

The coast-wide collapse in marine survival of west coast Chinook and Steelhead- Missed Opportunities in Salmon Conservation?

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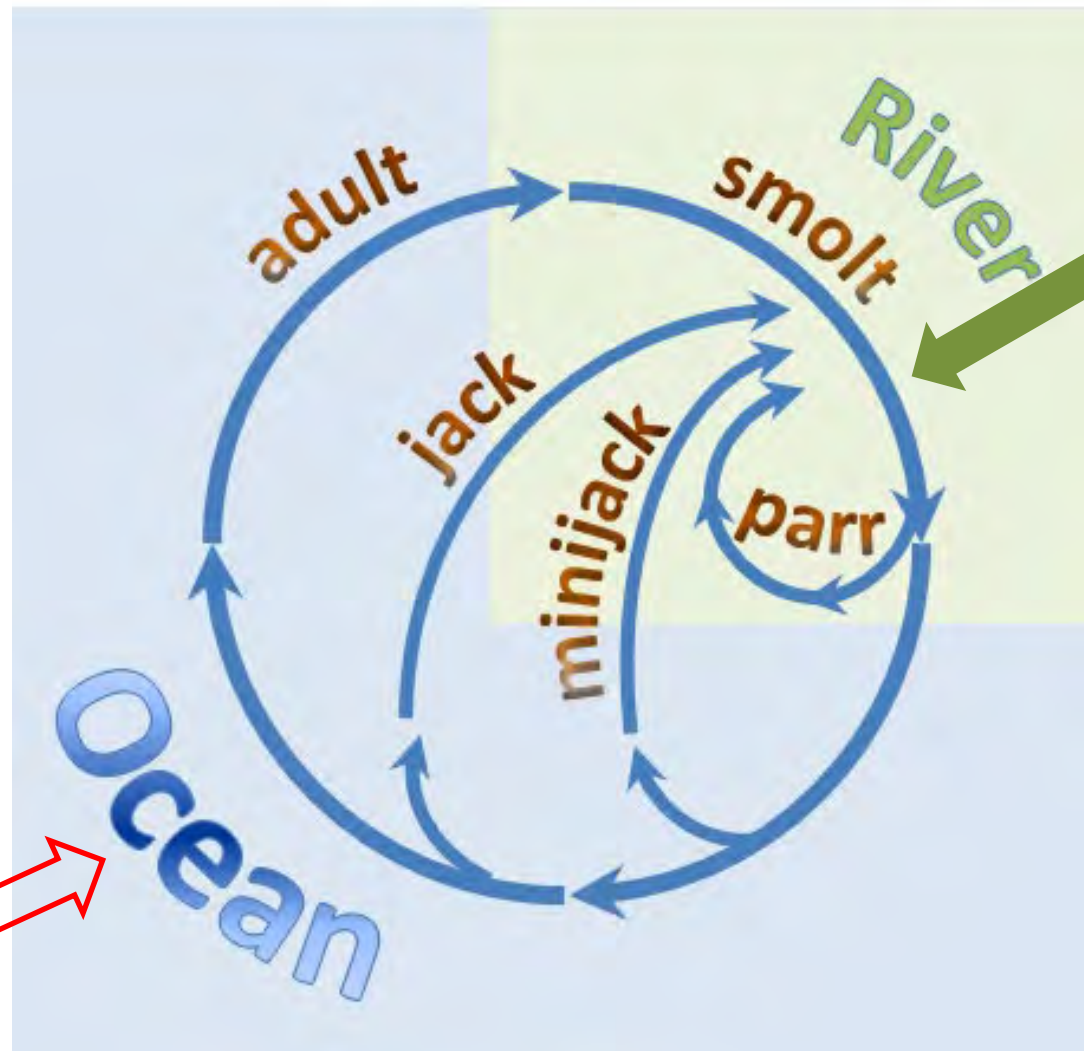
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The Real Salmon Habitat Problem: There are Many Habitats!!

