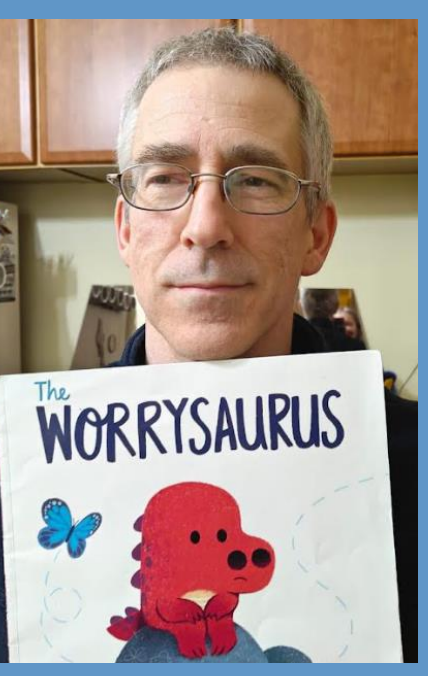




# Trends in size of mature sockeye and pink salmon near the southern limit of their range in the eastern Pacific Ocean

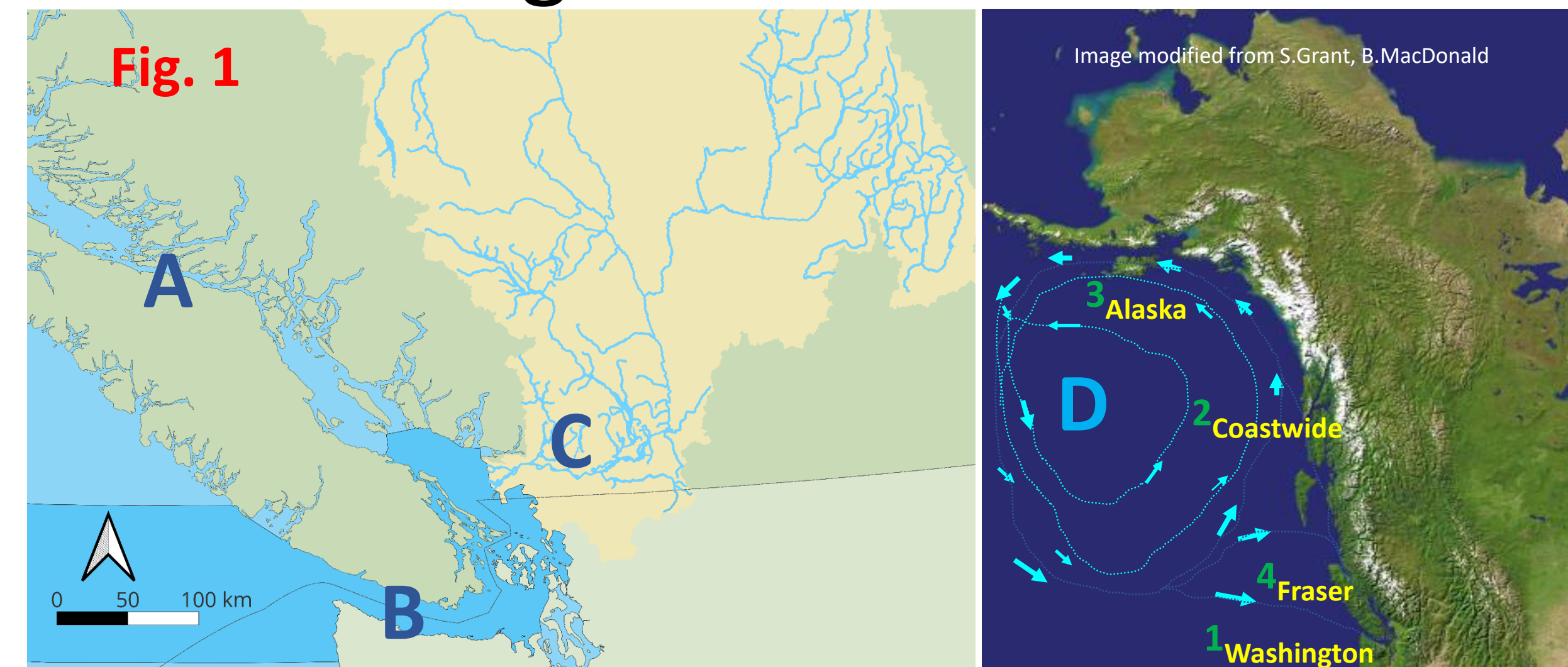
S. Latham\*, D. Brkic, A. Phung, E. Taylor, J. Sellars, C. Ball, Pacific Salmon Commission, Vancouver, BC  
email: Latham@psc.org



