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**Nonylphenol in marine organisms in North American estuaries:
Trophic chain accumulation and proteomic responses**

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We characterized the presence of the endocrine disruptor 4-nonylphenol (NP) within Morro Bay, California, and four other west coast estuaries in North America. Our goals were to determine how NP accumulates along the trophic chain within a small estuarine ecosystem, identify sources, and explore a suggested link with tissue pathologies of the arrow goby, *Clevelandia ios*. Concentrations of NP in seawater, sediment, organisms, and household products, were determined by GC-MS, and *C. ios* tissues were examined histopathologically to characterize gonadal tumors and liver pathologies. Proteomic studies were conducted using gel electrophoresis and mass spectrometry. NP concentrations increased from seawater (<1 ppb) to estuarine sediment (38 ppb, dw), and continued to increase with trophic position for molluscs, fish, sea otters and marine mammals. Gobies and/or molluscs from the five estuaries had similarly high NP levels for all species regardless of nearby urbanization. A common

input is wastewater, suggested by excessive NP in septic sludge (5000 ppm dw), likely originating from toilet paper where NP ranges between 50 and 2790 ppb (ww). Based on histopathology, 29% of female *C. ios* from Morro Bay have gonadal tumors, and livers of both genders display glycogen depletion and macrophage aggregates, indicative of environmental contaminants. Tumors and most liver pathologies are absent in *C. ios* from British Columbia, Canada, coinciding with a restricted range of NP in fish tissues. A proteomic analysis in response to laboratory exposure showed pronounced and long-term (60 days) changes in the abundance of *C. ios* liver proteins involved in energy metabolism and oxidative stress.