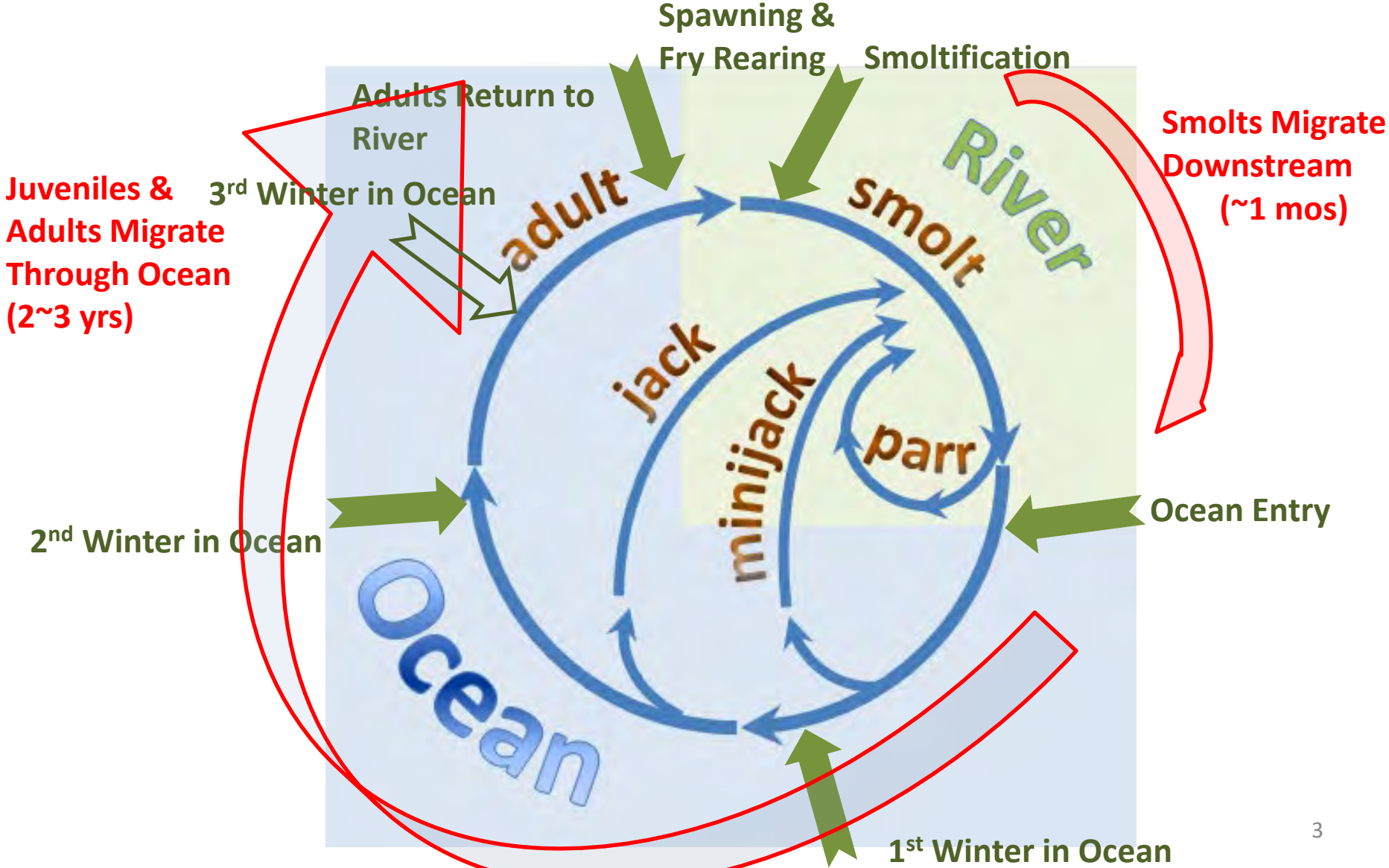


If the Ocean is
the problem...

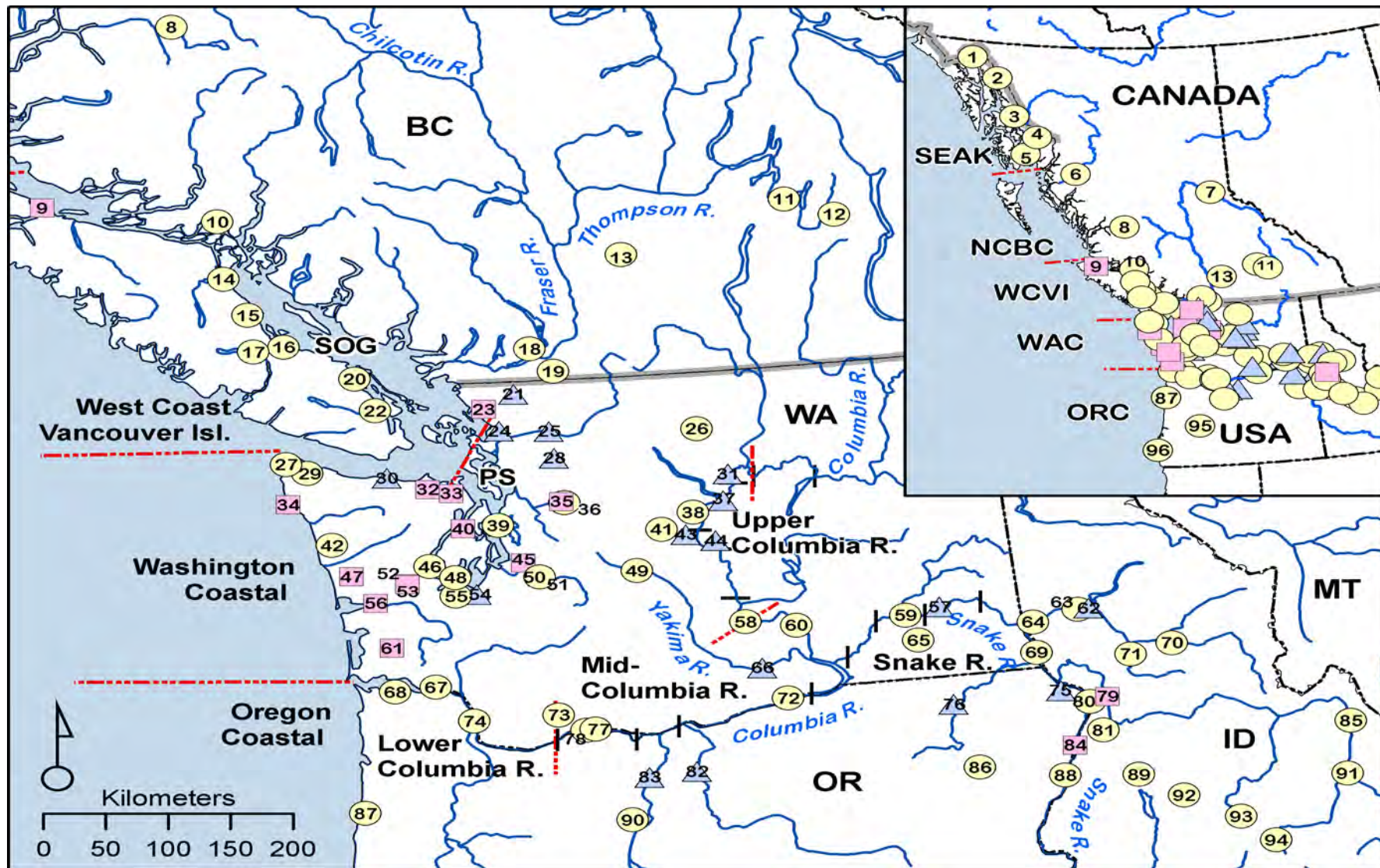
...can we make
enough
modification to
freshwater to
compensate?
... And how do
we do so??

