Report for 2004DC61B: Identification of PCB and Chlordane sources in the Anacostia RIver Watershed

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Report Follows

Identification of PCB, PAH and Chlordane Source Areas in the Anacostia River Watershed

Final Report

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ABSTRACT

In 2004 this Anacostia River biomonitoring project used a two-week Asiatic clam (*Corbicula fluminea*) translocation bioaccumulation protocol in an attempt to find the contaminant source areas of its most highly contaminated first-order tributaries. These tributaries were identified from earlier studies as Lower Beaverdam Creek (PCBs), NorthEast Branch (total PAHs and chlordane) and Watts Branch (total PAHs and chlordane). Clams placed at the Lower Beaverdam Creek Landover Metro site had significant accumulation of PCBs and Aroclors, which dropped to reference control levels in clams at the upstream Corporate Drive site above the Landover Metro/ Ardwick-Ardmore Industrial Park/ New Carrolton Metro area. Clams at the NorthEast Branch Odell Road site had high total PAHs which dropped by 50% at the Virginia Manor Road site upstream, above the Beltsville Industrial Center. Clams at the Riverdale East Branch second order stream near the mouth of the Northwest Branch had high pesticides and chlordane not found upstream. Clams at the Watts Branch Upper site had total PAHs not significantly lower than at other Watts Branch sites. Using comparison with data from previous studies it appeared that clam accumulations of high levels of PCBs, Aroclor and PAHs in the Anacostia watershed were associated with industrial park areas in Prince George's County. High bioavailable chlordane was not associated with other contaminants or an identifiable industrial park. Clams at the Fort Foote control site had a significantly greater pesticide (endosulfan I) accumulation than other sites and may have detected an endosulfan I spill in the Potomac River in May 2004. The high endosulfan in clams was lost over their two week translocation period at Anacostia watershed sites.

Introduction

The heavily contaminated tidal freshwater 10 km Anacostia River estuary stems from the Potomac estuary and is the major water body within the District of Columbia. The poor quality of the Anacostia River estuary has been known for years (Freudberg et al.1989, Cummins et al. 1991) and it is considered one of the three most contaminated locations in the Chesapeake Bay. The Anacostia River runs along the lower third of the District and essentially separates Federal buildings and upscale housing from the poorer and mostly minority communities to the south and west. There is a high incidence of cancer and other diseases in this minority community, where there is also subsistence fishing in the Anacostia in spite of a fishing advisory. Anacostia River estuary catfish have tumors related to high polycyclic hydrocarbon (PAH) levels in sediment (Pinkney e.a. 2000), and high tissue levels of polychlorinated biphenyls (PCBs) and chlordane which can be associated with cancer. Fish that yearly migrate into the Anacostia estuary also have been found contaminated (Velinsky and Cummins 1994). Reference: Phelps, HL. 2005. Identification of PCB, PAH and chlordane source areas in the Anacostia River watershed. DC Water Resources Research Institute, Washington, DC 9p.

The Anacostia River estuary has very little benthic life and shows sediment toxicity to clam larvae (Phelps 1985, Phelps 1993, Phelps 1995). Most studies of Anacostia River contaminants have focused on water and sediments of the estuary portion (Velinsky et al. 1992, Wade et al 1994, Velinsky and Ashley 2001, AWTA 2002). However, contaminants are increasingly recognized as coming from Anacostia tributaries, with many in Maryland (Warner et al.1997, Phelps 2004, Washington Post 2004). UDC's WRRC-sponsored clam biomonitoring studies have developed a rapid two-week protocol using Asiatic clams (*Corbicula fluminea*) translocated from the healthy Potomac to sites in the Anacostia River watershed where they accumulate bioavailable contaminants. These common, non-endangered clams have a high filtration rate, can accumulate toxic contaminants from the water and have been used elsewhere for active freshwater biomonitoring (Dougherty and Cherry 1988, Crawford and Luoma 1993, DeKock and Kramer 1994, Colombo et al 1995). Clam translocation and bioaccumulation has identified one of Anacostia's five first order tributaries as a source of bioavailable polychlorinated biphenyls (PCBs), two as sources of chlordane, and four as sources of polycyclic hydrocarbons (PAHs). This information is essential for DC's Mayor to bring to the attention of counties surrounding the District for remediation efforts to achieve a fishable and swimmable DC Anacostia River.

