Pink Salmon Impacts on the North Pacific Ecosystem, including Southern Resident Killer Whales

Photo by Candice Emmons, NOAA Fisheries/NWFSC

Greg Ruggerone — **Natural Resources Consultants, Seattle, WA**

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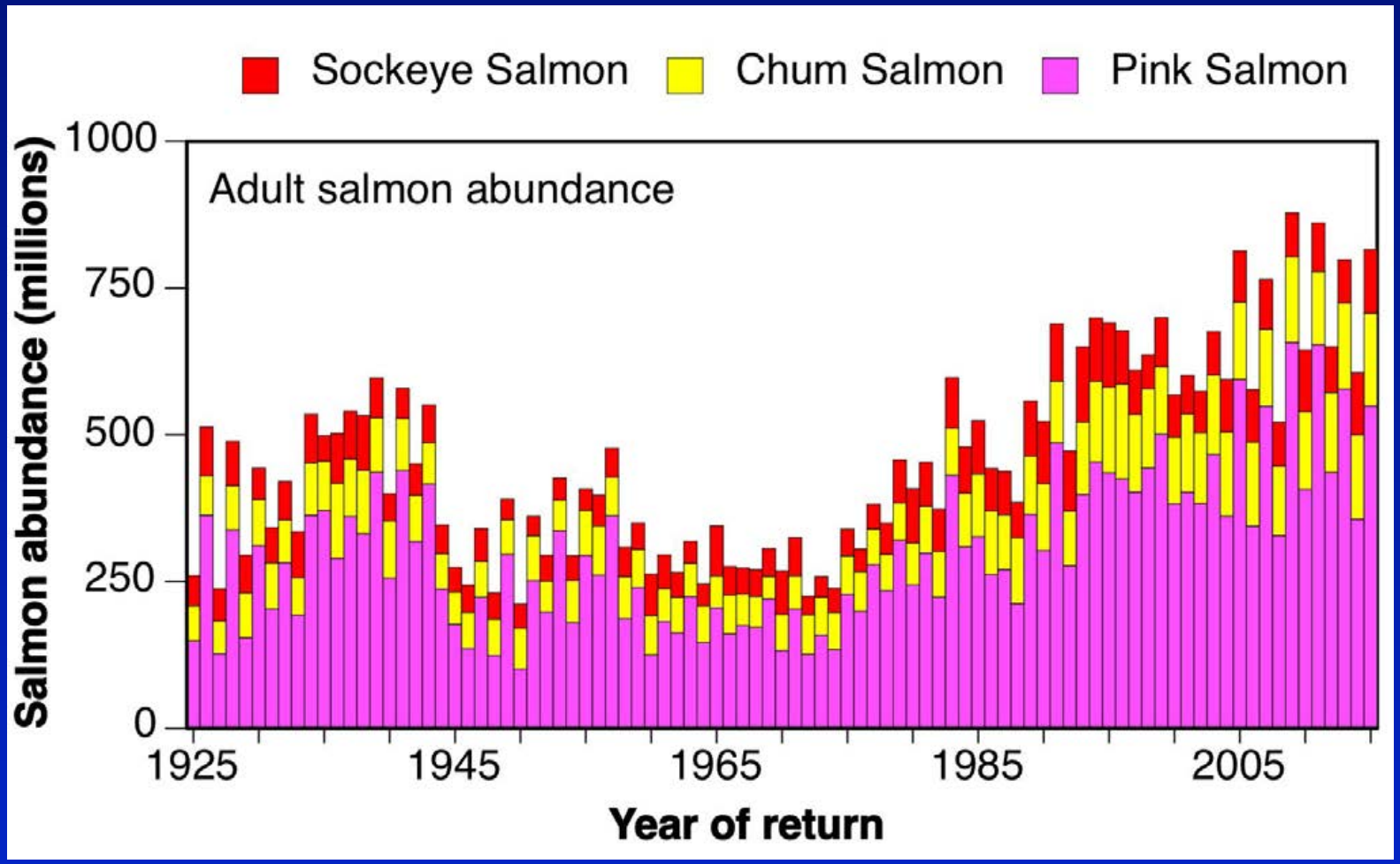
Salmon: Jennifer Nielsen, Bev Agler, Brendan Connors, Ed Farley, Jim Irvine, Kate Myers, Don Rogers, Lorna Wilson