*And are we
even
approaching the
problem in the
right way?*

Measuring Smolt-to-Adult Survival (SARs)



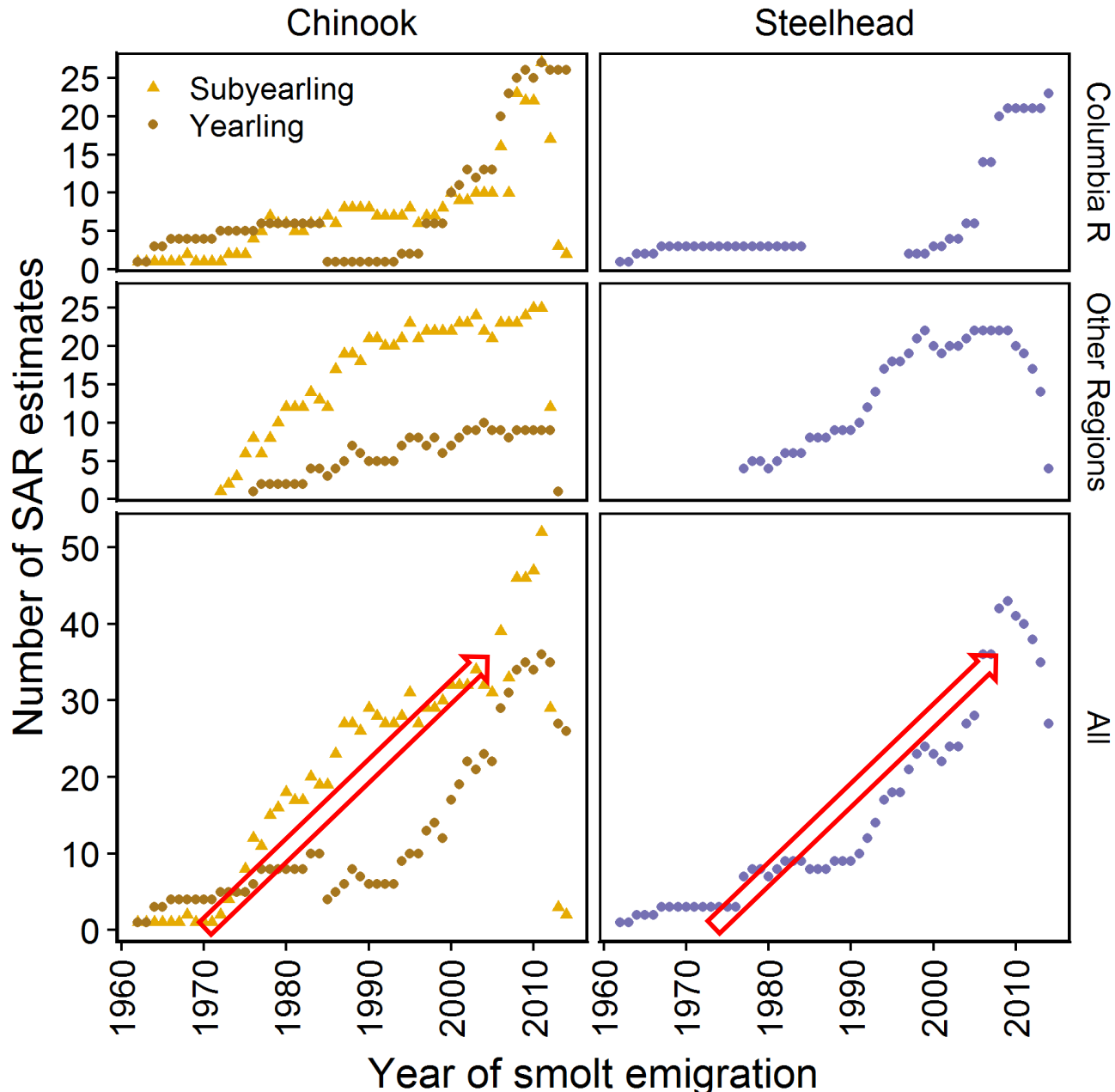
The Current Study: Coast-wide Salmon Survival for Chinook & Steelhead



Chinook & Steelhead SAR Data

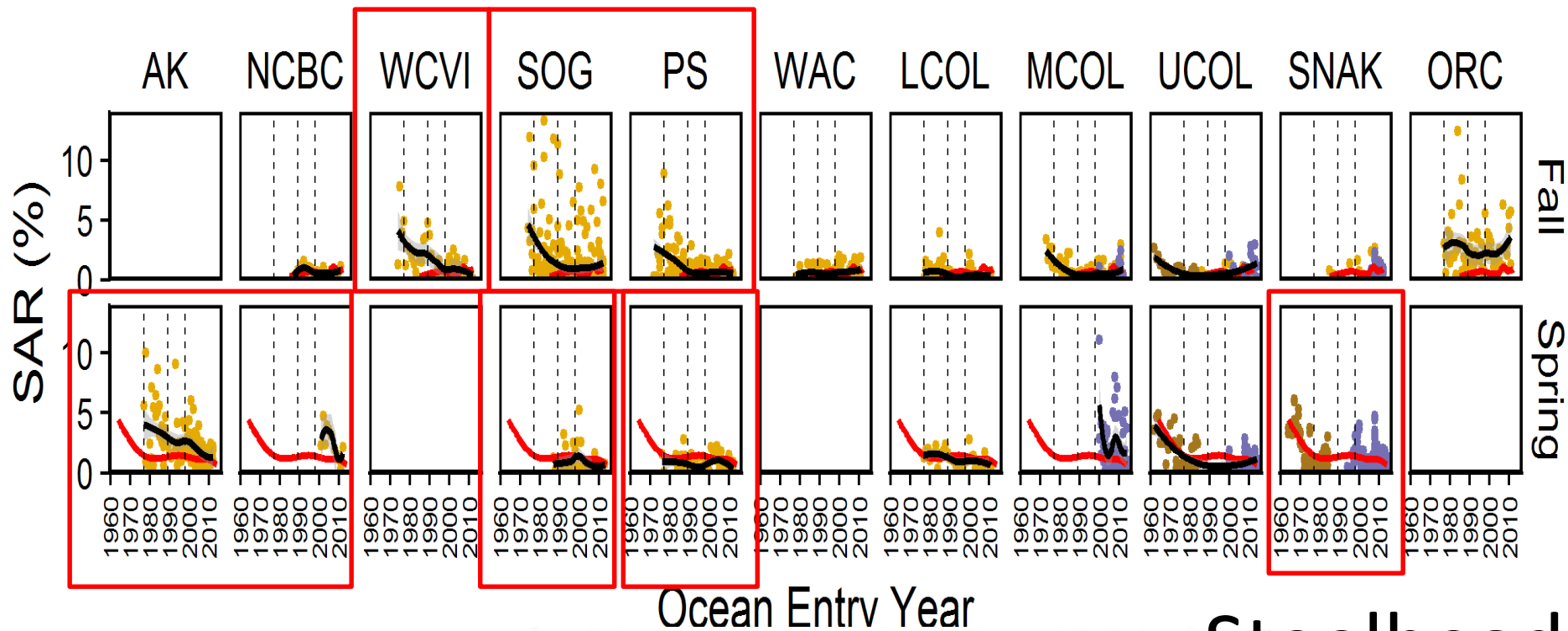
- Chinook survival data from Pacific Salmon Commission
 - 1) Smolt-to-adult survival data submitted by State & Federal agencies for the west coast of North America (*CWT-based*)
 - 2) Columbia River data from Fish Passage Center (*PIT*)
- Steelhead survival data not available for Province of BC hatcheries, but available for Washington State (courtesy Dr Nealla Kendall; *CWT-based*).
- B.C. contributed the long-running Keogh River wild steelhead survival dataset (*Mark-recapture*)
- In total, 3,055 years of annual survival available estimates for analysis (a few datasets characterized as “*experimental*” excluded)

