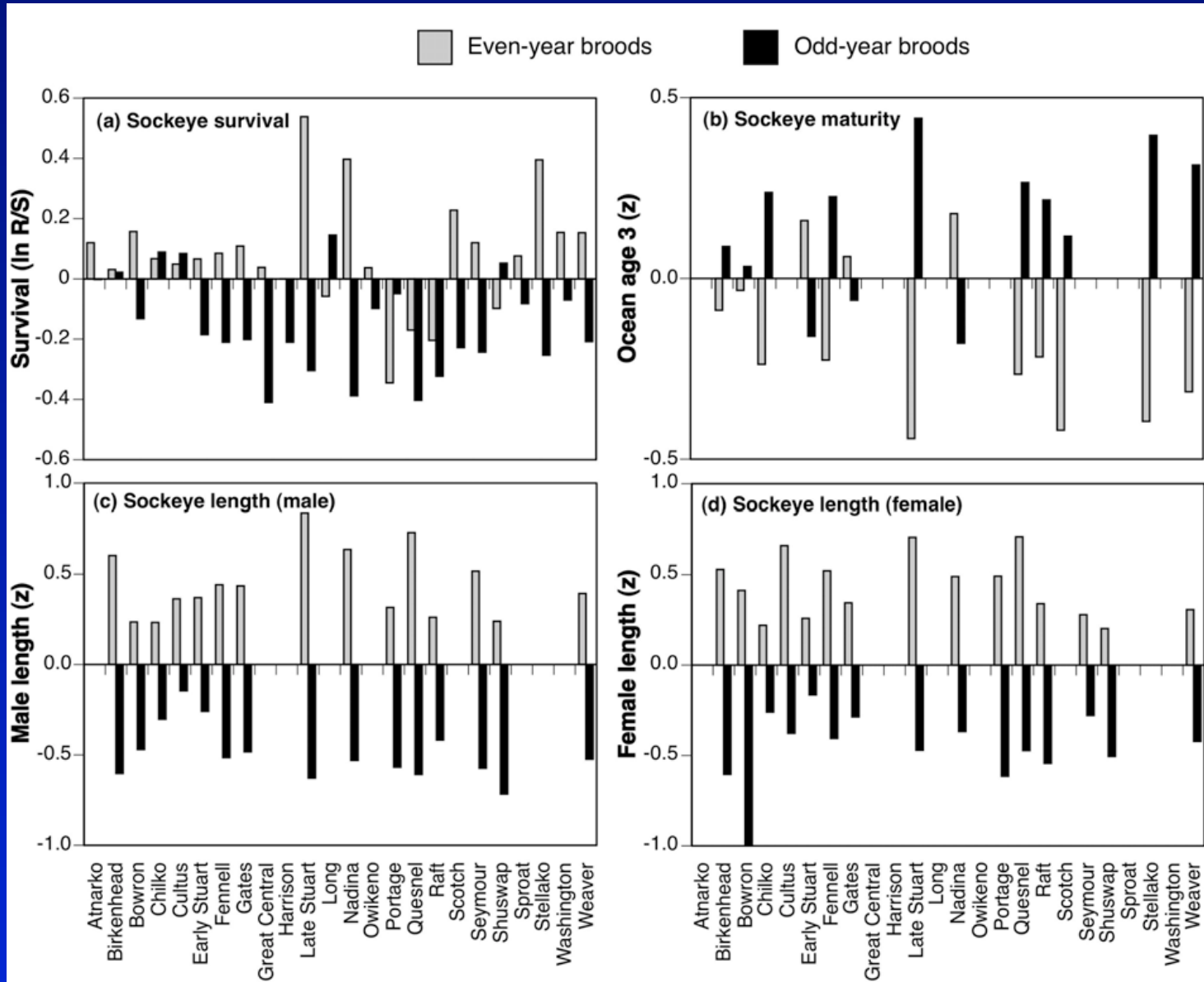


# Could competition with pink salmon influence the multi-regional decline in sockeye survival?

- Populations from region of synchronous decline
- Interactions with pinks at multiple temporal and spatial scales
- Multiple lines of evidence (growth; age at maturity; life-time productivity)
- Multiple factors (inter- and intra - specific competition; climate)