Plankton: Sonia Batten, Ivonne Ortiz

Pink Salmon Dominate Pacific Salmon Numbers

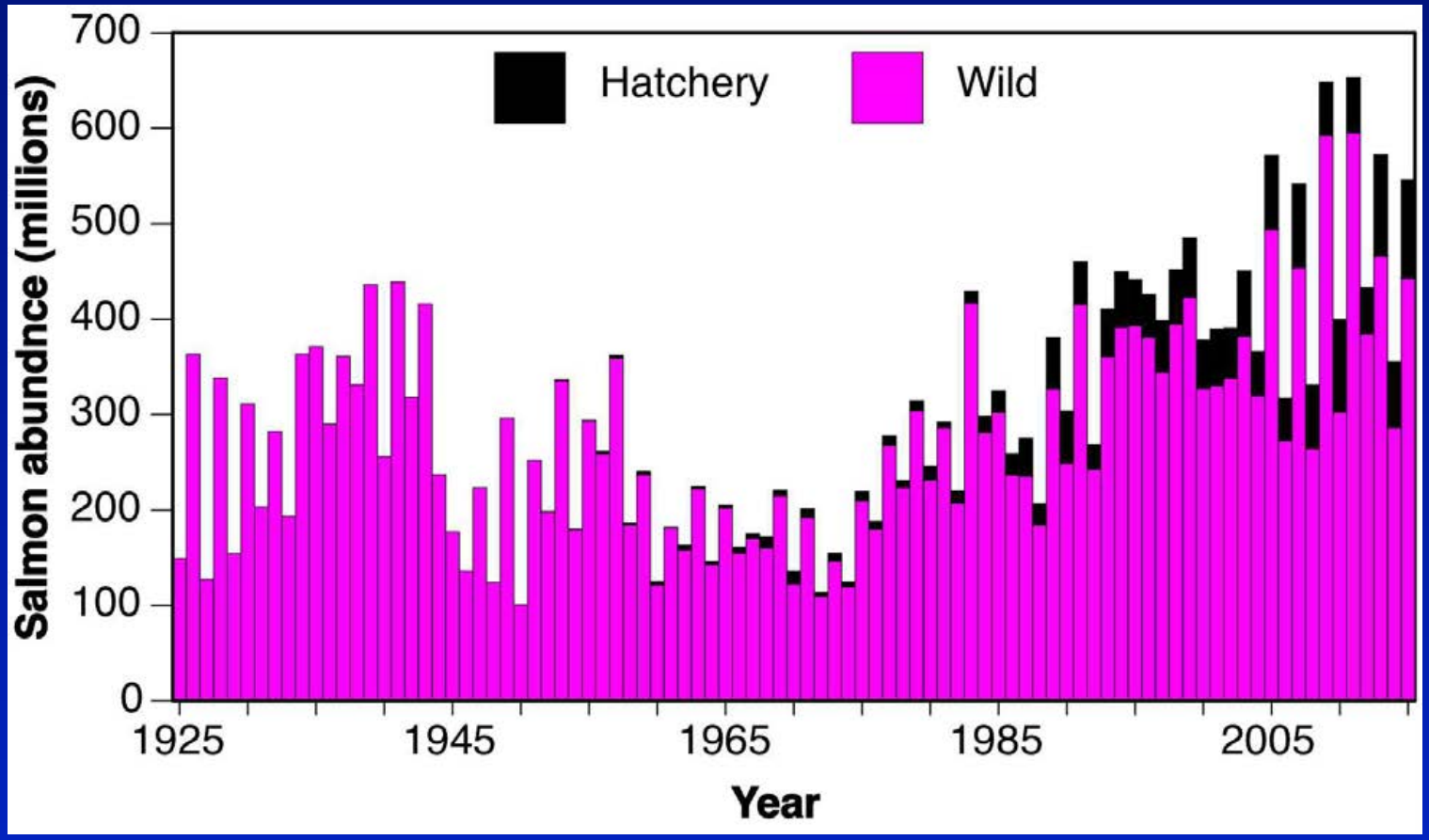


- 500 million pinks/year, 2005-2015
- Pinks nearly 70% of all salmon

Chinook, coho, steelhead
<5% of total catch biomass

Ruggerone and Irvine 2018

Pink Salmon Dominate Pacific Salmon Numbers

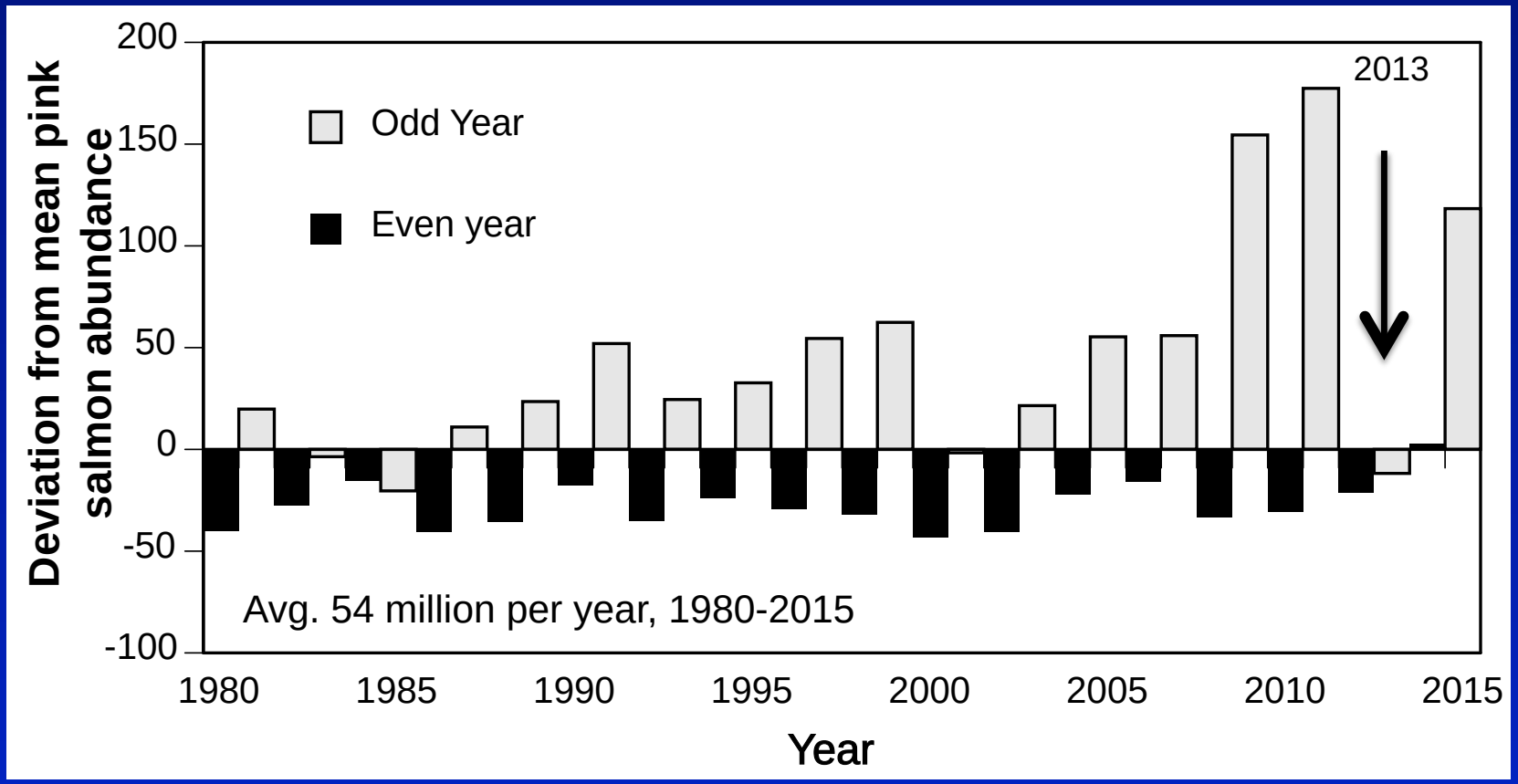


- 650 million pink salmon in peak odd-years
- Hatchery pinks = 82 million/yr, 2005-2015; > wild chum; = wild sockeye
- Alaska: up to 48% commercial catch = hatchery fish (mostly pinks)