As SARs Drop, Monitoring Increases



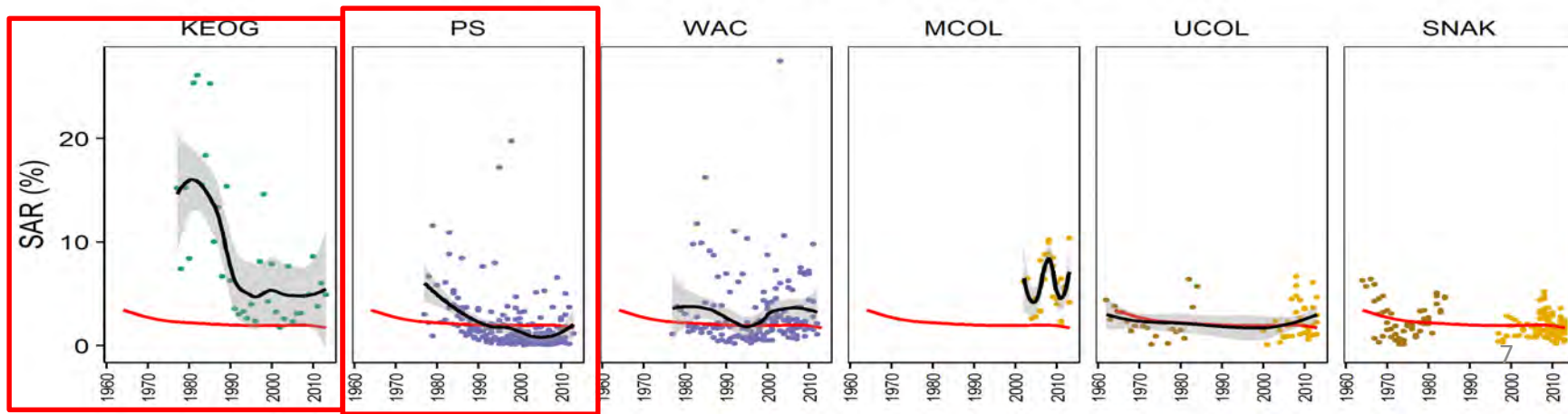
Source • FPC_PIT • PSC_CWT • Raymond

Chinook



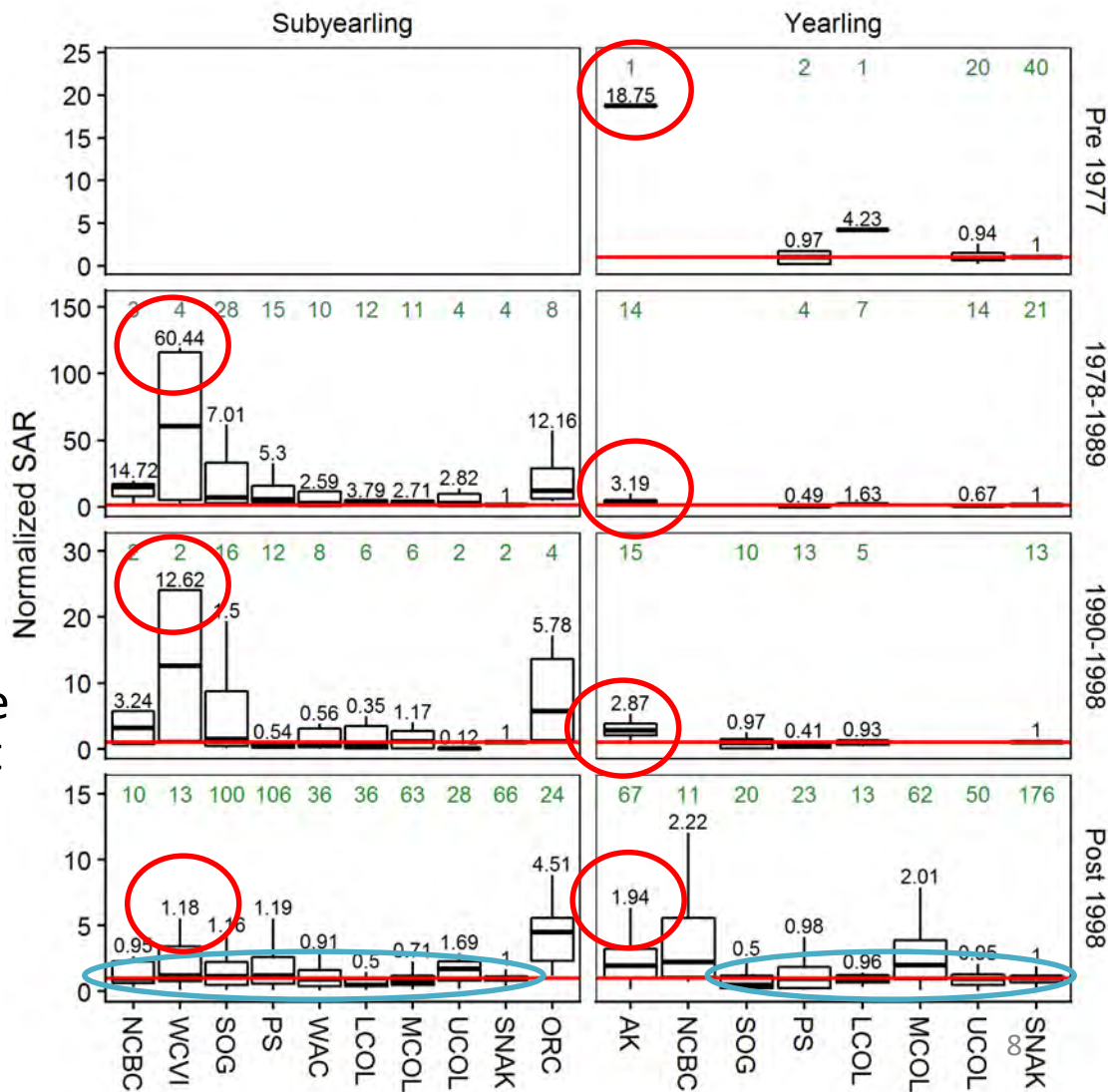
Source • BC_Keogh • FPC_PIT • Raymond • WDFW

Steelhead



Chinook SARs Normalized by Snake River Median SARs (i.e., Relative Survival)

- Compared SARs for the west coast of North America (excl. California)
- SARs are scaled by dividing by annual Snake River values
- So $SAR_{SnakeRiver} = 1$
- The major regional difference in SARs seen in earlier time periods no longer exists
- Almost all regions now have SARs equivalent to the Snake River
- Even AK & NCBC SAR difference now ***much*** smaller...and almost the same in the most recent years
- How can we recover salmon if Alaska & N. BC can't with near-pristine freshwater habitat??



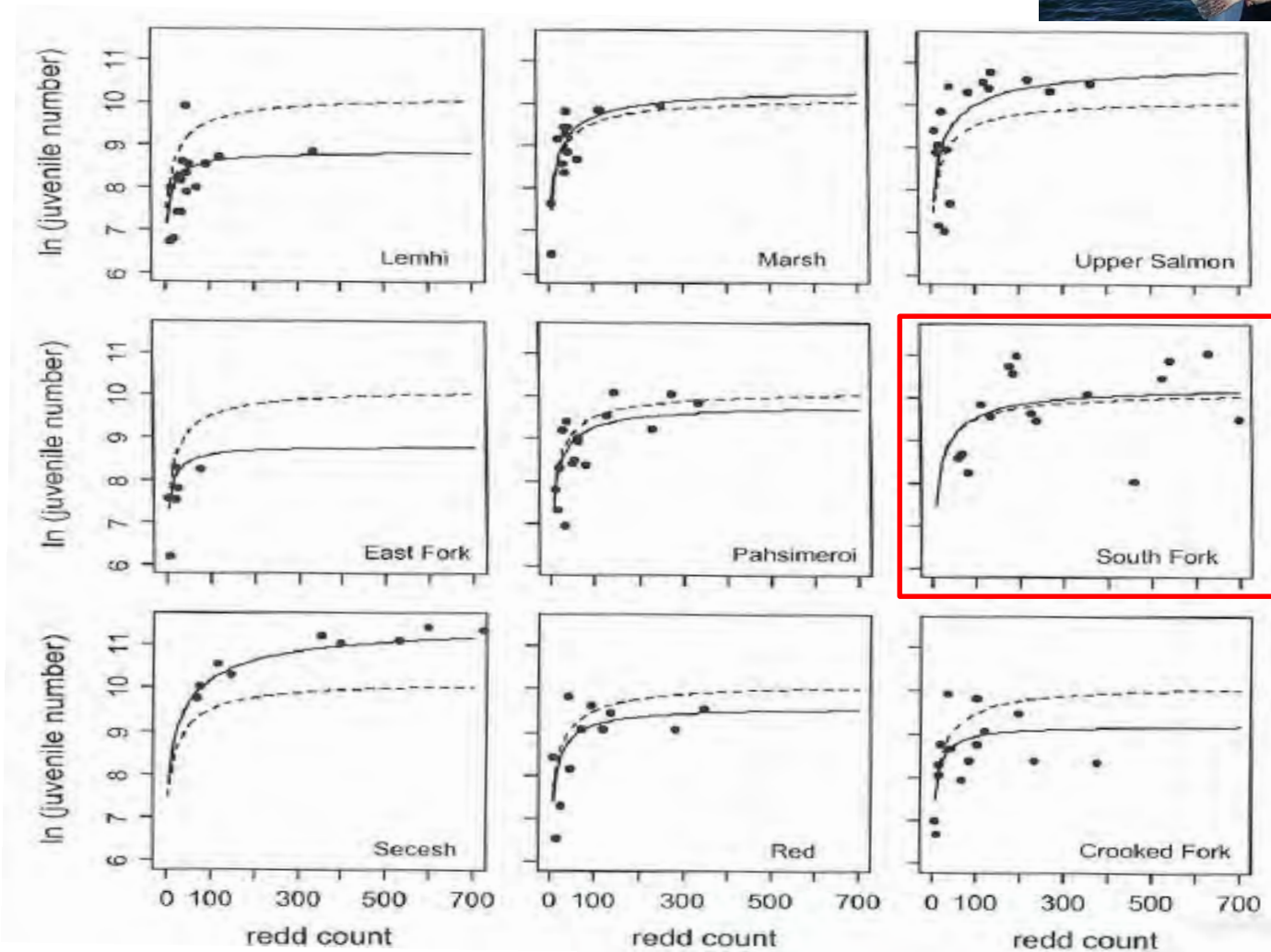
Conclusions

- 1) Almost all regions of the west coast show large drops in salmon SARs over time
 - A. This includes regions with essentially pristine freshwater habitats (→ SE Alaska, N. BC)
 - B. We don't know where in the life cycle survival is dropping but it is likely marine
 - C. Geographically widespread declines in SARs raise important questions about how effective point-source recovery actions can be

