ISTC Reports

Illinois Sustainable Technology Center

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ILLINOIS SUSTAINABLE TECHNOLOGY CENTER
PRAIRIE RESEARCH INSTITUTE

TR-067
August 2017
www.istc.illinois.edu

Final Report

Assessment of Risk to Mink Exposed to PCBs in the Lower Illinois River Watershed

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Submitted to:

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August 2000

Abstract

Staff of the Cooperative Wildlife Research Laboratory recently used environmental contaminant concentrations in mink (*Mustela vison*) to monitor environmental health using Illinois watersheds as a geographical framework. Our results indicated elevated PCBs in mink collected from 6 watersheds with concentrations in those collected from the Lower Illinois River Watershed being the greatest (mean = 3.14 mg/kg, range non-detect - 12.30 mg/kg). Although we have no data to indicate that the mink from this watershed are adversely affected by PCBs, the concentrations measured in their tissues indicate potential environmental concentrations of concern and warrants additional study. The goal of the current study was to better define the sources and distribution of PCBs and to evaluate the potential for adverse effects in biota living in streams in the Lower Illinois River Watershed, with the emphasis being risk to mink reproduction. Sediment, crayfish (Cambarus sp.), and fish were collected from Hill, Palmer, Carr, and Fountain creeks where mink with elevated liver PCB concentrations have previously been collected. PCBs were quantified in only 2 of 3 red shiner fish composite samples (57 and 66 ppb) collected at the confluence of Hill and Palmer Creeks. Concentrations in all other samples (sediment, crayfish, and fish) were below our analytical detect limits (50 ppb). The current study did not provide information to indicate that PCBs in sediment or major aquatic food items are possible sources for PCB accumulation in mink collected from the Lower Illinois River Watershed. Quite the contrary, our results indicate that the creeks in our study do not appear to be a significant source of PCBs for mink. Because mink have a fairly large home range (1 - 5 km of stream length, EPA 1993) and their diet consist of terrestrial as well as aquatic food items, it would be necessary to evaluate habitats in other locations in order to determine the source of PCBs in the mink previously collected from the Lower Illinois River Watershed.

Introduction

Wild species are valuable sentinels of environmental health providing information not readily available from monitoring of the ambient environment. Because wild species are intimately associated with their habitats, they tend to accumulate biologically available contaminants from various components of their environment. While chemical monitoring provides information on specific contaminants at a specific time and under specific sets of environmental conditions, wild species integrate exposure to multiple contaminants over time. Wild species not only provide data on the bioavailability of environmental contaminants, but also may provide evidence of potential adverse effects. In addition, as sentinels of environmental health, wild species may provide information that can be valuable in assessing human health issues.

Staff of the Cooperative Wildlife Research Laboratory recently used environmental contaminant concentrations in mink (*Mustela vison*) to monitor environmental health of various watersheds in Illinois (Kravitz 1998). During the 1996 and 1997 trapping seasons, 327 mink carcasses from 11 watersheds were collected from cooperating trappers and 92 composite samples were formed based on similarity of trapping locations. Polychlorinated biphenyls (PCBs), 16 organochlorine pesticides, 2 organophosphate compounds (chlorpyrifos and terbufos), and several metals (mercury, lead, and cadmium) were evaluated in mink tissues. Our results indicated elevated PCBs in composite liver samples of mink collected from 6 watersheds, with concentrations in mink collected from the Lower Illinois River Watershed being the greatest. Therefore, PCB concentrations in the 18 individual mink forming the composite samples from this watershed also were determined. Liver PCB concentrations in these mink ranged from not detected to 12.30 mg/kg (mean = 3.14 mg/kg).

The streams from the Lower Illinois River Watershed where mink were collected have been classified by the Illinois Environmental Protection Agency (IEPA 1996a,b) as "partial support/minor impairment." The designated use for the streams where mink were collected is "general use" and one purpose of streams with this designation is to provide for the protection of indigenous aquatic live. Based on this classification, the phrase "partial support/minor impairment" is defined as "....water quality that has been impaired, but only to a minor degree. There may be minor exceedences in applicable water quality standards or criteria for assessing the designated use attainment." In the streams where mink were collected, this classification was based on professional judgement rather than monitoring.

One of the goals of our previous research was to use mink as environmental monitors of contaminants using Illinois watersheds as a geographical framework. Because previous studies by Platonow and Karstad (1973) reported reproductive impairment in mink with liver PCB concentrations as low as 0.87 mg/kg and Kamrin and Ringer (1996) suggest that mink liver PCB concentrations above 4 mg/kg may be associated with lethality, there is concern that PCB concentrations in the Lower Illinois River Watershed may be adversely affecting biota. Mink reproduction appears to be one of the most sensitive biological indicators of the adverse effects of PCBs, therefore, we planned to assess the effects of PCBs using mink reproduction as the primary endpoint. Directly measuring mink reproduction in the wild is difficult, however it is possible to determine PCB concentrations in various exposure media and to assess mink reproduction using modeling tools.

Although we have no data to indicate that the mink from this watershed are adversely affected by PCBs, the concentrations measured in their tissues indicate potential environmental concentrations of concern and warrants additional study. The goal of the current study was to better define the sources and distribution of PCBs and to evaluate the potential for adverse effects in biota living in streams in the Lower Illinois River Watershed, with the emphasis being risk to mink reproduction.

Methods and Materials

Sediment, crayfish (Cambarus sp.), and fish were collected from Hill, Palmer, Carr, and Fountain creeks where mink with elevated liver PCB concentrations have previously been collected. Three sediment samples (approximately 500 g each) were collected at each mink collection sites and at locations 100 and 200 m up and down stream from that location. Two of the 3 samples were collected within 5 m of the left and right stream banks and the third at the center of the stream. Each of these 3 samples was combined to form a composite sample for that site. One half of each sediment composite sample was analyzed for PCBs and the remaining ½ of each sediment sample was archived for possible future analysis.

