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CONTAMINANT EXPOSURE AND POTENTIAL EFFECTS ON TERRESTRIAL VERTEBRATES RESIDING IN THE NATIONAL CAPITAL REGION NETWORK AND MID-ATLANTIC NETWORK

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Summary

Part of the mission of the National Park Service is to preserve the natural resources, processes, systems, and associated values of its units in an unimpaired condition. Environmental contamination and pollution processes are well recognized stressors addressed by its management policies and plans. A recent study indicates that contemporary terrestrial vertebrate ecotoxicological data are lacking for 59 of 126 Park Service units located in coastal watersheds exhibiting serious water quality problems or high vulnerability to pollution. Based upon these findings, a more in-depth evaluation of contaminant threats and ecotoxicological data gaps related to terrestrial vertebrates was undertaken at 23 Inventory and Monitoring National Park units in National Capital Region and Mid-Atlantic Networks.

Ecotoxicological data were compiled for each park unit through literature searches and meetings with Park Service personnel. Information on contemporary and on persistent legacy pollutants in air, water, soil, and terrestrial vertebrates (amphibians, reptiles, birds and mammals) were evaluated. To identify contaminant threats in proximity to the 23 Park Service study units, data was gathered on National Priority List Superfund sites, Section 303(d) Impaired Waterbodies, the number and relative toxicity of current use pesticides and herbicides, Toxic Release Inventory sites and discharge of priority pollutants, and Fish Consumption Advisories. A metric was derived that described the quality and quantity of existing data for each park, and in combination with known contaminant threats, park units in need of additional study were identified.

Results demonstrated that over half of the Park Service study units are near Toxic Release Inventory sites discharging dioxins, polychlorinated biphenyls, lead or mercury into air or water, and fish consumption advisories are in effect at or near 22 of the 23 study units. Pesticide and herbicide use at the park units is minimal, with the exception of those units with significant agricultural leases. Despite highly regulated use, many of the pesticides and herbicides applied are believed to be highly toxic to amphibians, and some of the compounds are also highly toxic to birds. Only 70 reports were found that describe terrestrial vertebrate ecotoxicology data on or near the study units. Of the greater than 75,000 compounds in commerce in the United States, existing terrestrial vertebrate exposure and effects data in the present study were limited to 58 legacy organochlorine pesticides, polychlorinated biphenyls and individual congeners, insecticides and rodenticides, metals, and some contemporary compounds (e.g., polybrominated diphenyl ether flame retardants, and alkylphenol and ethoxylate surfactants).

Based upon these and other findings, ecotoxicological monitoring and research investigations of terrestrial vertebrates are warranted at several National Parks. These include Shenandoah National Park, Richmond National Battlefield, Chesapeake & Ohio Canal National Historic Park, Valley Forge National Historic Park, Hopewell Furnace National Historic Site, Monocacy National Battlefield, and Harpers Ferry National Historic Park. The types of investigations vary according to the species present at these parks and potential contaminant threats, but should focus on contemporary use pesticides and herbicides, polychlorinated biphenyls, mercury, lead, and perhaps, emerging contaminants including antibiotics, flame retardants, pharmaceuticals, and surfactants. Other management recommendations include additional training for natural resource staff members in the area of ecotoxicology, inclusion of terrestrial vertebrate

contaminant monitoring and the Contaminant Assessment Process (U.S. Geological Survey Biomonitoring of Environmental Status and Trends Project) into the National Park Service Vital Signs Program, development of protocols for handling and toxicological analysis of dead or seemingly affected wildlife, consideration of some alternative methods and compounds for pest management and weed control, and use of non-toxic fishing tackle by visitors.

Keywords: biomarkers, ecotoxicology, geographic information systems, monitoring, pollution, watersheds

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Introduction

Recognition of the hazards of environmental pollutants to wildlife date back to ancient times (Greek maxim, "a bad crow lays a bad egg"), with the earliest scientific investigations occurring during the industrial revolution (reviewed by Hoffman et al., 2003). Although the hazards of arsenic, lead, zinc and crude oil to wildlife were recognized in the first half of the twentieth century, it was not until the publication of Rachel Carson's *Silent Spring* (1962) that adverse effects of these toxicants and organic pesticides became nationally and internationally acknowledged. By 1964, a cooperative effort involving several Federal agencies resulted in the National Pesticide Monitoring Program, and related research efforts in government, academia, and industry were greatly expanded. Despite these efforts, exposure data for pesticides, metals, industrial chemicals, petroleum hydrocarbons and other toxicants in wild terrestrial vertebrates are limited to merely a few hundred of the greater than 75,000 compounds in commerce in the United States (Rattner et al., 2005). Exposure and adverse effect thresholds, critical concentrations, and diagnostic guidelines for wild terrestrial vertebrates (principally birds) have been established for relatively few compounds (Table 1, Appendix E) (Rattner et al., 2000a). Inter-specific variation in exposure and sensitivity to toxicants greatly complicates the use of these diagnostic criteria in risk assessments. Furthermore, the only water quality criteria that are widely accepted for the protection of terrestrial wildlife include DDT, polychlorinated biphenyls (PCBs), dioxin and mercury (U.S. Environmental Protection Agency, 1995).

A significant component of the mission of the National Park Service (NPS) is to preserve the natural resources, processes, systems and associated values of its units in an unimpaired condition, striving to perpetuate their inherent integrity, for the enjoyment of present and future generations (http://science.nature.nps.gov/im/monitor/ProgramGoals.cfm). Clearly, its management policies address environmental contamination and pollution processes that are threats to its resources. In addition to the NPS, there are several other agencies within the Department of the Interior (DOI) that have mandates to assess and mitigate this hazard to the Nation's natural resources (e.g., Fish and Wildlife Service, U.S. Geological Survey). Despite the accomplishments of various DOI programs, terrestrial vertebrates remain at risk to contaminants in many ecosystems.

One DOI activity addressing the hazards of environmental contamination is the U.S. Geological Survey Biomonitoring of Environmental Status and Trends (BEST) Project that has its roots in the National Pesticide Monitoring Program (Jacknow et al. 1986; Zylstra 1994). Currently, the BEST Project seeks to (1) assess the exposure and effects of environmental contaminants on select species and habitats throughout the United States, (2) conduct research and synthesize activities that provide biomonitoring methods for field application and (3) support the development of methods and tools to assist DOI agencies in assessing chemical threats to species and lands under its stewardship (http://www.best.usgs.gov/default.htm). To address these contaminant hazards on local, regional and national scales, the BEST Project has attempted to identify critical ecotoxicological data gaps through at least two decision support tools. The first being the Contaminant Assessment Process (CAP), which synthesizes retrospective information on contaminant sources, types and transport pathways, and sensitive species; it also ranks contaminant issues according to their relative risk, and if needed, initiates field sampling to further evaluate potential problems or establish baseline conditions (Coyle et al. 1999;

Table 1. Principal contaminants for which critical concentrations and diagnostic guidelines have been established for wild terrestrial vertebrates

Contaminants	
Organochlorine Pesticides	Polychlorinated biphenyls
Chlordecone	Total aroclors
p,p'-DDE	Coplanar congeners, dioxins, dibenzofurans
Dicofol	
Dieldrin	Petroleum hydrocarbons
Endrin	
Heptachlor epoxide	Metals, Metalloids and Trace Elements
Hexachlorobenzene	Cadmium
Hexachlorocyclohexane	Fluoride
Mirex	Lead
Oxychlordane	Mercury
	Selenium
Organophosphorus and Carbamate Pesticides	Vanadium

http://www.best.usgs.gov/default.htm). To date, the CAP has been conducted at numerous National Wildlife Refuges (NWRs). Another BEST project support tool is the Contaminants Exposure and Effects-Terrestrial Vertebrates (CEE-TV) database (Rattner et al. 2000a, 2005; http://www.pwrc.usgs.gov/contaminants-online). It has been used to conduct searches for exposure and effects data for a given species or location, identify temporal contaminant exposure trends, analyze NWR and National Park (NP) unit data gaps, and rank terrestrial vertebrate ecotoxicological information needs based on data density and known pollution problems (Cohen et al., 2003; Rattner et al., 2005). For example, since 1990 terrestrial vertebrate contaminant exposure and effects data are available for only 66 of the 126 NP units in coastal habitat, and 59 units that lacked recent data fell in or near watersheds of concern (U.S. Environmental Protection Agency, 1997).

Based upon the aforementioned information gaps and apparent ecotoxicological threats on or near NPS units (Cohen et al. 2003; Rattner et al. 2005), a study was undertaken at 23 Inventory and Monitoring (I&M) Program units in the National Capital Region and Mid-Atlantic Networks. These two Networks include NP units located in Pennsylvania, Maryland, District of Columbia, West Virginia and Virginia, and the area of the 23 units, including a 10 kilometer buffer zone around each, totaled 23,367 square kilometers (Figure 1; Table 2). The physiographic regions of the study area included Coastal Plains Province, Piedmont Province, Blue Ridge Province and Valley and Ridge Province, and habitat types were primarily agricultural, forested and urban. Our intent was to provide natural resource managers with information on existing or potential pollution hazards, and identify and prioritize future contaminant biomonitoring for these sites. Although there are certainly well described risks to aquatic species at some of these sites, the present effort focused on amphibians, reptiles, birds and mammals. These terrestrial vertebrates are ecologically important and publicly appreciated natural resources, but are not adequately characterized from an ecotoxicological perspective. The specific objectives of the present investigation include:

1. Compile and evaluate existing information on contaminant exposure and effects in terrestrial vertebrates (viz., amphibians, reptiles, birds and mammals) utilizing NP in the National Capital Region Network and Mid-Atlantic Network.

2. Use information from the CEE-TV database, the U.S. Environmental Protection Agency, and other scientific data, to prepare a brief synopsis of contaminant hazards and information gaps at each NP unit in the aforementioned networks.

3. Identify real or potential pollution hazards and how they might affect species of concern.

Herein, we describe the methods used to compile and analyze these data, present a summary report for each of the NP units, describe apparent information gaps and contaminant threats to terrestrial vertebrates, and recommend monitoring and research needs.

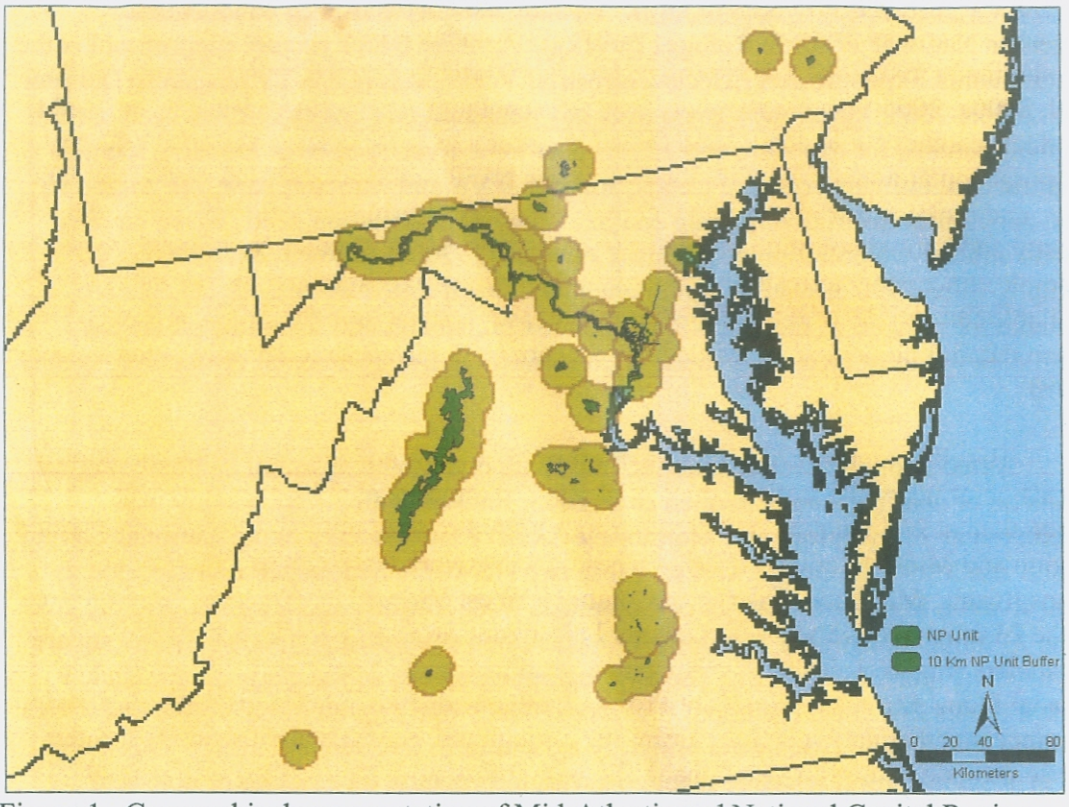

Figure 1. Geographical representation of Mid-Atlantic and National Capital Region Network National Park Units and corresponding 10 kilometer buffers.

