Pacific Salmon

Pacific salmon represent an ecological, economic and cultural resource of significant importance to western North America. Within the 20th century, however, natural abundance and productivity have declined. Owing largely to a variety of human-induced stressors, including habitat degradation, overfishing, and climate change, salmon populations have occurred in the context of significant climate variability, recognized as a large-scale regulatory mechanism of Pacific salmon production. By virtue of their anadromous and semelparous life history traits, Pacific salmon have a unique nutrient cycle that transports nutrients of marine origin to typically oligotrophic freshwater lakes, where they are released into the ecosystem (Fig. 1). In many aquatic ecosystems, this can comprise up to 50% of the production of aquatic nutrient budgets. Pacific salmon (Oncorhynchus nerka) are unique among Pacific salmon in that the entire lifecycle is upstream, as opposed to intrinsically marine, and therefore changes in their abundance can influence food web dynamics in these systems and are eventually recorded in late sediments.1-4

Contemporary Climate-Salmon Relationship: The Pacific Decadal Oscillation (PDO)

Fisheries records are inherently noisy, however, relationships between pelagic fish productivity and underlying climatic influences have recently been established. The Pacific Decadal Oscillation (PDO), is a dominant mode of Pacific climate variability, which explains a time scale of 15-25 yr and 50-70 yr in North Pacific Ocean (Fig. 1). The PDO has been shown to directly influence NE Pacific fish species, in particular, salmon recruitment and fishery dynamics. Changes in PDO state indicate shifts in ocean temperature and currents, which are key drivers of salmon population dynamics. Positive PDO phases are characterized by increased ocean temperatures and enhanced upwelling, which can lead to increased productivity and biomass in the NE Pacific Ocean. Conversely, negative PDO phases are associated with cooler temperatures and reduced upwelling, resulting in lower productivity and biomass. These changes can have significant impacts on salmon population dynamics, as indicated by changes in fishery yields and population trends. Therefore, understanding the PDO is crucial for predicting salmon population dynamics and informing management strategies.

Study Site: Tahltan Lake, BC, Canada

Tahltan Lake is a sub-basin in the sockeye salmon nursery/lake system of the Shilshole River drainage of northern British Columbia (131°17’W, 57°37’S) (Fig. 2). The saltern is located and dominated by diatom species and 3. Tahltan Lake isographic with relatively low salinity and low productivity compared to other lakes in the region, which is typical for regions where salmon production is reduced due to nutrient limitation. This makes Tahltan Lake an ideal site to study the impacts of climate variability on salmon population dynamics. The lake has a surface area of 4.8 km² and a maximum depth of 48 m. The lake is located at an elevation of 812 m and is situated in a mountainous region. The lake receives water from several tributaries, which are primarily fed by rainfall and snowmelt. The lake has a long and varied history of human activity, including logging, mining, and recreational use, which may have influenced salmon population dynamics over time.

Relationship of Salmon Escapement to Long-Term Potential Drivers

A period of ~1,50 to 200 years shows a correlation between salmon escapement from Alaska and changes in PDO state. This suggests that PDO variability can influence salmon population dynamics on a decadal scale. Changes in PDO state can potentially affect salmon production through changes in ocean temperature, circulation, and upwelling, which can impact the availability of food resources and larval survival rates. Therefore, understanding the PDO is crucial for predicting salmon population dynamics and informing management strategies.

Multi-centennial cyclicality in Canadian sockeye salmon (Oncorhynchus nerka) production: A window into large-scale environmental forcing mechanisms

Pacific salmon were harvested for historical records of salmon production and climate variability.

Literature Cited: