Clam Active Biomonitoring and POM Passive Monitoring for Anacostia Watershed Contaminant Point Sources.

Final Report to the DC Water Resources Research Center

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Abstract

In 2008 and 2009 active biomonitoring (ABM) with freshwater clams (*Corbicula fluminea*) was carried out at sites in the Anacostia River watershed to survey sources of EPA Priority Pollutants and focus on the polychlorinated biphenyls (PCBs) and chlordane responsible for the Anacostia fishing advisory. A total of seven projects were carried out: (1) in Still Creek which runs through Greenbelt National Park identify the source area of chlordane contamination, (2) survey Wells Run at University Park, MD for all EPA Priority Pollutants, (3) at the lower tidal Anacostia sediment 'hot spot' of Stickfoot Sewer look for increased EPA Priority Pollutants in clams. (4) examine the median stream of the Baltimore-Washington Parkway for relationship to the nearby Riverdale East stream chlordane contamination, (5) in Sligo Creek locate the source of the high chlordane contamination, (6) in upper Lower Beaverdam Creek identify the outlet source of polychlorobiphenyls (PCBs) and (7) in upper Lower Beaverdam Creek compare active PCB biomonitoring with clams (ABM) to passive PCB monitoring using polyoxymethylene plastic strips (POM). All projects were successful. In summary: (1) Still Creek chlordane contamination was found to originate outside the National Park, (2) Wells Run had polycyclic aromatic hydrocarbons (PAH) from combustion and chlordane exceeding reference, (3) clams placed near the Stickfoot Sewer outlet indicated the bioavailable contaminants did not exceed other tidal river sites except for 2X PAHs, (4) the Baltimore Washington Parkway median stream lacked the high chlordane of nearby Riverdale East so the Parkway may not be a source (5) The Sligo Creek chlordane source was in the upstream Main Branch, (6) The Lower Beaverdam Creek PCB outlet source was located above the previously considered outlet and (7) The Lower Beaverdam Creek ABM and POM PCB results at two and four weeks were not the same but both found high low-molecular-weight congeners upstream and were statistically the same when congeners 5, 8 and 28 were excluded.. This report includes results from previously unreported 2008 Anacostia watershed ABM studies. Projects were based on earlier ABM studies of contaminants in the Anacostia watershed and some results are being used for further investigation by the Maryland Department of the Environment.

Introduction

The tidal freshwater Anacostia River that flows from Maryland through DC to the Potomac River is one of three toxic Regions of Concern in the USEPA/NOAA

Reference: Phelps, H.L. 2010. Clam Active Biomonitoring and POM Passive Monitoring for Anacostia Watershed Contaminant Point Sources. DC WRRI, Washington, DC. 11p.

Chesapeake Bay Program (Chesapeake Bay Program 1999) and listed among America's 10 worst rivers (http://mapping2.orr.noaa.gov/portal/AnacostiaRiver/). The Anacostia has a fishing advisory based on high polychlorinated biphenyls (PCBs) and chlordane in fish tissue. The sediment in the 10 km tidal river is toxic to benthic life (Phelps 1993) and the tumors in over 60% of resident fish are probably due to high sediment PAHs (Pinkney et al. 2000). The Anacostia tidal sediments were extensively studied from 1999 to 2002 by an EPA/NOAA partnership (Wade et al. 1994, Phelps 1995, Coffin et al. 1999, SRC 2000, AWTA 2002, NOAA 2002) and the 2002 Anacostia toxics remediation plan was developed to cap tidal sediment "hot spots". The most recent toxics rremediation plan added controlling stormwater runoff from tributaries (Gruessner et al. 1997, Warner et al. 1997, Washington Post 2004a, ARP 2010). However, active biomonitoring (ABM) studies were finding point sources of contaminants in the tributaries (Phelps 2002, Phelps 2003, Phelps 2004, Phelps 2005, Phelps 2008 Washington Post 2008a, Chesapeake Journal 2009). ABM used the locally available Asiatic clam (*Corbicula fluminea*) (Dressler and Cory 1980) known as a freshwater contaminant bioaccumulator (Dougherty 1990) that can detect low-level and variable levels of bioavailable contaminants at specific watershed locations (DeKock and Kramer 1994). *Corbicula* ABM for 62 EPA Priority Pollutants and seven metals in 13 major Anacostia subwatersheds found PCBs associated with an industrial park and 80% of pesticides as chlordane associated with legacy dump sites. ABM also determined that toxic metals were not an Anacostia problem and high PAHs were associated with industrial parks and parking lot runoff but not with coal-tar sealcoating (Phelps 2008).