Table 2. List of National Park Service units, abbreviations and area (park and 10 kilometer buffer) included in this project.

Park Name	Abbreviation	Area (km^2)
Antietam National Battlefield	Antietam NB	503.5
Appomattox Court House National Historical Park	Appomattox Court House NHP	491.7
Booker T. Washington National Monument	Booker T. Washington NM	359.5
Catoctin Mountain Park	Catoctin Mountain NP	563.3
Chesapeake & Ohio Canal National Historical Park	Chesapeake & Ohio Canal NHP	5088.4
Eisenhower National Historic Site	Gettysburg NMP/Eisenhower NHS	395.2
Fort McHenry National Monument & Historic Shrine	Fort McHenry NM & HS	331.0
Fredericksburg & Spotsylvania National Military Park	Fredericksburg & Spotsylvania NMP	1467.9
George Washington Memorial Parkway	George Washington MP	1013.1
Gettysburg National Military Park	Gettysburg NMP/Eisenhower NHS	647.7
Harper's Ferry National Historical Park	Harper's Ferry NHP	560.4
Hopewell Furnace National Historic Site	Hopewell Furnace NHS	403.5
Manassas National Battlefield Park	Manassas NBP	544.7
Monocacy National Battlefield	Monocacy NB	438.8
National Capital Parks-East	NCPE	1826.0
National Mall & Memorial Parks	National Mall & Memorial Parks	524.8
Petersburg National Battlefield	Petersburg NB	1190.2
Prince William Forest Park	Prince William FP	673.9
Richmond National Battlefield Park	Richmond NBP	1311.3
Rock Creek Park	Rock Creek Park	542.8
Shenandoah National Park	Shenandoah NP	4042.3
Valley Forge National Historical Park	Valley Forge NHP	482.6
Wolf Trap National Park for the Performing Arts	Wolf Trap NP	341.0

Methods

I. Data Compilation

Using the CAP guidance document (Coyle et al., 1999), 18 questions (Table 3) were selected to focus and assist in the compilation of environmental contaminant data for the 23 I&M NP units in the National Capital Region and Mid-Atlantic Networks. (Note: Gettysburg NMP and Eisenhower NHS were joined as one unit because of their proximity. Henceforth, this report will refer to the total number of NP units as 22 study areas.) Staff at each I&M NP unit were contacted by telephone to identify the Natural Resource Manager or Specialist (Appendix A) that could take the lead in addressing these questions. Once appropriate staff were identified, they were contacted, a brief overview of the project was provided, and an appointment was made for a site visit. The information discussed in the telephone conversation was forwarded electronically along with the list of 18 questions addressing environmental contaminant issues.

Prior to each site visit, a presentation was prepared that described the overall project and publicly available information for the NP unit. Shapefiles were obtained for each park boundary and a 10 kilometer buffer was created around each unit. Potential pollution sources that could affect terrestrial vertebrates [National Priorities List (NPL) Superfund Sites (www.epa.gov/superfund/sites/cursites/index.htm), Clean Water Act Section 303(d) Impaired Waters in 2002 (www.epa.gov/waters/data/downloads.html), Toxic Release Inventory Sites (TRI) for 1997 through 2003 (www.epa.gov/triexplorer/facility.htm) and Fish Consumption Advisories (www.epa.gov/waterscience/fish/advisories/index.html) in 2004] were overlaid on the NPS unit boundary and buffer shapefiles. The Geographic Information System (GIS) procedures used to generate and obtain these shapefiles are described in Appendix B.

For each NP unit visit, a 30 minute presentation describing the project and our preliminary findings was delivered. Responses to the interview questions were obtained and discussed. In addition, NPS staff were provided hardcopies of existing publications that fell within or near the boundary of their park. These data were derived from the CEE-TV database (http://www.pwrc.usgs.gov/contaminants-online/) and other sources using contemporary literature search tools (e.g., Fish and Wildlife Reviews, Cambridge Scientific Abstracts, Current Contents and NatureBib). In some instances contaminant-related reports, maps and species lists were provided by NPS staff. A letter acknowledging each site visit was prepared and mailed.

Table 3. Questions to assist with compilation of environmental contaminant data on or near Mid-Atlantic and National Captial Region Network park units.

1. Are there any current or potential contaminated sites on or near the park property?
2. What are past land uses of this property (both during and prior to NPS acquisition)?
3. Have any pesticides, herbicides, rodenticides, and/or avicides been used on or near park property? What are the product names?
4. Are there any solid waste or wastewater disposal problems on or near park property?
5. Are there any signs of pollution?
6. Have the proper officials been notified? Who?
7. Are there any road systems in or near park property that could be a source of contaminants? (i.e. transportation of hazardous materials)
8. Have there been any observed die-offs, deformities, sicknesses, or failed breeding in any terrestrial vertebrate species?
9. Is there current or past contaminant research or monitoring that has occurred on park property?
10. What are the primary surface and groundwater sources for the park? (i.e. streams, ponds, lakes, springs, wells)
11. Are there critical areas for trust resources on or off the park property?
12. Are there any species of concern (endangered, threatened, endemic) that have been sighted on or near park property?
13. Are there animal species list that can be obtained for the park resources?
14. Are there management activities that could be a potential concern for trust resources? Are there environmental impact statements for these activities that can be obtained?
15. Are there any shapefiles, maps, or data available that could be of assistance in identifying pathways or sources of contaminants?
16. Have there been any public meetings held concerning contaminants on or near the park property? Who may we contact to obtain literature about the meetings?
17. Are there current or former staff, previous landowners, or neighboring landowners that may provide additional applicable information? Contact information?
18. Are there additional federal, state, and environmental organizations that may provide applicable information? Contact information?

II. Preparation of Summary Report for Each Park Unit

Following each site visit, a summary report was drafted using publicly available information and data provided by NPS staff. Each report contained background information (size, designation, habitat use, and past land use of the park), current and potential environmental contaminant information, conclusions and literature cited. The environmental contaminant information included:

1. NPL superfund sites

2. Impaired waterbodies

3. Pesticide and herbicide use for 2004

4. Solid waste facilities [(http://www.deq.virginia.gov/waste/aswrs.html), (http://www.depweb.state.pa.us/landrecwaste/cwp/view.asp?A=1238&Q=463564), (http://www.mde.state.md.us/assets/document/ALL_SOLID_WASTE_FACILITIES.pdf) and (http://www.state.wv.us/swmb/2005%20State%20Plan/Chapter%203.pdf)]

5. Wastewater treatment sites (http://cfpub.epa.gov/cwns/standard.cfm)

6. Terrestrial vertebrate contaminant exposure and/or effects data

7. TRI sites (http://www.epa.gov/triexplorer/facility.htm) with special emphasis on those releasing persistent pollutants (Appendix C)

8. Fish consumption advisories

The conclusions focused on toxic chemicals identified, and recommended additional priority contaminant monitoring/research that may be warranted.

Within one to three months of the site visit, the draft report for each NP unit was sent to the appropriate contact for review. Comments forwarded by NPS staff were addressed in a revised report. Because of revisions of the NPS Integrated Pest Management database, 2004 pesticide use information for each park unit was obtained after completion of draft reports and was subsequently incorporated into each report.

III. Evaluation of Contaminant Threats and Perceived Information Needs

A. Descriptive and Qualitative Review of Information

Information on the presence of contemporary and legacy contaminants in abiotic environmental media (water, soil, and air), tissues of prey species, and pesticide and herbicide use data was examined to determine the potential for terrestrial vertebrate exposure. In addition, presence of critical areas (created wetlands) or sensitive species at an NPS unit served as a trigger to elevate the need for terrestrial vertebrate ecotoxicological data. And finally, the nature of the existing information (die-off of single individual vs. a hypothesis-driven study documenting widespread

contaminant exposure) and when it was collected (recent, after 1990 versus historic, before 1990) was also considered. This type of information provided a general priority of the need for environmental contaminant monitoring.

B. Classification of Contaminant Threats at NP Properties

We summarized the potential threat of contaminants from numerous sources at each NP unit using a semi-quantitative classification scheme. This was in part derived from the ranking scheme that had been used Index of Watershed Indicators (U.S. Environmental Protection Agency, 1997). The potential contaminant threats and their ranking follow:

1. Current NPL Superfund sites requiring remedial action within the park boundary or its 10 kilometer buffer. Each park was given a score (color classification) of zero (green) if there were no NPL sites or a numeric value (red) corresponding to the number of NPL sites.

2. Percent of surface waters listed as impaired under U.S. Environmental Protection Agency's Clean Water Act Section 303(d) within 10 kilometer of the park. Each park was scored based on the percentage of impaired waters following the Index of Watershed Indicators (U.S. Environmental Protection Agency, 1997).

% Surface Waters Impaired	Score (Color Classification)
0-20%	0 (green)
21-50%	1 (yellow)
51-80%	2 (orange)
> 80%	3 (red)

3. Number of pesticides classified as moderately to very highly toxic applied to greater than one acre of the NP unit in 2004. Based on the toxicity classification scheme in Hill and Camardese (1986) and Smith (1987), pesticides were classified as not toxic, slightly toxic, moderately toxic, highly toxic, and very highly toxic depending on their acute toxicity to birds, mammals and amphibians (Tucker and Crabtree, 1970; Sparling et al., 2000). Fish were used as a surrogate species when acute toxicity data for amphibians were not available (Birge et al., 2000). Due to the paucity of acute toxicity data for reptilian species, they were not included in this analysis. Each park was scored (color classification) corresponding to the number of moderately toxic, highly toxic and very highly toxic pesticides applied to the NP property.

Pesticides Applied	Score (Color Classification)
No moderately to very highly toxic ingredient	0 (green)
1 moderately to very highly toxic ingredient	1 (yellow)
2-4 moderately to very highly toxic ingredient	2 (orange)
> 4 moderately to very highly toxic ingredient	3 (red)

4. Relative toxicity of pesticides applied to greater than one acre of the NP unit property in 2004. Each park was given a score related to the potency of the most toxic pesticide applied to the NP property.

Acute Toxicity Classification	Score (Color Classification)
Not toxic to slightly toxic	0 (green)
Moderately toxic	1 (yellow)
Highly to very highly toxic	2 (red)

5. Toxic Release Inventory sites discharging contaminants from 1997 through 2003 within the park boundary or its 10 kilometer buffer. Each park was given a score (color classification) of zero (green) if there were no TRI sites or a numeric value (yellow through red) related to the number of TRI sites discharging pollutants.

Toxic Release Inventory Sites	Score (Color Classification)
No TRI Sites	0 (green)
1-5 TRI Sites	1 (yellow)
6-10 TRI Sites	2 (brown)
11-20 TRI Sites	3 (orange)
> 20 TRI Sites	4 (red)

6. Number of TRI sites discharging priority pollutants from 1997 through 2003 within the park boundary or its 10 kilometer buffer. (Note: Combining the quantities of priority pollutants released at each site is not meaningful because of their vastly different toxicities.) Each park was given a score of zero (green) if TRI sites discharged no priority pollutants or a numeric value (yellow through red) related to the quantity of priority pollutants discharged by TRI sites.

TRI Sites Discharging Priority Pollutants	Score (Color Classification)
No Discharge of Priority Pollutants by TRI Sites	0 (green)
1-5 TRI Sites Discharged Priority Pollutants	1 (yellow)
6-10 TRI Sites Discharged Priority Pollutants	2 (orange)
> 11 TRI Sites Discharged Priority Pollutants	3 (red)

7. Current state fish consumption advisories in waters within the park boundary or its 10 kilometer buffer. A restricted consumption advisory is issued where it is advised to limit eating locally caught fish while a no consumption advisory is issued where it is advised to not eat locally caught fish. Based on the scheme used in the Index of Watershed Indicators (U.S. Environmental Protection Agency, 1997), each park was scored as follows:

Advisories	Score (Color Classification)
No Fish Consumption Advisory	0 (green)
Restricted Consumption Advisory	1 (yellow)
No Consumption Advisory	2 (red)

IV. Extant Terrestrial Vertebrate Ecotoxicological Data on NP Properties

A. Quantity of Contemporary Terrestrial Vertebrate Data

We summarized the quantity of contemporary terrestrial vertebrate ecotoxicological data for each NP unit using the presence (number of reports) and time of collection of data (recent, since 1990 vs. historic, prior to 1990). The presence of reports and time of collection were examined for each NP unit using the following scheme:

1. Each park was given a numeric score corresponding to the number of CEE-TV reports located within the NP unit and its 10 kilometer buffer.

CEE-TV Reports	Score (Color Classification)
> 5 reports	2 (green)
1-5 reports	1 (yellow)
No reports	0 (red)

2. Each park was given a numeric score corresponding to the number of recent (1990 to present) CEE-TV reports located within the NP unit and 10 kilometer buffer.

Contemporary CEE-TV Reports	Score (Color Classification)
> 5 reports	2 (green)
1-5 reports	1 (yellow)
No reports	0 (red)

To obtain a summary score for the amount of recent data for each NP unit and 10 kilometer buffer, the scores from the number of reports and their timeliness were summed. Each park was classified using the following scheme:

Quantity of Contemporary Data Score	Color Classification
3-4	Green
1-2	Yellow
0	Red

B. Quality of Terrestrial Vertebrate Data

Because of the shortcomings of the aforementioned information (i.e., quantity of contemporary data communicates little about its biological significance), the score was adjusted to take into account the type and perceived quality of information (e.g. a hypothesis-driven study often has greater data quality and specificity than a necropsy report). Categories included necropsy reports (information on one or a few individuals involving very specific contaminant analyses), monitoring/survey studies (select group of analytes determined for a group of animals) (weighted in analysis by multiplying by a factor of two), or hypothesis-driven investigations (exposure and/or effects data for many individuals analyzed using inferential statistical methods) (weighted in analysis by multiplying by a factor of three).

C. Terrestrial Vertebrate Ecotoxicological Data Richness

The quantity and the quality of the terrestrial vertebrate ecotoxicological information were combined into a data richness score for each park.

V. Data Gap Analysis and Prioritization of Terrestrial Vertebrate Ecotoxicological Research at NP Units.

Our impressions of the need for terrestrial vertebrate ecotoxicological monitoring studies were initially derived by qualitative inspection of existing data, size of park unit and known contaminant threats. Subsequently, a metric was derived describing the combined quantity and quality of existing data for each park. This metric in combination with known contaminant threats and size of the NP unit was examined to identify and rank the relative contaminant monitoring/research needs of each park unit. For example, parks with low contaminant threats or a large number of terrestrial vertebrate ecotoxicological data were ranked low, while parks with high contaminant threats and relatively little terrestrial vertebrate data have a higher priority for study.

Ecotoxicological Findings Related to Terrestrial Vertebrates Residing at NP Study Units

Data related to contaminant threats from air, water, soil, terrestrial vertebrate food items, pesticide and herbicide use, and extant wildlife exposure and effects information are qualitatively described below. The summary report for each of the 22 NP study areas can be found in Appendix D. The results of a semi-quantitative ranking scheme identifying contaminant threats, quality of existing terrestrial vertebrate exposure and effects data, and prioritization of the monitoring needs are then presented.

I. Descriptive and Qualitative Review of Information

A. Air

Based on priority pollutant TRI data, over half of the parks are near significant air pollution sources that may be of concern (Table 4). Deposition of these pollutants on water, soil and vegetation undoubtedly increase their bioavailability to terrestrial vertebrates. Discharged lead, mercury and even dioxins from TRI sites through the air may be deposited at nearby park units. Air pollution standards for ozone, nitrogen dioxide and lead have been established for the protection of vegetation and even animals. However, it is widely recognized that the principal exposure route in terrestrial vertebrates is through ingestion of food, water and soil. Risk assessments involving wild terrestrial vertebrates rarely consider the inhalation route because of the paucity of exposure and effects data (Newman and Schreiber, 1988). Furthermore, simulation studies examining the relative contribution of various exposure routes in birds have demonstrated that inhalation is a minor uptake pathway compared to oral and dermal routes (Driver et al., 1991).

B. Water

Standards for water quality have been developed for many anthropogenic and naturally occurring compounds for the protection of aquatic forms, domesticated birds and mammals, and humans. However, with the exception of DDT, PCBs, dioxin and mercury, water quality standards have yet to be established for the protection of wild terrestrial vertebrates. Nonetheless, there were many priority pollutants that were present in impaired waters within or near 12 of 22 NP study areas. Commonly found contaminants exceeding the total maximum daily load included PCBs, mercury, and oil/grease, and in a few instances Kepone and chlordane. Toxic release inventory sites near 12 of the study areas release significant quantities of lead and/or mercury into surface waters (Table 5).

C. Soil

Ingestion of soil while feeding or preening can be a significant contaminant exposure route for many terrestrial vertebrates (Beyer and Fries, 2003). Data were found for a few of our study sites that seem to document uptake of metals from ingested soil or sediment (e.g., lead, copper and zinc in small mammals near Fort McHenry NM & HS and National Mall & Memorial Parks; Scanlon, 1979; Beyer et al., 1990). Clearly, many pollutants deposited in soil are taken up by plant and invertebrate food items of terrestrial vertebrates, however, empirical data documenting trophic transfer were not available for the park units in this study.

Table 4. Relative quantity of priority pollutants released into the air by TRI sites within 10 kilometers of NP units

	Dioxins (g/yr)			Lead (lb/yr)		Mercury (lb/yr)			PCBs (lb/yr)
Park Name	0.1	0.01	0.001	1000	100	100	10	1	1
Chesapeake & Ohio Canal NHS			X		X	X			
Fort McHenry NM & HS			X		X			X	
George Washington MP		X			X			X	
Harper's Ferry NHP					X				
Hopewell Furnace NHS					X				
Monocacy NB			X		X		X		
National Mall & Memorial Parks		X			X	X			
National Capital Parks-East			X		X	X			
Petersburg NB			X		X	X			
Prince William FP			X	X		X			
Richmond NBP			X	X		X			X
Rock Creek Park		X			X	X			
Valley Forge NHP			X		X		X		

Table 5. Relative quantity of priority pollutants released into the water by TRI sites within 10 kilometers of NP units

	Lead (lb/yr)				Mercury (lb/yr)		
Park Name	1000	100	10	1	10	1	<1
Chesapeake & Ohio Canal NHS			X				X
Fort McHenry NM & HS	X					X	
George Washington MP	X						X
Hopewell Furnace NHS				X			
Monocacy NB				X			X
National Mall & Memorial Parks				X			X
National Capital Parks-East	X						X
Petersburg NB			X			X	
Prince William FP			X		X		
Richmond NBP		X				X	
Rock Creek Park				X			X
Valley Forge NHP			X				

D. Fish Consumption Advisories

With the exception of Appomattox Court House NHP, fish consumption advisories are in effect near or at each of the other 22 study units. The vast majority of these advisories are related to mercury and PCBs, however, these consumption advisories are statewide. These human consumption advisories are germane as many terrestrial vertebrates at the study sites are piscivorous.

E. Pesticide and Herbicide Use

Application of pesticides and herbicides at NP units is a highly regulated process. For most sites use is minimal, the exceptions being units with major agricultural leases (Antietam NB, Gettysburg NMP, Fredericksburg & Spotsylvania NM, and Monocacy NB). Based upon published or extrapolated wildlife toxicology data for the chemicals applied in quantities exceeding 4 hectares of treatment, the most hazardous compounds include pendimethalin, ammonium soaps/fatty acids, propiconazole, and fluazifop-butyl. Toxicity data and hazard rankings suggest that amphibians are the terrestrial vertebrate class at greatest risk. For example, some compounds known to be moderately to highly toxic to amphibians and birds are used at NP units (Antietam NB, Gettysburg NMP, Harpers Ferry NHP, Hopewell Furnace NHS, Monocacy NB, Richmond NBP, Rock Creek Park, and Shenandoah NP). Small quantities (1 hectare of treatment for adelgid control) of imidacloprid are used at Shenandoah NP and this chemical is believed to be highly toxic to birds and mammals. It appears that the pesticides and herbicides used at several urban units (including National Mall & Memorial Parks, National Capital Parks-East, Wolf Trap NP, George Washington MP, and Manassas NB) are of low toxicity, and do not pose a significant threat to terrestrial vertebrates.

F. Terrestrial Vertebrate Ecotoxicology Data

For the 22 study areas, there were 70 unique reports from which terrestrial vertebrate contaminant exposure and effects data were derived. These documents consisted of 27 necropsy reports, 16 monitoring studies, and 27 hypothesis-driven investigations. The vast majority of these reports deal with exposure and effects data involving legacy organochlorine pesticides and PCBs, many of which are now banned, and metals, metalloids and trace elements. Only one report (Rattner et al., 2004) addresses exposure to contaminants of more contemporary concern (Kolpin et al., 2002). There were only 58 unique compounds quantified in CEE-TV reports, including some organochlorine pesticides and PCBs, organophosphorus and carbamate pesticides, rodenticides, metals, and petroleum hydrocarbons.

Necropsy reports are available for 10 of the 22 study units, but most of these reports are not recent. These units are in urbanized areas where the probability of detecting dead or dying individuals is great. In all likelihood, such incidents occurred at some of the other more rural park units, but went undetected. Many of these reports deal with passerines and raptors that succumbed to organochlorine pesticide intoxication (principally chlordane and its metabolites, and dieldrin). One incident in 2002, near the Chesapeake & Ohio Canal NHP, involving gray squirrels (*Sciurus carolinensis*), opossum (*Didelphis virginiana*), red fox (*Vulpes vulpes*), blue jay (*Cyanocitta cristata*), and crow (*Corvus sp.*) appeared to be due to endosulfan intoxication (detected in gastrointestinal tract). This organochlorine pesticide is unusual in that it is rapidly cleared from tissue of birds and mammals, but it can be quite toxic in an acute exposure scenario. Several incidents involving passerines and raptors documented organophosphorus and carbamate

insecticide intoxication. A few of these incidents involved the anticholinesterase insecticide carbofuran; use of granular formulations of this compound were restricted by the U.S. Environmental Protection Agency in 1994 because of wild bird die-offs. Two incidents, involving dead squirrels, were attributed to rodenticide poisoning (brodifacoum, bromodiolone, and diphacinone), and such chemicals can pose a secondary poisoning hazard to raptors and scavengers that may ingest dead and dying mammals.

Terrestrial vertebrate monitoring data were available at 9 study units. Most monitoring data were from Petersburg NB and National Capital Parks-East, and involved starlings collected as part of the National Contaminant Biomonitoring Program (successor to the National Pesticide Monitoring Program). These data document the gradual decline in concentrations of organochlorine pesticides over a two decade period. One historic report (White et al., 1977) documented that the concentration of lead in starling tissues is greater in birds collected from urban areas compared to rural areas.

Reports for hypothesis-driven investigations were available at 12 of 22 study units, with the largest number of studies being at Fort McHenry NM & HS and at National Capital Parks-East. In these highly contaminated areas, organochlorine pesticide and PCB exposure were documented in a variety of species including fish-eating birds. At both of these units there is recent evidence of PCB exposure and cytochrome P450 associated monooxygenase induction (well known exposure biomarker for arylhydrocarbon receptor active compounds)(Rattner et al., 1997; 2000b). Cytochrome P450 induction and PCB exposure have also been recently described in tree swallows at Valley Forge NHP (Yorks, 1999). With the exception of one study in mink (O'Shea et al., 1981), concentrations of PCBs did not appear to reach levels that disrupt reproduction in terrestrial vertebrates near the park units. Relatively recent osprey egg samples from the Potomac River (Rattner et al., 2004) suggest that ongoing exposure to *p,p'*-DDE may still pose a threat to fish-eating birds. A number of older studies documented that lead exposure in amphibians, birds and small mammals is greater near major highways compared to rural routes, presumably reflecting the use of lead gasoline before its ban in the 1970's. One study documented that spent lead shot near a skeet range posed a modest threat to passerines and possibly other species (Vyas et al., 2000). Increasing mercury concentrations in the environment and widespread fish consumption advisories have been a cause for concern on a nationwide scale. Although mercury has not been systematically monitored in terrestrial vertebrates on or near NP units, based on historic data there is no evidence that its concentration is approaching hazardous levels.

II. Classification of Potential Contaminant Threats to Terrestrial Vertebrates at NP properties

Contaminant threats, including proximity to NPL Superfund sites, percent of waters that are impaired, the number and relative toxicity of pesticides applied at a park unit, TRI sites, discharge of persistent pollutants, and fish consumption advisories were considerable at 8 of the 22 study areas, while such threats were seemingly low at only 5 park units (Table 6). In this ranking scheme, park units with the seemingly greatest threat of contamination were those near (1) impaired waters, (2) numerous TRI sites and (3) TRI sites releasing large numbers of priority pollutants (i.e., Fort McHenry NM & HS, Richmond NBP, National Capital Parks-East and

Table 6. Rank of Overall Contaminant Threat to Mid-Atlantic and National Capital Region Network Park Units[a]

Park Name	NPL Superfund Sites	Percent Surface Waters Impaired	No. of Toxic Pesticides[b]	Relative Toxicity of Pesticides	No. of TRI Sites	No. TRI Sites Discharging POPs	State Fish Advisories	Overall Contaminant Threat[c]
Antietam NB	0	1	2	2	1	0	1	7
Appomattox Court House NHP	0	0	2	1	1	1	0	5
Booker T Washington NM	0	0	1	1	0	0	2	4
Catoctin Mountain NP	0	0	1	1	1	0	1	4
Chesapeake & Ohio Canal NHP	2	0	1	1	4	3	2	13
Fort McHenry NM & HS	2	3	2	2	4	3	2	18
Fredericksburg & Spotsylvania NM	0	0	2	1	1	1	2	7
George Washington MP	1	0	0	0	2	1	2	6
Gettysburg NMP & Eishenhower NHS	0	0	3	2	1	0	1	7
Harper's Ferry NHP	0	0	3	2	1	1	2	9
Hopewell Furnace NHS	0	1	2	2	2	1	2	10
Manassas NBP	0	0	0	0	2	1	2	5
Monocacy NB	0	0	3	2	3	1	1	10
National Capital Parks-East	4	1	0	0	4	3	2	14
National Mall & Memorial Parks	1	1	0	0	2	1	2	7
Petersburg NB	0	1	1	1	4	2	2	11
Prince William FP	1	0	1	1	1	1	2	7
Richmond NBP	1	0	2	2	4	3	2	14
Rock Creek Park	1	1	2	2	2	1	2	11
Shenandoah NP	2	1	3	2	3	1	2	14
Valley Forge NHP	2	1	1	1	4	1	2	12
Wolf Trap NP for the Performing Arts	0	0	0	0	1	0	1	2

[a] Color classification scheme described in detail in Section II-B

[b] Based on the toxicity classification scheme in Hill and Camardese (1986) and Smith (1987) toxic pesticides were classified as moderately toxic, highly toxic, and very highly toxic.