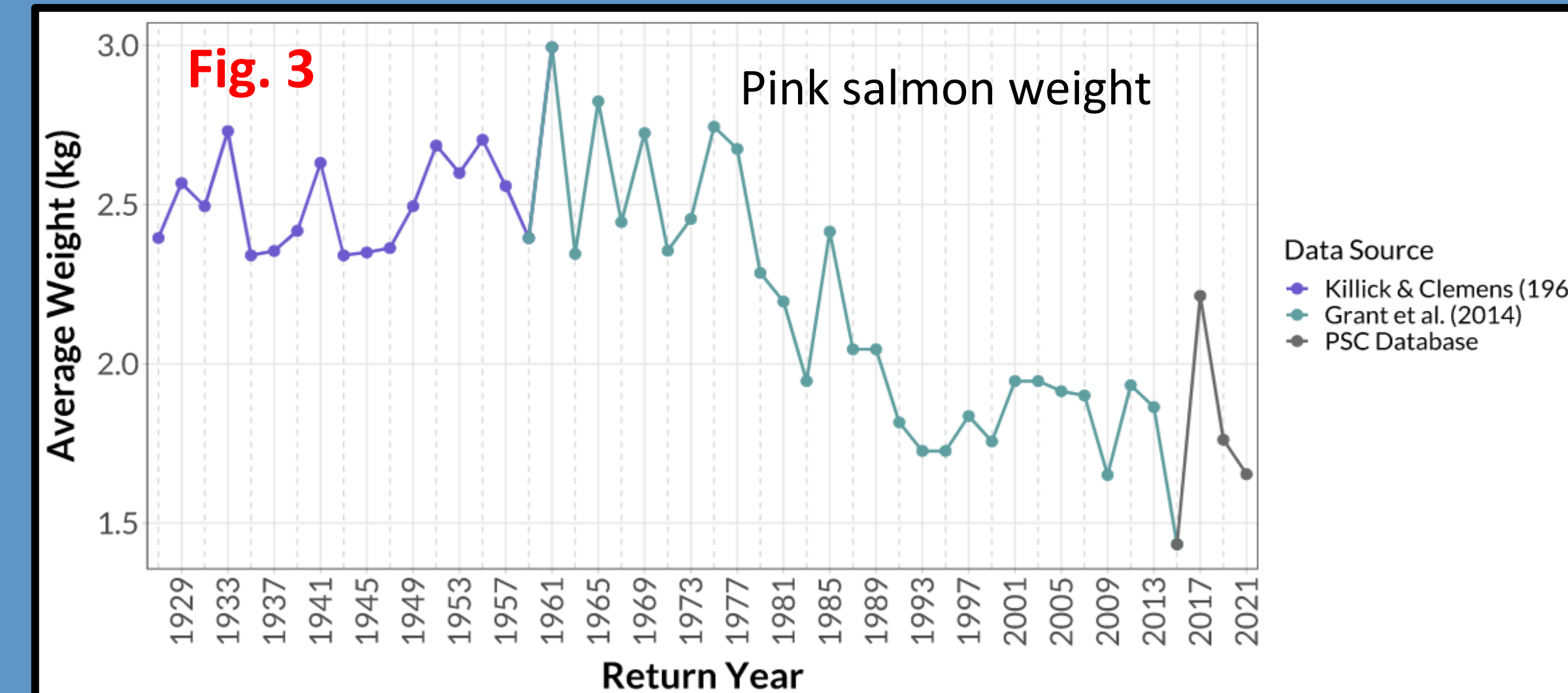
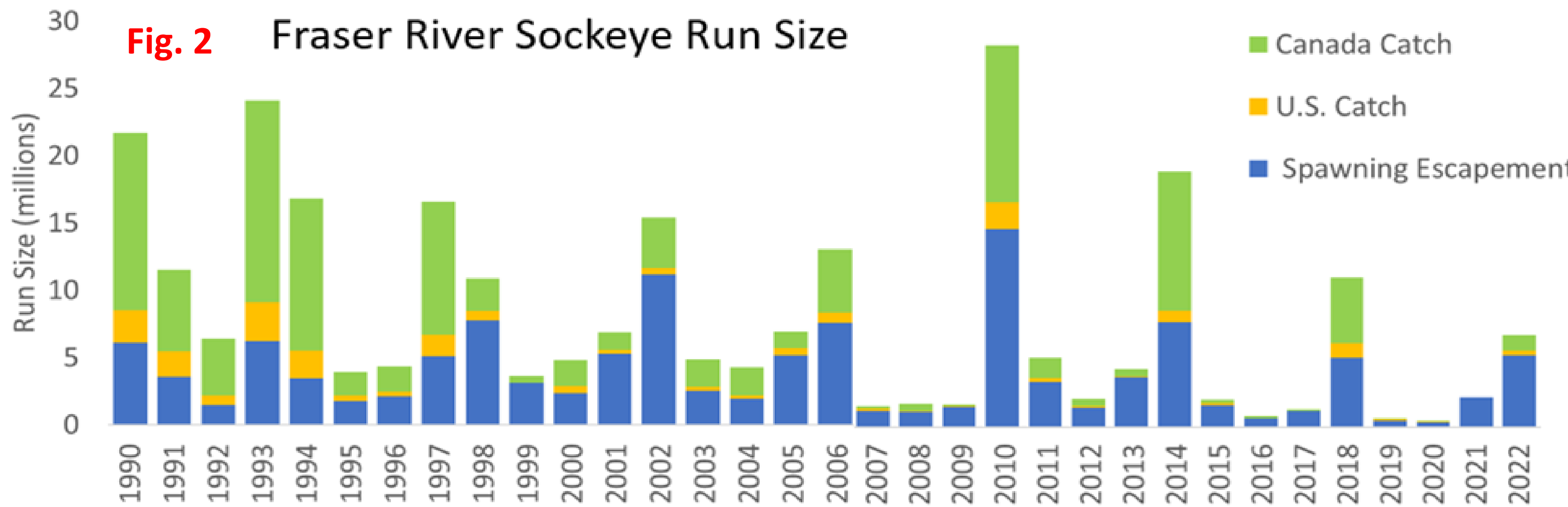
## Introduction