The Anacostia has a Total Maximum Daily Load (TMDL) for PCBs and the Maryland Department of the Environment (MDE) is investigating a PCB source found by ABM in upper Lower Beaverdam Creek (Phelps 2003). ABM is limited to water temperatures over 50 deg. C. but year-round PCB congener monitoring using polyoxymethylene plastic strips (POM) is being developed by Dr. Ghosh of the University of Maryland Baltimore Campus (UMBC) (Sun and Ghosh 2008). Dr. Ghosh participated in the monitoring study comparing ABM and POM for PCB congener detection in Lower Beaverdam Creek.

Methods

In 2008 and 2009 active biomonitoring for contaminants in the Anacostia watershed was conducted using methods previously described (Phelps 2008). *Corbicula* clams (17 – 23 mm shell height) were collected by sieving the sandy Potomac River shoreline at the reference site of Fort Foote (MD), 5 km downstream from the mouth of the Anacostia. Clams were kept cool and dry and translocated in shellfish mesh bags within 6 hours to Anacostia watershed biomonitoring sites (Table 1, Figure 1). A Fort Foote Potomac (FF) clam reference sample was taken for analysis. ABM clams were deployed for two weeks except at Lower Beaverdam Creek where comparison was made among two and four week deployments for PCBs alongside polyoxymethylene (POM) plastic strips.

Results

Table 1. Corbicula Active Biomonitoring Anacostia Site Data 2009.

Sample Dates/Site	**Analysis**	**northing**	**westing**
7/31/09, 9/13/09			
FF (Forte Foote reference)	ALL	$38^0$46’27.27”	$76^0$01'45.50"
7/31-8/15/09			
A1 (2 week above Landover Metro site)	PCB	$38^0$56’42.10”	$76^0$52’15.66”
B1 (2 week below, at Landover Metro site)	PCB	$38^0$55’56.38”	$76^0$53'21.49"
UST (Upper Still Creek)	PEST	$38^0$59'13.31”	$76^0$52'05.97”
SCM (Sligo Creek Main Branch	PEST	$39^0$01'14.77"	$77^0$01'58.03"
SCW (Sligo Creek Wheaton Branch	PEST	$39^0$01'14.75"	$77^0$01'59.39"
BWP (BW Parkway Median)	PEST	$38^0$59’15.84”	$76^0$54’29.63”
7/31-8/28/09			
A2 (4 week above Landover Metro site)	PCB	$38^0$56’42.10”	$76^0$52’15.66”
B2 (4 week below, at Landover Metro site)	PCB	$38^0$55’56.38”	$76^0$53'21.49"
9/13-9/29/09			
PP (Poplar Point)	ALL	$38^0$52’11.12”	$79^0$59’52.65”
WRC (Wells Run Creek)	ALL	$38^0$53’08.87”	$76^0$56’32.13”

