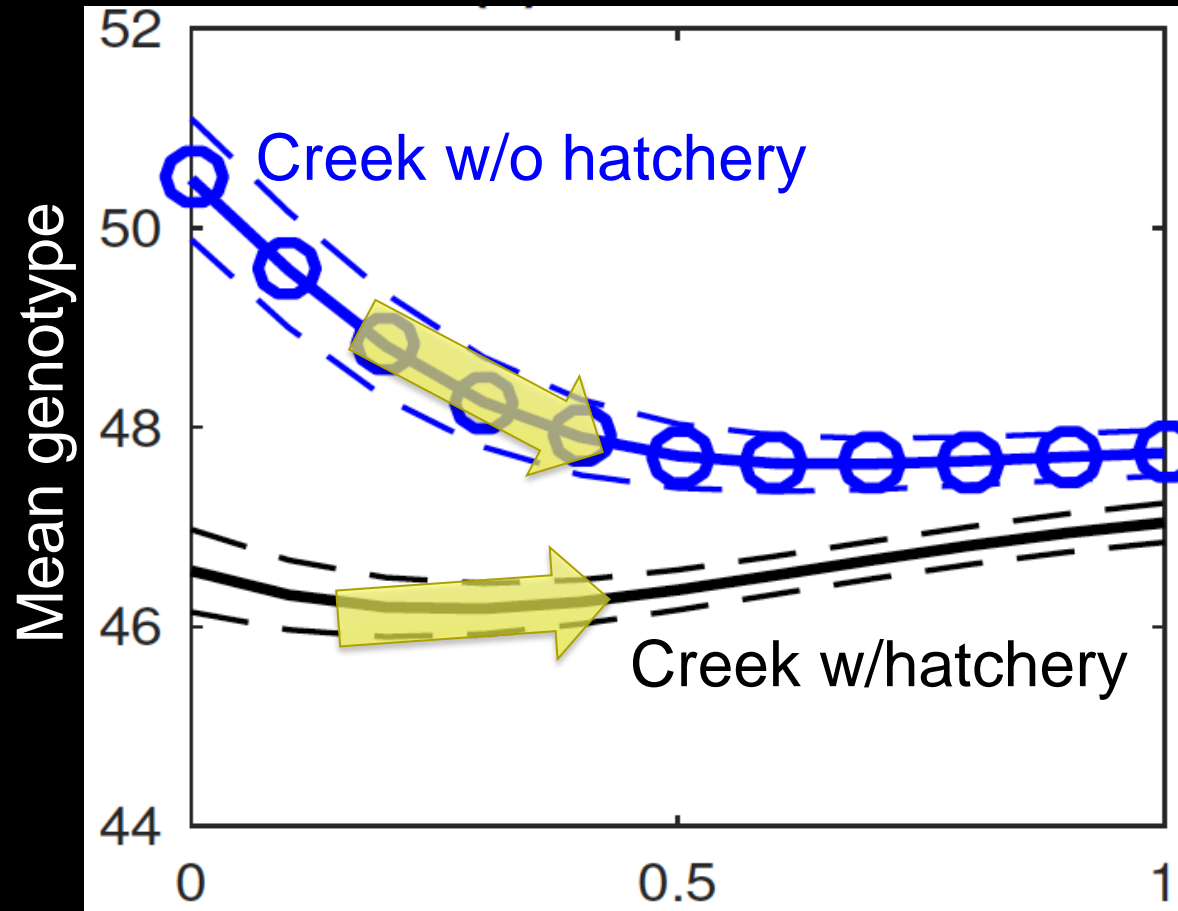


Trait: migration timing

Ocean arrival time selection

