Polychlorinated Biphenyls in Tributary Fishes of the Housatonic River, Massachusetts, USA

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ABSTRACT

Five species of fishes collected in 1998 from two tributaries of the Housatonic River, Berkshire County, Massachusetts were analyzed for total PCB content. The PCB content was significantly higher in fish in the stations closest to the tributary confluence, although there were no differences between the tributaries. Migration of fish between the mainstream and the tributaries is the most likely explanation for the presence of PCB contamination upstream of the source.

INTRODUCTION

PCBs (Polychlorinated biphenyls) had been a serious environmental concern for decades when the U. S. Environmental Protection Agency (USEPA) restricted their use in 1977, and then banned their general use in 1979 (General Electric 1998). That agency has determined that PCBs are probable human carcinogens.

The General Electric (GE) Corporation in Pittsfield, Massachusetts produced capacitors and transformers from the early 1930s through 1977. PCBs in the form of Pyranol (60 % Aroclor 1254 and/or 1260 by weight) were used as insulating liquids in their manufacture. General Electric released at least several hundred thousand gallons of PCBs into the environment, some lost inadvertently and some which were dumped into the Housatonic River as a means of disposal (Blasland and Bouck Engineers Inc.1990). In 1981, and again in 1990, General Electric and state and federal agencies agreed to assess the extent of the PCB contamination of sediments and the biota of the Housatonic River.

Numerous studies have been done on PCBs in the sediments, flood plain and biota of the Housatonic River (e.g. Academy of Natural Sciences 1995 and 1996, Blasland and Bouck Engineers Inc. 1991, Blasland, Bouck and Lee Inc. 1996a) in both Connecticut and Massachusetts since the early 1980s, and further monitoring of the river proper continues.

The average PCB concentration in sediments between the GE facility and Woods Pond (Fig.1) in 1982 was 29 µg/kg (Blasland, Bouck & Lee Inc. 1996a), and that reach contained over 50% of the PCBs in the river. Between Woods Pond and Rising Pond dam, PCB sediment concentrations averaged 3 µg/kg. Blasland, Bouck and Lee Inc. (1996b) concluded that the area between the GE facility and Rising Pond Dam contained about 90% of the total PCBs in the system, and concentrations of PCBs decreased at each site downstream from the source of the contamination. From Rising Pond Dam to the Connecticut/ Massachusetts border, the concentrations of PCBs in the river sediments averaged less than 1 µg/kg in 1982 (Stewart Laboratories 1982).

Downstream from Woods Pond in 1982, thirty percent of the fish sampled had PCB concentrations over 5 µg/kg and the PCB concentration exceeded 2 µg/kg in all

the fish studied (Blasland & Bouck Engineers Inc. 1990). In 1991, the levels of PCBs had decreased compared to 1982, yet all of the fish still exceeded the Food and Drug Administration's (FDA) 2 µg/kg limit for human consumption (Blasland and Bouck Engineers 1991). The latest fish survey of the Housatonic River (1994) found that close to the Connecticut border, the PCB concentration in fish ranged from 2.8-4.8 µg/kg (Blasland, Bouck & Lee Inc. 1996b). As a result of public concern about contamination in the tributaries, fish samples were taken in two heavily fished downstream tributaries of the Housatonic River (Williams River and Green River) in 1995. PCB concentration ranged from 0.81 to 21 µg/kg (Blasland, Bouck & Lee Inc.1996b).

The purpose of our study was to examine the current extent of PCB contamination in fishes from two tributaries of the Housatonic River- the Williams River and Hop Brook, downstream from the source of contamination.

MATERIALS AND METHODS

The confluence of Hop Brook is approximately 27 km downstream from the GE facility within the section of the river containing 0 to 22 µg/kg PCBs in the sediment. The Williams River confluence is located approximately 45 km downstream from the GE facility within the section of river containing between 0 and 2.3 µg/kg PCBs in the sediment. The Rising Pond dam, between the two tributary mouths is sufficient to prevent the migration of fishes upstream.

Two sites on each tributary were chosen for fish sampling (Fig.1). Five fish were collected from each site, using baited hooks between 20 June and 19 July 1998. Only fish considered edible were kept. Trout were excluded because they might have been recently stocked. Fallfish (*Semotilus corporalis*, a large predatory minnow) were included as edible fish because they are mistaken for trout by inexperienced anglers. Fishes were measured (total length to nearest mm), weighed (nearest 0.1 g) and then immediately filleted into two symmetrical halves. Fishes were aged from scales where possible. The fillets were wrapped in aluminum foil, labeled, placed in plastic Ziploc™ bags, and held in a freezer at -10 degrees C until all samples were collected. Chemical analyses were performed using EPA Method 8082 for chlorinated hydrocarbons (USEPA 1996). Statistical/graphical procedures were done using Statistica™ (Statsoft 1997).