Ruggerone and Irvine 2018

Eastern Kamchatka Pink Salmon Abundance

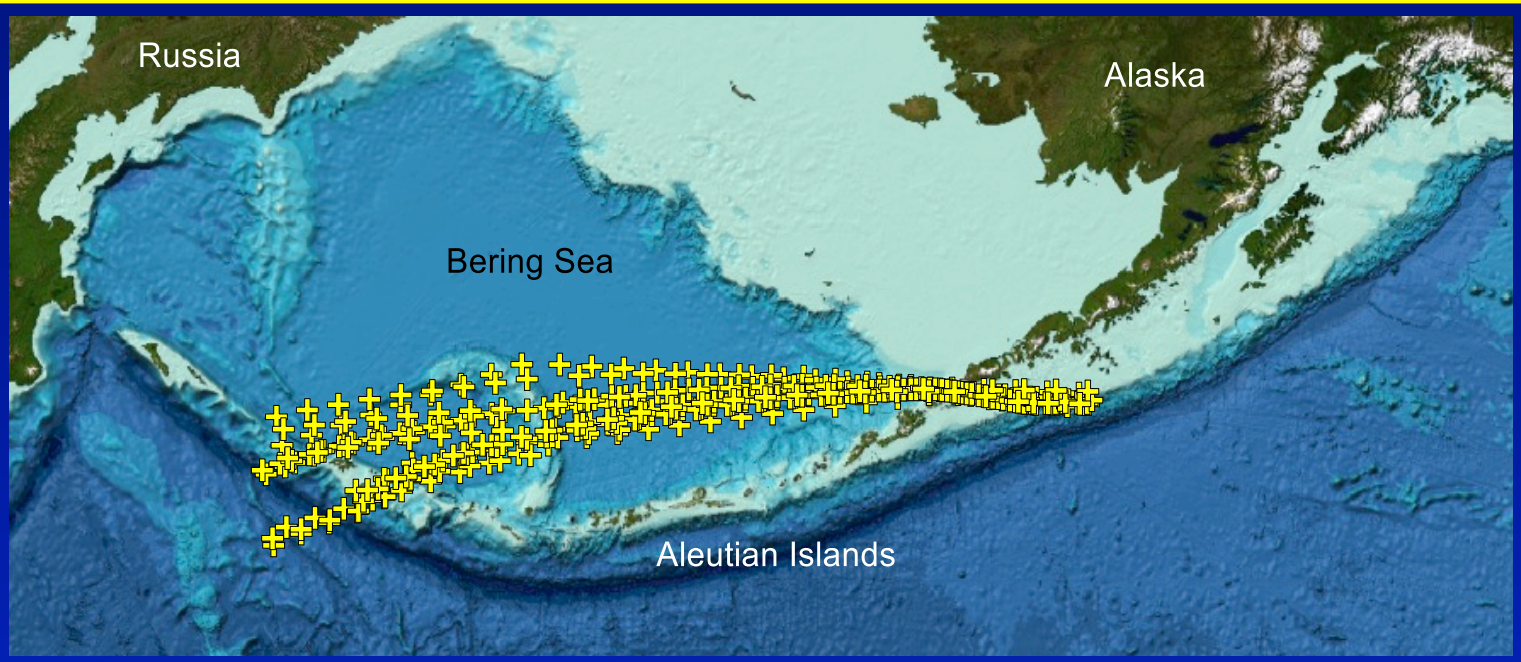
Major Population in Central Pacific/Bering Sea

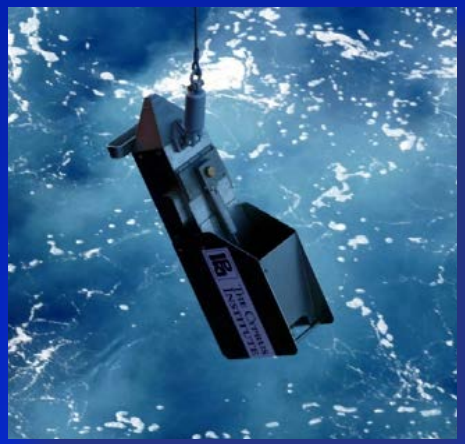


- Abundance exceptional in odd years on high seas
- Overlap with Bristol Bay sockeye and populations from south

Do Pink Salmon Cause a Trophic Cascade?

