Density-dependent Growth of Salmon in the North Pacific Ocean: Implications of a Limited, Climatically Varying Carrying Capacity for Fisheries Management and International Governance

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Recent evidence has revealed that hatchery-origin salmon compete with wild salmon for a common pool of prey resources in the North Pacific Ocean. Density-dependent effects on growth of chum salmon are of special concern because of large increases in hatchery production of this species (and pink salmon) in Asia and evidence for both intra- and inter-specific competition for limited prey. Age-specific body size-at-return of chum salmon has declined over the last 3-4 decades in Japan, Korea, Alaska, Washington, and BC, and these declines have been explained by competition with abundant hatchery-produced chum salmon from Asia, although spatial overlap of distribution remains uncertain. This has led to international interest on potential effects of hatchery production on wild stocks in Asia and North America. In order to investigate the relative contribution of density-dependent growth arising from a limited carrying capacity and climatically varying oceanographic drivers, in this pilot project we investigated the marine growth of one population of chum salmon from BC (Big Qualicum, Vancouver Island, 1968-2005). Salmon marine growth was determined by analysing scales from fish captured on the spawning grounds at ages three (3_1) and four (4_1). Preliminary results indicated that return year had a significant effect on the growth rate of most chum salmon in both age groups. Specifically, scale growth (and presumably fish length) was greatest in the first marine year and declined incrementally in subsequent years. The growth rate of 3_1 chum salmon in all years was higher than 4_1 chum salmon. The effect of sex on scale growth was less conclusive, with male growth rates being higher than female growth rates in some years. Correlation analysis revealed a negative correlation between the first and second year of growth for both 3_1 and 4_1 chum salmon, suggesting that chum salmon may have an optimal size at the end of their second year. Growth was also correlated by ocean entry year, and as different ages of fish presumably occupy different areas in the ocean, this demonstrates the importance of large-scale climatic factors in determining chum salmon growth. Proposed future work includes comparisons of marine growth among pink, chum, and sockeye salmon from neighbouring and spatially diverse populations across British Columbia.

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