DENSITY-DEPENDENCE IS UBIQUITOUS

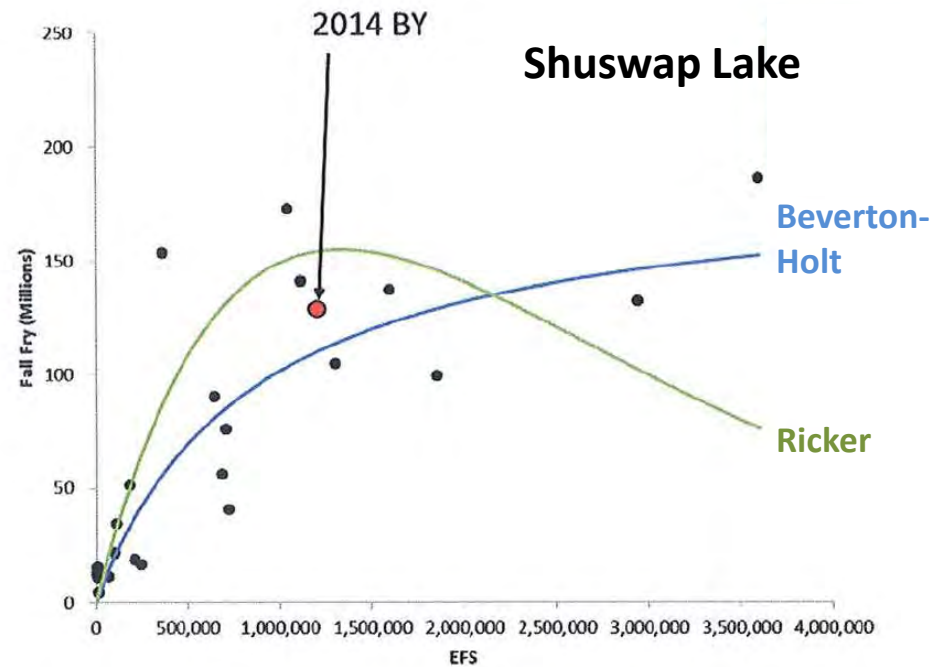
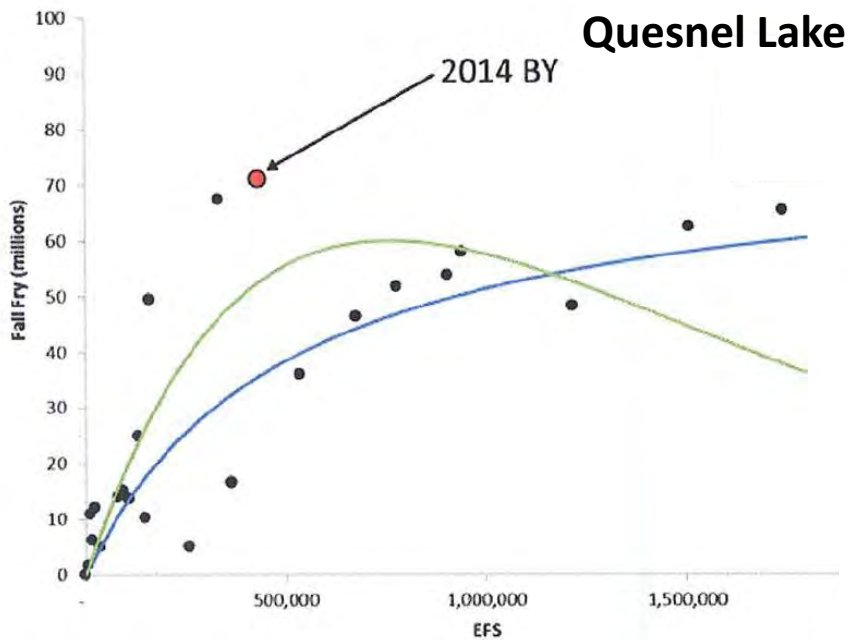
- **Columbia River basin:** *“Strong density-dependence is now evident in at least 25 of 27 Spring/Summer Chinook populations, the Snake River Fall Chinook ESU, and all 20 steelhead populations examined upstream of Bonneville Dam”* **Independent Scientific Advisory Board (2015)**

Snake River Chinook



Reference: Walters, A. W., T. Copeland and D. A. Venditti (2013). "The density dilemma: limitations on juvenile production in threatened salmon populations." *Ecology of Freshwater Fish* 22(4): 508-519. (Fig. 2)

