Box 1. Glaciers + Lakes = High Salmon Productivity?

Rivers flowing into the Gulf of Alaska are strongly influenced by glaciers. Roughly 7% of freshwater discharge into the Gulf of Alaska is meltwater from rapidly thinning glaciers (Hill et al. 2015). **In general, glacial rivers support low productivity of algae, invertebrates, and fish** due to their low bed stability, high sediment loads, and cold temperatures (Milner et al. 2001). **However, proglacial lakes moderate these harsh physical conditions** by stabilizing flow regimes, trapping sediment, and buffering temperatures (Dorava and Milner 2000; Kyle and Brabets 2001; see below).

River type →	Glacial (no lake)	Glacial (below lake)	Non-glacial
Typical biophysical traits ↓			
Channel morphology	Braided, shallow, unstable bed and riverbanks, few pools	Narrower channels, stable bed and riverbanks, more pools	Narrower channels, stable bed and riverbanks, more pools
Turbidity	Highest	Moderate	Lowest
Thermal regime	Cold, least variable	Moderate, somewhat variable	Moderate to warm, most variable
Algal & invertebrate production	Lowest	Moderate	Highest
Salmon production	Lowest	Highest	Moderate

Many rivers below proglacial lakes support highly productive salmon populations, including those in the Kenai, Kasilof, and Klutina rivers in Southcentral Alaska. Dorava and Milner (2000) proposed that lake-mediated glacial rivers produce more salmon per unit channel length than glacial or non-glacial rivers lacking lake influence, citing examples in the Cook Inlet basin. **Lake-regulated rivers also exhibit diversity in salmon run timing, prolonging the availability of salmon to fisheries and ecosystems.** Many lake-regulated rivers support two genetically distinct populations of Chinook and Sockeye salmon: early runs spawning in tributaries and late runs spawning in the mainstem below the lake (e.g., Burger et al. 1985, 1997, Savereide 2005).

The distribution of proglacial lakes is changing as glaciers recede. For example, a large new proglacial lake formed at the toe of the Melbern Glacier in the Alsek River drainage, YT, Canada, ca. 2005. Melbern Lake and its outlet river are now developing characteristics suitable for colonization by Chinook and Sockeye salmon, which could ultimately be harvested in U.S. fisheries (A. von Finster, Dept. Fisheries and Oceans retired, pers. comm.). Conversely, in 2016, Kluane Lake, a major pro-glacial lake in the Yukon River basin, lost its main glacial tributary when the Kaskawulsh Glacier receded to the point that its drainage flowed south towards the Pacific Ocean instead of north into the lake (Shugar et al. 2017). The loss of glacial inflow may transform the ecology of the lake and its salmon-bearing outlet river.