Body size at maturity is an important trait in Pacific salmon for fisheries (e.g., fecundity, economic value) and ecosystems (nutrient transport, support of predators). Declines in size at maturity have recently been reported for many eastern North Pacific salmon populations, <sup>1,2,3</sup> including Fraser River sockeye and pink salmon <sup>4</sup> (Fig. 1). Numerically, salmon from northern populations are doing well, but salmon in the south are doing relatively poorly – e.g., marine survival has crashed and Fraser River sockeye rarely support fisheries now (Fig. 2). Climate and increased competition from pink and sockeye salmon are possible explanations, <sup>5</sup> but evidence is ambivalent. <sup>4</sup> Other causal factors (e.g. predation) <sup>2</sup> may play important roles in growth/survival patterns. Research progress is likely hindered by different data collection methods, data types, and data storage across various agencies. To promote interagency and interdisciplinary research to address this and other topics, the Pacific Salmon Commission has developed a “BioDataApp” through which to share relevant data. Several data series can be visualized interactively (*fun!*) and downloaded with documentation (*serious*).

## Shrinking salmon

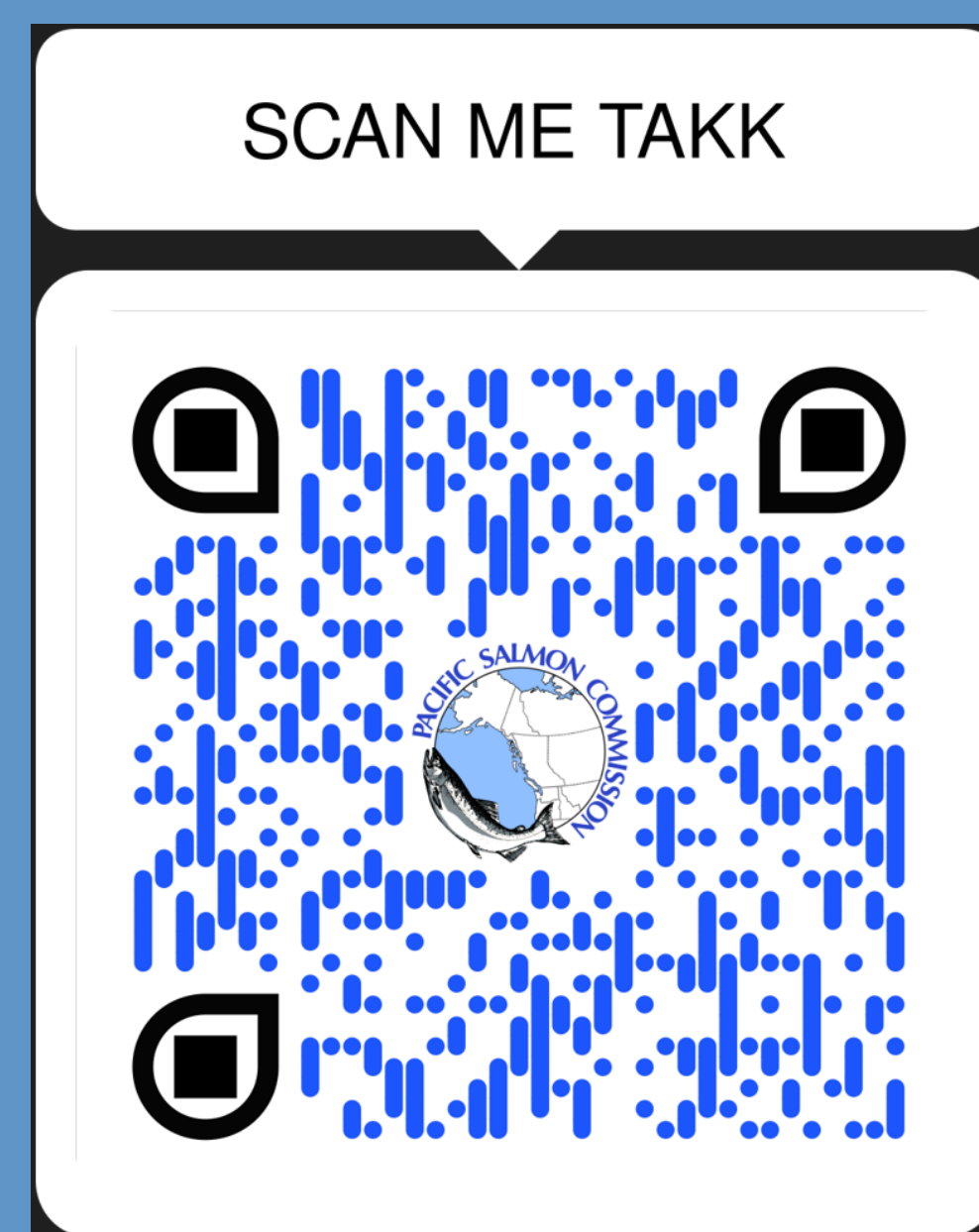