The most serious contaminants of the Anacostia from the standpoint of human health are the pesticide chlordane and PCBs which are above FDA action levels in Anacostia fish (Velinsky and Cummins 1994). PCBs are known to be toxic and have been banned but residuals come from a variety of sources (Ahlborg et al. 1994, Safe 1994). Chlordane is a termite pesticide harmful to humans and has been banned for over 20 years but is slow to biodegrade and its accumulation in fish tissues is one basis for the 1994 Anacostia fishing advisory. Translocated clams accumulated chlordane in the lower NorthEast Branch and Watts Branch tributaries (Phelps 2000, 2002). High PAH levels in sediment are identified with sediment toxicity and fish tumors (Pinkney et al 2000). PAHs from oils and manufacturing and combustion byproducts are a major contaminant of the Anacostia estuary but are not bioaccumulated by fish so active clam biomonitoring is needed to find sources. The primary objective of this 2004 study was to use active clam biomonitoring to locate the uncontaminated upstream portions of the major Anacostia tributaries contributing PCBs, PAHs, and chlordane (Phelps 2004). The second objective was to continue the involvement and training of UDC undergraduate students in research on DC's Anacostia River.

Methodology

Asiatic clams (*Corbicula fluminea*) were collected from May through September at the healthy nearby Potomac River estuary control site of Fort Foote (MD). Clams collected by along-shore sieving were selected from the same cohort, 20 - 30 mm, and kept cool and dry before 20-30 were placed in mesh shellfish cages at the tributary sites within 24 hours (Table 1).

As clams can accumulate a maximum of contaminants within one to two weeks (Phelps 2004) they were collected after two weeks exposure. The 15 - 30 clams were washed, depurated for 24 hours in three changes of spring water at room temperature and briefly frozen to open shells and extract tissues. The combined frozen tissues were sent to the certified Severn-Trent Laboratory (STL), Burlington, VT for chemical analyses. The STL EPA Priority Pollutant tissue analysis included 21 pesticides, 28 polychlorinated biphenyl (PCB) congenors, 6 Aroclors, 18 polycyclic hydrocarbons (PAHs), and six metals of interest (As, Cd, Cr, Cu, Fe, and Zn), and percent lipid. Results were available within five weeks. The STL analytical variability has been determined as SD = 0.175 (mean) - 1.12 (n = 9) (Phelps 2002). Statistical comparison between sites was by t test and the 95% confidence limits of the mean were calculated as 2.05 SD = 0.36 (mean). Analytical error was considered the most significant since clam tissues were pooled for analysis.

The sites chosen for biomonitoring were located on the Anacostia watershed first order tributaries where previously translocated clams had accumulated high PCBs (Lower Beaverdam Creek), chlordane (NorthEast Branch and Watts Branch), and PAHs (NorthEast Branch and Watts Branch) (Phelps 2003, Phelps 2004). Not all tissue contaminants were examined at each site.

Results

The GPS site locations and clam translocation dates are in Table 1, listed in order of date. The Riverdale East Branch site clams had to be replaced four times. Translocated clam survival was 97 - 100%.

Table 1. Clam site locations listed by translocation date.

Date placed	Date collected	Site (Code)	UTM GPS Northing	UTM GPS Westing
5/13	5/13	Fort Foote, MD (FF5/04)	38°46’458”	077°01’752”
5/13	5/27	Watts Branch Upper, DC (WBU)	38°58’357”	076°54’619”
	5/27	Landover Metro Yard, MD (LMT)	38°55’932”	076°53’355”
	5/27	Riverdale West Branch, MD (RVW)	38°57’582”	076°55’557”
6/1	6/15	NorthEast Branch 04, MD (NEB04)	38°57’621”	078°55’583”
	6/15	Odell Road, MD (ODR)	38°58’375”	076°55’509”
	6/15	Virginia Manor Road, MD (VMR)	39°03’522”	076°53’909”
7/20	8/10	Corporate Drive, MD (CRD)	38°56’318”	076°51’646”
8/28	9/9	Riverdale East Branch, MD (RVE)	38°57’644”	076°55’572”

Contaminants detected in clam tissues were summarized by the total accumulation of each type (tmetals, tPAHs, tPCBs tAroclors and tpesticides), with alpha and beta chlordane additionally summed as tChlr (Table 2). FF control was the average of Fort Foote clams with eight previous Fort Foote samples from 1999 to 2003 (Phelps 2004).

Table 2. Clam tissue contaminant concentration totals (µg/Kg) at sites by tributary.