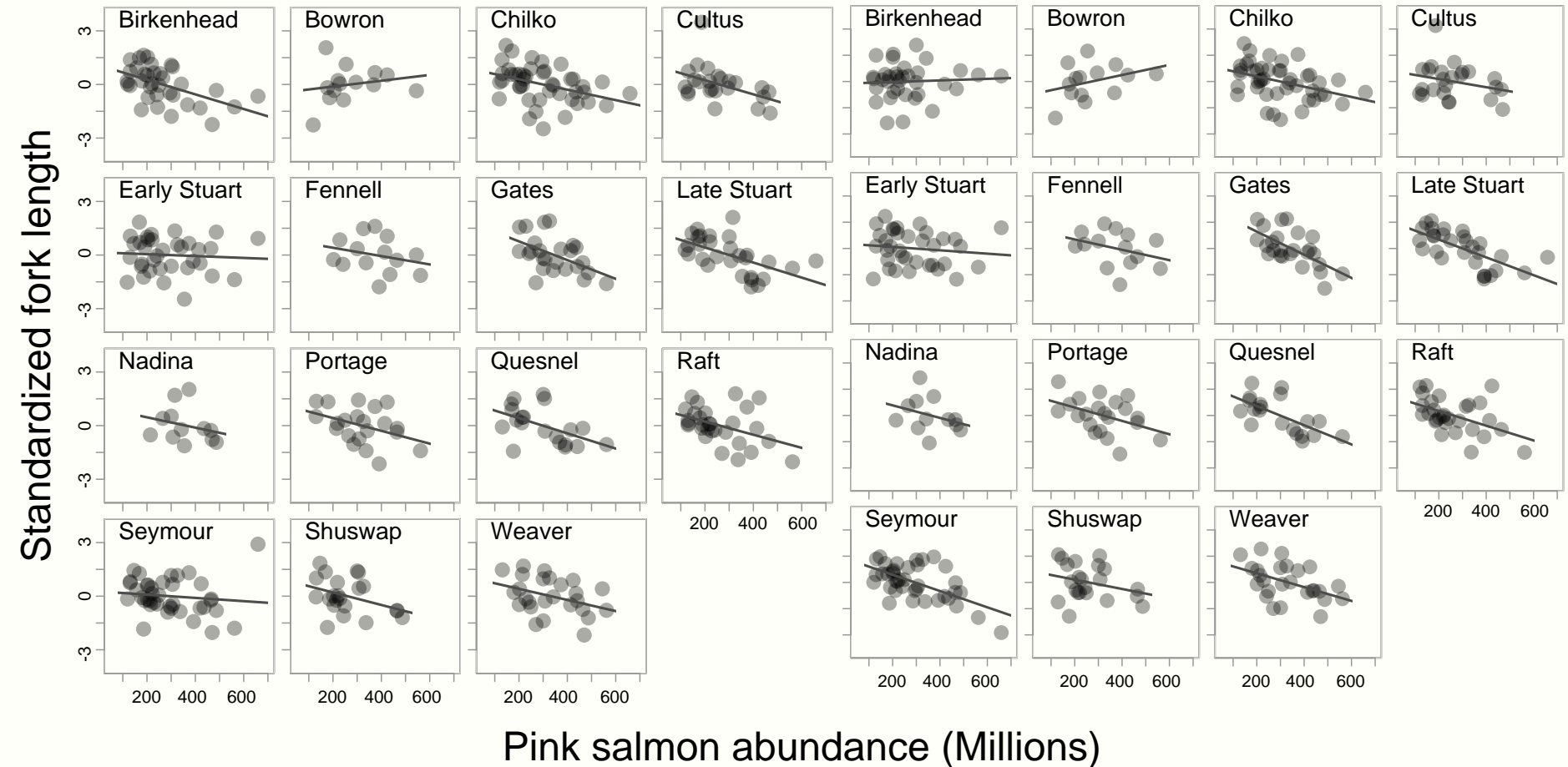
# Odd/even year patterns in sockeye salmon