[c] Overall contaminant threat score was derived as the sum of individual contaminant threat categories and color coded according to severity (green, low; yellow, moderate; red, serious)

Chesapeake & Ohio Canal NHP). This rank order is not all that unexpected. For example, Fort McHenry NM & HS (located in highly industrialized Baltimore Harbor) and National Capital Parks-East (located near the Anacostia River) are adjacent to estuarine waters that have been historically designated as Chesapeake Bay regions of concern (U.S. Environmental Protection Agency, 1994). Furthermore, the Chesapeake & Ohio Canal NHP is an expansive unit near a variety of current or historic industrial sites (railroads, DOD facilities, and a tannery). Other units that appear to be moderately threatened by contaminants include Petersburg NB and Valley Forge NHP, principally because of their proximity to numerous TRI sites. In contrast, Shenandoah NP, located in a rural forested area, also ranked high in this scheme, due to the use of a large number of pesticide formulations containing highly toxic active ingredients. Using fish as a surrogate species, it is suspected that some of these pesticides may be highly toxic to amphibians (Birge et al., 2000).

The nature of the contaminant threat for those park units that ranked moderate in this scheme is varied. Antietam NB, Gettysburg NMP/Eisenhower NHS, and Monocacy NB would have ranked even lower had it not been for substantial pesticide use associated with farming practices on these units.

Park units with apparently lowest contaminant threats were located in areas with no NPL Superfund sites, few TRI sites, and a low percentage of impaired waters (e.g., Wolf Trap NP, Catoctin Mountain NP, and Appomattox Court House NHP). However, some of the parks with seemingly low contaminant threats either contain or are close to areas that are of moderate concern. For example, Smith Mountain Lake and the Roanoke River have fish consumption advisories due to elevated PCB burdens, and are within two kilometers of Booker T. Washington NM. Fish consumption advisories due to PCBs exist for Bull Run, a stream that runs through the northeastern portion of Manassas NBP.

III. Extant Terrestrial Vertebrate Ecotoxicological Data on NP properties

Considerable terrestrial vertebrate ecotoxicological data derived from hypothesis-driven studies are available in or near several park units (e.g., National Capital Parks-East, Fort McHenry NM & HS, Petersburg NB)(Table 7). However, there are a number of study units for which there are no contemporary contaminant exposure and effects information for terrestrial vertebrates (e.g., Hopewell Furnace NHS, Antietam NB, Harper's Ferry NHP, and Catoctin Mountain NP). A number of parks contain a single historic (before 1990) ecotoxicological report, but no current information. For example, Appomattox Court House NHP and Booker T. Washington NM both contain only a 1979 report that documented heavy metals in wild turkey (*Meleagris gallopava*) feathers (Scanlon et al., 1979). Necropsy reports constituted a large portion of the contaminant exposure and effects data collected in and around NP study units. George Washington MP, Rock Creek Park, National Mall & Memorial Parks, and Chesapeake & Ohio Canal NHP all had moderate numbers of reports. However, over half of these reports contained relatively limited information focused on a single contaminant.

Table 7. Terrestrial vertebrate ecotoxicological data metrics relative to NP unit and buffer size

Park Name	Area (Km^2)	No. Reports	Quantity of Contemporary Data	Quality of Information	Data Richness Score
Antietam NB	503.5	0	0	0	0
Appomattox Court House NHP	491.7	1	1	3	1
Booker T Washington NM	359.5	1	1	3	1
Catoctin Mountain NP	563.3	0	0	0	0
Chesapeake & Ohio Canal NHP	5088.4	11	3	18	3
Fort McHenry NM & HS	331.0	10	3	26	4
Fredericksburg & Spotsylvania NM	1467.9	1	1	2	1
George Washington MP	1013.1	9	3	14	3
Gettysburg NMP/Eishenhower NHS	666.5	2	2	6	1
Harper's Ferry NHP	560.4	0	0	0	0
Hopewell Furnace NHS	403.5	0	0	0	0
Manassas NBP	544.7	1	1	3	1
Monocacy NB	438.8	1	1	2	1
National Capital Parks-East	1826.0	34	4	68	4
National Mall & Memorial Parks	524.8	11	3	17	3
Petersburg NB	1190.2	11	3	19	3
Prince William FP	673.9	1	2	1	1
Richmond NBP	1311.3	3	2	4	1
Rock Creek Park	542.8	10	3	16	3
Shenandoah NP	4042.3	3	2	8	1
Valley Forge NHP	482.6	1	2	3	1
Wolf Trap NP for the Performing Arts	341.0	1	2	1	1

IV. Prioritization of Terrestrial Vertebrate Ecotoxicological Monitoring/Research at NP units

Those NP units with most significant monitoring or research priority are sites with greatest contaminant threat ***and*** little or no terrestrial vertebrate ecotoxicological data. Units that match this criterion include Shenandoah NP, Richmond NB, Valley Forge NHP, Hopewell Furnace NHS, Monocacy NB, and Harpers Ferry NHP (Table 8). Although the threat of contaminants to terrestrial vertebrates is great at Fort McHenry NM &HS, National Capital Parks-East, and Chesapeake & Ohio Canal NHP, a number of necropsy, monitoring and research study reports are available for these sites. However, the Chesapeake & Ohio Canal NHP and its buffer constitute the largest study area in this investigation, and based upon its size deserves special consideration. The hazard of contaminants to terrestrial vertebrates at Wolf Trap NP, Booker T. Washington NM, and Catoctin Mountain NP appears to be minimal, but little if any terrestrial vertebrate ecotoxicological data are available at these sites.

Table 8. Prioritization of NP unit based on quality of terrestrial vertebrate ecotoxicological data and contaminant threat scores

Park Name	Area (Km^2)	Data Richness Score	Overall Contaminant Threat
Shenandoah NP	4042.3	1	14
Richmond NBP	1311.3	1	14
Valley Forge NHP	482.6	1	12
Hopewell Furnace NHS	403.5	0	10
Harper's Ferry NHP	560.4	0	9
Monocacy NB	438.8	1	10
Antietam NB	503.5	0	7
Chesapeake & Ohio Canal NHP	5088.4	3	13
Fort McHenry NM & HS	331.0	4	18
National Capital Parks-East	1826.0	4	14
Rock Creek Park	542.8	3	11
Fredericksburg & Spotsylvania NM	1467.9	1	7
Gettysburg NMP/Eishenhower NHS	666.5	1	7
Catoctin Mountain NP	563.3	0	4
Petersburg NB	1190.2	3	11
Prince William FP	673.9	1	7
Appomattox Court House NHP	491.7	1	5
Manassas NBP	544.7	1	5
National Mall & Memorial Parks	524.8	3	7
George Washington MP	1013.1	3	6
Booker T Washington NM	359.5	1	4
Wolf Trap NP for the Performing Arts	341.0	1	2

Management Recommendations

Based upon staff interviews, and information available in management plans and related documents, it is apparent that there is genuine interest in environmental contaminant effects on natural resources, and the mitigation of such threats on or near NP units. Below are provided some general management and programmatic recommendations that may enhance this effort.

Basic Knowledge

Staff were concerned about potential environmental contaminant hazards to biota at the 23 NP properties, but specific knowledge of pollution conditions that might be affecting terrestrial vertebrates was limited. It is recommended that natural resource staff obtain basic training in the area of ecotoxicology through the National Conservation Training Center or other such venues. In addition, staff with ecotoxicological expertise from other DOI agencies or Universities in proximity to a given NP unit might be engaged through interagency agreements or collaborations to assist with environmental contaminants issues.

Vital Signs

The NPS clearly recognizes the importance of knowing the condition of natural resources in its parks and undertakes management activities to ensure their unimpaired use for future generations. A Vital Signs Monitoring Program has been instituted to track "physical, chemical and biological elements and processes of park ecosystems" that presumably represent the condition of their resources and effects of stressors. Program goals include compilation of basic information on the status and trends of select indicators, development of information on early warning signs of abnormal conditions, generation of baseline data for reference and altered environments, meeting statutory mandates, and tracking progress to meet goals (http://science.nature.nps.gov/im/monitor/ProgramGoals). This program, and its predecessors, target pollution threats to NPS resources. Past efforts have focused on flora for which there are known effects of air pollution, and protective standards (e.g., ozone). Protocols are also available that describe monitoring of water quality and responses of aquatic biota to degraded systems. Water quality monitoring activities have been conducted at some sites in the present study. However, little emphasis has been given to "potential effects of environmental contaminants to terrestrial vertebrates" at I&M study areas examined, the one exception being National Capital Parks-East. Based upon the past and present significance of this issue within the DOI (e.g., LaRoe et al. 1995), it is recommended that greater emphasis be placed on terrestrial vertebrates as a pollution "indicator" in the Vital Signs Monitoring Program.

Use of Existing Diagnostic Tools

A standardized and comprehensive CAP that examines the threat posed by environmental contaminants to DOI lands and natural resources has been developed by the BEST project (Coyle et al., 1999). This protocol entails retrospective analysis and, if appropriate, subsequent field sampling. This scheme is an inexpensive and rapid screening tool to identify significant transport pathways, point and non-point sources, and potential ecotoxicological problems. In the past decade, CAP has been applied to over 300 NWRs, but only two NPs (Acadia NP, Congree

Swamp NM). Components of this assessment process were used in the present investigation, and appear to have widespread application at other NP units. It is recommended that this protocol (or modification thereof) be used on NP units as part of the Vital Signs Program.

Measures of Terrestrial Vertebrate Population Parameters

Although detailed terrestrial vertebrate species lists were available for each study unit, knowledge of abundance, occupancy, detection, survival, recruitment, and extinction rates (MacKenzie et al., 2002; Pollock et al., 2002; O'Connell et al., 2006) for many terrestrial vertebrates appeared to be rudimentary. Ideally, such parameters need to be incorporated into monitoring programs. Perhaps monitoring of species that feed at high trophic levels or are known to be sensitive to certain pollutants deserve special attention (Golden and Rattner, 2003; http://www.pwrc.usgs.gov/contaminants-online/pages/RankingProgram/RPintro.htm). Such data has broad application, and can occasionally be used to identify significant contamination problems.

Pesticide and Herbicide Application

Although use is highly regulated on NP units, a few pesticides and herbicides are known or believed to be highly toxic to amphibians (e.g., pendimethalin, ammonia soaps/fatty acids, and fluazifop-methyl) and birds (imidicloprid). It is not clear if these compounds were applied in close proximity to habitat used by amphibians and birds, but if this is the case, their use should be curtailed. Alternative methods should be considered whenever possible, and broadcast applications should be minimized.

Systematic Analysis of Dead Animals, Failed Reproductive Attempts, or Deformed Offspring

In conversations with Park Service staff, observations of dead, dying or deformed animals were rarely reported. However, this may be a function of limited time of natural resource staff for actual monitoring of biota. Nonetheless, in a few instances dead animals have been recovered (e.g., Gettysburg NMP, Harpers Ferry NHP, Monocacy NB). A better linkage between maintenance/law enforcement staff and natural resource managers on the reporting of such incidents may be needed at some NP units. Furthermore, results of analyses of dead animals may need to be tracked more thoroughly. It would be appropriate to establish a protocol for handling, storage and analysis of animal carcasses from such events. This might include contact information for appropriate federal and state agencies to assist with necropsies and toxicological analyses should circumstances be warranted.

Lead Sinkers and Shot

Some NP units (e.g., Yellowstone NP) have implemented fishing programs that require the use of non-toxic tackle (use of leaded split shot sinkers, weighted jigs, and soft weighted ribbon are prohibited). It is well recognized that lead has no known function in biological systems, and annually millions of waterfowl and other species succumb to lead poisoning. The NPS might consider mandating the use of non-toxic alternatives for fishing on its properties. Although public hunting is restricted on NP units in our study, controlled harvest of deer by federal

employees occurs at Gettysburg NMP and Eisenhower NHS. It appears that such activities involve the use of ammunition containing lead. Because of the hazard of spent lead shot and bullet fragments to wildlife, non-toxic alternatives to lead ammunition should be used for such harvest activities.