**A-C:** Length, weight, age, sex and stock ID are sampled in catches from the lower Fraser and marine areas near Vancouver Island; length, age and sex are sampled on spawning grounds.  
**D:** Hypothesized open-ocean distribution of Fraser sockeye, where most growth occurs.  
Declines in Pacific salmon sizes have been documented in Chinook <sup>1,2,3</sup> coho <sup>3</sup> chum <sup>1,3</sup> pink <sup>1,4</sup> and sockeye salmon <sup>1,3,4</sup> (see References).



## Data series

- Several time series have been selected for the BioDataApp, some of which are long, compound data series collected across methods.
- Annual pink salmon mean weight, 1927-present, summary data (Fig. 3).
  - Annual sockeye mean weight 1915-1979, 2003-present (summary data, Fig. 4).
  - Stock-specific spawning ground lengths by age and sex, 1964-present, individual fish records (Fig. 5a, 5b).
  - Sockeye stock-specific weight and condition factor in fishery samples, 2003-present, individual fish records (Fig. 6).
  - Stock-specific age composition for sockeye, 1953-present, summary data (not shown).
- A biennial trend is seen in these data, perhaps due to pink salmon competitors. Users can opt to see the data in odd vs even-numbered years. Similarly, due to potential effects of sockeye competitors, data can be seen by 4-year cycle.