Continuous plankton recorder, June-Aug., 2000-2014





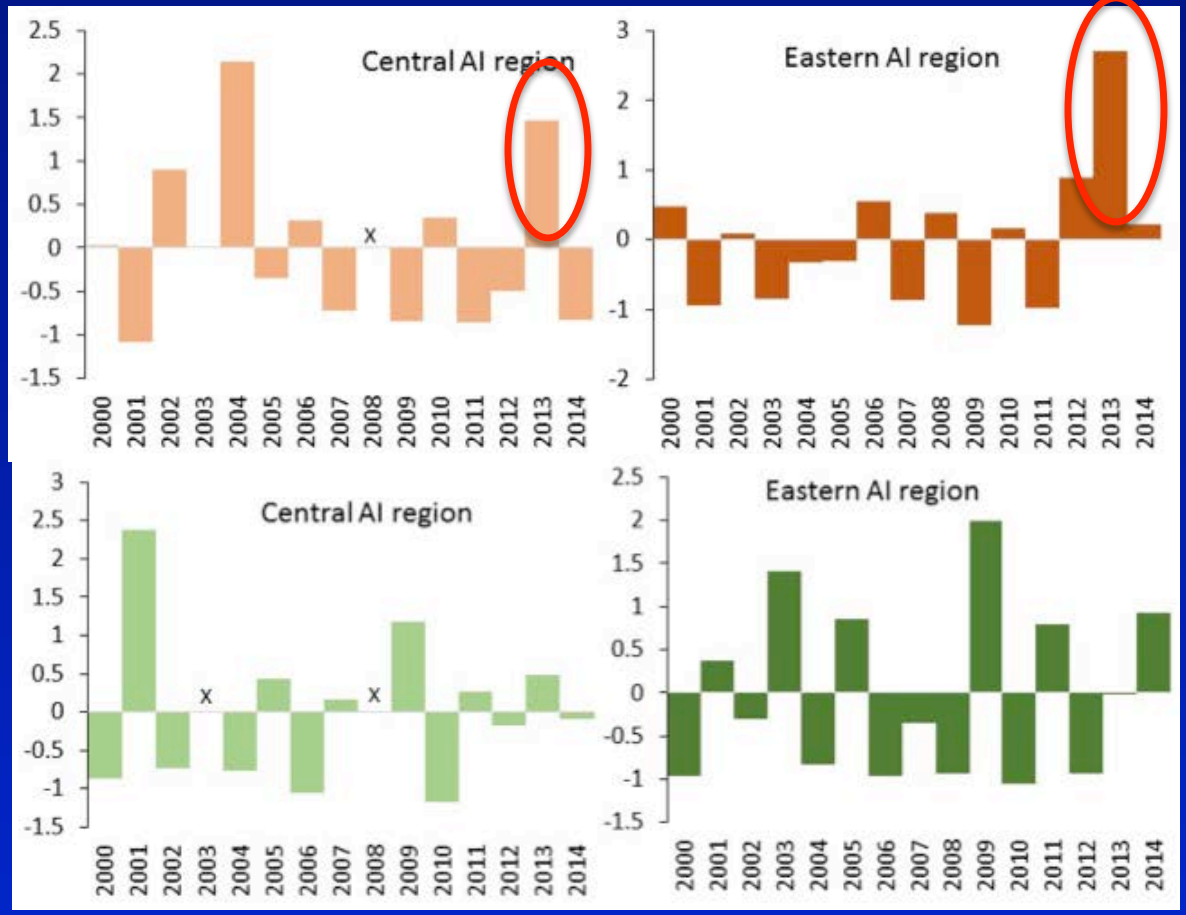
Batten, Ruggerone, Ortiz 2018

Do Pink Salmon Cause a Trophic Cascade?

Plankton Counts: June-Aug 2000-2014

Large copepods decline in odd years when pinks ~40x more abundant

Diatoms increase in odd years when more pinks and fewer zooplankton



Batten, Ruggerone Ortiz 2018

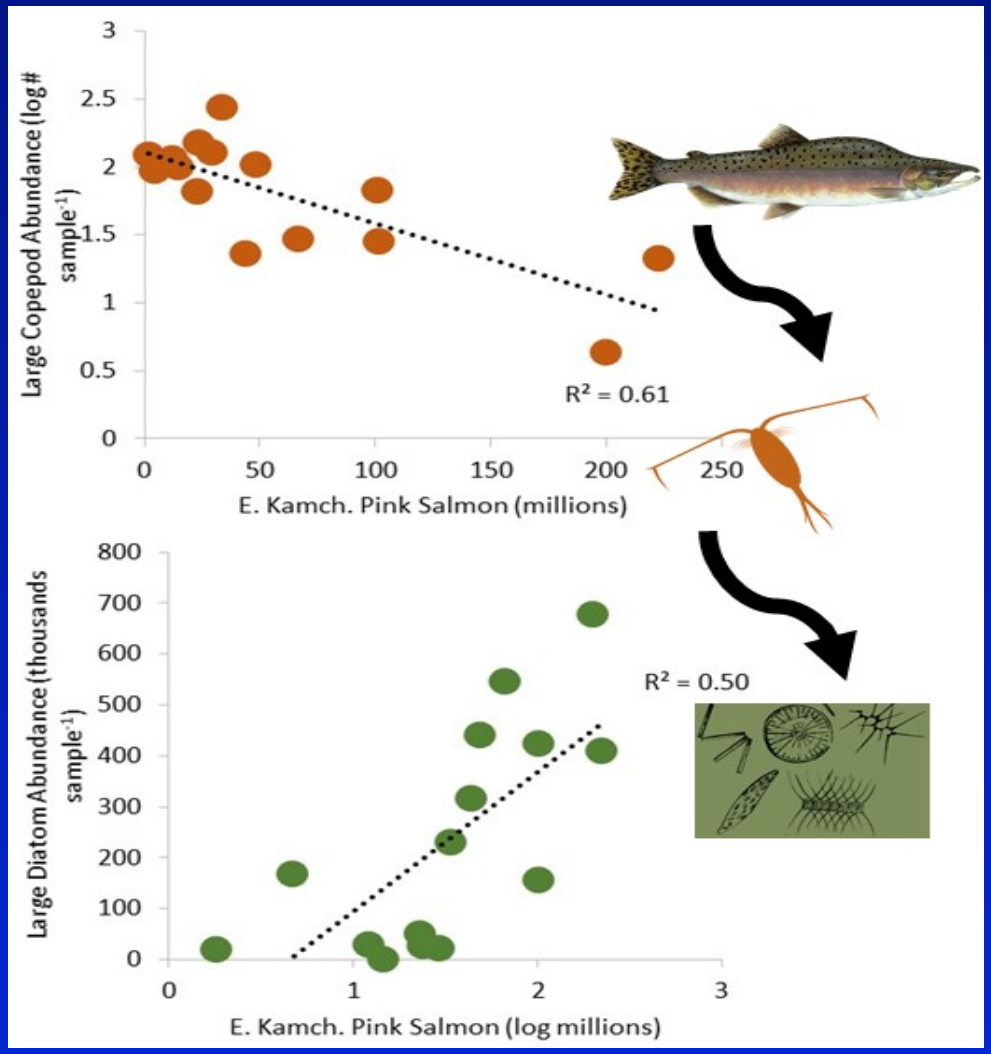
Climate cannot explain odd/even patterns
2013: Zooplankton boomed unexpectedly. Why?

Do Pink Salmon Cause a Trophic Cascade?

