

Technical Report Project 10 – Fraser River sockeye salmon production dynamics

Project description: The researchers conducted basic statistical analyses of data on sockeye salmon abundance and productivity (the number of adult returns produced per spawner). They reviewed previous research on sockeye cyclic dominance and density-dependence, including Fraser and non-Fraser sockeye populations. They also summarized the frequency and effects of over-escapement on subsequent productivity and abundance of adult recruits.

Researchers:

Dr. Randall Peterman is a Professor in the School of Resource and Environmental Management at Simon Fraser University. He holds a Canada Research Chair in Fisheries Risk Assessment and Management and has been Director of the Cooperative Resource Management Institute. His research focuses on quantitative methods to improve the understanding and management of fish populations, particularly in the presence of uncertainties and conservation risks. His research group specializes in developing and applying quantitative methods to improve fisheries management.

Dr. Brigitte Dorner has a M.Sc. in computing science at Simon Fraser University and a Ph.D. in Resource and Environmental Management from Simon Fraser University. She works as a post-doctoral fellow with Dr. Peterman on dynamics and management of Pacific salmon, including comparative analysis of time trends in salmon productivity. Her areas of specialty include salmon ecology, fisheries management, operating models, management strategy evaluation, landscape ecology, forest ecology, spatial statistics, spatial modeling, GIS and remote sensing.

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This report compares variation over time in productivity across Fraser and non-Fraser sockeye salmon stocks and describes the degree to which patterns have been similar across stocks within the Fraser system as well as outside the Fraser. Productivity refers to the number of adult returns produced per spawner (the fish that reproduce for a given sockeye population in a given year).

The researchers analyzed data from 64 wild sockeye salmon stocks, 19 of which were from the Fraser River. The remaining stocks were from Washington, Alaska and other parts of British Columbia. Data on both adult and juvenile abundances were analyzed.

There have been relatively large, rapid and consistent decreases in sockeye productivity over the last decade, not only in the Fraser system, but also in many other areas along the west coast of North America, including stocks from:

- Puget Sound (Lake Washington)
- Barkley Sound on the West Coast of Vancouver Island (Great Central and Sproat Lakes)
- Central Coast (Long Lake, Owikeno Lake, South Atnarko Lakes)
- North Coast of B.C. (Nass and Skeena)
- Southeast Alaska (McDonald, Redoubt, Chilkat)
- Yakutat (northern part of Southeast Alaska)(East Alsek, Klukshu, Italio)

For many stocks, declines in productivity started in the late 1980s or early 1990s, most likely due to reduced survival when sockeye are leaving freshwater or in the marine environment. **The observation that declines in productivity have occurred over a much larger area than just the Fraser River system is a very important new finding.**

Widespread declines in freshwater and/or marine survival could be due to a shared factor or factors, such as increases in predation, climate-driven increases in pathogen-induced mortality, or reduced food availability due to oceanographic changes. However, it is also possible that the observed similarities are merely coincidental and were caused by different mechanisms for different stocks. Further research will be needed to draw definitive conclusions about the relative role of large-scale versus more local causes.

### **Harrison Sockeye**

The Harrison River sockeye population is the only stock in the Fraser River watershed for which productivity shows a clear increasing trend over the last two decades. Harrison sockeye have noticeable differences in their life history strategy from that of other sockeye stocks, and may offer clues about causes of the decline in those other populations. Specifically, Harrison sockeye:

- Migrate to sea in their first year of life as fry
- Rear for some time in the Fraser River estuary
- Remain in the Strait of Georgia later than other Fraser River sockeye
- Appear to migrate as juveniles around the southern end of Vancouver Island through the Strait of Juan de Fuca instead of through Johnstone Strait to the north

Because the southern fry-migration route is shared with Lake Washington sockeye (a stock that showed decreasing productivity over time), the reason for the Harrison's trend is probably not attributable to its different migration route.

### **Are large numbers of spawners detrimental to productivity?**

The researchers also investigated whether large numbers of spawners could be blamed for declines in productivity and returns of sockeye. The report concludes that this may have been the case for Quesnel sockeye, but not for any of the other Fraser sockeye stocks. As well, there is no evidence that increased spawner abundance is responsible for widespread declines in other sockeye populations.

### **Recommendations:**

The researchers recommend the following actions:

- When investigating potential causes for declines in productivity, give priority to mechanisms that could have affected stocks over the broad geographic range across which declines were observed.
- Create an international, long-term working group to coordinate collection and analysis of a well-structured salmon productivity database.
- All salmon management and research agencies in Alaska, BC, and Washington need to strategically increase the number of sockeye stocks for which they annually estimate juvenile abundance.
- Conduct further research on salmon migration routes and timing during outmigration, as well as residence in the marine environment and stressors encountered during those life stages.