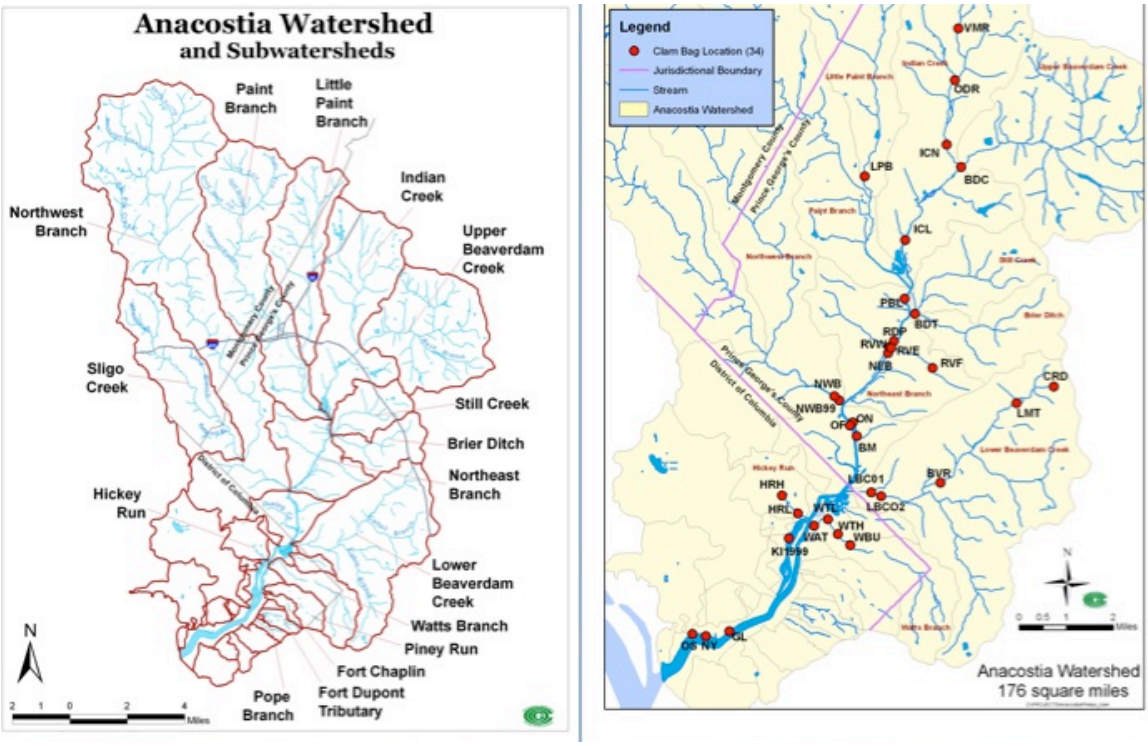


Figure 1. Maps of the Anacostia Watershed and several ABM monitoring sites.

Still Creek flows into to the Northeast Branch of the Anacostia (Fig. 1) and has a watershed of 4 square miles of which 43% is Greenbelt National Park (Fig. 2). In 2004 a complete ABM study at the mouth of Still Creek (Phelps 2005) found chlordane the only major EPA Priority Pollutant contaminant. In 2007 ABM at four first order streams within the Park found high chlordane only in the Upper Mainstem (Fig. 2). In 2009 active biomonitoring in Upper Mainstem outside the Park (site UST) found total chlordane (280 ppb) heptachlor epoxide (13 ppb), gamma chlordane (34 ppb) and alpha chlordane (35 ppb). The total chlordane of 280 ppb is close to the USFDA 300ppb UAFDA action level for human health. The Still Creek Upper Mainstem is a small first order tributary originating in a Greenbelt MD suburb with no known industry. Heptachlor epoxide is a chlordane breakdown product and the finding of 5% heptachlor epoxide suggested Still Creek contamination may originate from a legacy chlordane dump site created when chlordane use for termites was banned in 1983.

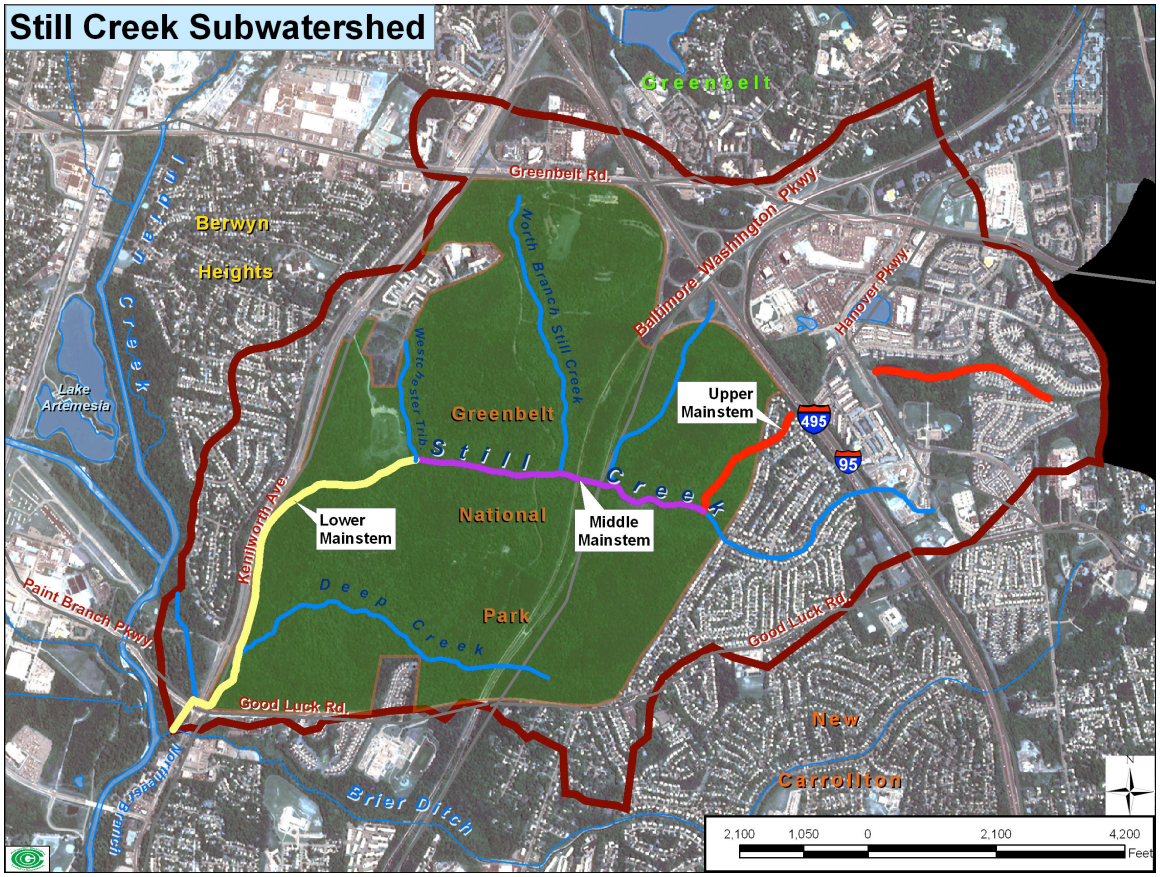


Figure 2. Still Creek watershed.

Wells Run is a small subtributary of the Northeast Branch that runs through University Park, MD. It has an active citizen group concerned about stream health that asked to have an ABM scan. One of the purposes in developing ABM was to encourage evaluation of stream contaminants in the entire Anacostia watershed. Clams were placed at site WRC in Wells Run for two weeks in September 2009. Wells Run clam contaminants compared with FF reference levels found no significant increase in PCB congeners, aroclors or metals. However total PAHs (436 ppm) statistically exceeded FF reference (104 ppm) and were similar to average high tPAHs in the Anacostia River (360 ppm). The majority were 4-5 ring PAHs typical of combustion such as auto exhaust and burning. Clams at site WRC also had significantly increased total chlordane (240 ppb) with gamma (17ppb) plus alpha (29ppb) chlordane as 19.2% of total chlordane. This could indicate an upstream chlordane source although heptachlor epoxide was not detected.

Poplar Point in the lower tidal Anacostia is an AWTA toxic sediment 'hot spot' inclluding the outlet site of Stickfoot Sewer (site PP) (NOAA 2002). Stickfoot Sewer is enclosed so clams were placed in the tidal river close to the outlet. ABM in 2001 and 2002 at five other tidal Anacostia River sites had found no significant contaminant differences, probably due to tidal mixing (Phelps 2002, Phelps 2003). Like ABM at three

other tidal river 'hot spots', tPCBs and tMetals accumulated by clams at site PP did not exceed reference (site FF). Total clam PAHS (681 ppm) exceeded reference (122 ppm) and were twice the Anacostia tidal site average (360 ppm) The only detected pesticide was high total chlordane (1200 ppb) which included gamma (82 ppb) and alpha (140 ppb) chlordane (18.3%) and exceeded reference (120 ppb) (site FF). There was no detectable heptachlor epoxide so a legacy source of chlordane was not established.