Transportation Routes

A few of the NP study units had significant transportation routes (railroads, highways) through their property, and have had fuel spills over the years (e.g., Harpers Ferry NHP, Valley Forge NHP). In addition, antifreeze and hydraulic fluid drips from vehicles, and road salt can be quite toxic to biota. If opportunities arise, the NPS should pursue re-routing visitor traffic or restricting transport of hazardous materials away from critical habitat. Furthermore, the NPS should pursue damage claims and remediation following spills through the Natural Resource Damage Assessment and Restoration program.

Expansion of Some Aquatic Ecotoxicological Investigations to Include Terrestrial Vertebrates

If contaminant exposure and effects are documented in aquatic invertebrates and fish monitoring/research investigations, consideration should be given to expanding the scope of those studies to include terrestrial species that reside close to aquatic habitats (e.g., amphibians and reptiles) and those that are piscivorous (e.g., fish-eating birds, furbearers).

Monitoring and Research Recommendations

Priority Sites

Of the 23 NPS I&M units that were evaluated, several appear to warrant ecotoxicological investigation (monitoring or hypothesis-driven research studies) involving terrestrial vertebrates. Studies should be tailored to address contaminant issues specific for each park unit and the particular species of interest. Because of significant contaminant threats and limited terrestrial vertebrate ecotoxicological data, the following units are given highest priority.

1. Shenandoah NP is a relatively large unit for which there are minimal terrestrial vertebrate ecotoxicological data (3 CEE-TV database records). The park is near several NPL superfund sites, fish consumption advisories related to PCBs and mercury are in effect, and some pesticides in use appear to be moderately to highly toxic to amphibians and birds. The endangered Shenandoah salamander (*Plethodon shenandoah*) is present at this park.

2. Richmond NB is a unit of moderate size for which there are minimal terrestrial vertebrate ecotoxicological data (3 CEE-TV database records). The park is near one NPL superfund site, fish consumption advisories related to PCBs and Kepone are in effect, and persistent pollutants are being discharged at TRI sites.

3. Chesapeake & Ohio Canal NHP is a large unit for which there are moderate terrestrial vertebrate contaminant exposure and effects data. However, many of these data are necropsy reports involving only a few individuals, and a limited number of robust ecotoxicology studies have been undertaken. Fish consumption advisories are in effect for PCBs and mercury, there are numerous TRI sites, and a significant railroad route and maintenance yard are in proximity to the unit. The endangered Indiana bat (*Myotis sodalis*) is found at this site.

4. Valley Forge NHP is a relatively small park at which only one ecotoxicology study involving terrestrial vertebrates has been conducted. The park is near 2 NPL sites and 2 TRI sites, fish consumption advisories are in effect for PCBs and mercury, and a significant transportation route traverses the park at which there have been some hazardous material spills.

5. Hopewell Furnace NHS is a relatively small unit for which there are apparently no terrestrial vertebrate ecotoxicology data. Fish consumption advisories are in effect for PCBs and mercury, and lead is released at nearby TRI sites.

6. Monocacy NB is a relatively small park for which there are very limited terrestrial vertebrate ecotoxicological data that are rather dated. A fish consumption advisory is in effect for mercury in waters that run through the unit, and there is significant pesticide and herbicide use with some compounds moderately to highly toxic to amphibians.

7. Harpers Ferry NHP is a relatively small unit for which there are no terrestrial vertebrate exposure or effects data. Fish consumption advisories are in effect for PCBs and mercury, there is moderate pesticide and herbicide use, and lead is released by nearby TRI sites.

Agrichemical Issues

Several NP in this study have major agricultural leases that use significant quantities of pesticides and herbicides. Some of the compounds applied are moderately to highly toxic to terrestrial wildlife. It is recommended that terrestrial vertebrate use of these agricultural fields be monitored, particularly after pesticide application. Occasionally, adverse effects on non-target organisms are caused by agrichemicals, but go unnoticed because animals are rapidly scavenged. Many new pesticides that have entered the market place (e.g., chlorfenapyr, imidichloprid, ivermectins) are not bioaccumulative. This characteristic is a tribute to advances in pesticide chemistry, but does complicate exposure assessments in nontarget organisms. Furthermore, because of changes in registration processes, effects of newer compounds on wildlife are incompletely known, and should be further studied.

Emerging Contaminant Issues

Although some monitoring of new emerging contaminants (e.g., alkylphenols and ethoxylates, perfluorinated compounds, and polybrominated diphenyl ether flame retardants) has been undertaken near two park units in the present study, it is apparent that a wide array of antibiotics,

drugs, steroids, cleaning agents and fragrances are making their way through many waste water treatment plants into tributaries (Kolpin et al., 2002). The toxicities of many of these compounds are understood from a human health perspective, but neither their toxicities to wildlife nor the ecological consequences of chronic low level exposure are known. Furthermore, there is increased interest on biotoxin effects on wildlife, particularly those associated with harmful algal blooms. Ideally, exposure monitoring for such emerging contaminants and biotoxins should be incorporated into existing monitoring activities.

Mercury

Increasing mercury concentrations in the environment and widespread fish consumption advisories have been a cause for concern on a nationwide scale. Historically, mercury has not posed a threat to wildlife in Chesapeake and Delaware Bays, but region-wide human fish consumption advisories are in effect. Long-range atmospheric transport of inorganic mercury, and its transformation by sulfate-reducing bacteria to highly toxic methylmercury, appear to be a significant source pathway (Wiener et al., 2003). Studies of mercury in sediment, water, invertebrate, fish, and wildlife may be appropriate at several park units.

Measurement Endpoints and Taxa

It is difficult to prescribe a generic suite of terrestrial vertebrate exposure and effects endpoints as a standard protocol for monitoring a broad array of contaminants (e.g., organochlorine pesticides, polyhalogenated organic industrial compounds, anticholinesterase, rodenticides, metals, etc.). There are inter-specific differences in exposure pathways, target tissues, metabolism and detoxication, biomarker responses, and sensitivity and vulnerability. In general, birds have been used extensively as sentinels of pollution in that they are more sensitive than mammals. In relative terms, little is known about contaminant exposure and effects in reptiles. For humane reasons, it is recommended that sublethal measures and non-destructive samples (e.g., blood, egg, feather, hair, scat) be utilized to document harm, although for some compounds diagnostic residues are based upon contaminant concentrations or biochemical responses in tissues (liver, kidney, brain) (Appendix E). In the present investigation, remarkably little contaminant exposure and effects data are available for amphibians and reptiles residing in NP units. Based upon habitats in the study areas, amphibians may be particularly vulnerable to agrichemicals. Certainly, broad-based ecotoxicological monitoring studies involving these two taxa in the National Capital Region and Mid-Atlantic Networks are warranted. However, for certain contaminant threats (e.g., insecticides, lead, mercury), it would also be appropriate to use avian sentinels.

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Appendix A. List of National Park Service units and unit personnel contacted during to project.

Park Name	Network	Contact	Position
Antietam National Battlefield	National Capital Region	Edward Wenschhof	Chief Ranger
		John Howard	Superintendent
		Joe Calzarette	Natural Resource Manager
Appomattox Court House National Historical Park	Mid-Atlantic	Brian Eick	Natural Resource Manager
Booker T. Washington National Monument	Mid-Atlantic	Timothy G. Sims	Natural Resource Manager
Catoctin Mountain Park	National Capital Region	James Voigt	Natural Resource Manager
Chesapeake & Ohio Canal National Historical Park	National Capital Region	Marie A. Frias Sauter	Natural Resource Specialist
		William I. Spinrad, Jr.	Land Manager
Eisenhower National Historic Site	Mid-Atlantic	Zachary Bolitho	Natural Resource Manager
		James Johnson	Chief Resource Management
Fort McHenry National Monument & Historic Shrine	Mid-Atlantic	Greg McGuire	Facility Manager
		Paul Bitzel	Horticulturalist
		Jim Peters	Volunteer
Fredericksburg & Spotsylvania National Military Park	Mid-Atlantic	Gregg Kneipp	Natural Resource Manager
George Washington Memorial Parkway	National Capital Region	Brent Steury	Natural Resource Manager
		Marcus Koenen	Inventory and Monitoring Coordinator
		Melissa E. Kangas	Natural Resource Specialist
Gettysburg National Military Park	Mid-Atlantic	Zachary Bolitho	Natural Resource Manager
		James Johnson	Chief Resource Management
Harper's Ferry National Historical Park	National Capital Region	Dale Nisbet	Natural Resource Specialist
		Thurmond W. Hebb	Natural Resource Manager
Hopewell Furnace National Historic Site	Mid-Atlantic	Steven W. Ambrose	Park Ranger
Manassas National Battlefield Park	National Capital Region	Bryan Gorsira	Natural Resource Manager
Monacacy National Battlefield	National Capital Region	Andrew Banasik	Natural Resource Manager
National Capital Parks-East	National Capital Region	Susan Rudy	Natural Resource Manager
		Michael P. Wilderman	Resource Management Specialist
		Stephen W. Syphax	Chief Resource Management
		Fred Cunningham	Superintendent, Greenbelt National Park
National Mall & Memorial Parks	National Capital Region	Steve Lorenzetti	Chief Resource Management
Petersburg National Battlefield	Mid-Atlantic	Tim Blumenschine	Natural Resources Specialist
		Dave Shockley	Chief Resource Management
Prince William Forest Park	National Capital Region	Jennifer A. Lee	Biologist

Appendix A. List of National Park Service units and unit personnel contacted during to project.

Park Name	Network	Contact	Position
Richmond National Battlefield Park	Mid-Atlantic	Kristen G. Allen	Natural Resource Management Specialist
Rock Creek Park	National Capital Region	Kenneth Ferebee	Natural Resource Specialist
		Bill Yeamen	Natural Resource Specialist
Shenandoah National Park	Mid-Atlantic	Laura Illage	Chief Ranger
		Gordon Olson	Natural Resource Manager
		Shane Spitzer	Air Quality Monitoring Specialist
Valley Forge National Historical Park	Mid-Atlantic	Margaret A. Carfioli	Acting Natural Resource Specialist
Wolf Trap National Park for the Performing Arts	National Capital Region	Duane Erwin	Natural Resource Manager

Appendix A. List of National Park Service units and unit personnel contacted during to project.

Park Name	Network	Contact	Position
Richmond National Battlefield Park	Mid-Atlantic	Kristen G. Allen	Natural Resource Management Specialist
Rock Creek Park	National Capital Region	Kenneth Ferebee	Natural Resource Specialist
		Bill Yeamen	Natural Resource Specialist
Shenandoah National Park	Mid-Atlantic	Laura Illage	Chief Ranger
		Gordon Olson	Natural Resource Manager
		Shane Spitzer	Air Quality Monitoring Specialist
Valley Forge National Historical Park	Mid-Atlantic	Margaret A. Carfioli	Acting Natural Resource Specialist
Wolf Trap National Park for the Performing Arts	National Capital Region	Duane Erwin	Natural Resource Manager

Appendix B. Geographic Information System (GIS) procedure followed for each National Park (NP) unit.