# Sockeye length-at-age declined with increasing abundance of pink salmon

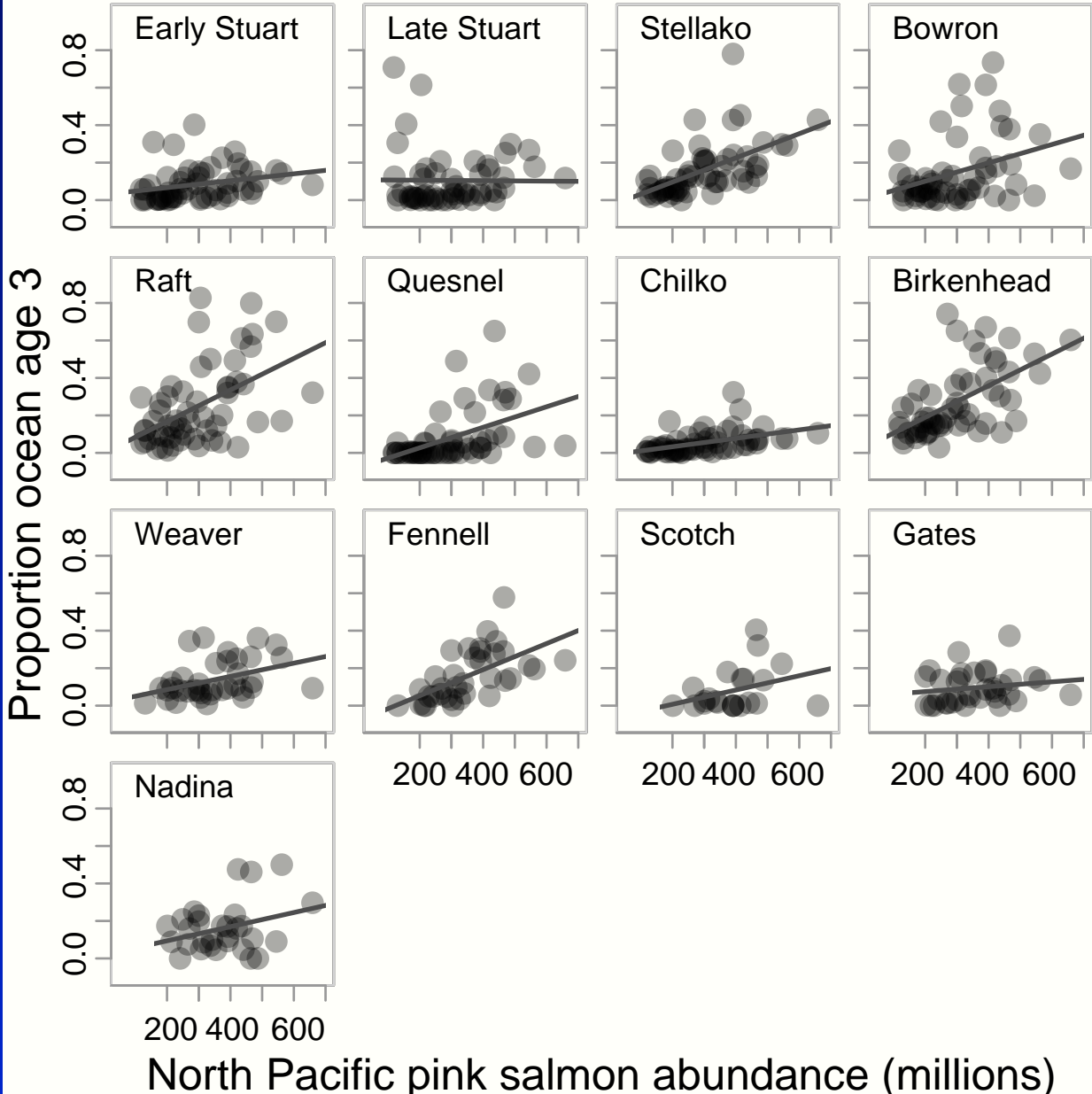