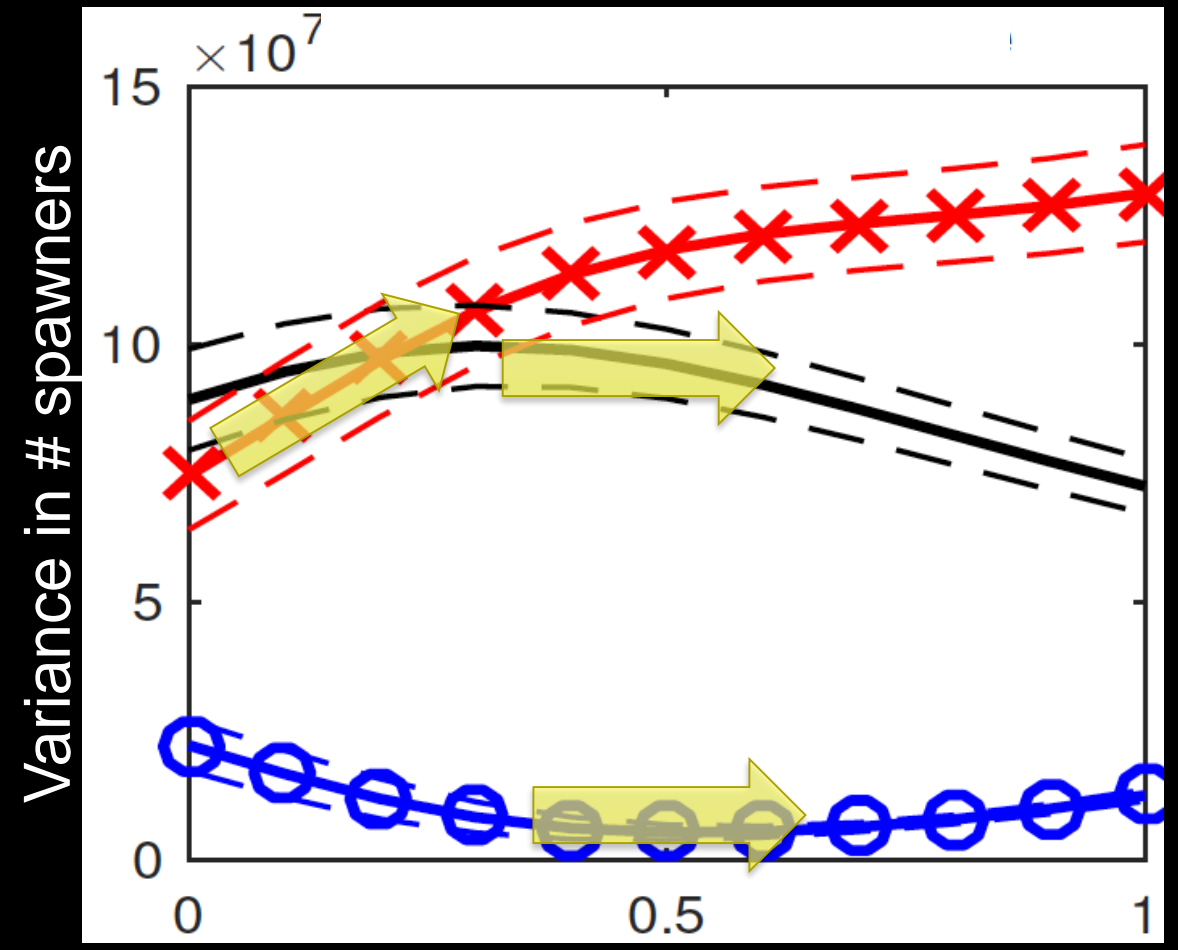
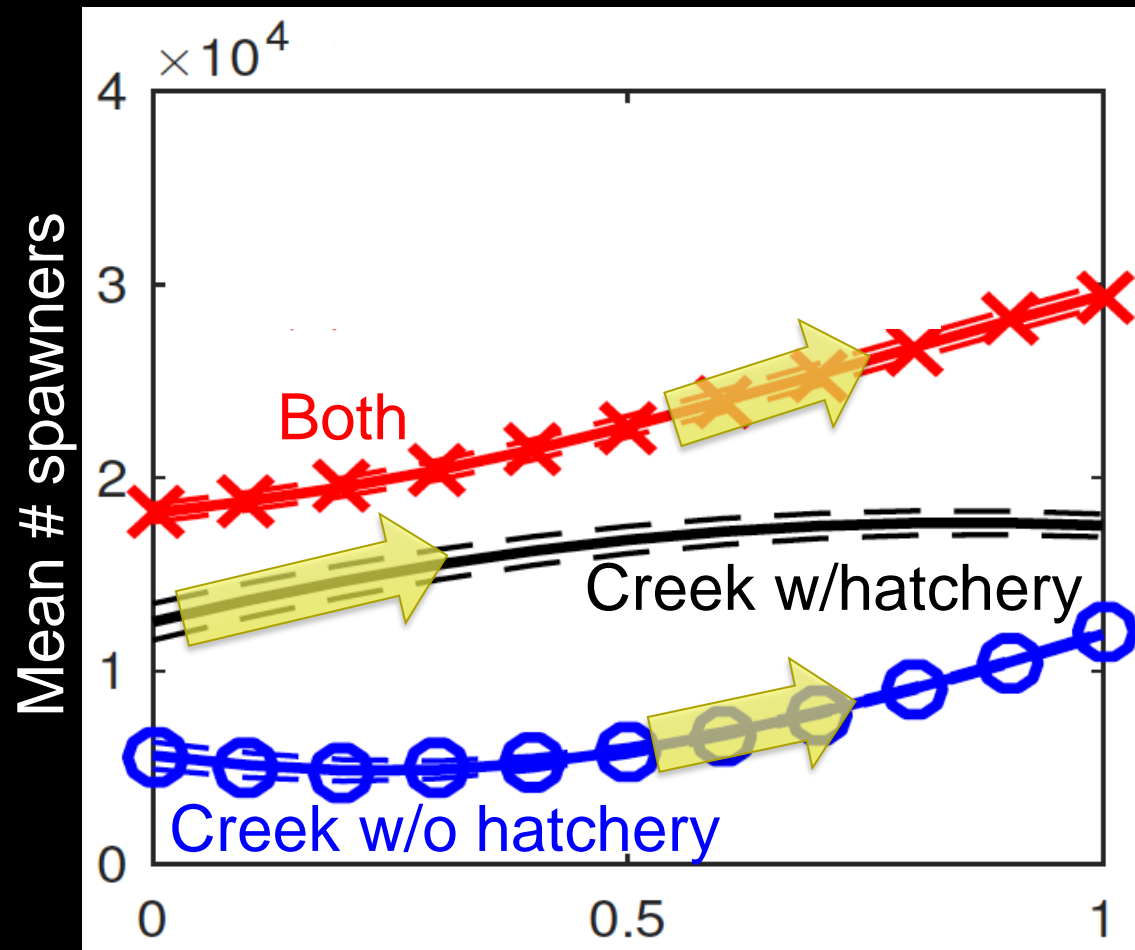
- Natural mortality
- Harvest mortality