Help us: try this fun, flexible, informative app

Select age: Ocean Age 3 | Select sex: Combined

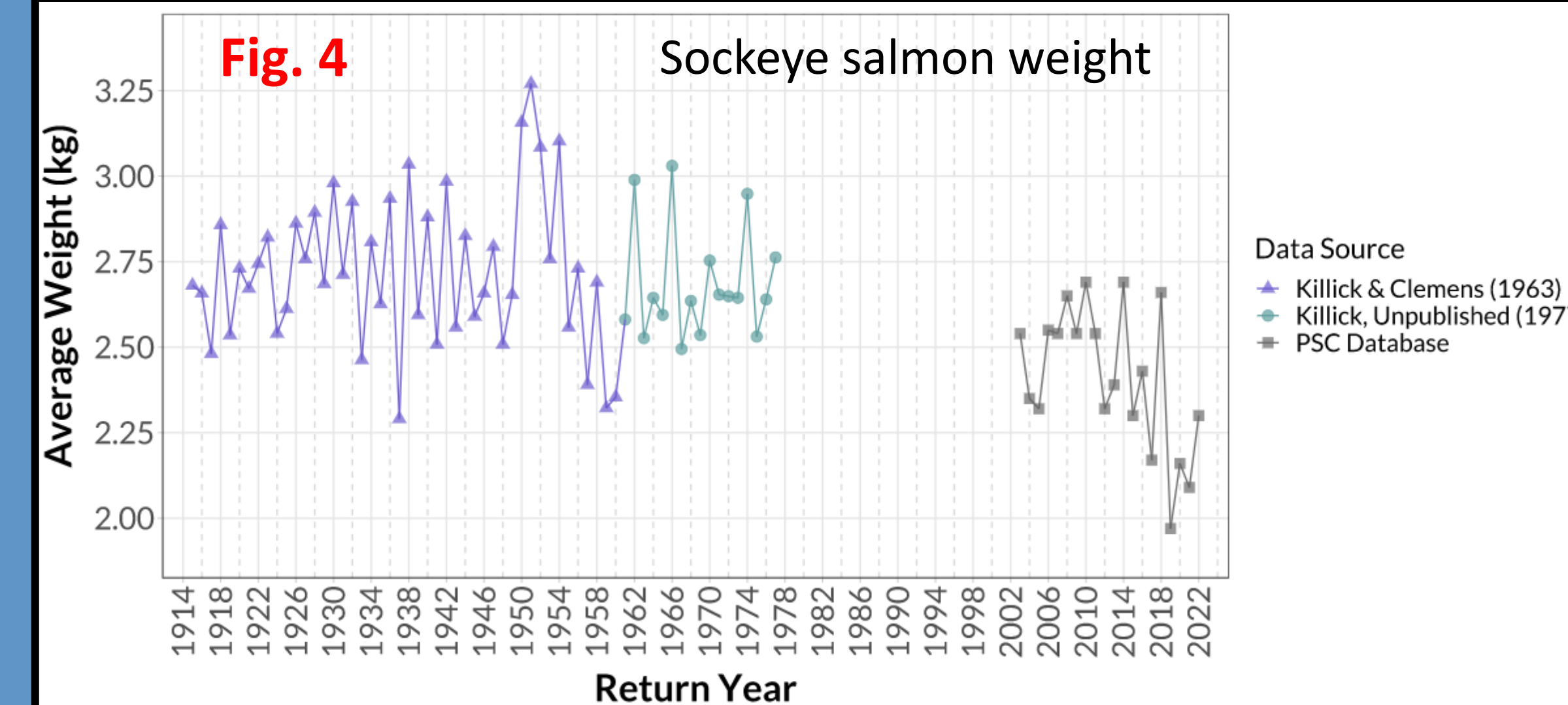