Male

Female



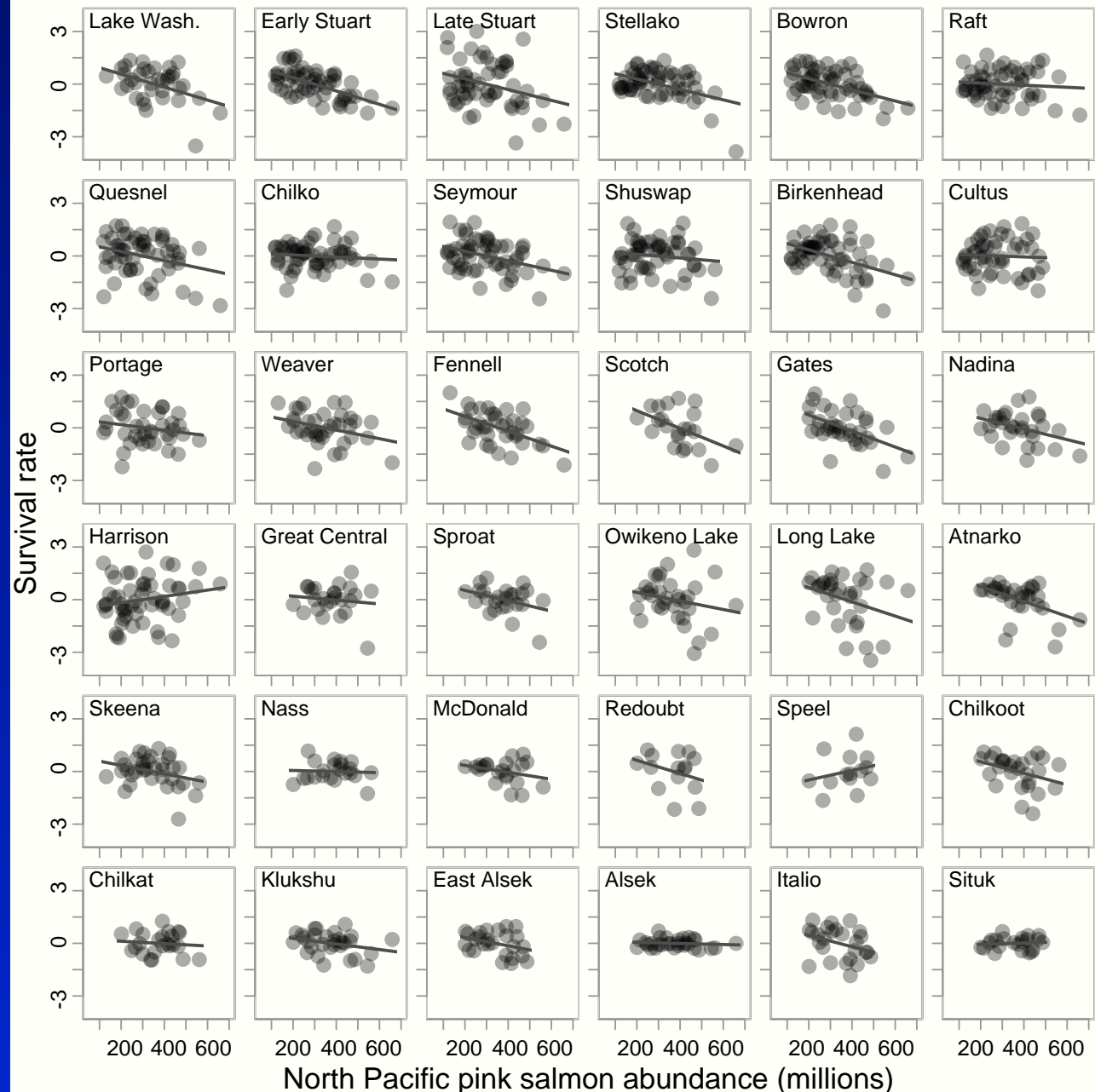
Pink salmon abundance (Millions)