RESULTS

Five species of fish were collected and analyzed in this study- fallfish (*Semotilus corporalis*), brown bullhead (*Ameiurus nebulosus*), rock bass (*Ambloplites rupestris*), bluegill (*Lepomis macrochirus)* and smallmouth bass (*Micropterus dolomieu*). PCB levels ranged from 0.05 to 5.8 µg/kg (Table 1). A two-way ANOVA showed that mean PCB concentrations in fishes were significantly higher in the downstream stations than in fishes from the upstream stations ($F_{1,16} = 7.03$, $p = 0.017$). There was no statistically significant difference in PCB concentration in fish between tributaries. At both upstream stations, 100% of the fish fell under the FDA limit of 2 µg/kg PCB for safe human consumption. In both downstream stations, only 60% of the fish had less than 2 µg/kg PCBs.

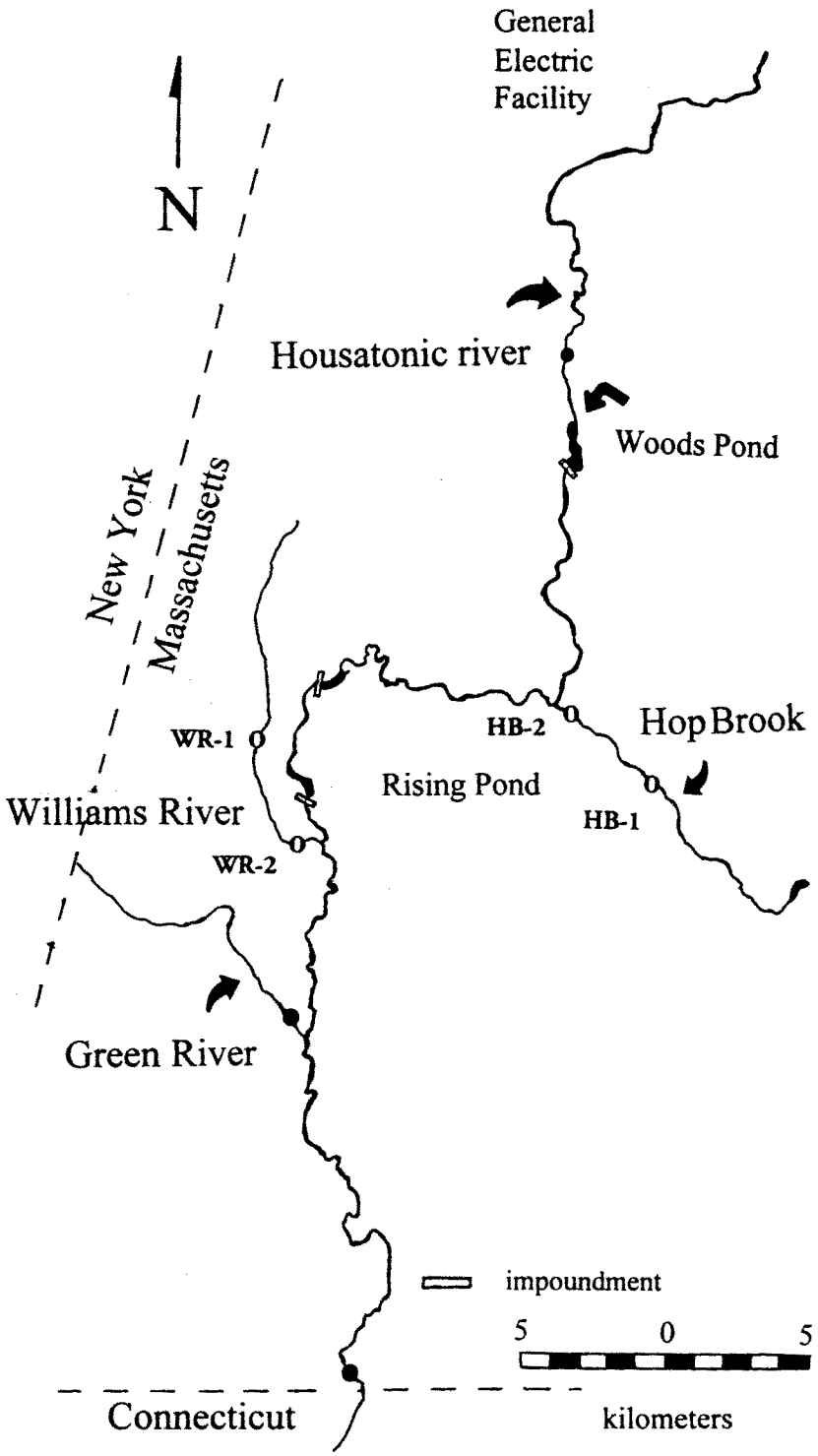

Figure 1. Map of the upper Housatonic River, Berkshire County, Massachusetts showing the location of sampling sites for this study **O**, and previous studies ●.

