

Mercury Threatens Wildlife Resources

By William Loftus and Oron Bass, Jr.

In recent decades, our national park areas have faced a previously unrecognized threat – the introduction of contaminants from external sources often distant from park boundaries. The effects of long-range transport of contaminants, which contribute to acidic deposition, ozone damage, and impairment of scenic resources, have become obvious to park employees and visitors alike. National parks also have suffered from point and nonpoint source pollutants entering parks in waters shared by cities, industry, and agriculture.

The NPS has responded by instituting research and monitoring programs with the guidance and participation of the Air and Water Resources divisions. NPS also is a major player in the National Atmospheric Deposition Program. Individual parks, to maintain their air and water quality standards as required by the Clean Air and Clean Water Acts, often work closely with other federal and state agencies to monitor physical and chemical parameters.

Although NPS has programs to monitor the status of park air and waters, the contamination situation described in this report strongly indicates that present monitoring programs are inadequate to detect ecotoxins that accumulate in park biota. This case history deals with mercury, but applies as well to other bioaccumulated heavy metals and pesticides. We hope the mercury case history in the Everglades will demonstrate the need for periodic testing of the biota for contaminants (biomonitoring) to improve chances of detecting a problem before symptoms occur.

Mercury (Hg) is a heavy metal found naturally in air, water, and earth in a number of chemical forms. It is very volatile, easily entering the atmosphere where it may be dispersed widely (Swain, 1989). The biota accumulate mercury in body tissues, through which it is passed to higher trophic levels in the food web (Johnels et al., 1967). Top-level carnivores may accumulate loads at which toxic effects, such as nerve damage, convulsions, and death occur. The U.S. Food and Drug Administration presently sets a maximum limit of 1.0 ppm Hg in human foods. Methylmercury is

the most toxic and accumulatory mercury compound. It is believed to be produced by the microbial methylation of Hg in aquatic systems (National Academy of Sciences, 1978).

The first hint that Hg was present in Everglades NP (EVER) came during the DDT-scare of the early 1970s. Ogden et al. (1974) presented the results of screening a variety of wildlife for pesticides and heavy metals. They expressed concern about the biotic effects of Hg because levels in some freshwater fishes averaged between 0.6 and 0.9 ppm. Levels in eggs from wading birds and alligators ranged from 0.4 to 0.5 ppm Hg, and exceeded 1.0 ppm in some wading bird tissues. Ogden et al. (1974) suggested that the biota be monitored for contaminants every 2 or 3 years, but for reasons unclear to us their suggestion was not heeded.

In 1989, a statewide sampling program for Hg in freshwater gamefish by the Florida Game and Fresh Water Fish Commission revealed that muscle filets from largemouth bass (*Micropterus salmoides*) in the Everglades had the highest levels (>1.0 - 1.5 ppm) in