Sockeye delayed maturation with increasing abundance of pink salmon

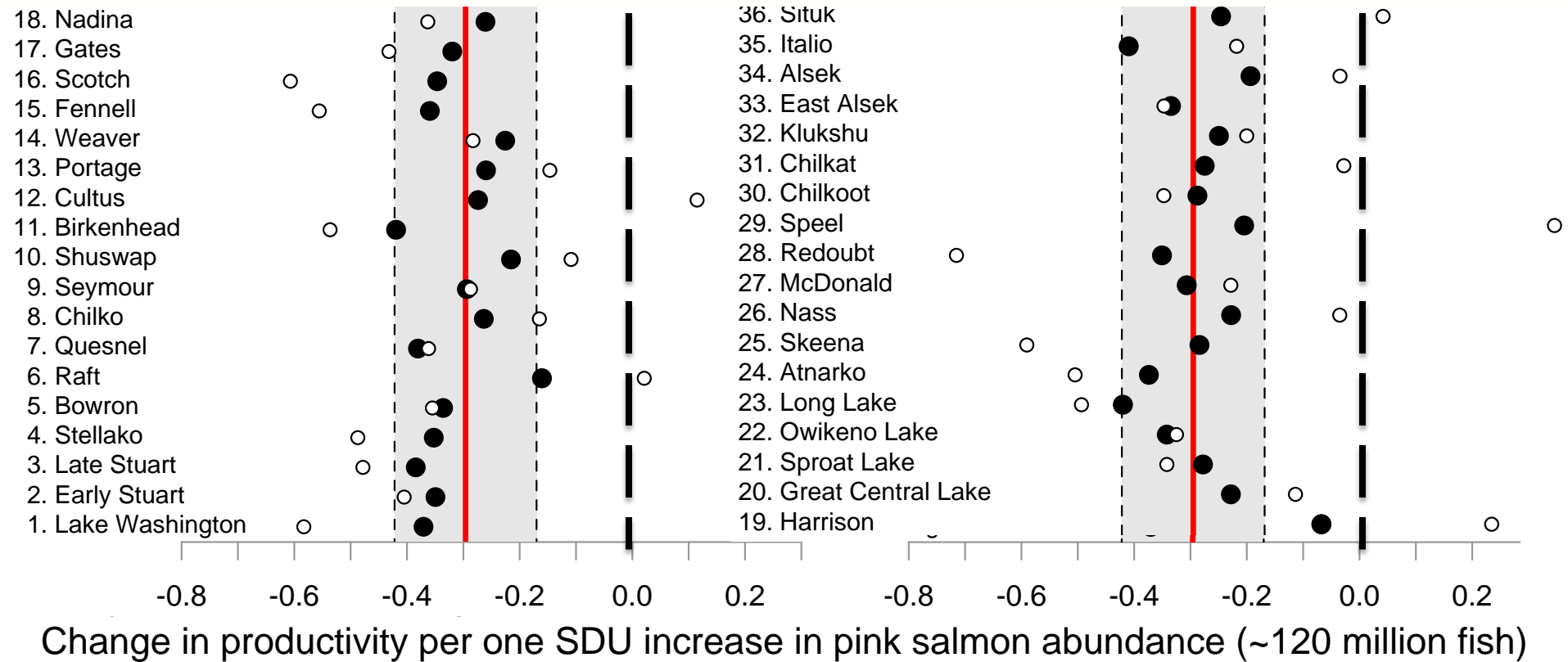


Sockeye survival declined with increasing abundance of pink salmon

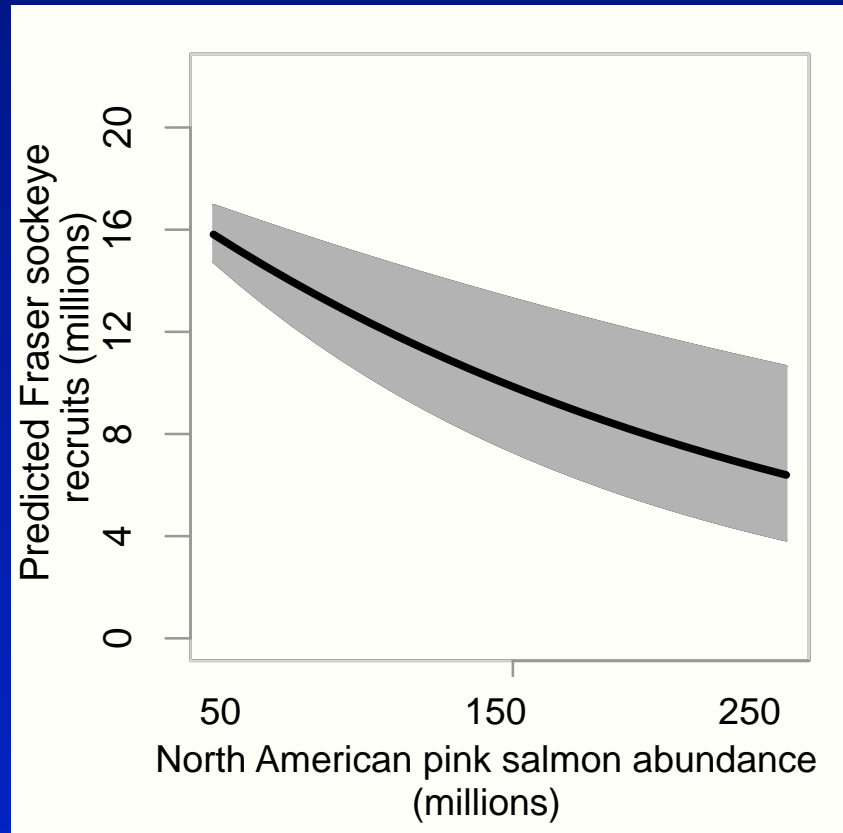
Survival = residual from Ricker curve



# Multi-model average predicted relationship: Productivity



# Predicted effect of pink salmon on Fraser sockeye abundance



- Per capita effect of North American pink salmon greater than per capita effect of North Pacific pink salmon
- Analysis indicates adverse impact of massive hatchery pink salmon production in Alaska on Fraser sockeye