Select grouping of years: Even/Odd

Select stocks: Adams Lake, Big Silver, Birkenhead, Bowron

Select Trendline Method: Loess

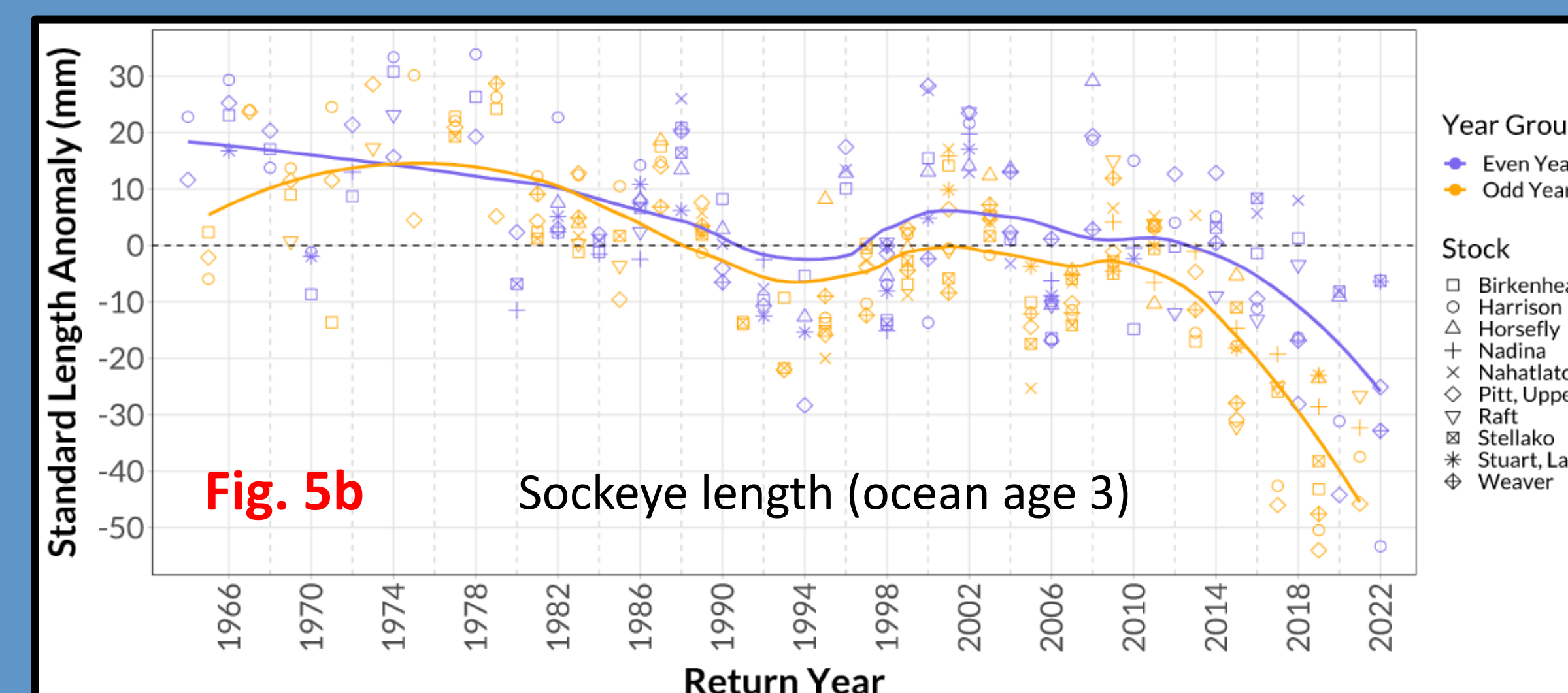
