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Northern elephant seals: integrators of persistent organic pollutants in the deep ocean

Peterson Sarah(1), Michael Peterson(2), Cathy Debier(3), Adrian Covaci(4), Dan Costa(5)

(1) *University of California, Santa Cruz, 100 Shaffer Road, Santa Cruz, California, 95060, United States.*

(2) *University of California, Berkeley.*

(3) *Université catholique de Louvain.*

(4) *University of Antwerp.*

(5) *University of California, Santa Cruz.*

Northern elephant seals (*Mirounga angustirostris*) travel thousands of kilometers to forage in mesopelagic (200-1000 m) regions of the North Pacific. Lengthy foraging trips interspersed with time on land make elephant seals ideal integrators of difficult-to-study oceanic ecosystems. On land, elephant seals fast, resulting in extreme fluctuations in mass. Our study (1) measured the concentrations of persistent organic pollutants (DDTs, PCBs, and PBDEs) in adult seals during body condition extremes, (2) quantified correlations between contaminants to determine similarity of bioaccumulation patterns, and (3) used satellite-tagged females to describe contaminants in relation to foraging ecology. Full-thickness blubber cores and serum samples were collected from seals before and after their long (6-8 month) foraging trip (2011 and 2012). Female samples were paired (N=24), whereas unique males were sampled before (N=16) or after (N=17) the foraging trip. All females were instrumented with satellite- and time-depth recorder tags. DDTs, PCBs and PBDEs were detected in all samples, in decreasing mean concentration. On average, the DDT metabolite, p,p'-DDE, comprised 99% of Σ DDTs in blubber samples. Mean concentrations of Σ DDTs, Σ PCBs, and Σ PBDEs in blubber upon arrival to land from a foraging trip were twice as high for males (2008, 1176, and 31 ng g⁻¹ lipid, respectively) compared with females (987, 653, and 15 ng g⁻¹ lipid, respectively). Upon arrival to land, Σ DDTs and Σ PBDEs in male and female blubber samples were highly correlated ($p < 0.001$; $r = 0.92$ and $r = 0.95$, respectively), whereas only males had a significant correlation between Σ PCBs and Σ PBDEs ($p < 0.001$, $r = 0.77$) and between Σ PCBs and Σ DDTs ($p < 0.001$, $r = 0.91$). Differences in male and female bioaccumulation may be due to behavioral differences in both foraging and reproduction. Our results support elephant seals as an integrator of deep-ocean contaminant exposure. Elephant seals are easily studied and their bioaccumulation patterns may reflect threats to more cryptic marine predators.