1. Open ArcMap with an empty map saved in individual park folder as park name
2. Set coordinate system to USA Contiguous Albers Conic Equal Area USGS
3. Set display units to decimal degrees (actually this changes a lot from dd, dms, km and m)
4. Add Northeastern_States shapefile
    a. (Datasource: www.nationalatlas.gov/atlasftp.html)
5. Add Northeastern_Counties shapefile
    a. (Datasource: www.nationalatlas.gov/atlasftp.html)
6. Add Project Parks and Project Parkways shapefile
    a. (Datasource: National Park System Boundary Dataset, NPS Water Resources, 1996)
    b. Adapted previous shapefile (C://CEETV2003/National Parks/np/np polygon) to new shapefile (C://CEETV2005/NPS_Project/NPS_Project_Units)
7. Select Park Unit of interest
8. Export as a Shapefile to Current View Park of Interest
    a. Save as park name within individual park folder
9. Delete Project Parks and Project Parkways shapefile
10. Using Buffer Wizard create a 10 kilometer buffer around park
    a. Outside and include inside
    b. Save as Park Name Buffer in individual park folder
11. Add CEE-TV database locations
12. Clip CEE-TV data within buffer
13. Obtain, photocopy, and file articles from CEE-TV records
    a. In CEE-TV database hardcopy files
    b. In NPS database hardcopy files
14. Write annotated bibliography for CEE-TV Reports
15. Go to the TRI Explorer Website (http://www.epa.gov/triexplorer/facility.htm) and download all data for facility to TRI folder in individual park folder
    a. Facility Search by County for 2003 & 2002
    b. Facility Search by County for 1997 through 2001 data
        i. Old release facilities without 2002 & 03 releases
16. Make an excel file
    a. Open excel program and blank worksheet
    b. Open each companies file
        i. Adjust column width
        ii. Copy and paste 1997 to 2003 data into blank worksheet
    c. Sort year, ascending and custom filter only on-site ">0" and "not ."
    d. Make sure numbers format with decimals (9 places)
    e. Save new excel worksheet as excel file and dbf file
    f. Sort ascending by TRI ID
17. In ArcGIS Add all TRI sites to map
    a. Select only those in buffer and export as a shapefile saving in TRI folder in individual park folder

29. Look for Solid Waste Facilities
    a. State-level
        i. Pennsylvania (http://www.depweb.state.pa.us/landrecwaste/cwp/view.asp?A=1238&Q=463564)
        ii. Maryland (http://www.mde.state.md.us/Programs/LandPrograms/Solid_Waste/facilities/index.asp)
        iii. Virginia (http://www.deq.virginia.gov/waste/waste.html)
        iv. West Virginia (http://www.state.wv.us/swmb/2005%20State%20Plan/Chapter%203.pdf)
    b. Create Table with name, address and type of facility
30. Look for Wastewater Treatment Facilities
    a. Look at EPA's 2004 Clean Waters Needs Survey: Facility Inventory Report by county.
        i. (http://cfpub.epa.gov/cwns/rpt_discharge1_00.cfm)
31. Obtain Pesticide Use Information from IPM Coordinator and Data Manager (Terry Cacek and Glenda Jackson) for parks
    a. Determined which active ingredients were used over greater than 1 acre for each park.
    b. Obtained acute toxicity data for each active ingredient from Material Safety Data Sheets, various literature, EPA's Pesticide Reregistration website (http://cfpub.epa.gov/oppref/rereg/status.cfm?show=rereg), and Pesticide Action Network of North America website (http://www.pesticideinfo.org/Index.html)
        i. Various literature includes:
            1. Sparling et al. 2000
            2. Smith 1987
            3. Hudson et al. 1984
            4. Schafer et al. 1983
    c. Based on Smith (1987) and Hill and Camardese.(1986) each active ingredient was ranked based on acute toxicity data.
        i. Rating classes not reported for reptilian species due to limited availability of toxicity data for most active ingredients
        ii. Rating classes for most of the active ingredients for amphibians were derived from fish lethal concentrations to cause 50% mortality (LC_{50}).
32. In Excel create list and table of pesticides and herbicides used in park that are moderately to very highly toxic.

Appendix C. List of priority pollutants on U.S. Environmental Protection Agency's Priority Persistent Bio-accumulative Toxic Chemicals and/or United Nations Persistent Organic Pollutants.

1. Aldrin [a]
2. Dieldrin [a]
3. Endrin
4. Benzo(a)pyrene
5. Chlordane [a]
6. Heptachlor
7. Hexachlorobenzene [a]
8. DDT, DDD, DDE [a]
9. Dioxins and furans [a]
10. Mirex [a]
11. Octachlorostyrene
12. PCBs [a]
13. Toxaphene [a]
14. Alkyl-lead
15. Mercury

[a] Indicates chemical was listed by both U.S. Environmental Protection Agency's Priority Persistent Bio-accumulative Toxic Chemicals and/or United Nations Persistent Organic Pollutants

Appendix D
Contaminant threat and ecotoxicological summary reports for 23 NP I&M units in the National Capital Region and Mid-Atlantic Networks.

Antietam National Battlefield and Cemetery

I. BACKGROUND

Size: 1316 hectare

Designation: National Battlefield – August 30, 1890

Setting/habitat: Antietam National Battlefield (NB) is located in the Great Valley Section of the Ridge and Valley Province of Maryland. Using the National Oceanic and Atmospheric Administration's 250 m (1990 urban-enhanced) Land Use Land Cover data (1999), the environment surrounding Antietam NB is classified as: 74.7% agricultural; 22.1% forested; 1.8% water; 1.4% urban or residential; and <0.1% barren lands.

Past land uses: Military Operations

II. CURRENT AND POTENTIAL ENVIRONMENTAL CONTAMINATION

A. Known Contaminated sites:

There are no known contaminated sites located on Antietam NB property. However, 24.82% of the surface waters within 10 kilometer of the park are listed as impaired.

B. NPL Superfund sites:

There are no current Environmental Protection Agency (EPA) National Priorities List (NPL) Superfund sites that require further remedial action located within 10 kilometer of Antietam NB.

C. Impaired waterbodies:

The EPA and the Maryland Department of Environment (MDE) under Section 303(d) listed two waterbodies as impaired in 2002 (http://www.epa.gov/waters/data/downloads.html) within 10 kilometers of Antietam NB. The Potomac River and Antietam Creek are not impaired by contaminants but are impaired from both nutrients and siltation. A portion of the impaired Antietam Creek does cross the park boundary from north to south.

D. Pesticides, herbicides, rodenticides, avicides used:

Six pesticide or herbicide products that were applied at Antietam NB in 2004 contained active ingredients recognized as being moderately to very highly toxic to terrestrial vertebrates (Table 1). Toxicity rating classes are: 0 = not toxic; 1 = slightly toxic; 2 = moderately toxic; 3 = highly toxic; 4 = very highly toxic. Rating classes are not reported for reptilian species due to the limited availability of toxicity data for most active ingredients.

Table 1. Moderately to very highly toxic pesticides, herbicides, rodenticides, and avicides to terrestrial vertebrates that were applied at Antietam NB property in 2004.

Active Ingredient	Product	Applied Acres	Mammals	Birds	Amphibians	Reference Cited[a]
2-Methoxy-3,6-Dichlorobenzoic Acid	Banvel Herbicide	82	1	2	0	1, 3
Glyphosate	Roundup Pro	503.75	0-1	0-1	0-2[b]	1, 2, 3
	Rodeo	11				
Metolachlor	Dual	36	1	0-1	0-2[b]	1, 2, 3
Pendimethalin	Prowl	68	0-1	1	2-3[b]	1, 2, 3

[a] References cited: 1. Sparling *et al.* 2000; Smith 1987; Hudson, *et al.* 1984; Schafer *et al.* 1983) 2. EPA Pesticide Registration website: http://cfpub.epa.gov/oppref/rereg/status.cfm?show=rereg 3. Pesticide Action Network of North America website: http://www.pesticideinfo.org/Index.html

[b] Toxicity ratings were derived from fish lethal concentrations to cause 50% mortality.

E. Solid waste or wastewater disposal sites:

There are no permitted solid waste disposal sites located within the 10 kilometer buffer around Antietam NB (http://www.mde.state.md.us/assets/document/ALL_SOLID_WASTE_FACILITIES.pdf) (http://www.state.wv.us/swmb/2005%20State%20Plan/Chapter%203.pdf). There are three wastewater treatment facilities located within 10 kilometers of Antietam NB, including Sharpsburg/Keedysville, Boonsboro, and Shepherdstown Wastewater Treatment Facilities (http://cfpub.epa.gov/cwns/standard.cfm).

F. Terrestrial vertebrate contaminant research or monitoring:

No current or past known contaminant monitoring or ecotoxicological research projects have been conducted on terrestrial vertebrates within the 10 kilometer buffer surrounding Antietam NB. Historically, fish sampling has been conducted for the Antietam Creek area (J. Calzarette, NPS, personal communication).

G. Toxic release facilities:

The EPA's Toxic Release Inventory Program lists one toxic release facility that discharged contaminants within 10 kilometers of Antietam NB from 1997 through 2003 (http://www.epa.gov/triexplorer) (Figure 1). The Larstan Industry, plastics and foam rubber producer, released 1160 pounds of diisocyanates via land disposal methods into the environment in 2002.

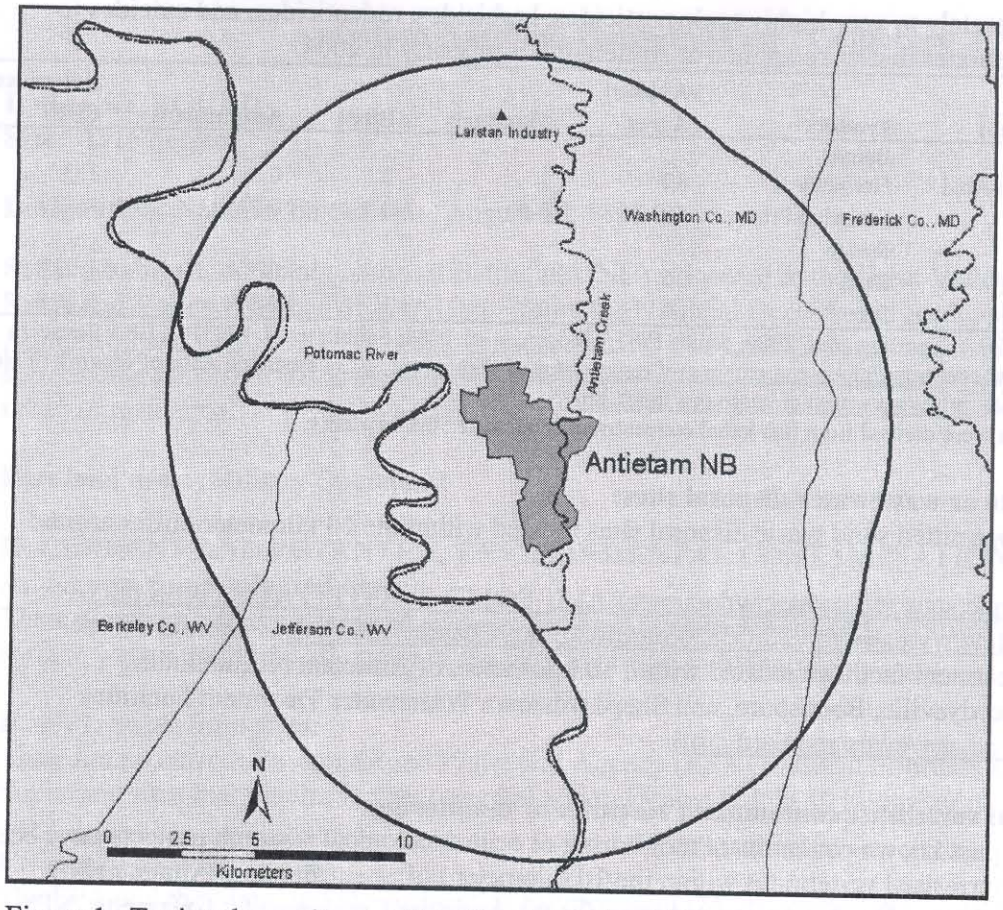

Figure 1. Toxic release sites (&) listed by the EPA within a 10 kilometer buffer around Antietam NB for 1997 through 2003.

H. Fish consumption advisories:
The EPA's Water Program has listed one fish consumption advisory that indicates the presence of persistent pollutants and chemicals within 10 kilometers of Antietam NB. This is a statewide restricted consumption advisory for Maryland due to mercury issued in 2004 (http://www.epa.gov/waterscience/fish/advisories/index.html).

III. CONCLUSIONS:

I. Persistent bio-accumulative toxic chemicals:
There are no persistent bio-accumulative toxic chemicals being released at TRI sites and this class of compounds is not the cause of impaired waterbodies near Antietam NB. However, an active fish consumption advisory in Maryland for mercury indicates that these chemicals may be present. Eisler (2000) has described the hazards of these contaminants to wildlife.

J. Critical Areas and Sensitive Species:
Antietam NB contained no pertinent critical areas for species under DOI management. However, bald eagles (*Haliaeetus leucocephalus*), a federally threatened species, have been sighted over the property.

K. Additional priority contaminant monitoring/research:
The Antietam NB was not found to have current sources for contamination within 10 kilometers of its boundary in this study. Upon discovery of a contaminated site, samples from terrestrial vertebrates should be collected to determine the level of exposure.

Appomattox Court House National Historical Park

I. BACKGROUND

Size: 718 hectare

Designation: National Historical Park - April 15, 1954
National Historical Monument - August. 13, 1935
U. S. War Department Battlefield Site - June 18, 1930

Setting/habitat: Appomattox Court House National Historical Park (NHP) is located in the Piedmont Province of Virginia. Using the National Oceanic and Atmospheric Administration's 250 m (1990 urban-enhanced) Land Use Land Cover data (1999), the environment surrounding Appomattox Court House NHP is classified as: 66.5% forested; 27.4% agricultural; 4.4% urban or residential; 1.7% barren lands; 0.1% water; and 0.1% wetland.

Past land uses: Agricultural operations

II. CURRENT AND POTENTIAL ENVIRONMENTAL CONTAMINATION

B. Known Contaminated sites:

At one residential location on the Appomattox Court House NHP property a leaking oil furnace exists that could possibly contaminate nearby streams (Brian Eick, NPS, personal communication).

B. NPL Superfund sites:

There are no current Environmental Protection Agency (EPA) National Priorities List (NPL) Superfund sites that require further remedial action located within 10 kilometers of Appomattox Court House NHP.