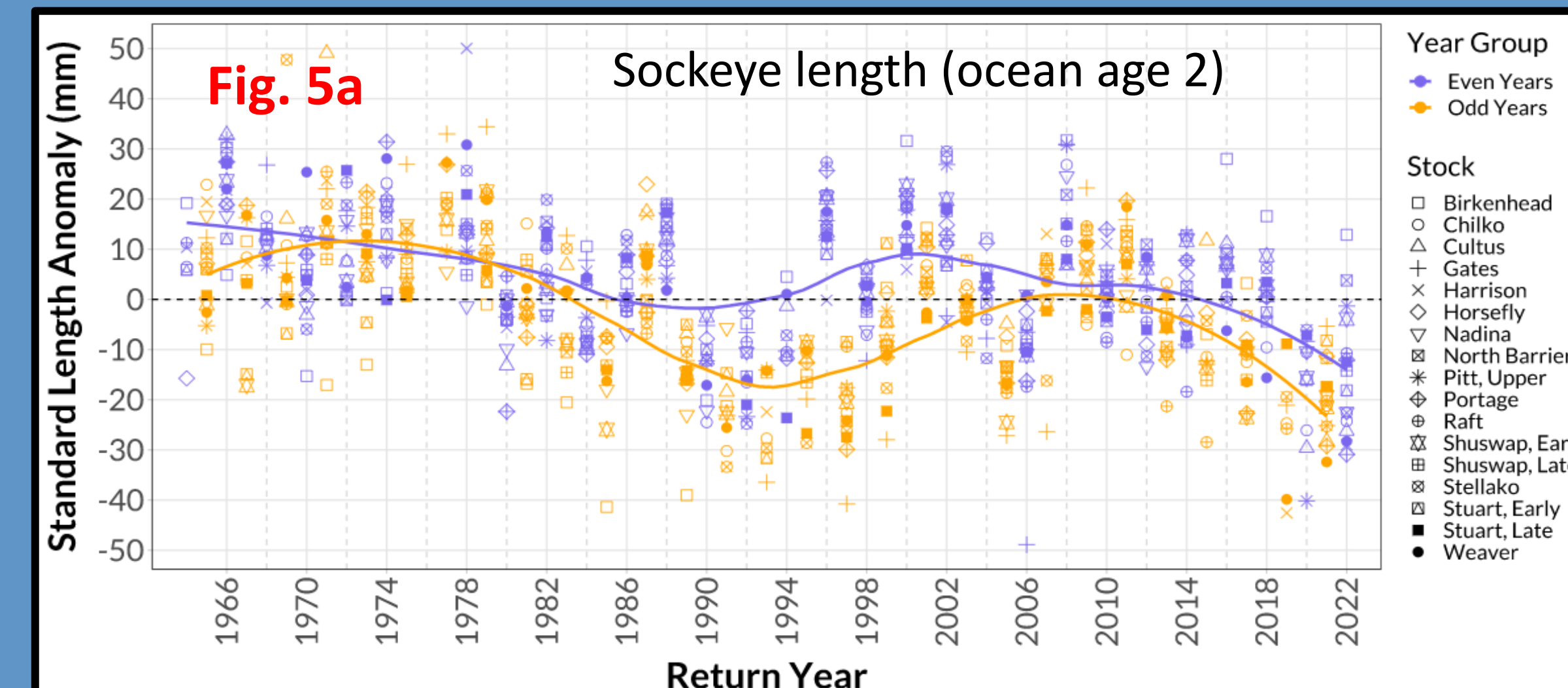
Select minimum sample size (of each sex): 20 | Select minimum number of years of data: 20