Plankton response to Pink Salmon

Large copepods decline when pinks abundant

Diatoms increase when few zooplankton and many pink salmon

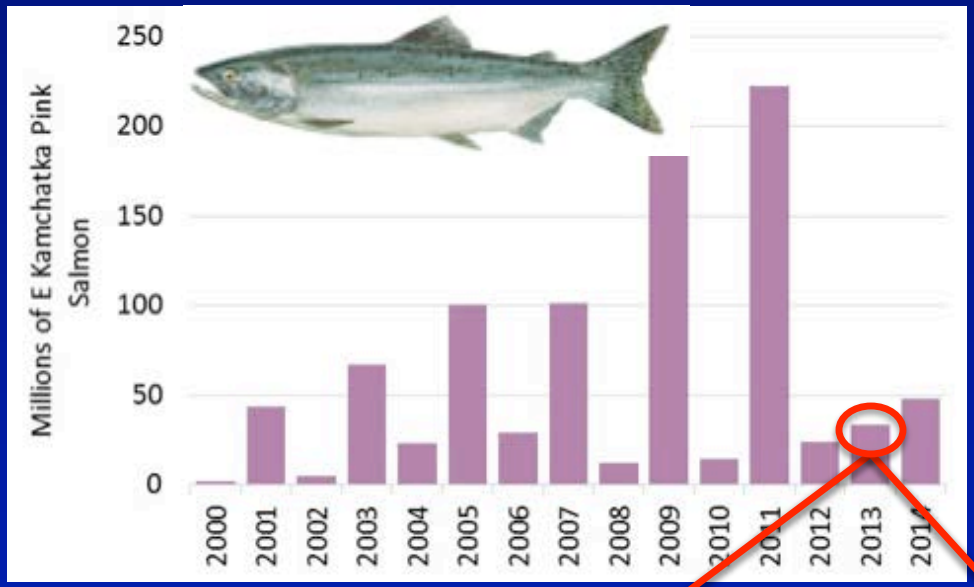


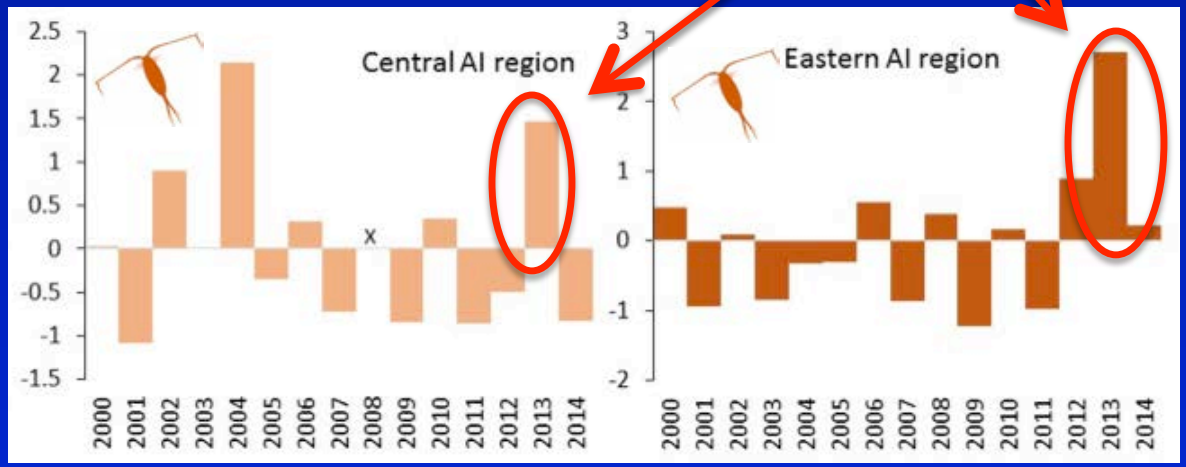
Batten, Ruggerone, Ortiz 2018

Do Pink Salmon Cause a Trophic Cascade?

2013:
Eastern Kamchatka pink salmon unexpectedly crashed, and zooplankton rebounded sharply

- Patterns not apparent in Western Bering Sea
  - Higher zooplankton counts
  - Pinks not biennial





Batten, Ruggerone, Ortiz 2018

Pink Salmon Competition with Sockeye Salmon

Competition between Asian pink salmon (*Oncorhynchus gorbuscha*) and Alaskan sockeye salmon (*O. nerka*) in the North Pacific Ocean

Evidence for competitive dominance of Pink salmon (*Oncorhynchus gorbuscha*) over other Salmonids in the North Pacific Ocean

Productivity and life history of sockeye salmon in relation to competition with pink and sockeye salmon in the North Pacific Ocean

Influence of the marine abundance of pink (*Oncorhynchus gorbuscha*) and sockeye salmon (*O. nerka*) on growth of Ozernaya River sockeye

Pink and Sockeye Salmon Interactions at Sea and Their Influence on Forecast Error of Bristol Bay Sockeye Salmon

Evidence for Bottom-Up Effects on Pink and Chum Salmon Abundance and the Consequences for Other Salmon Species

Seasonal marine growth of Bristol Bay sockeye salmon (*Oncorhynchus nerka*) in relation to competition with Asian pink salmon (*O. gorbuscha*) and the 1977 ocean regime shift