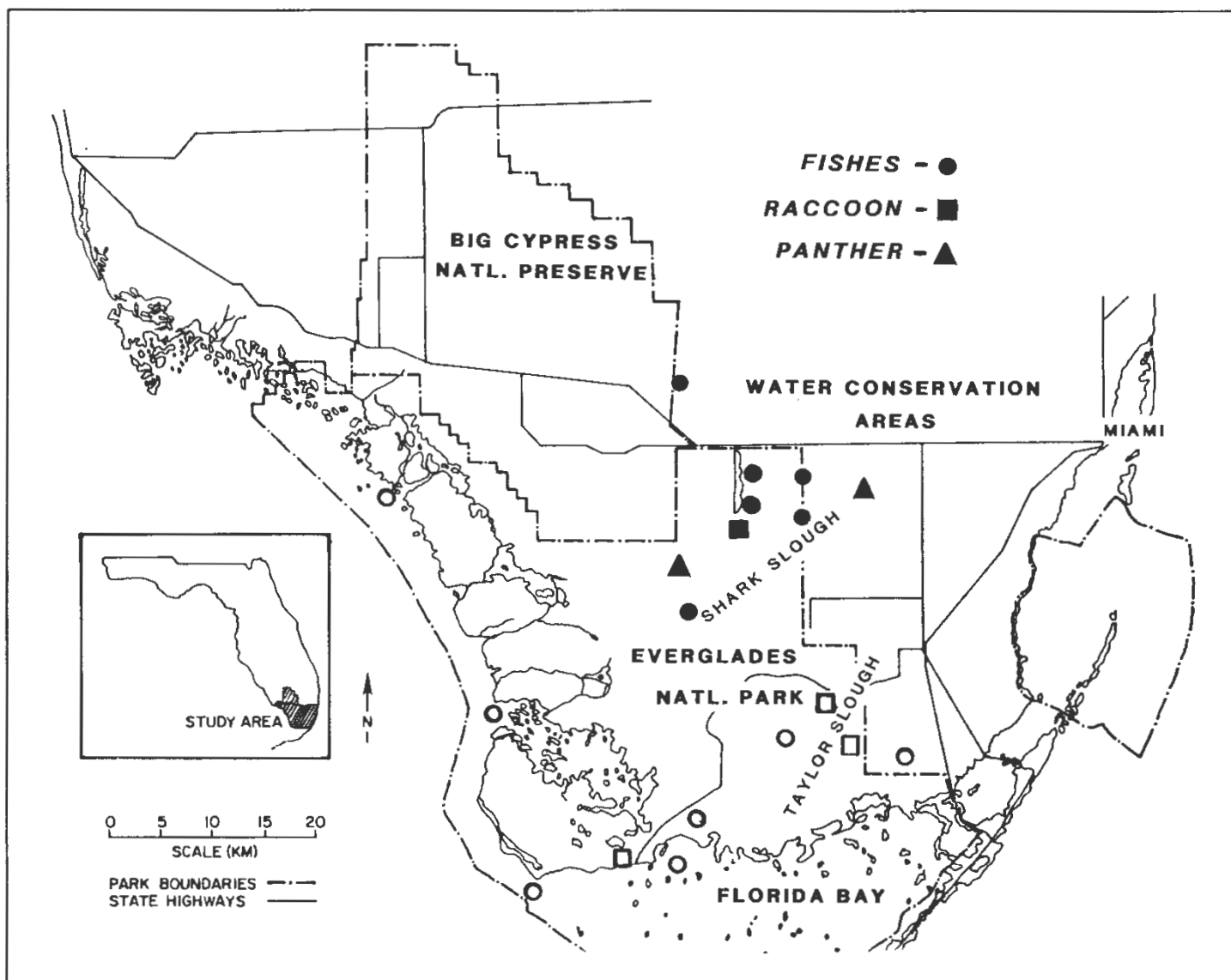


Figure 1. Extreme southern Florida, showing the major drainage areas in and near Everglades NP. High (closed symbols) or low (open symbol) mercury levels in tissues from fishes, raccoons, and the Florida panther, show the pattern of association with Shark Slough.

And Human Health in Everglades NP

the state (Hand and Friedemann, 1990). Consumption advisories for fishermen were issued by the Florida Dept. of Health and Rehabilitative Services. EVER cooperated with the USFWS to analyze bass and yellow bullhead catfish (*Ameiurus natalis*) samples at their Columbia, Mo. lab. Bass from Shark River Slough, downstream of the Water Conservation Areas, had the highest levels ($x=1.706-1.847$ ppm); Taylor Slough drainage bass had lower levels ($x=0.511-0.603$ ppm) (Fig. 1). Park managers responded by issuing a brochure explaining the threat to human health. The consumption of bass from Shark Slough waters was prohibited and was restricted in other park waters.

Signs warning of contamination were posted at popular angling sites. Because the greatest fishing activity and harvest occur in saltwater areas, higher trophic-order gamefishes like spotted seatrout (*Cynoscion nebulosus*) and gray snapper (*Lutjanus griseus*) were tested next. Fortunately, mercury levels were lower than in the freshwater fishes ($x=0.112-0.586$ ppm), and seemed to pose no human health threat.

Until late in 1989, the emphasis for action focused on the human health issue. However, this changed with the death of Florida Panther #27 (*Felis concolor coryi*) in the summer of 1989 in Shark Slough (Fig. 2) (See *Park Science* 10(4):15). Autopsy results were inconclusive but revealed that the cat had regurgitated prior to death. Results of the liver scan revealed an incredible 110.0 ppm of Hg, much higher than liver values from panthers killed by automobiles or other causes. Again, the Shark Slough link was evident.