The small Riverdale East culverted stream entering the Northeast Branch (Fig. 1) had been found highly contaminated with chlordane (site RVE, 720 ppb chlordane) that increased up to the Baltimore Washington Parkway (site RVF, 1800 ppb chlordane) before ending in a suburb (Fig. 3) (Phelps 2003, Phelps 2004). The chlordane was accompanied by heptachlor epoxide, a chlordane degradation product, and it was suggested the origin could be legacy dump sites in the vicinity of the Baltimore-Washington Parkway. There is a small stream running down the forested median strip of the Baltimore-Washington Parkway near site RVF. Clams placed at that location (site BWP) for two weeks had twice the total chlordane (220 ppb) of reference (FF site) (100 ppb) but much lower than the nearby Riverdale East site RVF and did not have heptachlor epoxide. It appeared that chlordane in the Parkway median stream (site BWP) did not have the same origin as high chlordane in the nearby Riverdale East stream.

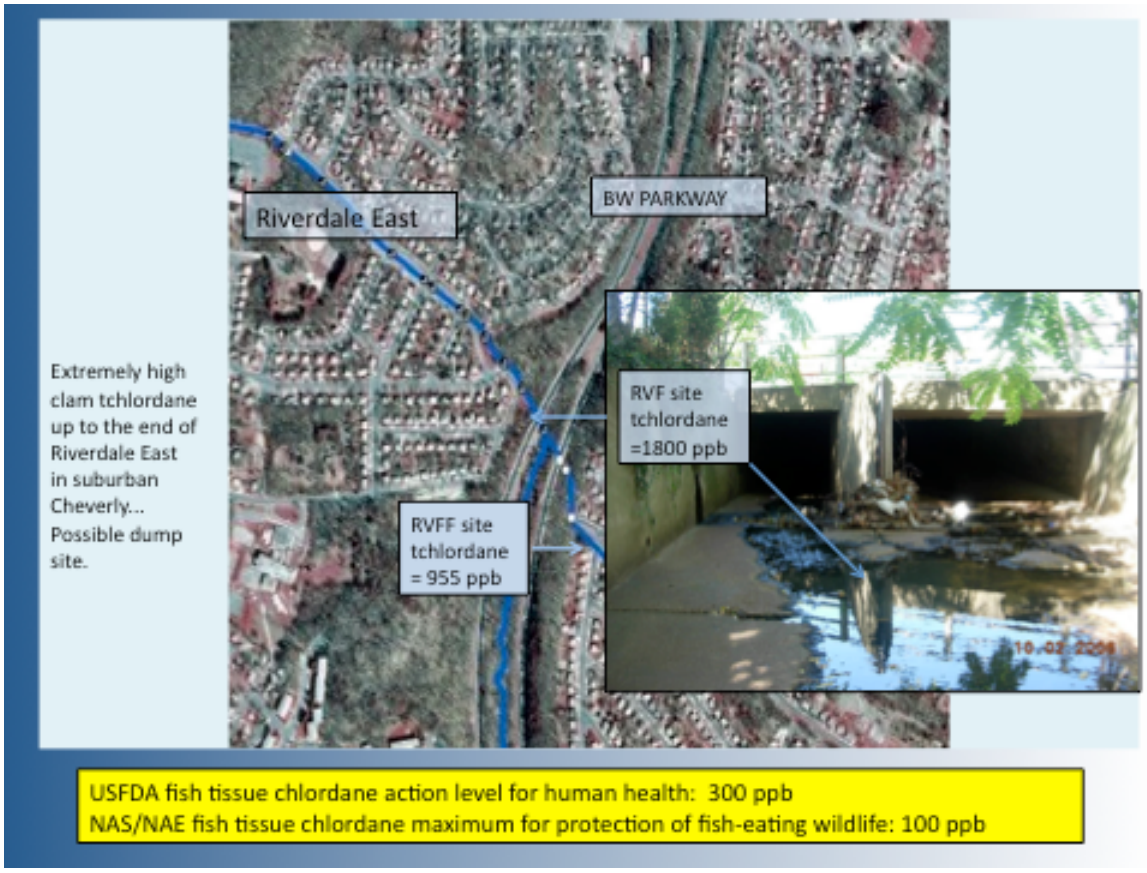
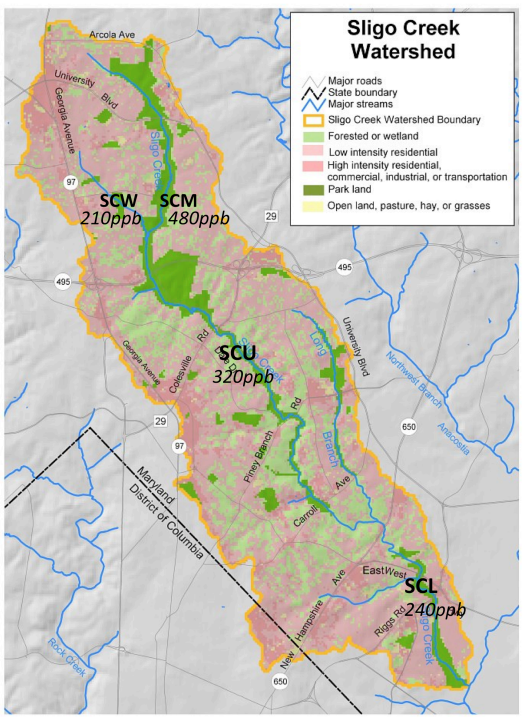