C. Impaired waterbodies:

The EPA and the Virginia Department of Environment Quality (VADEQ) under Section 303(d) does not list any impaired waterbodies in 2002 (http://www.epa.gov/waters/data/downloads.html) within 10 kilometers of Appomattox Court House NHP.

D. Pesticides, herbicides, rodenticides, avicides used:

Four pesticide or herbicide products that were applied at Appomattox Court House NHP in 2004 contained active ingredients recognized as being moderately to very highly toxic to terrestrial vertebrates (Table 1). Toxicity rating classes are: 0 = not toxic; 1 = slightly toxic; 2 = moderately toxic; 3 = highly toxic; 4 = very highly toxic. Rating classes are not reported for reptilian species due to the limited availability of toxicity data for most active ingredients.

Table 1. Moderately to very highly toxic pesticides, herbicides, rodenticides, and avicides to terrestrial vertebrates that were applied at Appomattox Court House NHP property in 2004.

Active Ingredient	Product	Applied Acres	Mammals	Birds	Amphibians	Reference Cited[a]
Glyphosate	Roundup Pro	17.5	0-1	0-1	0-2[b]	1, 2, 3
	Accord	61.35				
Imazameth	Plateau Herbicide	26	0-1	0-1	2[b]	1
Myclobutanil	Spectracide Immunox Multi-purpose Fungicide	1	1	2	2[b]	1, 3

[a] References cited: 1. Sparling *et al.* 2000; Smith 1987; Hudson, *et al.* 1984; Schafer *et al.* 1983) 2. EPA Pesticide Registration website: http://cfpub.epa.gov/oppref/rereg/status.cfm?show=rereg 3. Pesticide Action Network of North America website: http://www.pesticideinfo.org/Index.html

[b] Toxicity ratings were derived from fish lethal concentrations to cause 50% mortality.

E. Solid waste or wastewater disposal sites:

There are two permitted solid waste disposal sites located within the 10 kilometer buffer around Appomattox Court House NHP (Table 2) (http://www.deq.virginia.gov/waste/aswrs.html). There are two wastewater treatment facilities located within 10 kilometers of Appomattox Court House NHP, which include Appomattox Sewage Treatment Plants I & II (http://cfpub.epa.gov/cwns/standard.cfm).

Table 2. Permitted solid waste facilities within a 10 kilometer buffer around Appomattox Court House NHP.

Facility Name	Address	Type	Ownership
Appomattox County Baling Facility	P.O. Box 863, Appomattox, VA	Materials Recovery Facility	Govt.
Appomattox County Sanitary Landfill	P.O. Box 863, Appomattox, VA	Sanitary Landfill	Govt.

F. Terrestrial vertebrate contaminant research or monitoring:

No current known contaminant monitoring or ecotoxicological research projects are being conducted on terrestrial vertebrates within the 10 kilometer buffer surrounding Appomattox Court House NHP. Historically, Scanlon *et al.* (1979) determined lead, cadmium, nickel and zinc levels in feathers of wild turkeys from numerous counties in Virginia, including Appomattox and Buckingham Counties.

Scanlon, P. F., T. G. O'Brien, N. L. Schauer, J. L. Coggin, and D. E. Steffen. 1979. Heavy metal levels in feathers of wild turkeys from Virginia. Environmental Contaminant Toxicology 21:591-595.

Wild turkey (*Meleagris gallopava*) feathers were collected from hunters in numerous counties in Virginia during the 1976 fall season, including 22 turkeys from Appomattox and Buckingham Counties. The Appomattox County turkeys ($n = 3$) contained similar concentrations of lead, nickel, and zinc as the other VA counties (Mean ± SE; lead = 1.4 ± 0.3; nickel = 0.74 ± 0.26; zinc = 94.0 ± 3.9 µg/g dw). The Buckingham County turkeys ($n = 19$) contained similar concentrations of most metals (Mean ± SE; lead = 1.5 ± 0.4; nickel = 0.62 ± 0.10; zinc = 90.7 ± 5.2 µg/g dw). However, cadmium levels were higher in Appomattox County (cadmium = 0.60 ± 0.30) than Buckingham

County (cadmium = 0.06 ± 0.01) and most other VA counties. It was noted that levels of lead, nickel and zinc were lower for all VA counties than levels found in ring-necked pheasant (*Phasianus colchicus*) feathers from Illinois. For comparison there were no previously reported cadmium levels from the feathers of other species.

H. Toxic release facilities:

The EPA's Toxic Release Inventory Program lists one toxic release facility that discharged contaminants within 10 kilometers of Appomattox Court House NHP from 1997 through 2003 (http://www.epa.gov/triexplorer) (Figure 1). The Thomasville Furniture Industries, Inc. released an average of 6.71 pounds per year of lead compounds by way of the air from 2001 to 2003.

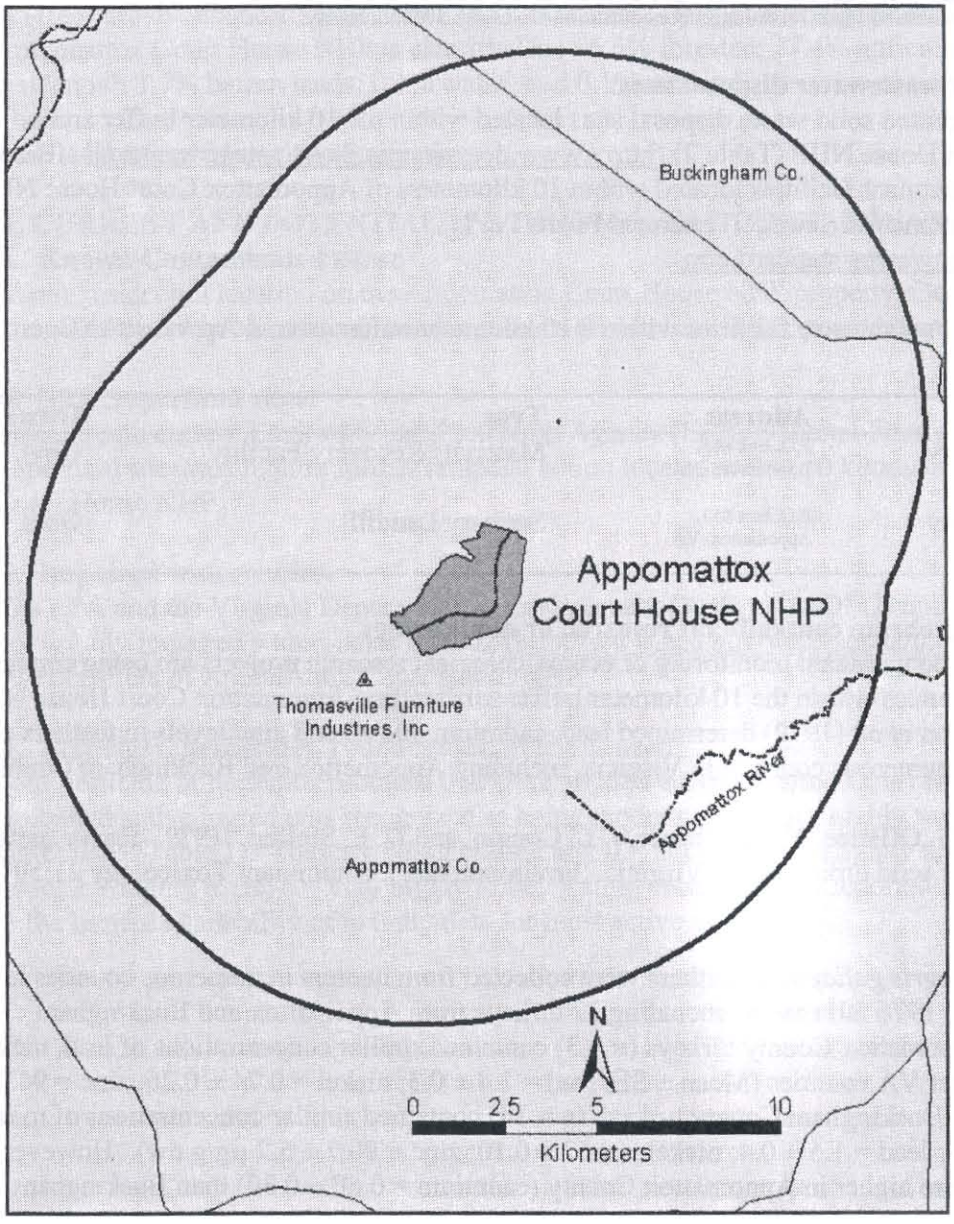

Figure 1. Priority contaminant toxic release site (3) listed by the EPA within a 10 kilometer buffer around Appomattox Court House NHP for 1997 through 2003.

H. Fish consumption advisories:

The EPA's Water Program listed no fish consumption advisories within 10 kilometers of Appomattox Court House NHP.

III. CONCLUSIONS:

I. Persistent bio-accumulative toxic chemicals:

Lead, a persistent bio-accumulative toxic chemical, is being released by Thomasville Furniture Industries, Inc. within 10 kilometers of Appomattox Court House NHP. However, there are no active fish consumption advisories or impaired waterbodies within this area. Eisler (2000) has described the hazards of lead to wildlife.

J. Critical Areas and Sensitive Species:

There were no pertinent critical areas or sensitive species identified within Appomattox Court House NHP.

K. Additional priority contaminant monitoring/research:

The Appomattox Court House NHP was not found to have current sources for contamination within 10 kilometers of its boundary in this study. Upon discovery of a contaminated site, samples from terrestrial vertebrates should be collected to determine the level of exposure.

Booker T. Washington National Monument

I. BACKGROUND

Size: 97 hectares

Designation: National Monument – April 2, 1956

Setting/habitat: Booker T. Washington National Monument (NM) is located predominantly in the Piedmont Province of Virginia. Using the National Oceanic and Atmospheric Administration's 250 m (1990 urban-enhanced) Land Use Land Cover data (1999), the environment surrounding Booker T. Washington NM is classified as: 50.5% forested; 36.5% agricultural; 7.7% water; 5.1% urban; and 0.2% barren lands.

Past land uses: Agricultural operations

II. CURRENT AND POTENTIAL ENVIRONMENTAL CONTAMINATION

A. Known contaminated sites:

There are no known current contaminated sites within the park boundaries of Booker T. Washington NM. The Environmental Protection Agency (EPA) under the Clean Water Act Section 303(d) has listed 18.15% of waters within 10 kilometers of Booker T. Washington NM as impaired.

B. NPL Superfund sites:

There are no current EPA National Priorities List (NPL) Superfund sites located within 10 kilometers of Booker T. Washington NM.

C. Impaired waterbodies:

Three waterbodies contained sufficient quantities of pathogens to be listed as impaired by the EPA and Virginia Department of Environmental Quality (VADEQ) under Section 303(d) (http://www.epa.gov/waters/data/downloads.html) in 2002. Gills Creek does flow through the southern portion of Booker T. Washington NM. However, no waterbodies contain high concentrations of contaminants to require listing as impaired.

D. Pesticides, herbicides, rodenticides, avicides used:

One pesticide or herbicide product that was applied at Booker T. Washington NM in 2004 contained an active ingredient recognized as being moderately to very highly toxic to terrestrial vertebrates (Table 1). Toxicity rating classes are: 0 = not toxic; 1 = slightly toxic; 2 = moderately toxic; 3 = highly toxic; 4 = very highly toxic. Rating classes are not reported for reptilian species due to the limited availability of toxicity data for most active ingredients.

Table 1. Moderately to very highly toxic pesticides, herbicides, rodenticides, and avicides to terrestrial vertebrates that were applied at Booker T. Washington NM property in 2004.

Active Ingredient	Product	Applied Acres	Mammals	Birds	Amphibians	Reference Cited[a]
Glyphosate	Roundup Pro	1.94	0-1	0-1	0-2[b]	1, 2, 3

[a] References cited: 1. Sparling *et al.* 2000; Smith 1987; Hudson, *et al.* 1984; Schafer *et al.* 1983) 2. EPA Pesticide Registration website: http://cfpub.epa.gov/oppref/rereg/status.cfm?show=rereg 3. Pesticide Action Network of North America website: http://www.pesticideinfo.org/Index.html

[b] Toxicity ratings were derived from fish lethal concentrations to cause 50% mortality.

E. Solid waste or wastewater disposal sites:
There are no permitted solid waste acceptance facilities or wastewater treatment plants located within 10 kilometers of Booker T. Washington NM (http://www.deq.virginia.gov/waste/aswrs.html) (http://cfpub.epa.gov/cwns/standard.cfm).

F. Terrestrial vertebrate contaminant research or monitoring:
Currently, no known contaminant monitoring or ecotoxicological research data is being collected on terrestrial vertebrates within the 10 kilometer buffer surrounding Booker T. Washington NM. Historically, Scanlon *et al.* (1979) determined lead, cadmium, nickel and zinc levels in feathers of wild turkeys from numerous counties in Virginia, including Bedford County.