Site	tMetalx.001	tPAH	tPCB	tArocl.	tPest.	tChlr.
FF Control (average)	77	376	93	140	72	
Potomac						
Fort Foote	116	60	76	116	169*	38
Lower Beaverdam Creek						
Landover Metro	24	---	366*	630*	97	50
Corporate Drive	70	267	105	120	93	83*
NorthEast Branch						
NorthEast Branch	69	923*	86	149	74	40
Riverdale West Branch	21		142	62	62	27
Riverdale East Branch		---	---	---	246*	144*
Odell Road		2196*	---	188	---	---
Virginia Manor Rd	66	996*	72	149	31	19
Watts Branch						
Watts Branch Upper	23	1088*	---	120	55	30

* Significantly (95%) greater than FF control

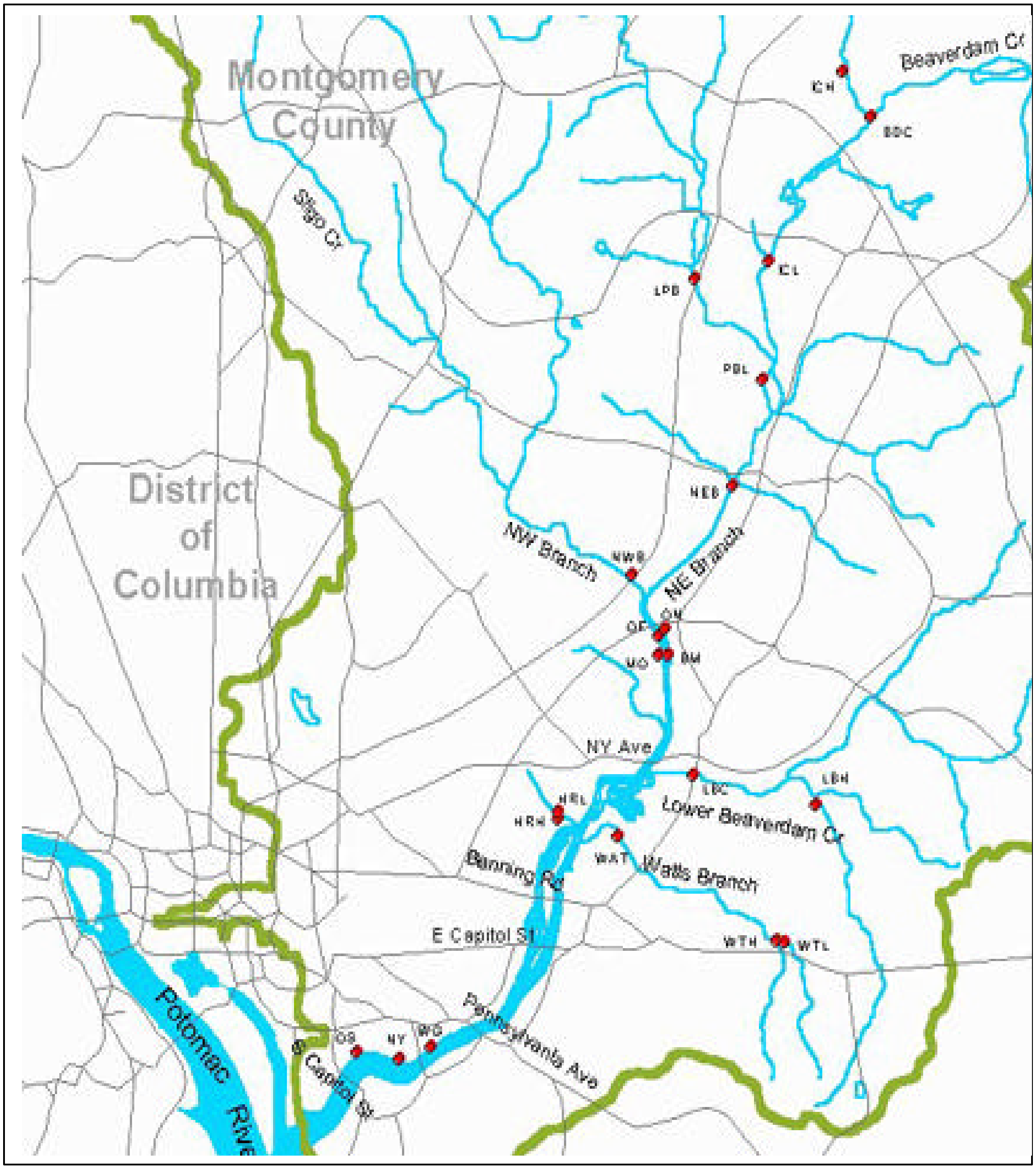

Figure 1. The Anacostia River watershed with some sites labeled**.**

The NorthEast Branch tributary clam total PAH and pesticide data was combined with NorthEast Branch first and second order stream data from earlier studies (Phelps 2004) (Fig. 2).