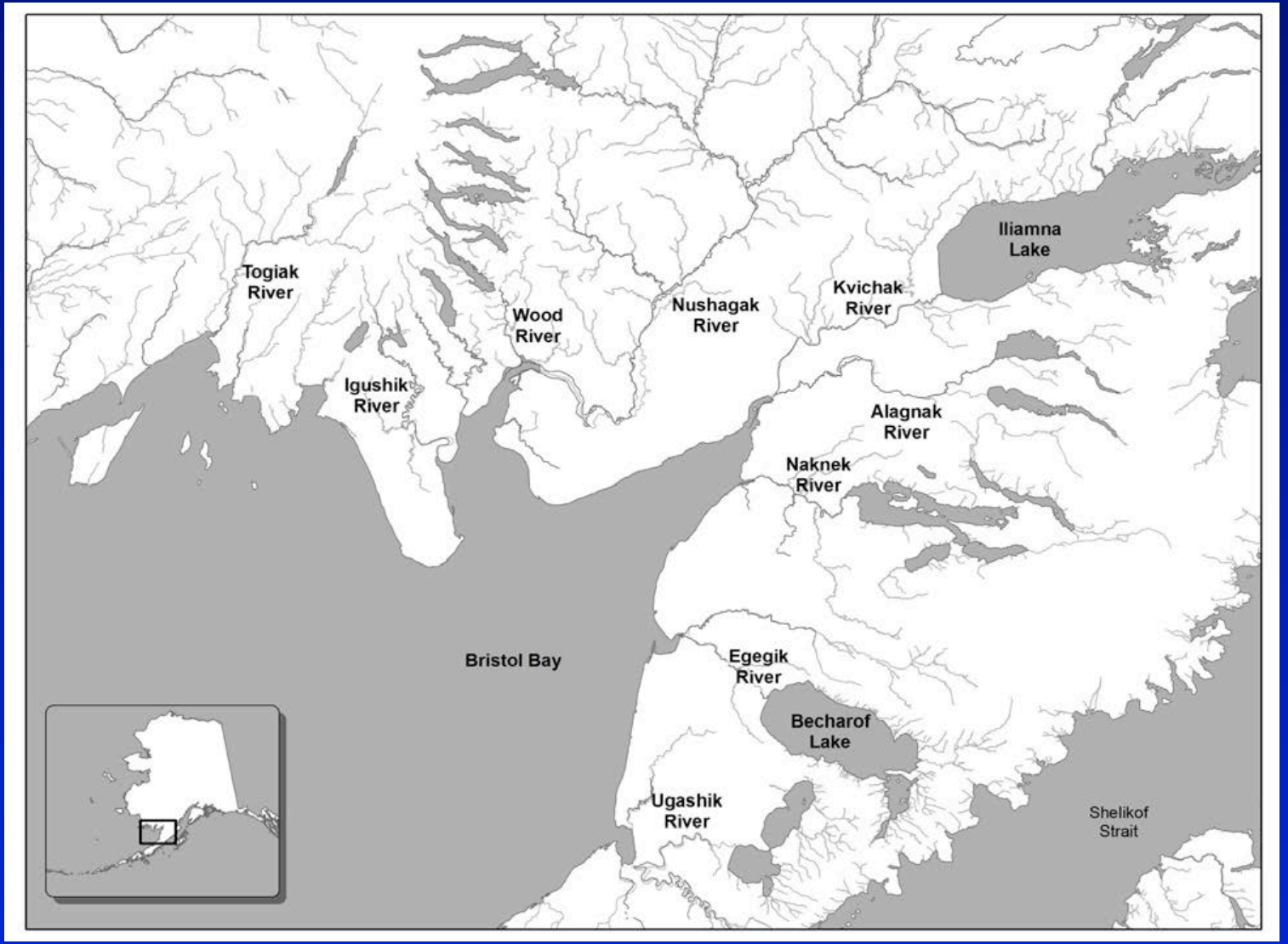
Evaluating signals of oil spill impacts, climate, and species interactions in Pacific herring and Pacific salmon populations in Prince William Sound and Copper River, Alaska

Bristol Bay Sockeye Watersheds

Largest sockeye population

>50 million/yr, recently

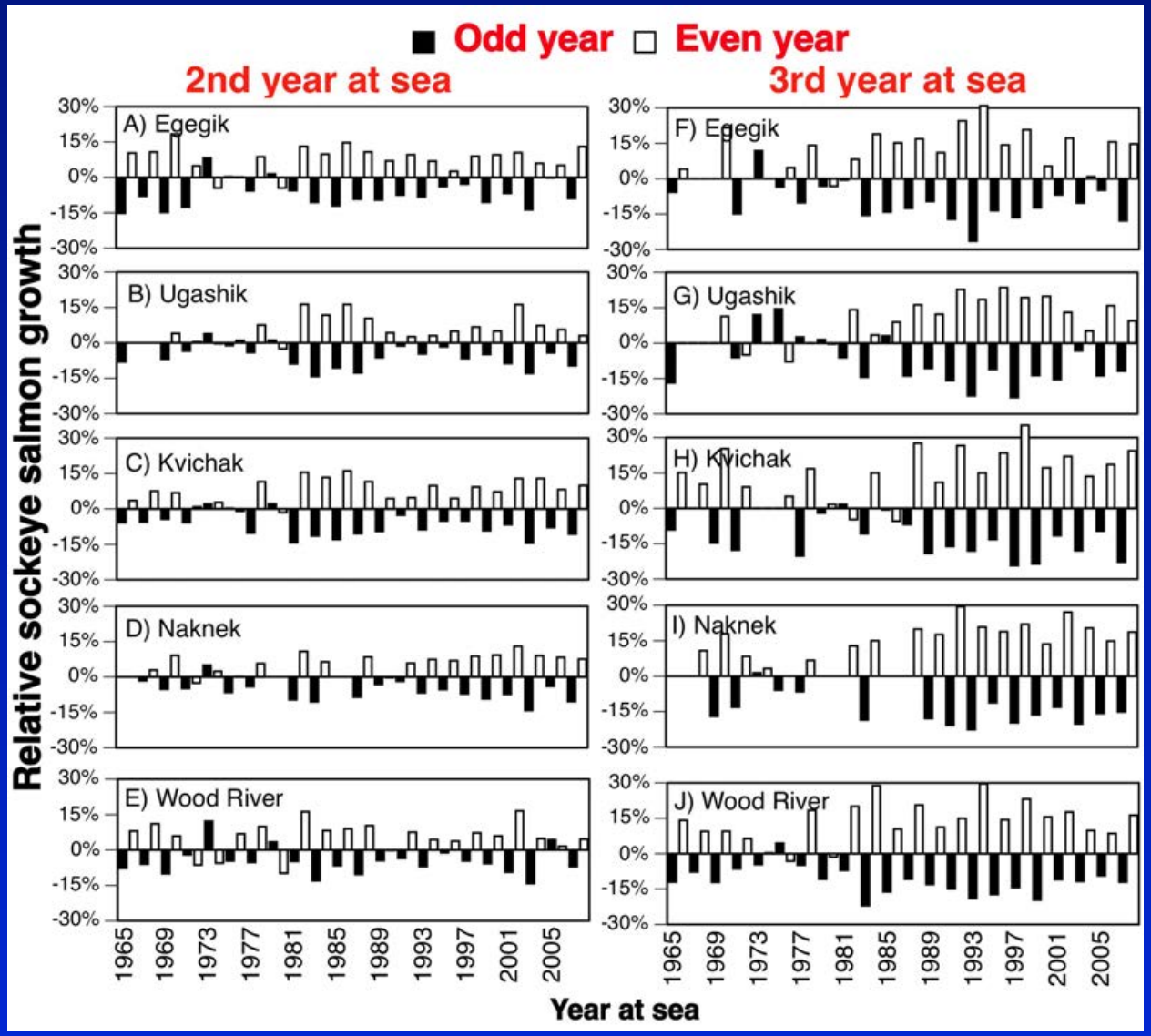
No hatchery salmon



Bristol Bay Sockeye Scale Growth

relative to growth in year before & after

Pink salmon 40% more abundant in odd-numbered years (high seas sampling)