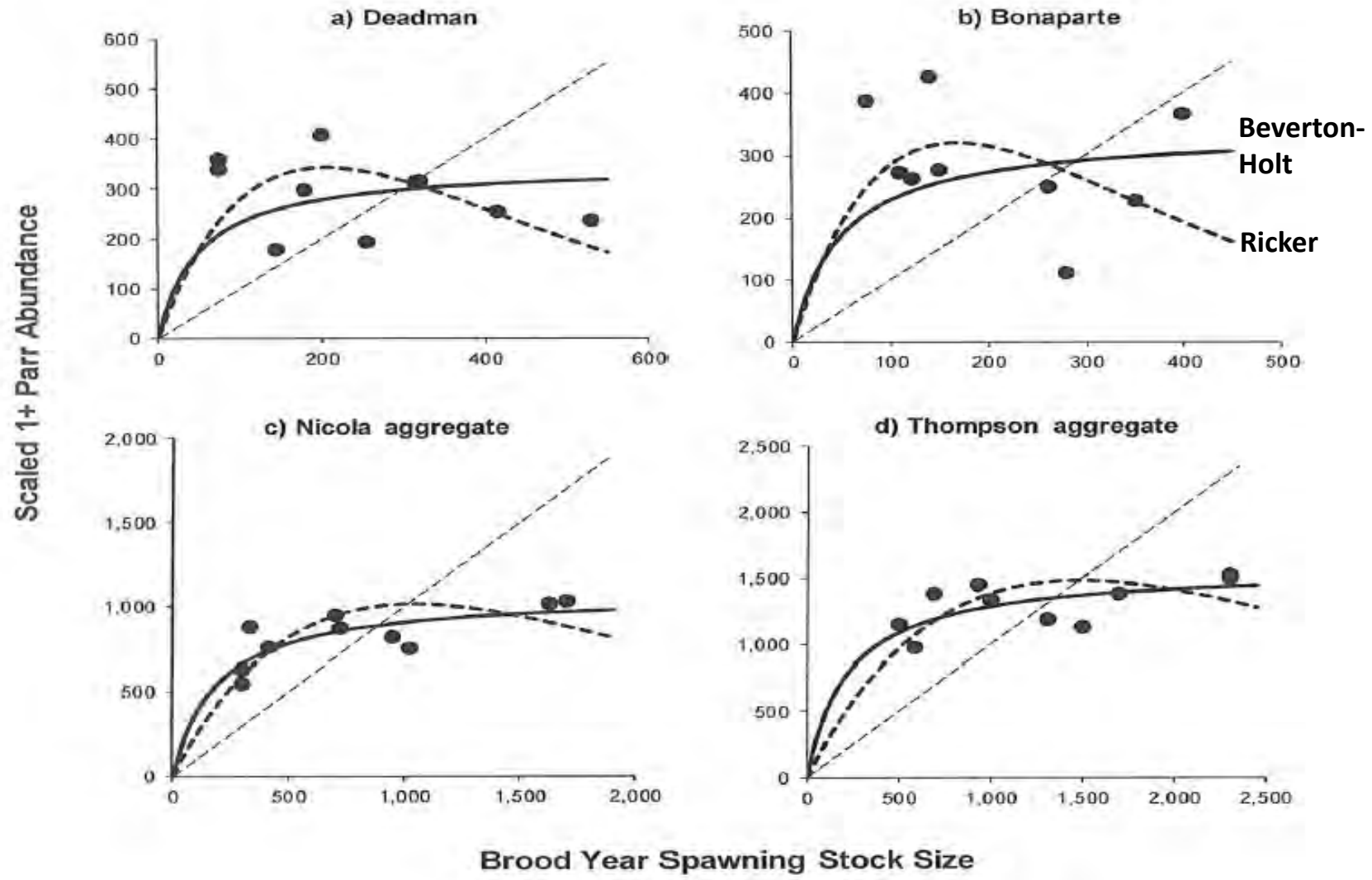
Fraser Sockeye



Reference: MacDonald et al (2018). State of the Salmon: Informing the survival of Fraser Sockeye returning in 2018 through life cycle observations. DFO. Can. Tech. Rep. Fish. Aquat. Sci. 3271: 53 + v pp.