Figure 3. Riverdale East and the Baltimore Washington Parkway.

Sligo Creek is a large subtributary of the Northwest Branch with a watershed mostly in Montgomery County and parts in Prince Georges County and DC (Fig 1). Sligo Creek has a active citizens group with a number of restoration projects and was selected as a model for the Anacostia Restoration Program being developed by the Army Corp of Engineers (ACE) and the Metropolitan Washington Council of Governments (MWCOG) (Washington Examiner 2008; Washington Post 2008b). In 2008 students carried out complete ABM surveys at two sites in the lower Creek. PCB congeners did not exceed reference (site FF) and total PAHs were about twice reference but significant pesticides were detected: dieldrin, heptachlor epoxide and chlordane. Total chlordane was lowest (240 ppb) downstream (site SCL) and higher (320 ppb) upstream (site SCU) (Fig. 4). In 2009 ABM upstream found lower total chlordane (230 ppb) at Wheaten Branch (site SCW) than in the Main Branch (480 ppb) (site SCM). Alpha plus gamma chlordane was 16.2% at site SCW) and 19.0% at site SCM) but dieldrin (43 ppb) and heptachlor expoxide (32 ppb, 6.7%)) were only found at site SCM which suggests a legacy chlordane dump site. It should be noted that the reference (site FF) total chlordane was high (120 ppb) with 20 ppb gamma chlordane and no alpha chlordane or heptachlor epoxide. It is hoped to further explore the upstream Sligo Main Stem to locate the chlordane source.



Sligo Creek is a model stream being studied for stormwater control (COE)

In 2008 student active biomonitoring used clams to study 72 EPA Priority Pollutants at upper (SCU) and lower (SCL) Sligo Creek sites. Only total chlordane (and PAHs) significantly exceeded the Potomac (reference) site. Highest total chlordane was upstream.

In 2009 upper Sligo Creek clam active biomonitoring for total chlordane found lowest levels in Wheaton Branch (SCW) and highest in Main Branch (SCM). Heptachlor epoxide suggested an old chlordane dump in SCM significantly contaminating the entire creek. This will be explored further in 2010.

Total clam chlordane: 100 ppb = NAS/NAE maximum for protection of fish-eating wildlife; 300 ppb = USFDA action level for human health

Figure 4. Chlordane ABM studies in Sligo Creek.

