



## Variable effects of marine-derived nutrients on algal production in salmon nursery lakes of Alaska during the past 300 years

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**ABSTRACT:** We measured historical changes in sedimentary  $\delta^{15}\text{N}$  and fossil pigments in four lakes with anadromous semelparous salmon and two reference lakes to quantify the degree to which the flux of marine-derived nutrients (MDNs as N isotopes) regulate algal production (as pigments). During the past 300 yr, production of the predominant algae (diatoms) was positively correlated ( $r = 0.42\text{--}0.93$ ,  $p < 0.02$ ) with sedimentary  $\delta^{15}\text{N}$  in nursery lakes of sockeye salmon (*Oncorhynchus nerka*) but was inversely correlated with sedimentary  $\delta^{15}\text{N}$  ( $r = -0.71$  to  $-0.73$ ,  $p < 0.0001$ ) in reference lakes that lacked migratory fishes. Overall, the pigment- $\delta^{15}\text{N}$  correlation during the 20th century was strongly correlated with both mean densities of spawning sockeye salmon during 1956-2000 ( $r = 0.97$ ,  $p < 0.002$ ) and the fraction of total ecosystem N derived from salmon during 1900-2000 ( $r = 0.98$ ,  $p < 0.001$ ). Together these patterns suggest that the sign of the  $\delta^{15}\text{N}$ -pigment correlation can be used to distinguish among lakes or periods of time in which algal production is regulated mainly by MDN influx (positive correlation) or other factors (negative correlation). Tests of this hypothesis revealed that the degree to which MDNs regulated algal production in nursery lakes varied greatly since 1700, with significant periods of weak control even in lakes with abundant salmon. Further, when considered at the landscape scale, the importance of MDNs to individual lakes varied substantially through time and in space, with little evidence of synchrony among sites or catchments.

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