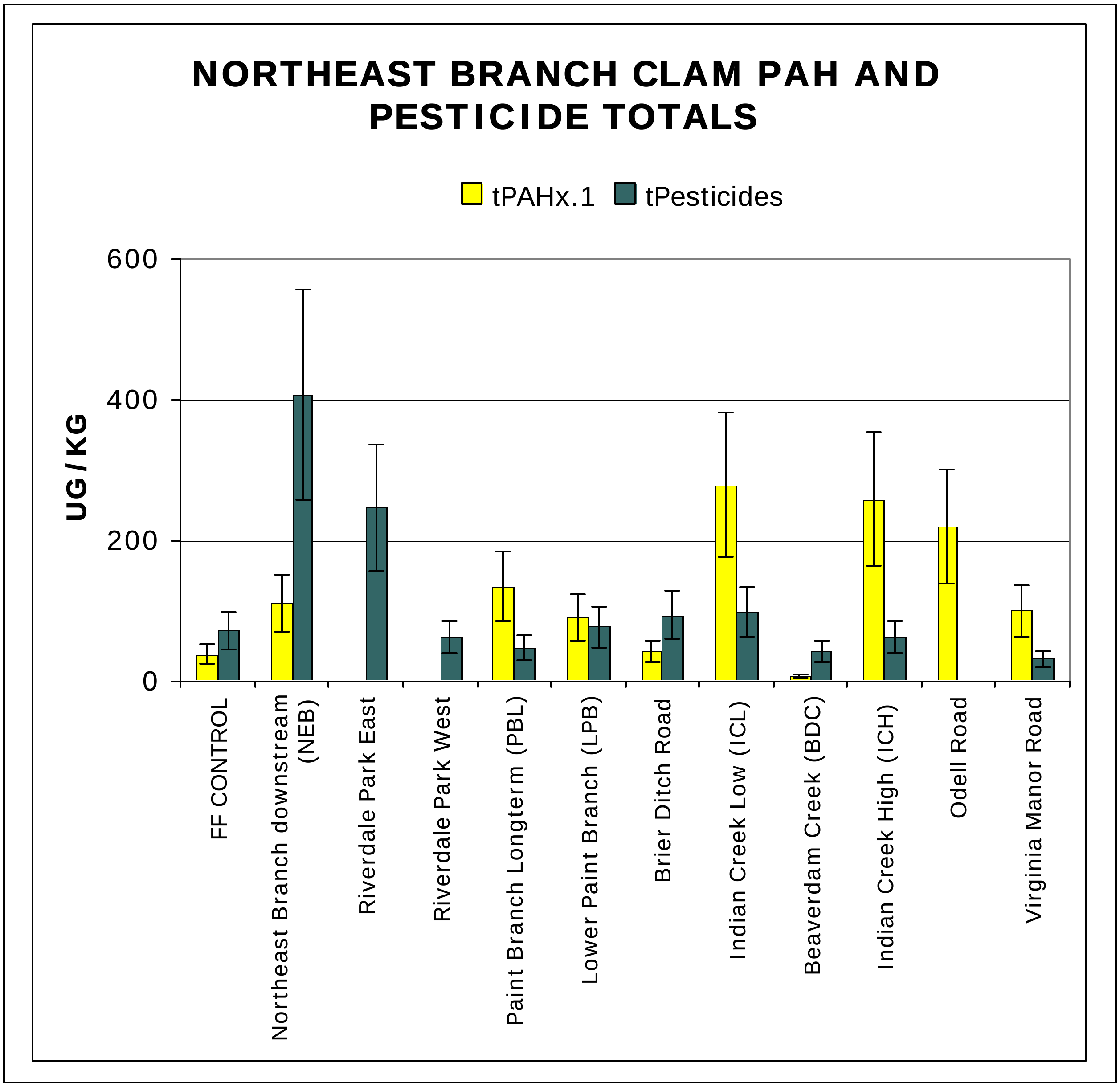

Figure 2. NorthEast Branch clam tissue concentrations of total polycyclic hydrocarbons (tPAHx .1) and total pesticides (tPest) at the NorthEast Branch downstream site just above head of tide and at second order stream sites proceeding upstream (Phelps 2004). Error bars show 95% analytical confidence limits. All sites were in Maryland.