Trucking increases genetic similarity



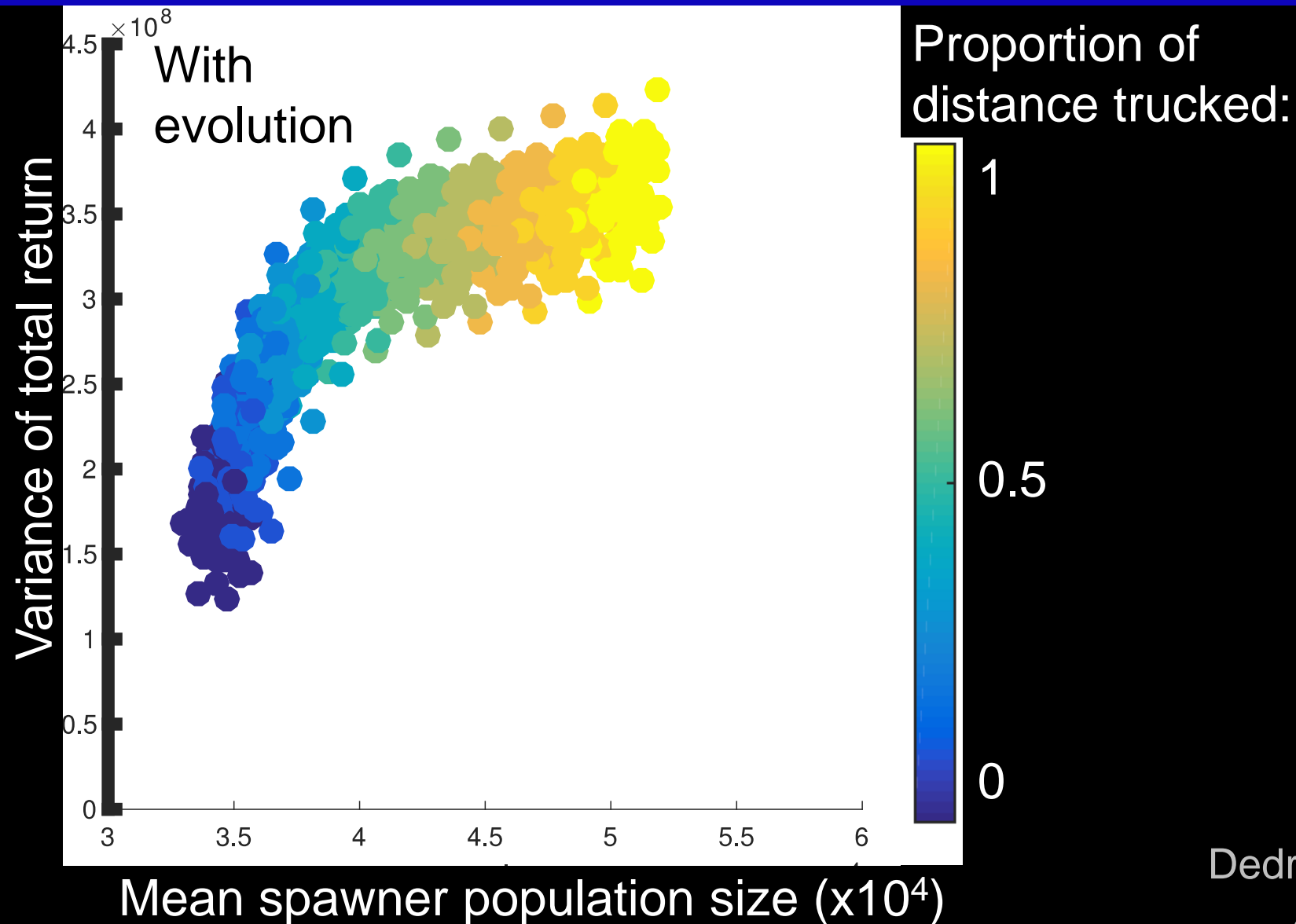
Proportion of distance trucked

Population size and variability increase w/trucking

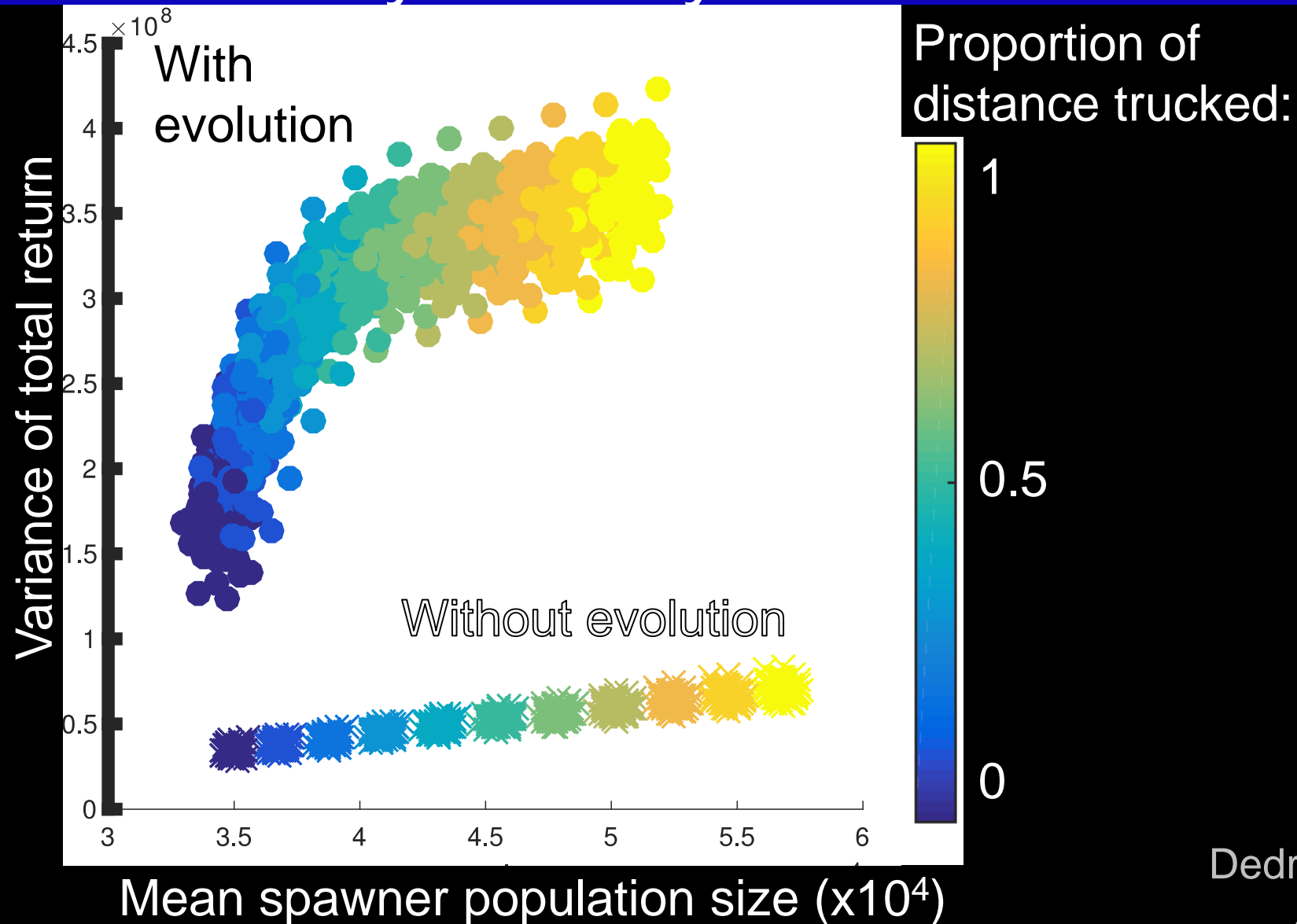


Proportion of distance trucked

Trade-off between population size and variability



Genetic homogenization outweighs demographic synchrony effects



Conclusions

- **Trucking can drive increased variability in salmon**
 - Genetic homogenization >> demographic synchrony in driving increased variability
- **For SOTM:**
 - There can be a such thing as too much dispersal, especially:
 - a) Considering genetic differentiation across locations, &
 - b) If environmental variation increases with climate change



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