Biomagnification of mercury and eutrophication: implications for wild-caught fish

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Bioaccumulative metals, including mercury (Hg) and arsenic, are often associated with geothermal activity. In New Zealand's central North Island region numerous lakes are influenced by geothermal inputs. These waterbodies are of particular significance to the local indigenous population (Māori), as a source of food and also as a cultural and spiritual resource. We examined the effect of trophic state in an oligotrophic, a mesotrophic and a eutrophic lake with naturally elevated levels of Hg on biomagnification of total Hg (THg) in aquatic organisms, i.e., the rate at which Hg accumulates with increasing trophic position. Trophic positions were distinguished by stable nitrogen isotope (^{15}N) measurements. Biomagnification of THg in the food chain (including koura or freshwater crayfish and fish) increased with eutrophication, as indicated by the ratios of THg concentrations in koura and trout with the basal resources or water, and by the biomagnification slope of log THg versus δ^{15}N. The average concentration of THg at the top of the food chain (rainbow trout) exceeded the maximum recommended level for consumption for a standard dietary intake by up to 440% and increased with levels of THg in the water column and with the percentage of geothermal inputs to the lakes. Survey data for six additional lakes found guideline exceedance for trout at 62% of the sites and koura at 25% of sites, indicating a potential health risk from wild food harvesting in these lakes. We propose that the biomagnification of THg increases with the concentration of methyl-mercury in the basal resources, which are affected by lake eutrophication. A critical factor for this biomagnification process would be the development of an anoxic hypolimnion, which could constitute an ecological "tipping point" for these lakes.