Crayfish traps were set at the sites where sediment samples were collected and checked every 48 hours. Crayfish collected from each trap were placed in plastic bags and frozen prior to PCB analysis.

At the same locations where crayfish traps were set, seines were used to collect fish. Fish collected from the same location were placed in plastic bags and frozen prior to PCB analysis. For analysis, fish were identified to species and fish of the same species were randomly selected and homogenized to form composite samples.

Contaminant Analysis

Samples were analyzed for PCBs (Aroclor 1254 and 35 individual congeners) following EPA Method 8081 (1992b). Samples were air dried and PCBs extracted using hexane (US EPA 1992a). The extract was transferred from hexane to methylene chloride using rotary evaporation followed by acid cleanup (Hong and Bush1990). Collected PCBs were transferred to isooctane in preparation for gas chromatography analysis. A Hewlett Packard 5890 Series II gas chromatograph with split/splitless capillary inlet and equipped with a ^{63}Ni electron capture detector, automatic sampler, and Turbochrom data system was used to quantify PCB and congener concentrations.

A portion of crayfish and fish extract was used to determine lipid content. A known amount of the extract was transferred to a pre-weighed aluminum pan and heated for 24 hours at 100°C. After cooling, the aluminum pan was reweighed and the difference between weights used to determined lipid content.

Results

A total of 25 sediment samples were collected from Palmer (n = 6), Lower Carr (n = 6), Upper Carr (n = 5), Fountain (n = 6), and Hill (n = 2) Creeks for PCB analysis. During the current study, a major portion of Hill Creek above it's confluence with Palmer Creek was being dredged. Dredging operations prevented collection of additional sediment samples from this Creek. PCB concentrations in all sediment samples were below the detection limits (50 ppb) for our assay.

A total of 129 crayfish were collected from Palmer (n = 50), Lower Carr (n = 25), Upper Carr (n = 40), and Fountain (n = 14) Creeks. Because of dredging operations, crayfish traps were not set on Hill Creek. The crayfish from each site were analyzed individually for PCBs when the crayfish was of sufficient size, or 2 crayfish from the same trap were combined to form a composite sample when necessary. PCB concentrations were determined in 13 crayfish samples from Upper Carr Creek, 7 from Lower Carr Creek, 10 from Palmer Creek, and 10 from Fountain Creek. PCB concentrations in all crayfish samples were below detection limits (50 ppb).

A total of 909 g of fish representing 6 species [red shiner (*Cyprinella tutrensis*), golden shiner (*Notemigonus crysoleucas*), central stoneroller (*Campostoma anomalum*), green sunfish (*Lepomis cyanellus*), mosquitofish (*Gamusia affinis*) and mud darter (*Etheostoma asprigene*)] were collected from 3 of the 5 creeks. No fish were collected during seining of Fountain Creek and fish from Hill and Palmer Creeks were collected at the confluence of those creeks. Because collected fish were small (5 - 8 cm in length), individuals of the same species collected from the same creek were combined to form composite samples. Four composite samples of red shiners from Upper Carr Creek, 7 composite samples (3 samples of red shiners, 3 samples of green sunfish, and 1 sample of mosquitofish) from Palmer Creek, and 3 composite samples of red shiners from Lower Carr Creek were analyzed for PCBs. PCBs were quantified in only 2 of 3 red shiner fish composite samples (57 and 66 ppb) collected at the confluence of Hill and Palmer Creeks. PCBs were not quantified in the 3 green sunfish or single mosquitofish composite samples collected from this same location or from any other fish composite sample.

Discussion

The results of the current study indicate that PCB concentrations measured in sediment and major food items of mink (crayfish and fish) collected from selected creeks in the Lower Illinois Watershed are below concentrations that would indicate a potential toxicological problem for mink. The only samples collected during the current study with quantifiable PCB concentrations ($\bar{x}$ = 62 ppb, n = 2), were collected near the confluence of Hill and Palmer Creeks.

Several factors may have influenced the sampling for this project. During the short period of time available for collection of samples (February - May) the habitats being sampled were very dynamic. Heavy rains caused flooding during our crayfish sampling and steam channelization and dredging on Hill Creek changed the physical make-up of that creek. Because of the dredging activity, it was not possible to collect sediment or biotic samples along a major portion of Hill Creek. Dredging activity and the flushing action of the flooding undoubtedly influenced contaminants that may have been present in sediments in Hill Creek as well as other creeks sampled.

It is interesting that the only samples with quantifiable PCB concentrations were collected near the confluence of Hill and Palmer Creeks and that mink previously trapped at this location had the greatest liver PCB concentrations of any mink collected from various watersheds in Illinois (Kravitz 1998). However, because PCB concentrations in sediment and biotic samples were low, we are not able to provide information regarding the potential sources of PCBs measured in mink collected from this watershed. Our laboratory is in the process of determining PCB concentrations in an additional 15 composite fish samples collected near the confluence of Hill and Palmer Creeks in order to supplement the fish PCB data from that site. The current study did not provide information to indicate that PCBs in sediment or major aquatic food items are possible sources for PCB accumulation in mink collected from the Lower Illinois River Watershed. Quite the contrary, our results indicate that the creeks in our study do not appear to be a significant source of PCBs for mink. Because mink have a fairly large home range (1 - 5 km of stream length, EPA 1993) and their diet consist of terrestrial as well as aquatic food items, it would be necessary to evaluate habitats in other locations in order to determine the source of PCBs in the mink previously collected from the Lower Illinois River Watershed.

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