Table 1. PCBs in fish from Hop Brook (HP) and the Williams River (WR) stations, Massachusetts, June-July 1998.

location	species	length(cm)	weight(g)	age (yrs)	total PCB (µg/kg)
WR-1	bluegill	15.3	90.6	3+	0.08
WR-1	bluegill	17.5	117.7	3+	0.04
WR-1	smallmouth	25.4	271.7	3+	0.46
WR-1	rock bass	17.8	117.7	5+	0.90
WR-1	rock bass	13.3	67.9	3+	0.12
WR-2	rock bass	19.7	144.9	3+	0.33
WR-2	rock bass	17.2	99.6	4+	0.17
WR-2	rock bass	23.2	226.4	5+	3.2
WR-2	smallmouth	26.1	176.6	3+	4.8
HB-1	fallfish	12.3	40.8	2+	0.06
HB-1	bullhead	12.1	33.6		0.31
HB-1	fallfish	12.3	40.8	1+	0.06
HB-1	fallfish	16.3	49.8	1+	0.14
HB-1	fallfish	18.4	63.4	1+	0.07
HB-2	fallfish	28.0	235.5	3+	5.8
HB-2	rock bass	15.9	81.5	4+	1.2
HB-2	rock bass	16.3	95.1	5+	0.29
HB-2	rock bass	14.6	67.9	4+	2.2
HB-2	fallfish	18.4	158.5	3+	0.31

DISCUSSION

It is clear that fish in the downstream portions of these Housatonic River tributaries are more highly contaminated with PCBs than those further upstream. A study in the St. Lawrence River tributaries also found significant PCB contamination in fishes (Quemerais et al. 1994). However, unlike the Housatonic River, some of the contamination in the St. Lawrence River originates from the tributaries. There are no known or suspected PCB sources in the tributaries we examined. The contamination levels in the fishes at the upstream stations in Housatonic tributaries are similar to those reported from the upper reaches of the mainstem above the GE facility. Haines (1983) found 0.08 µg/kg PCB in brook trout from remote lakes in New Hampshire, similar to those levels found in the Housatonic River upstream of the GE facility. We interpret these levels of contamination to be background for fishes in Western Massachusetts. PCB levels in fishes in the downstream stations are higher than background even though fishes were collected 0.4-1.2 km upstream of the confluence.

The contaminated fish in the tributaries might have migrated from the Housatonic River. Some populations of smallmouth bass and rock bass (Gerber and Haynes 1988, Robbins and MacCrimmon 1977, Schmidt and Stillman 1998) are known to migrate into tributaries for spawning. These potamodromous populations enter streams tributary to the Hudson River or lakes to spawn. Langhurst and Schoenike (1990) found smallmouth bass migrating seasonally between a tributary and the mainstream river in Wisconsin. It is possible that the fishes caught in the Housatonic tributaries were at least part-time residents of the Housatonic River and migrate in and out of the tributaries. Such migratory movements have not been documented in fallfish. Another possible explanation is that the fish we sampled were residents of the tributaries but their food, (crayfish and small fishes), migrated from the Housatonic River into the tributaries. Such movements have not been documented, and we prefer the former explanation.

Bioaccumulation of PCBs in fishes has been modeled using data from Lake Ontario (Morrison et al. 1997, Campfens and Mackay 1997). There the ratio of PCB was 0.57 µg/kg PCB in sediment to 3-4 µg/kg PCB in smallmouth bass and rock bass. Our data show these two species, with a mean of 2.1 µg/kg PCB in the Williams River and a mean of 1.2 µg/kg in Hop Brook. In the Housatonic River near Hop Brook the average PCB concentration in the sediment is 3 µg/kg and the average near the Williams River is less than 1 µg/kg (Stewart Laboratories 1982). If the Lake Ontario bioaccumulation models are valid for the Housatonic River, three-four year old fishes that spent part of their lives in the Housatonic River could conceivably accumulate the levels of PCB we observed.

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