Ruggerone et al. 2016

Bristol Bay sockeye growth vs pink salmon abundance

Normalized scale growth, 1965-2010
(28,000 measurements)

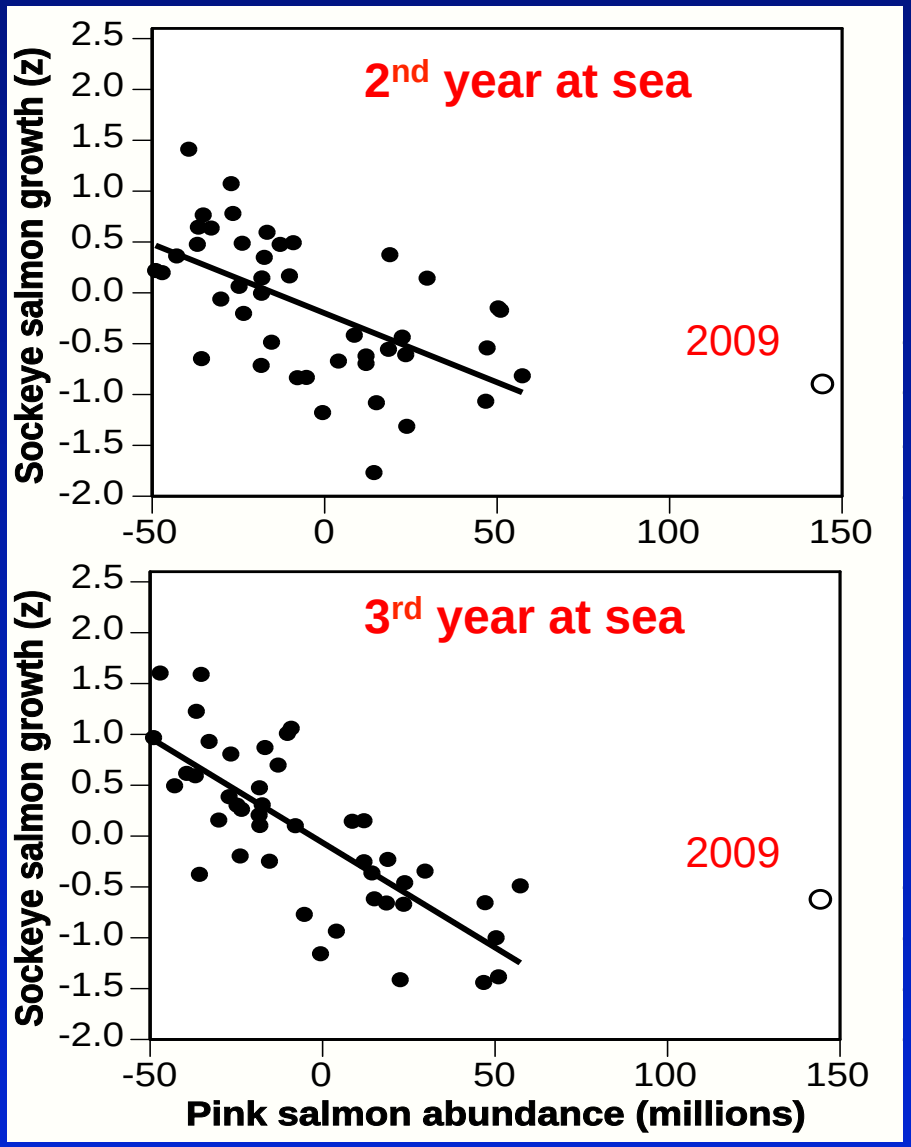
Eastern Kamchatka pink salmon abundance (detrended)

No relationship 1st year at sea
(few pinks)

Serial autocorrelation of residuals:
P > 0.05.