The Lower Beaverdam Creek tributary total PCBs and total Aroclors data was combined with earlier data from Lower Beaverdam Creek tributary study sites (Phelps 2003, Phelps 2004) (Fig. 3).

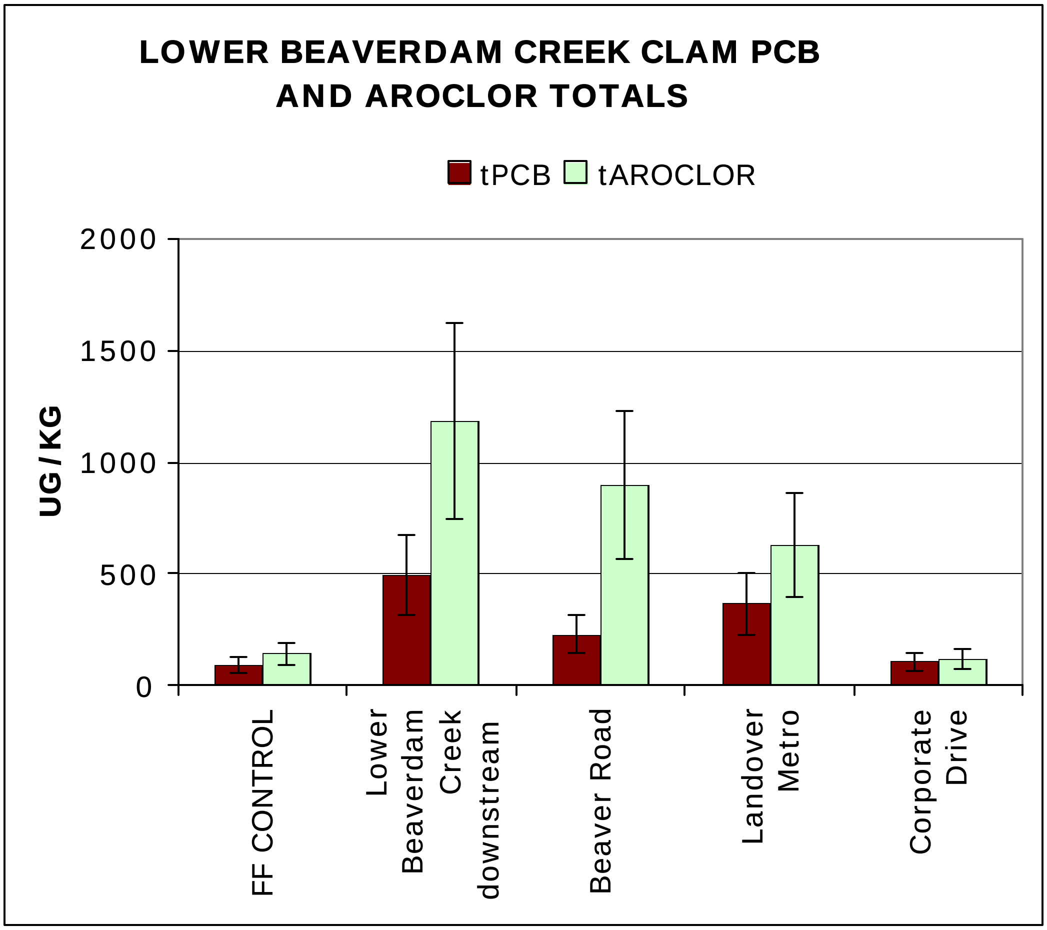

Figure 3. Lower Beaverdam Creek clam concentrations of total polychlorinated biphenyls (tPCB) and total Aroclors (tAROCLOR) at sites from just above the head of tide and proceeding upstream. Error bars show 95% analytical confidence limits. The Lower Beaverdam Creek downstream site was in DC and the remaining upstream sites in MD.

To focus on the sources of contaminants they will be considered in connection with data from previous studies.

METALS: No clam tissue metal concentrations were significantly greater than the FF control (Table 2). Total metals at Fort Foote were higher than the FFcontrol due to iron, but not significantly greater than average. Metal contamination is not considered a problem in the Anacostia River.

PAHs: At all sites the clam tissue total PAH concentrations were significantly increased over the FF control, except at Corporate Drive on Lower Beaverdam Creek (Table 2, Fig 2). High PAHs were also found in 20 of 24 previously studies on Anacostia watershed sites (Phelps 2004). The NorthEast Branch contributes about 45% of Anacostia watershed input with its clams having some of the highest pesticide and PAHs totals (Warner et al 1997, Phelps 2003, Phelps 2004). The present study suggested that clams with the highest accumulations of PAHs were on the NorthEast Branch below industrial parks.