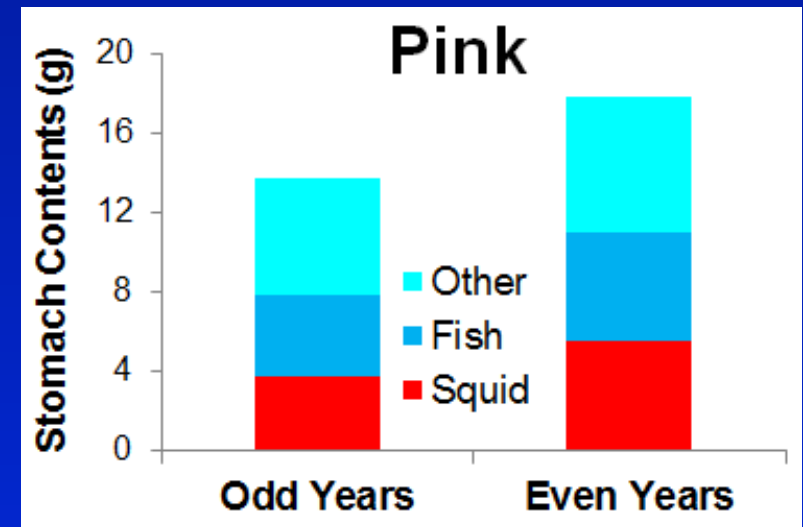
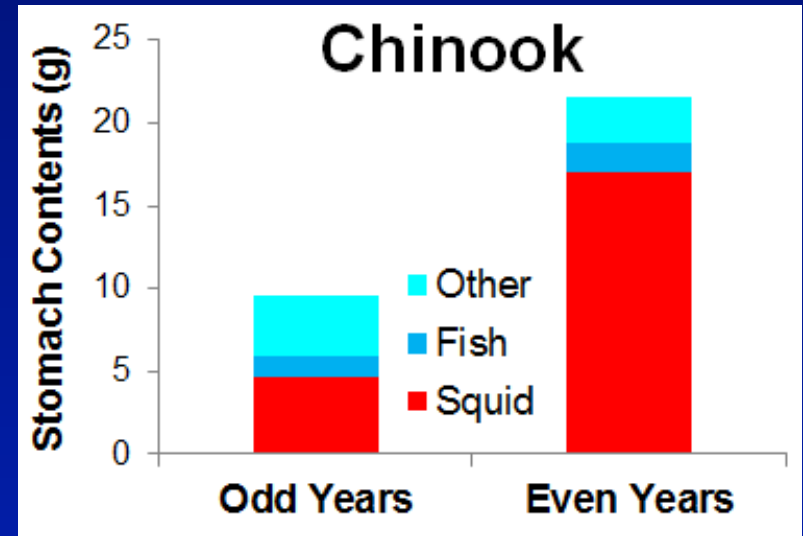
# Pink Salmon Interactions with Chinook Salmon

Photo by A. Solonsky



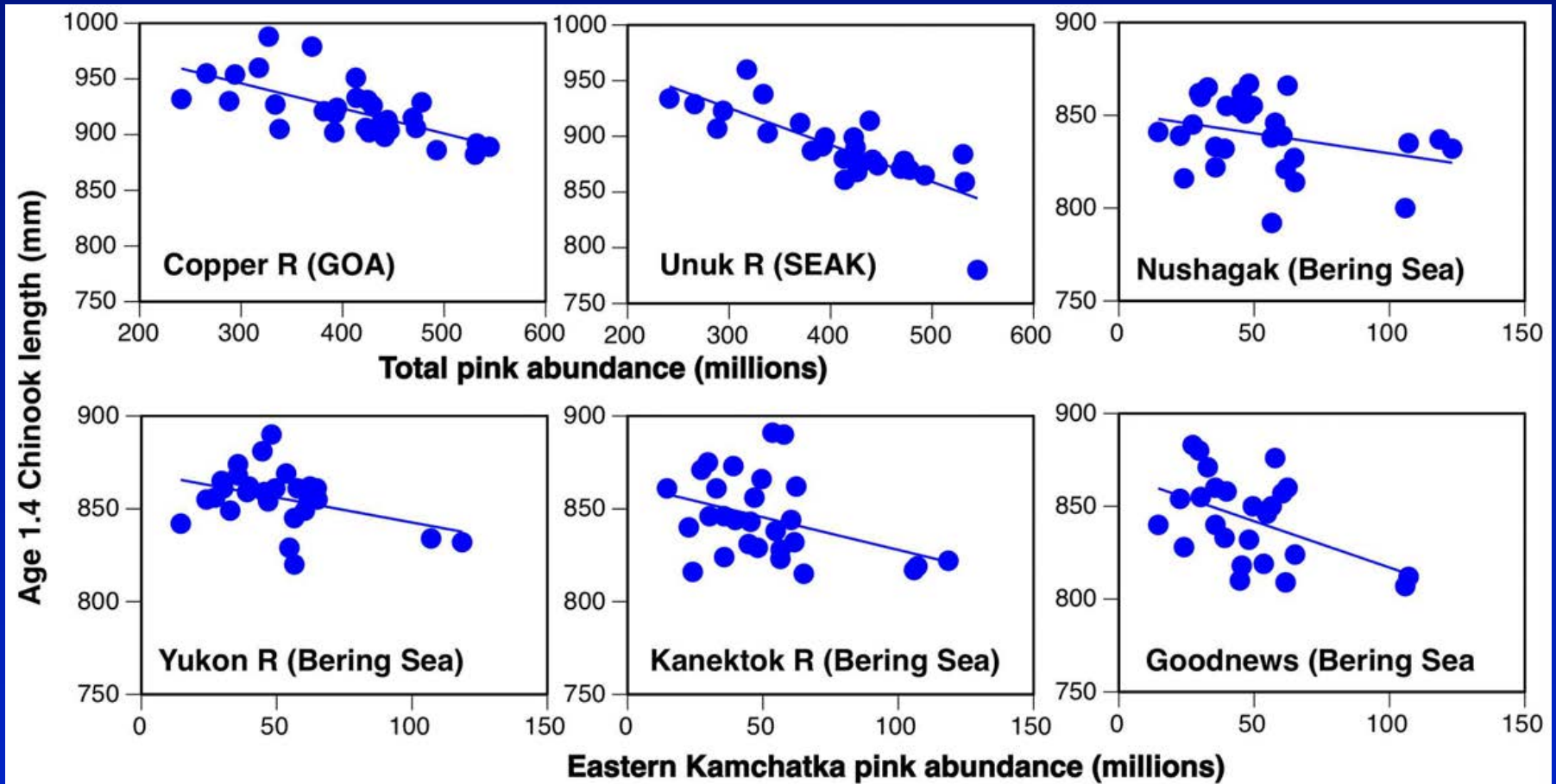
# Are Pink Salmon Reducing Chinook Growth & Survival?