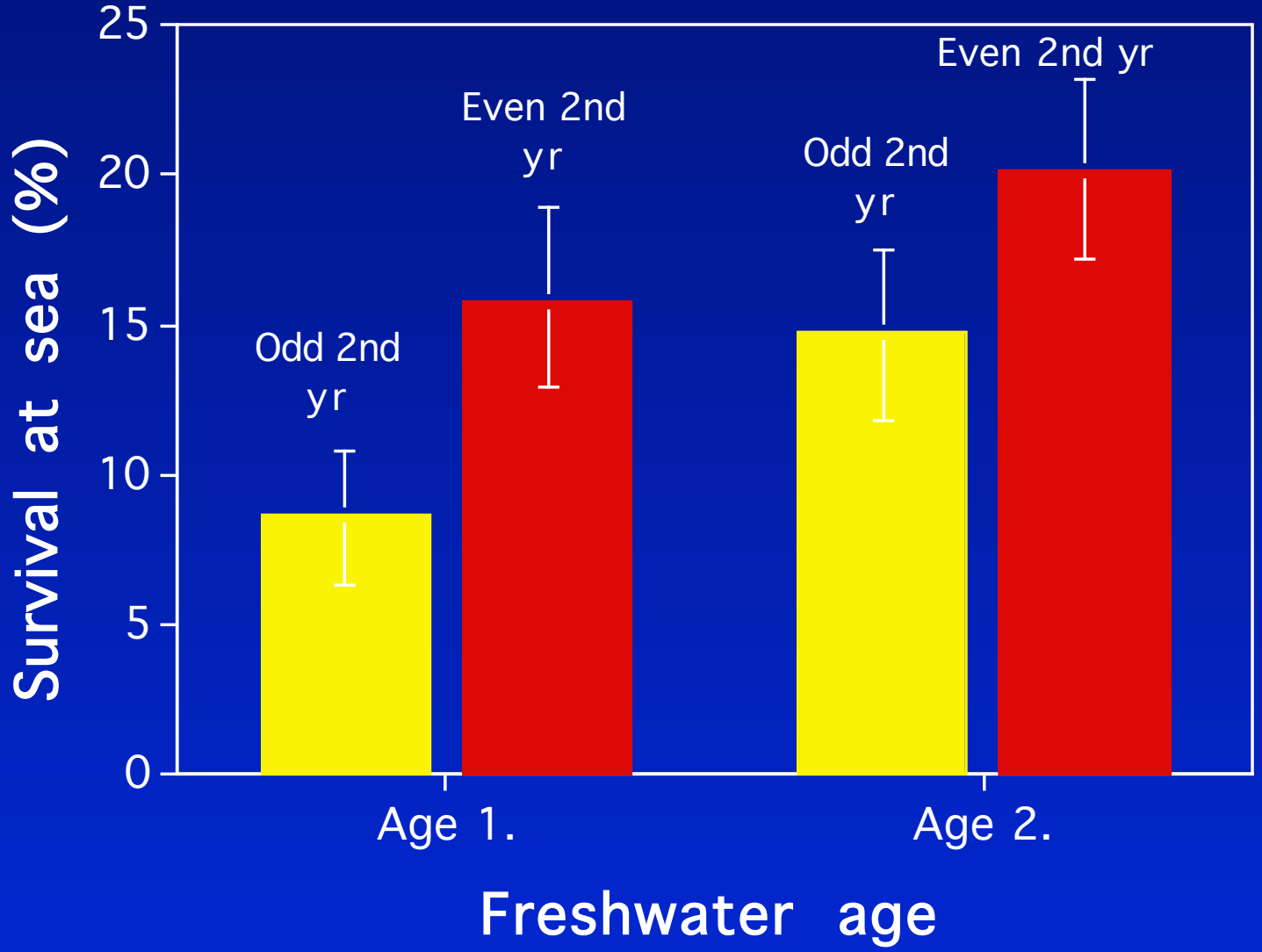
SST: P > 0.05

Pink range: 2 to 200 million per yr



Ruggerone et al. 2016

Smolt to Adult Survival, 1977-1997



Age-1: -45% when pinks

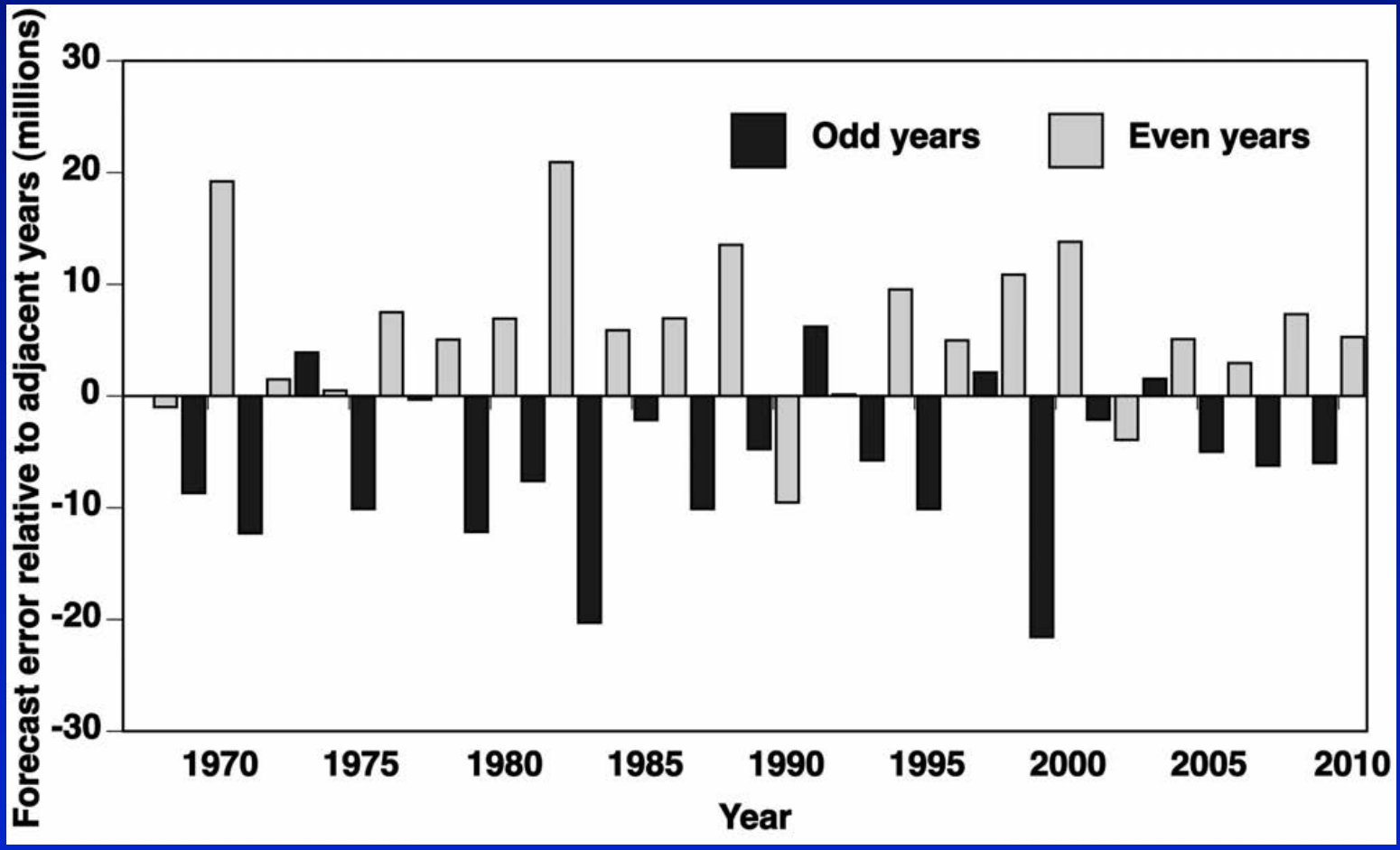
Age-2: -26% when pinks

Ruggerone et al. 2003

Bristol Bay Forecast Error

relative to error in year before & after

Stocks:
Kvichak,
Naknek,
Egegik,
Ugashik



Relative error = Error Y_i – (avg. error Y_{i-1}, Y_{i+1})
Forecast error (%) = (Forecast – Observed run) / Observed run