Mercury contamination in this highly endangered species is of great concern because of its small population, estimated at fewer than 30 individuals in the wild. Blood and hair samples taken from free-living cats using Shark Slough showed a similar pattern of high Hg levels (Fig. 1). Bioaccumulation of Hg through the panther diet was suggested as the source for the high levels. Panther #27, which lived in the Shark Slough area, fed heavily on raccoons (*Procyon lotor*) and alligators (*Alligator mississippiensis*), which in turn, fed on fishes and invertebrates. Panthers in other areas prey on whitetail deer (*Odocoileus virginianus*) as a staple, and deer have very low Hg levels (Roelke et al., 1992).

The next step in the investigation determined that raccoons from Shark Slough had higher levels than those living elsewhere (Fig. 1). Alligator samples await analysis but are likely to be high. In the northern Everglades, the alligator hunting season was closed because of unsafe Hg levels. Most recently, great egrets (*Casmerodius albus*) and other waders from Shark Slough had the highest Hg levels of samples tested from south Florida (M. Spalding, U/FL, pers. comm.).

Two major questions raised by this episode are (1) what are the sources of Hg contamination, and (2) what factors contribute to its mobilization and cycling in the environment. An association of high Hg levels in animal samples from Shark Slough is the presence of peat or muck soils in the central depression of the Everglades. In studies of Hg contamination in Scandinavia and the northern U.S. (Swain, 1989; Hand and Friedemann, 1990), association between peat substrates and high Hg levels has been indicated, especially when the peats were mixed or disturbed in some way. Presumably, disturbances liberate Hg stored over time in the peats, making it available for methylation and food-web transfer.



Figure 2. Remains of Florida Panther #27 found dead in Northeast Shark Slough.

The northern quarter of the original Everglades system, known as the Everglades Agricultural Area (EAA) was converted to agriculture decades ago. Two major farming activities in the EAA which may release Hg by disturbing the soils are sugarcane production and sod growing. Before the sugarcane harvest begins, thousands of hectares of fields are burned, sending huge plumes of smoke skyward. The processing mills are fueled by burning cane wastes. A recent report showed that sugarcane tissues contain Hg at levels of 0.03-1.2 ppm (Simons, 1991). As part of the growing cycle, the fields are alternately flooded and dried, leading to rapid oxidation of the peats and the release of stored Hg. Sod production in the EAA also results in peat disturbance and loss. The liberation of either natural or anthropogenically produced Hg from storage in peats may be a major source of contamination elsewhere in the system.

The metropolitan and agricultural areas of Florida's east coast, from Palm Beach to Homestead, are home to more than 4 million people, who use Hg in products such as batteries, dental materials, and fungicides in latex paints. All these uses represent *nonpoint* sources of a volatile metal easily transported by winds. There also exist *point* sources of Hg, such as fossil fuel-fired power plants (Joensuu, 1971) and waste incinerators. A study contracted by the NPS Air Quality division estimated that one of the power plants may emit several thousand kg of Hg annually (Gough et al., 1986). Another study, which modeled wind tracks over the Everglades in summer and winter, demonstrated that Hg emitted along the east coast would be transported over the Everglades (Segal et al., 1986).

Biocontaminant sampling and research is costly; unfortunately most parks do not have the fiscal resources to address this issue. EVER is participating with the state task force assigned to address and manage the episode, but the task force suffers from insufficient funds. To continue periodic monitoring and research, NPS must fund some of the work. The implications of mercury biocontamination are frightening. If we do not understand the sources or the processes, there will be no way to correct them, leaving the region with a chronic contamination situation.

Because of the potential threat to the few remaining

wild panthers in the Everglades, the Florida Panther Interagency Committee has recommended removal of at-risk panthers into captivity; no action has yet been taken. The past few years have seen notable reproductive failures and some developmental anomalies in alligators and wading birds as well. Interpretation of these findings is confounded by the coincidence of several years of extreme drought, but because of the evidence, the synergism of Hg must also be considered.

National parks are not immune from the waste products of the society surrounding them. The lesson of the Hg incident is clear. Even if air and water quality monitoring is intended to measure heavy metal or pesticide levels in the environment, those levels may be so low that their potential impacts on wildlife are not appreciated. We believe NPS must fund periodic biomonitoring for contaminants to identify problems *before* symptoms appear. The most efficient means is by sampling indicator organisms near the top levels of food webs, where symptoms are most likely to be manifested. The price of ignoring contaminant biomonitoring is the potential of discovering that the biotic resources of the park are being quietly but inevitably poisoned.

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Continued on page 20

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