- Chinook feed at higher trophic level, but considerable diet overlap:  
**Squid & Fish**
- **Bering Sea: Odd-yrs 1991-2000**  
**56% decline** Chinook stomach fullness  
**68% reduction** in squid & fish in Chinook
- Source: Davis 2003



# Do Pink Salmon Impact Chinook Salmon?

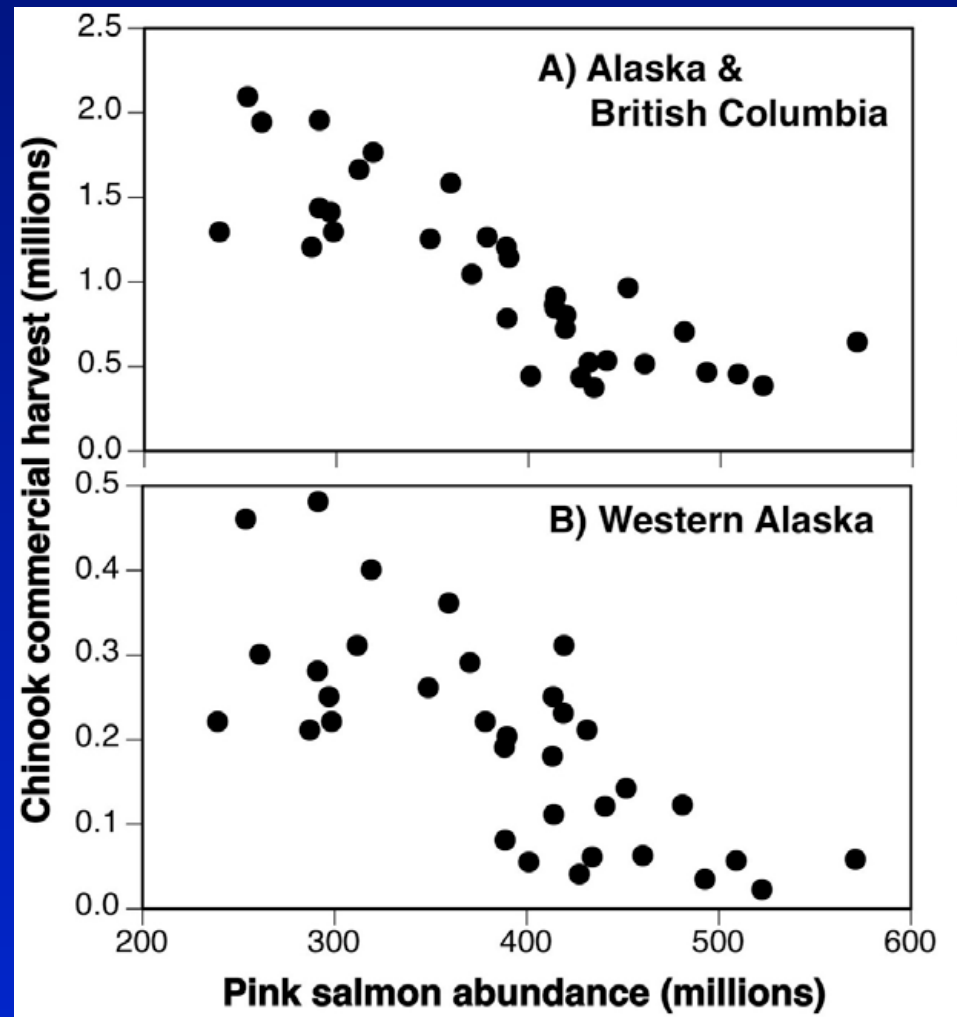
Chinook Length on pink salmon abundance



# Are Pink Salmon Reducing Chinook Survival?

- Chinook abundance depressed throughout Alaska
- Several new Stocks of Concern listings in SEAK
- Long-term decline in size at age & age at maturation (Lewis et al. 2015; Ohlberger et al. 2018)