PCBs: Total PCBs in clam tissue significantly exceeded FFcontrol at all sites except at Corporate Drive (Table 2, Fig. 3). Total PCBs accumulated by the clams placed at all Lower Beaverdam Creek sites but Corporate Drive exceeded the FDA food action level of 200 µg/Kg. The Landover Metro site is just below and the Corporate Drive site is just above the Landover Metro Station/ Ardwick-Ardmore Industrial Center / New Carrolton/Amtrak Metro area. Future investigations on the watershed sources of PCBs to the Anacostia River should start in this section of Lower Beaverdam Creek. The Corporate Drive site probably represents the highest uncontaminated reach of Lower Beaverdam Creek. Although Lower Beaverdam Creek is only 12% of Anacostia watershed input its watershed has the highest concentration of industrial parks in Prince George's County (Warner et al 1997).

AROCLORS: Aroclors are not measured but are estimated as PCB congenor mixtures that have been developed for specific industrial uses. Total clam Aroclors in this 2004 study significantly exceeded FFcontrol only at the Landover Metro Station site on Lower Beaverdam Creek and included Aroclor 1242 (220 µg/kg) and Aroclor 1254 (110 µg/kg). Overall, total Aroclors in clams dropped significantly going upstream in Lower Beaverdam Creek. Like total PCBs, total Aroclors were at control concentrations in the upstream Corporate Drive site clams.

PESTICIDES: Total pesticides in clam tissues significantly exceeded FFcontrol at Fort Foote (discussed below) and at Riverdale East Branch, a small second order stream near the mouth of the NorthEast Branch (Table 2, Fig, 2). Data from previous studies found clams at six other second-order streams of the NorthEast Branch did not have significantly increased total pesticides (Phelps 2004, Fig. 2). The small Riverdale East Branch appears a major pesticide source although it is near no identified industrial park area.

TOTAL CHLORDANE: In this 2004 study the total clam chlordane (alpha plus beta) significantly exceeded Fort Foote clams only at the NorthEast Branch second order Riverdale East Branch site (Fig 2). The high clam pesticide at the downstream Northeast Branch site, just below the Riverdale East Branch stream, was 88% chlordane (Phelps 2004). Chlordane is responsible for the fishing advisory and has been associated only with clams placed at the NorthEast Branch and Watts Branch (Phelps 2003). However, follow up studies have not confirmed chlordane accumulation in Watts Branch clams (Phelps 2004).

Fort Foote on the tidal freshwater Potomac River estuary five km below Washington, DC has been the source of *Corbicula* clams for the Anacostia biomonitoring studies. It is considered a good nearby reference area because this part of the Potomac is a major Chesapeake Bay restoration success with the return of submerged aquatic vegetation, benthic populations including clams and development as a top largemouth bass fishing area (Phelps 1994, Orth et al 1996). At least part of the success has been attributed to the water-clearing action of the big Asiatic clam population, which does not survive in the contaminated Anacostia River (Cohen et al 1984, Phelps 1985, Phelps 1993). In the present study the Fort Foote clams had abnormally high total pesticides, of which 65% (110 µg/kg) was endosulfan I. Endosulfan, a toxic pesticide used on crops and other plants, is normally not found in Fort Foote clams (Phelps, unpublished data). The EPA standard for endosulfan in freshwater is 100 µg/l and the Fort Foote clams may have detected a serious endosulfan spill in the Potomac in May. It is interesting to note that those same clams had no detectable Endosulfan I following their two-week deployment at Anacostia watershed sites.

Such apparently isolated incidences of high clam pollutant bioaccumulation, like napthalene in lower Watts Branch clams in 2002 (Phelps 2003), suggest *Corbicula* biomonitoring may be able to detect contaminant spills. Active clam biomonitoring can also indicate long-term freshwater contamination, similar to the International Mussel Watch for salt water (Sericano 2000, Phelps 2002). Much of the water and sediment chemical pollution presently being measured in the Anacostia is not known to be bioavailable (Sunda and Guillard 1976, Tatem 1976, Harrison 1984, AWTA 2002).More clam biomonitoring studies need to be made and followed up in the Anacostia River estuary, which has an excellent watershed to test this protocol for locating the sources of bioavailable pollutants. Active clam biomonitoring using local *Corbicula* also could be used to verify the effectiveness of remediation efforts.

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