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Discovering contaminants of emerging concern

CONTAMINANTS ARE UBIQUITOUS. According to Battaglin and Kolpin (2009), “the environmental occurrence of trace organic compounds such as pharmaceuticals, personal care products, pesticides, and hormones, and their potential adverse effects on aquatic and terrestrial life and on human health is an issue that concerns not only scientists and engineers, but also the general public.” Investigations are detecting such trace organic compounds with increasing frequency in the environment on a global scale (Halling-Sørensen et al. 1998; Kolpin et al. 2002; Ashton et al. 2004; Moldovan 2006; Gulkowska et al. 2007). Contaminants of emerging concern include endocrine disrupting compounds (Emerging Contaminants Workgroup 2008). Such contaminants occur in treated Las Vegas sewage effluent upstream of Lake Mead National Recreation Area (Nevada). More surprising, perhaps, is the documented occurrence of these contaminants in the remote alpine lakes of national parks such as Glacier, Mount Rainier, and Rocky Mountain in Montana, Washington, and Colorado respectively (Landers et al. 2008); findings of this recent EPA report on airborne contaminants are summarized in this issue (see pages 58–63). Furthermore, an NPS natural resource report by Rebecca A. Landewe summarizes the occurrence of chemical contaminants throughout the National Park System. Landewe (2008) reviews what is currently known about “new or existing compounds with emerging concern,” in particular endocrine disrupting compounds. These compounds have come under intense scrutiny in recent years because, when present during key life cycle stages even in miniscule amounts, they can have significant effects on the reproduction, growth, and development of organisms.

Landewe (2008) documents contamination by National Park Service (NPS) region: The snowpack of Yellowstone National Park (Intermountain Region) contains the by-products of fossil-fuel combustion, including toluene—a potential endocrine disruptor. The waters of Chattahoochee River National Recreation Area (Southeast Region) contain a cocktail of organic wastewater contaminants, 13 of which are endocrine disruptors. In the Midwest Region, estrogenic compounds from wastewater treatment facilities are present in Mississippi National River and Recreation Area. Potential endocrine-active compounds from detergents and other household and industrial products occur in more than 74 miles (119 km) of the Cuyahoga River, which flows through Cuyahoga Valley National Park. In a study in Voyageurs National Park, half of the sampled fish contained perfluorinated compounds, which are used in grease-resistant food packaging, stain-resistant fabrics, and nonstick cookware, for example. In the Northeast Region, residential septic systems leak groundwater

contaminated with estrogenic compounds at Cape Cod National Seashore.

Salmon contaminated with PCBs (polychlorinated biphenyls) and DDE (dichlorodiphenyldichloroethylene) spawn and die in the Copper River upstream of Wrangell–St. Elias National Park and Preserve (Alaska Region), introducing potential endocrine disruptors into an otherwise mostly pristine freshwater food web. PCBs are persistent organic pollutants that bioaccumulate in animals, and DDE is a potentially potent endocrine disruptor that results from the breakdown of the synthetic pesticide DDT (dichlorodiphenyltrichloroethane). In the Pacific West Region, insecticides such as chlorpyrifos, diazinon, and parathion in montane lakes in Sequoia National Park illustrate the far-flung impacts of atmospherically transported contaminants.

Much data on wildlife come from fish and other species hunted for food. Fish are among the aquatic species of concern for endocrine disrupting contaminants because they are immersed in water and take up contaminants through both skin and gills. In the 1990s, studies began to document the phenomenon of vitellogenin (VTG) production in male fish (e.g., Purdom et al. 1994; Harries et al. 1996; Lye et al. 1997, 1998); VTG is an egg yolk precursor protein synthesized in response to estrogen or xenoestrogenic (estrogen-mimicking) compounds. In natural systems, VTG is typically only produced by females. Intersexuality, the presence of both male and female reproductive structures in the same animal, is another common biomarker (alongside elevated VTG) of xenoestrogen exposure in fish. Investigators of the Western Airborne Contaminants Assessment Project (WACAP) documented the presence of intersex fish with the finding of some male fish with both female oocytes and male testes at Rocky Mountain and Glacier national parks, and elevated VTG in some male fish at Rocky Mountain, Glacier, and Mount Rainier national parks. Although WACAP scientists are still investigating the cause-and-effect relationship, these changes are indicative of a chemical effect possibly resulting from endocrine disrupting contaminants such as the insecticides dieldrin and DDT (Landers et al. 2008; Schwindt et al. 2009; also see Flanagan on pages 58–63 of this issue).

Concern over contaminants increases when reproductive disorders pass to subsequent generations; for example, laboratory studies have concluded that deficits in sperm production can be transgenerational (Lyons 2008). However, data about the effects of endocrine disrupting contaminants on populations are comparatively few (Geschwind et al. 1999), though a recent study suggests that one outcome may be population collapse (Kidd et al. 2008).

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At present many researchers, including WACAP investigators and NPS Water Resources Division scientists, are trying to decipher the full meaning of these new findings by asking pertinent questions, such as which contaminants are posing threats, what are the pathways for these contaminants, where are contaminants accumulating (areal extent and by elevation), what are the most useful indicators of contaminants, and what are the effects of contaminants at the population level? New findings, unanswered questions, and the health of wildlife and human populations provide plenty of rationale for continuing these studies in national parks and elsewhere.

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