Lower Beaverdam Creek (LBC) has the greatest percent of land in industrial parks (Warner et al. 1997) and highest polychlorinated biphenyl (PCB) pollution (Phelps 2002) (Fig. 1). High pesticides (mostly chlordane}, PCBs and Aroclors were found

starting at lower Lower Beaverdam Creek (sites LBC01, LBC02) proceeding upstream to Beaver Road (site BVR) near Tuxedo Industrial Park, then Landover Metro (site LMT) below the Ardwick Ardmore Industrial Center, followed by New Carrolton Metro Station (site NCM) and Corporate Drive (site CRD) just inside the Beltway, Route 495 (Fig. 1) (Phelps 2004, Phelps 2005, Phelps 2008). The upstream sites CRD and NCM had high total pesticides (mostly chlordane) but no elevated tPCB or tAroclor. Sites NCM, BVR and LBC downstream from the Ardwick-Ardmore Industrial Park had high tPCB with low-molecular-weight volatile PCB congeners, (mostly Aroclor 1242 and 1254) suggesting an ongoing source. ABM with stream walking at three sites between LMT and NCM (sites AA2, AA3, AA4) found a 3X tPCB increase at site AA4, mostly low molecular weight congeners. (Fig. 5) (Phelps 2008). In 2009 additional ABM placed using stream walking between LMT and AA4 were able to identify a short stream reach containing an outlet associated with high PCBs which is now being explored by the Maryland Department of the Environment.

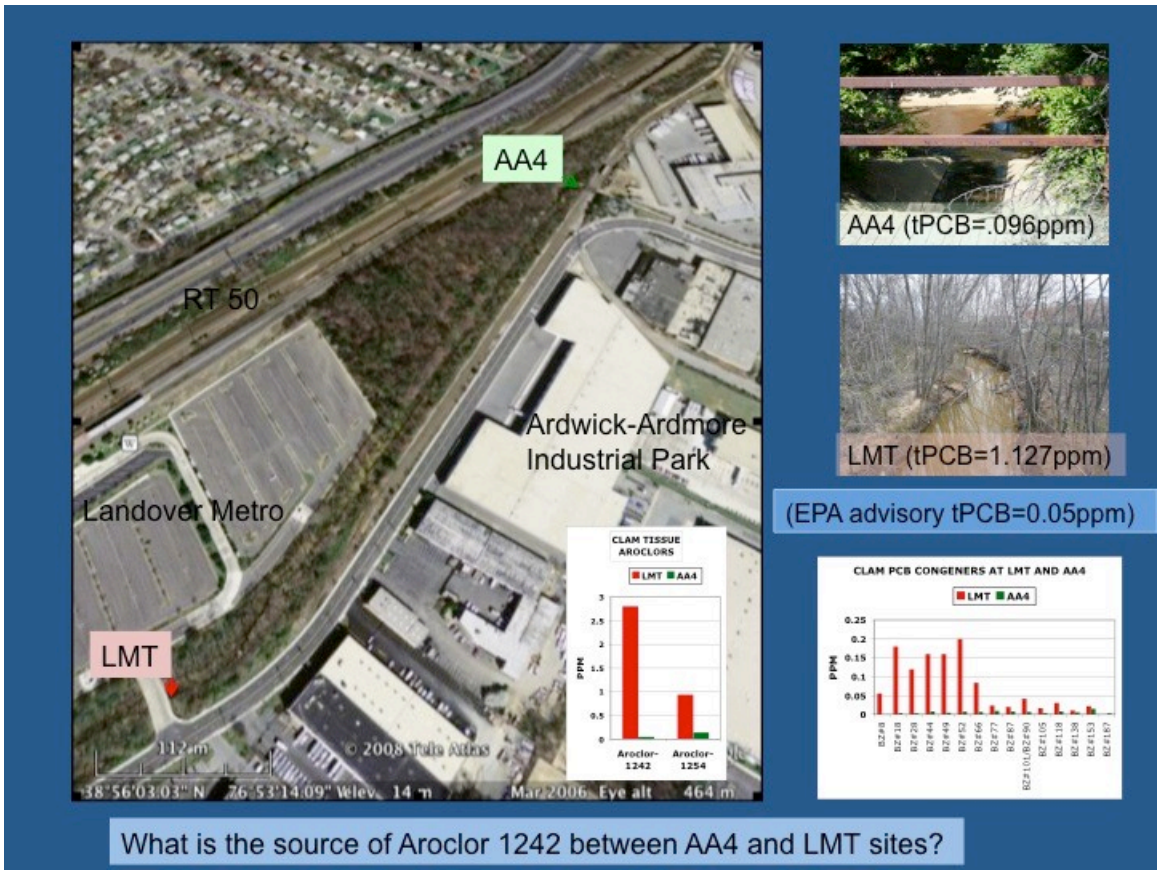
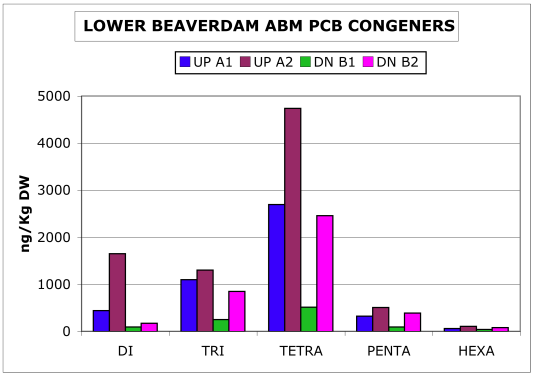