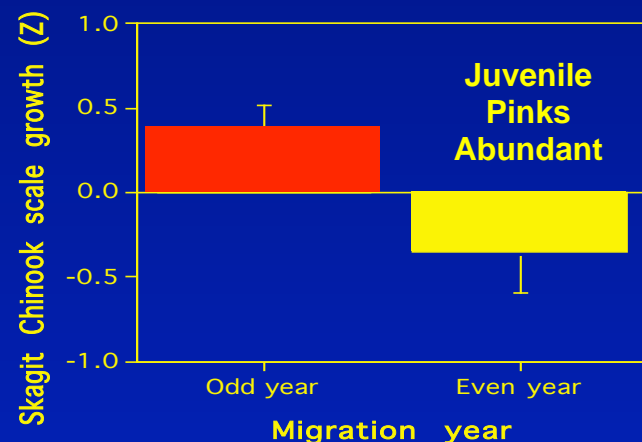
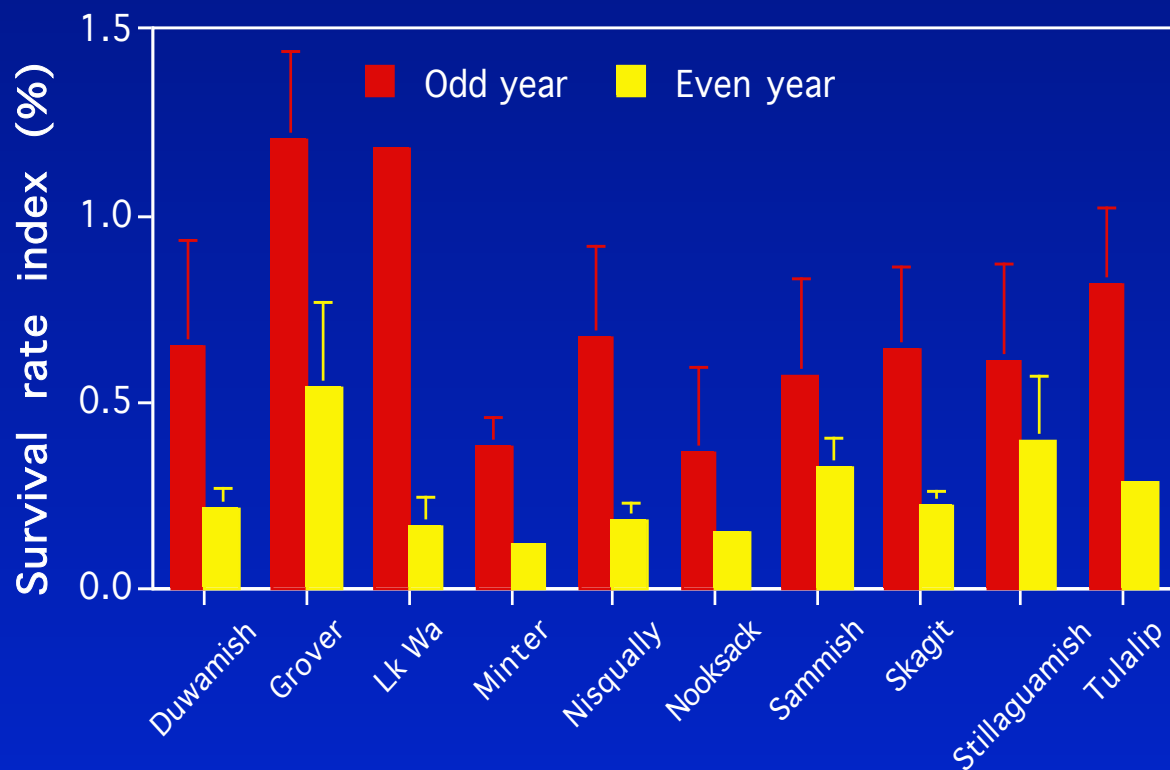
Pink salmon abundance averaged over 3 years of overlap with Chinook salmon



Years: 1980 to 2013

# Pink Salmon Effect on Salish Sea Chinook

Puget Sound Chinook survival 62% lower when migrating in even years w/ juvenile pinks salmon, 1984-1997



Survival based on code-wire-tags; CWT show pattern established during 1<sup>st</sup> year at sea

# Do Pink Salmon Affect Seabirds?

Seabirds eat same prey as pink salmon

Aleutian Islands: multiple species

Australia: shearwaters