Documentation | Download Data



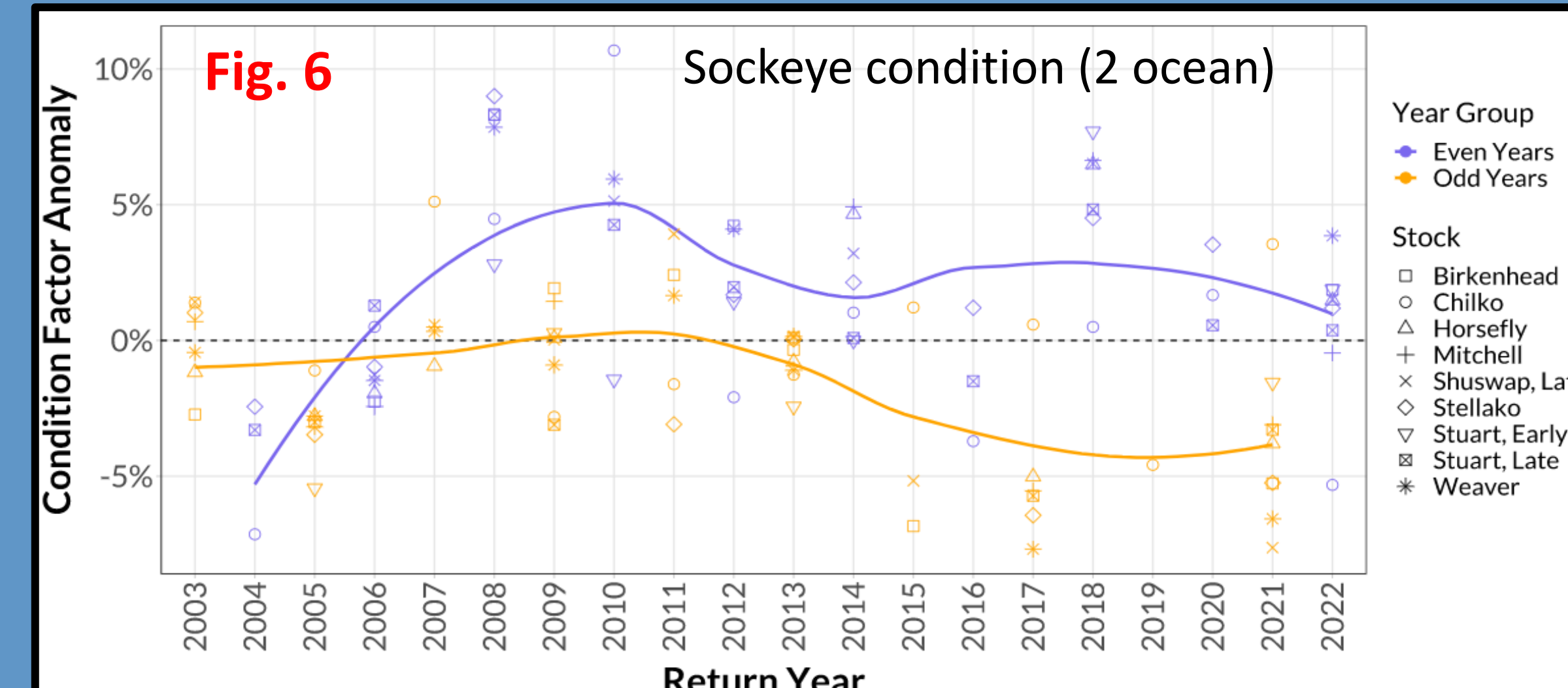
## Results

- The long-term trend in Fraser sockeye body size includes two periods of decline, one from the 1970s into the 1990s, and the other through the 2010s to present (Fig. 5). Average sizes have been among the smallest on record in each of the last 4 years.
- Fraser River pink salmon declined in size in the 1970s through 1990s (like Fraser sockeye), but weights have remained low since then (Fig. 3).
- Average sizes of sockeye have declined at a greater rate in recent years for older age classes than for younger ones (Fig. 5).
- There is a strong, persistent tendency for sockeye returning on odd-numbered years to be smaller (shorter, lighter, and skinnier) than sockeye returning on even-numbered years (see Fig. 5, 6).
- Earlier age-at-maturity accounts for decreased size in some other species, but Fraser sockeye have tended to mature later in life as their marine growth has apparently slowed (not shown).
- By compiling detailed data sets regarding declining productivity and growth of Fraser sockeye salmon, we hope to facilitate research that improves management in a changing climate.



## Next steps

- Solicit, receive, consider, and respond to feedback from early users. Improve documentation and evaluate strategies to increase effective and appropriate use of the data.
- Refine and extend current time series – recover, validate and convert archived data, include sockeye jacks, add even-year pink salmon. Add new time series for Fraser sockeye and pink salmon, especially those likely to respond to climate change – migration behaviour (timing and migration route), migratory success, growth data from scales, etc.
- Add data for other populations and species from elsewhere in the PSC family.



## References

- 1 Losee, J.P., et al. 2019. Changing salmon: An analysis of body mass, abundance, survival, and productivity trends across 45 years in Puget Sound. *Fish and Fisheries* 20(5): 934-951.
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- 4 Latham, S., et al. In: Bolt, J. et al. 2022 (Eds). State of the Physical, Biological and Selected Fishery Resources of Pacific Canadian Marine Ecosystems in 2021. *Can. Tech. Rep. Fish. Aquat. Sci.* 3482: vii + 242 p.
- 5 Connors, B., et al. 2020. Climate and competition influence Sockeye Salmon population dynamics across the Northeast Pacific Ocean. *Can. J. Fish. Aquat. Sci.* 77: 943-949.

## Acknowledgements

**IPSC:** Samples and data collected in 1985 and earlier were collected or compiled by the International Pacific Salmon Fisheries Commission (the PSC’s predecessor organization).  
**DFO:** Fisheries and Oceans Canada collected spawning ground samples and data (contributing to run-size, age composition, and body length estimates) since 1985.  
**PSC:** All other post-1985 sampling and data compilation shown here is the work of the Pacific Salmon Commission.