Figure 5. Lower Beaverdam Creek PCB congeners.

The second upper Lower Beaverdam Creek project compared PCB monitoring by clam ABM and polyoxymethlyene strips (POM). Two monitoring sets including ABM clams and plastic polyoxymethylene strips (POM) were placed for two and four weeks at

Landover Metro (site LMT) called the B(elow) site and upstream at A(bove site close below the AA4 site where high PCBs were first detected (Phelps 2008). The POM strips were provided and analyzed by Dr. Upal Ghosh of UMBC. Samples UP A1 and DN B1 were collected at two weeks and samples UP A2 and DN B2 at four weeks. The dry POM strips were taken to Dr. Ghosh's laboratory for PCB congener extraction and analysis. The frozen ABM clam tissues were sent to the Philadelphia laboratory of TestAmerica for analysis. Dr. Ghosh's lab analyzed POM strips for 86 PCB congeners and TestAmerica analyzed the ABM clam tissues for 20 PCB congeners. POM PCBs were reported in units per dry weight while tissue PCBs are routinely reported in units per wet weight. Clam tissue is 80% water and if both results are reported in dry weight units, at two weeks the total PCBs by POM was greater (>2X) (Fig. 6). Both methods found much greater total PCB at site A (upstream) than site B (downstream, site LMT) and ABM at four weeks showed total PCB increase while POM total PCBs did not. Reference site (FF) ABM total PCB was 90 ppb. Both ABM and POM recorded peaks of low-molecular-weight PCB congeners. Three high PCB congeners (5, 8 and 28) were reported by POM analysis but not by ABM. If those congeners were excluded there was PCB congener statistical similarity detected by POM and ABM methods.



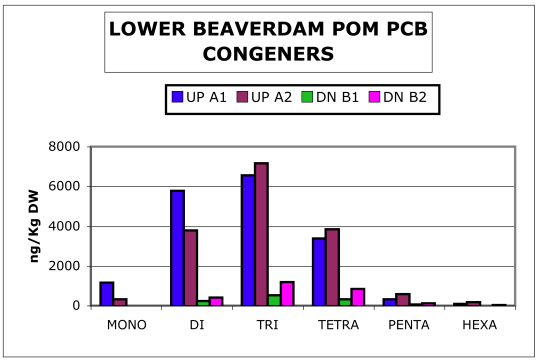


Figure 6. Lower Beaverdam Creek PCB congeners at sites A (upstream) and B downstream) at two (A1, B1) and four (A2,B2) weeks using POM strips and active biomonitoring (ABM) with Corbicula.

These studies have confirmed and extended knowledge of chlordane and PCB contaminant point sources in the Anacostia watershed. They explored POM as a new method for PCB congener analysis that could replace ABM. The student projects were presented at school and results have appeared in articles (Chesapeake Journal 2009,

Washington Gazette 2010). Publicity about these projects has generated increasing interest and involvement of citizen stream groups and the Maryland Department of the Environment in finding Anacostia watershed contaminant point sources. Point source contaminant remediation requires problem recognition by state environmental agencies leading to EPA involvement and this has been an important first step towards controlling Anacostia River's toxicity.. A survey paper on the use of ABM in finding Anacostia watershed point sources of toxic contaminants is being prepared for publication.

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