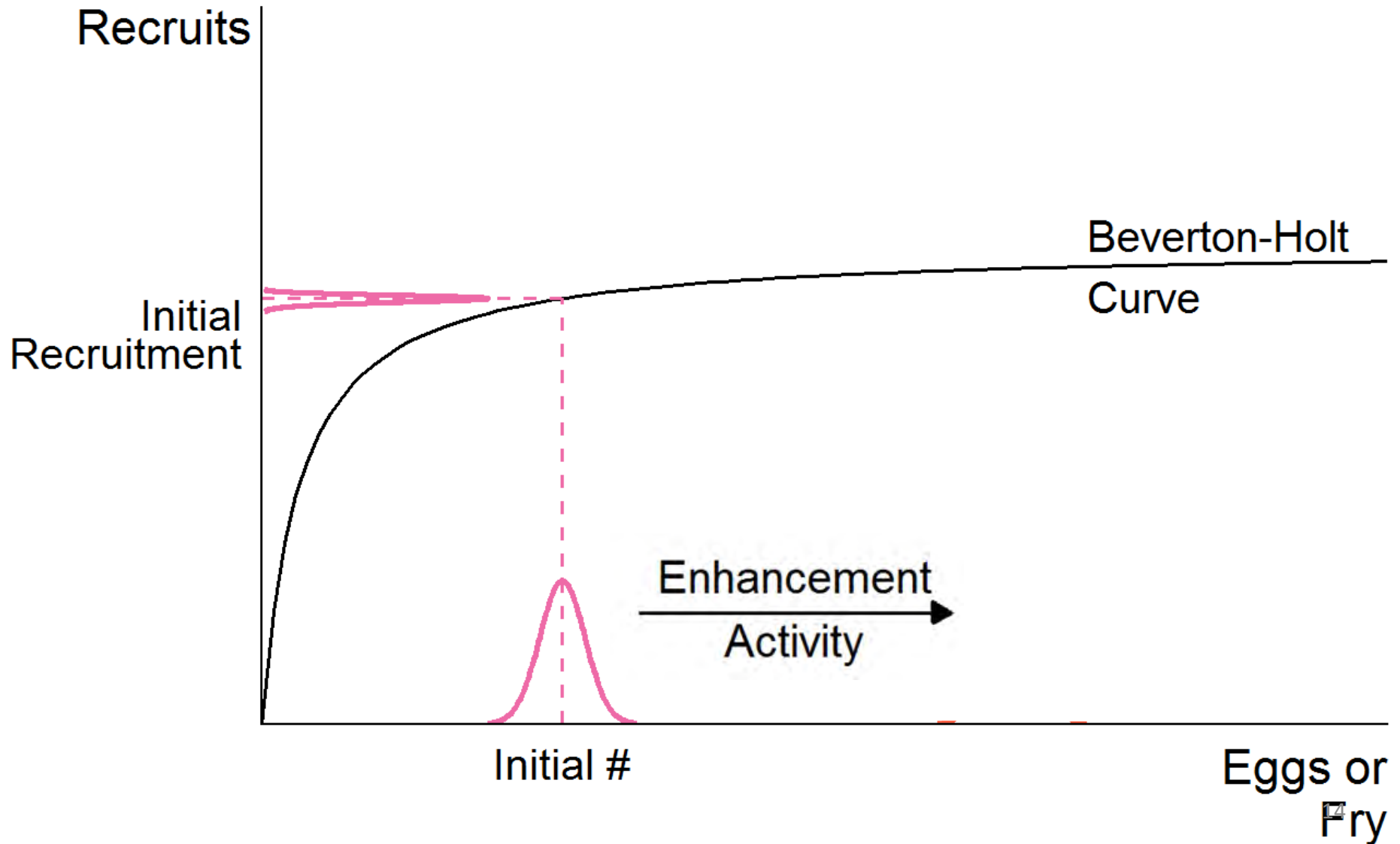


Interior Fraser Steelhead

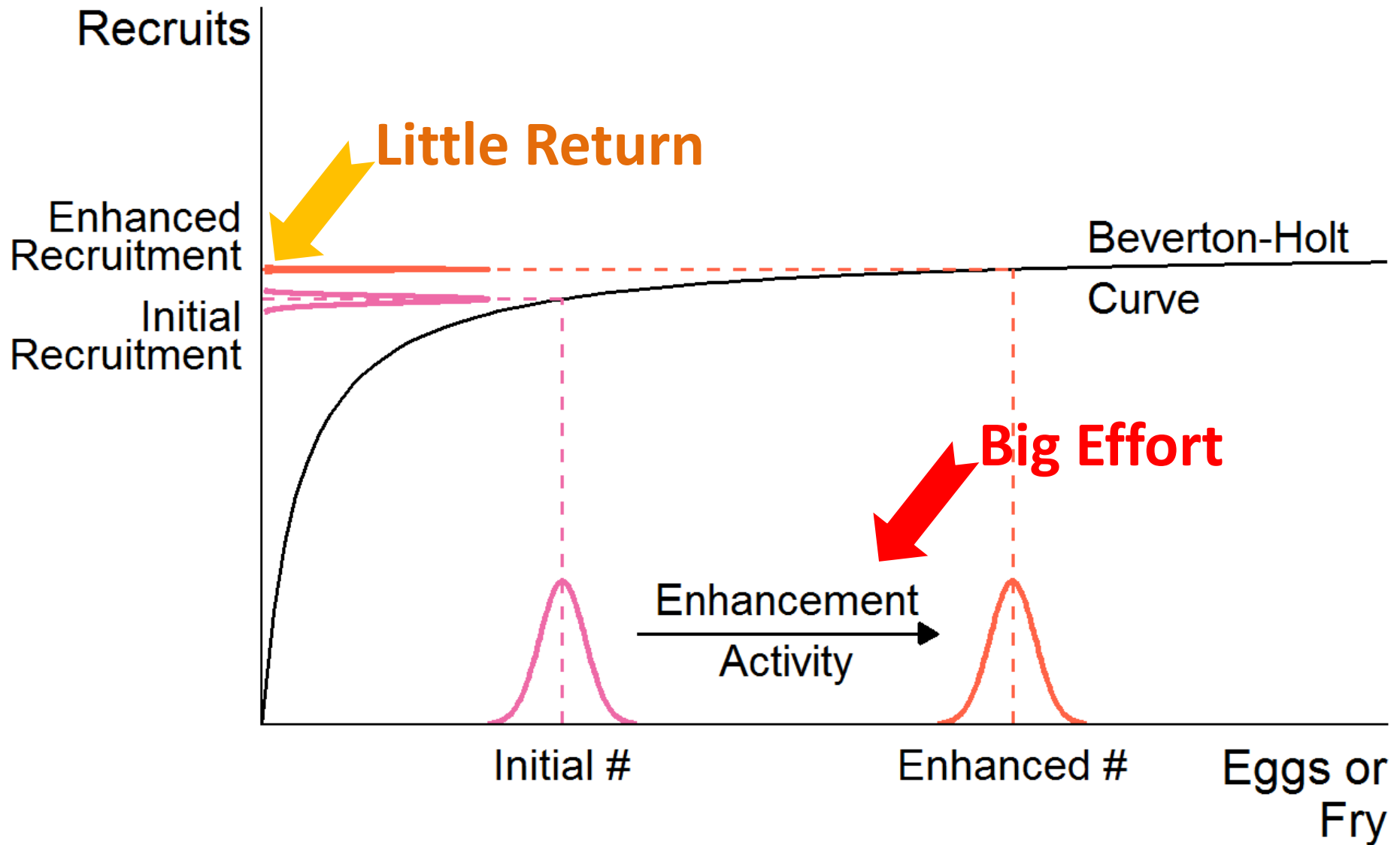


Reference: Decker, A. S., J. Hagen and R. G. Bison (2015). Stock-recruitment relationships for steelhead populations can be used to define biological reference points that signal the need for management changes. Province of British Columbia: Report ID 54914. (Fig. 7)

Stock-Recruitment & Salmon Recovery



Stock-Recruitment & Salmon Recovery



Conclusions

- 1) *Almost all regions of the west coast show large drops in salmon SARs over time*
 - A. *This includes regions with essentially pristine freshwater habitats (→SE Alaska, N. BC)*
 - B. *We don't know where in the life cycle survival is dropping (i.e., "proof"), but it is likely marine*
- 2) **DENSITY-DEPENDENCE is critical and its effects are often overlooked (certainly occurs in FW)**
 - A. It provides regulation and stabilization, (partially) compensating for poor SARs 😊
 - B. It will severely reduce the effectiveness of even well-intentioned habitat interventions occurring **prior** to its expression 😞
 - C. **Where (When) density-dependence is expressed is critical to successful salmon recovery efforts.**

THANK YOU



Erin Rechisky



Aswea Porter