Scanlon, P. F., T. G. O'Brien, N. L. Schauer, J. L. Coggin, and D. E. Steffen. 1979. Heavy metal levels in feathers of wild turkeys from Virginia. Environmental Contaminant Toxicology 21:591-595.

Wild turkey (*Meleagris gallopava*) feathers were collected from hunters in numerous counties in Virginia during the 1976 fall season, including six turkeys from Bedford County. The Bedford County turkeys contained similar concentrations of lead, cadmium, nickel, and zinc as the other VA counties (Mean ± SE; lead = 7.8 ± 6.7; cadmium = 0.03 ± 0.01; nickel = 0.92 ± 0.23; zinc = 108.2 ± 11.3 µg/g dw). It was noted that levels of lead, nickel and zinc were lower than levels found in ring-necked pheasant (*Phasianus colchicus*) feathers from Illinois. For comparison there were no previously reported cadmium levels from the feathers of other species.

G. Toxic release facilities:
The EPA's Toxic Release Inventory Program listed no toxic release facilities that discharged contaminants (http://www.epa.gov/triexplorer/facilities.htm) within 10 kilometers of Booker T. Washington NM for the years of 1997 through 2003.

H. Fish consumption advisories:
The EPA's Water Program has listed two fish consumption advisories that indicate the presence of persistent pollutants and chemicals within 10 kilometers of Booker T. Washington NM (Table 2) (http://www.epa.gov/waterscience/fish/advisories/index.html).

Table 5. Waterbodies with fish consumption advisories within a 10 kilometer buffer around Booker T. Washington NM.

Waterbody Name	State	Contaminant	Advisory	Year Issued
Roanoke River	VA	PCBs (Total)	Restricted Consumption & No Consumption	2004
Roanoke River/ Smith Mountain Lake	VA	PCBs (Total)	Restricted Consumption & No Consumption	2003 & 2004

III. CONCLUSIONS:

I. Persistent bio-accumulative toxic chemicals:

There was found to be no persistent bio-accumulative toxic chemicals being released or causing impairments in waterbodies within the 10 kilometer buffer surrounding Booker T. Washington NM. PCBs levels have been the source of fish consumption advisories in the area of interest. Eisler (2000) has described the hazards of PCBs to wildlife.

J. Critical Areas and Sensitive Species:

No critical areas or sensitive species were identified in Booker T. Washington NM. However, Smith Mountain Lake is an area within two kilometers of the park where wading birds forage.

K. Additional priority contaminant monitoring/research:

PCBs are a reason for fish consumption advisories for Smith Mountain Lake and the Roanoke River within 10 kilometers of Booker T. Washington in this study. Many wading birds use Smith Mountain Lake and the many nearby creeks for habitat, potentially exposing these species to PCBs. However, there is no terrestrial vertebrate exposure or effects data that has been collected on PCB levels from this area. Potentially collecting samples from terrestrial vertebrates may aid in identifying the level of PCB exposure these species are encountering. Additional contaminated sites have not been identified from the 10 kilometer buffer surrounding Booker T. Washington NM. Upon discovery of other contaminated sites, samples from terrestrial vertebrates should be collected to determine the level of exposure. Although not directly related to priority persistent pollutants, monitoring for potential effects of current and future residential development on terrestrial vertebrates in the area seem to be warranted.

Catoctin Mountain Park

I. BACKGROUND

Size: 2351 hectares

Designation: Catoctin Mountain Park - July 12, 1954
Catoctin Area part of National Capital Park System - December 4, 1945
Catoctin Recreational Demonstration Area - November 14, 1936

Setting/habitat: Catoctin Mountain Park is located in both the Northern Piedmont and the Blue Ridge Provinces in Maryland. Using the National Oceanic and Atmospheric Administration's 250 m (1990 urban-enhanced) Land Use Land Cover data (1999), the environment surrounding Catoctin Mountain Park is classified as: 48.7% agricultural; 48.3% forested; 2.2% urban or built-up; 0.7% barren lands; and 0.1% water.

Past land uses: Logging
Agricultural

II. CURRENT AND POTENTIAL ENVIRONMENTAL CONTAMINATION

C. Known Contaminated sites:

There are no known contaminated sites located on Catoctin Mountain Park property. The Environmental Protection Agency (EPA) under the Clean Water Act Section 303(d) has listed only 3.46% of waters within 10 kilometers of Catoctin Mountain Park as impaired.

B. NPL Superfund sites:

There are no current Environmental Protection Agency (EPA) National Priorities List (NPL) Superfund sites that require further remedial action.

C. Impaired waterbodies:

The EPA and the Maryland Department of Environment (MDE) under Section 303(d) listed two waterbodies as impaired in 2002 (http://www.epa.gov/waters/data/downloads.html) within 10 kilometers of Catoctin Mountain Park. The Catoctin Creek and Upper Monacacy are not impaired by contaminants but are impaired from nutrients and from siltation. However, the portions of the waterbodies that are impaired are located outside and downstream of the park boundary.

D. Pesticides, herbicides, rodenticides, avicides used:

Two pesticide or herbicide products that were applied at Catoctin Mountain Park in 2004 contained an active ingredient recognized as being moderately to very highly toxic to terrestrial vertebrates (Table 1). Toxicity rating classes are: 0 = not toxic; 1 = slightly toxic; 2 = moderately toxic; 3 = highly toxic; 4 = very highly toxic. Rating classes are not reported for reptilian species due to the limited availability of toxicity data for most active ingredients.

Table 1. Moderately to very highly toxic pesticides, herbicides, rodenticides, and avicides to terrestrial vertebrates that were applied at Catoctin Mountain Park property in 2004.

Active Ingredient	Product	Applied Acres	Mammals	Birds	Amphibians	Reference Cited[a]
Glyphosate	Rodeo	14.37	0-1	0-1	0-2[b]	1, 2, 3
	Roundup	3				

[a] References cited: 1. Sparling *et al.* 2000; Smith 1987; Hudson, *et al.* 1984; Schafer *et al.* 1983) 2. EPA Pesticide Registration website: http://cfpub.epa.gov/oppref/rereg/status.cfm?show=rereg 3. Pesticide Action Network of North America website: http://www.pesticideinfo.org/Index.html

[b] Toxicity ratings were derived from fish lethal concentrations to cause 50% mortality.

E. Solid waste or wastewater disposal sites:

There is one permitted solid waste disposal sites located within the 10 kilometer buffer around Catoctin Mountain Park (http://www.dep.state.pa.us/dep/deputate/airwaste/wm/default.htm). The Washington Township Transfer Station is located southeast of Waynesboro, PA and accepts municipal waste from the region. There are three wastewater treatment facilities located within 10 kilometers of Catoctin Mountain Park (http://cfpub.epa.gov/cwns/standard.cfm). Both the Emmitsburg Wastewater Treatment Plant (Maryland) and Washington Township Sewage Treatment Plant (Pennsylvania) were given a score rated as "needing improvement" by the Chesapeake Bay Foundation (2003) because of high nitrogen concentrations (5.1-8 mg/l) discharged at the sites. However, the Chesapeake Bay Foundation rated the Thurmont Wastewater Treatment Plant as "good" having nitrogen concentrations of 3.1-5 mg/l.

F. Terrestrial vertebrate contaminant research or monitoring:

Based on the CEE-TV database and additional literature searches conducted, no known contaminant monitoring or ecotoxicological research has been conducted on terrestrial vertebrates within the 10 kilometer buffer surrounding Catoctin Mountain Park. However, recently Engineering Consulting Services, LTD. (2004) conducted water and sediment sampling along Hunting and Owens Creeks within park property.

G. Toxic release facilities:

The EPA's Toxic Release Inventory Program lists two toxic release facilities that discharged contaminants within 10 kilometers of Catoctin Mountain Park from 1997 through 2003 (http://www.epa.gov/triexplorer/facility.htm). Neither of these sites released persistent pollutants and chemicals listed by the EPA and United Nations. In addition, both sites are located greater than 1.6 kilometers from Catoctin Mountain Park.

H. Fish consumption advisories:

The EPA's Water Program has listed two fish consumption advisories that indicate the presence of persistent pollutants and chemicals within 10 kilometers of Catoctin Mountain Park (Table 2) (http://www.epa.gov/waterscience/fish/advisories/index.html).

Table 2. Waterbodies with fish consumption advisories within a 10 kilometer buffer around Catoctin Mountain Park.

Waterbody Name	State	Pollutant	Advisory	Year Issued
Statewide	MD	Mercury	Restricted Consumption	2004
Statewide	PA	Mercury	Restricted Consumption	2001

III. CONCLUSIONS:

I. Persistent bio-accumulative toxic chemicals:

There are no persistent bio-accumulative toxic chemicals being released at TRI sites and this class of compounds is not the cause of impaired waterbodies within the area. However, active fish consumption advisories in Maryland and Pennsylvania mercury indicate that this pollutant may be present. Eisler (2000) has described the hazards of these contaminants to wildlife.

J. Critical Areas and Sensitive Species:

There were no critical areas reported for Catoctin Mountain Park. However, there is at least one federally threatened species, bald eagle (*Haliaeetus leucocephalis*), that occur inside the park.

K. Additional priority contaminant monitoring/research:

The Catoctin Mountain Park was not found to have current sources for contamination within 10 kilometers of its boundary in this study. Upon discovery of a contaminated site, samples from terrestrial vertebrates should be collected to determine the level of exposure.

Chesapeake and Ohio Canal National Historic Park

I. BACKGROUND

Size: 4856 hectares

Designation: Boundary Change - November 10, 1978
National Historical Park - January 8, 1971
National Monument - January 18, 1961
Acquired by National Park Service - September 23, 1938

Setting/habitat: The Chesapeake and Ohio Canal National Historic Park (C&0 Canal NHP) is located in the Coastal Plains, Piedmont Plateau, Blue Ridge, and Valley and Ridge Provinces in Virginia. Using the National Oceanic and Atmospheric Administration's 250 m (1990 urban-enhanced) Land Use Land Cover data (1999), the environment surrounding the C&0 Canal NHP is classified as: 41.0% forests; 38.0% agricultural; 19.1% urban or built-up; 1.7% water; and 0.2% barren lands.

Past land uses: Transportation, Industrial, Forestry and Agricultural Uses

II. CURRENT AND POTENTIAL ENVIRONMENTAL CONTAMINATION

A. Known contaminated sites:

A Tannery Site is located adjacent to park property near Williamsport, MD. NPS acquired 16.7 acres of this site in 1974 of which 5.5 acres contained waste lagoons. The subsurface soil, surface soil, sediments, and groundwater contained volatile organic compounds (VOCs), semi-volatile organic compounds (semi-VOCs) (i.e. benzo(a)pyrene), metals (arsenic, chromium, iron, lead, manganese, vanadium). The primary concern at this site seems to be the subsurface soil and groundwater contamination by metals. However, the surface water runoff appears to be negligible (Ecology and Environment, Inc. 2004). There are two Environmental Protection Agency (EPA) National Priorities List (NPL) Superfund site within the 10 kilometer buffer, Washington Navy Yard and Allegany Ballistics Laboratory (US Navy). Additionally, 14.7% of the surface water located within the 10 kilometer buffer surrounding the park boundary is impaired according to EPA's 303(d) list of impaired waterbodies.

B. NPL Superfund sites:

The Washington Navy Yard contains 28.9 ha along the Anacostia River in Washington, DC (Figure 1). The Washington Navy Yard has operated since 1799 as a ship building/repair and naval gun factory (http://cfpub.epa.gov/supercpad/cursites/srchsites.cfm). In 1961 the facility became an administrative facility. Throughout its operation as a ship building/repair and naval gun factory the waste generated included polycyclic aromatic hydrocarbons (PAHs), heavy metals, polychlorinated biphenyls (PCBs), and dioxins. Since 1998, the EPA's Superfund Program has removed a portion of the hazardous waste, including lead paint, PCBs, and mercury. However, dioxins, other metals, and PAHs still exist in portions of the site. The Anacostia River is the primary surface water feature associated with the Washington Navy Yard. The storm water system, with nine outfalls into the Anacostia River, has been documented to contain lead and PCBs.

The Allegany Ballistics Laboratory encompasses 658.8 hectares and is located along the Potomac River floodplain in Mineral County, WV of which only 636.2 hectares is part of the NPL listing (http://cfpub.epa.gov/supercpad/cursites/srchsites.cfm). The facility has been in operation since 1942 testing propellants and motors for ballistics. Contaminated sites include the Northern Riverside Waste Disposal Area, burning grounds, inert non-ordnance disposal landfills, photographic solutions disposal areas, surface water impoundments, and a beryllium landfill. Contaminants have been detected in ground and surface water and in soils and include explosives, volatile organic compounds (VOCs), acids and bases, laboratory and industrial wastes, solvent recovery and metal plating sludges, paints and thinners. The primary surface water feature is the Northern Branch Potomac River where some contaminants have been detected.

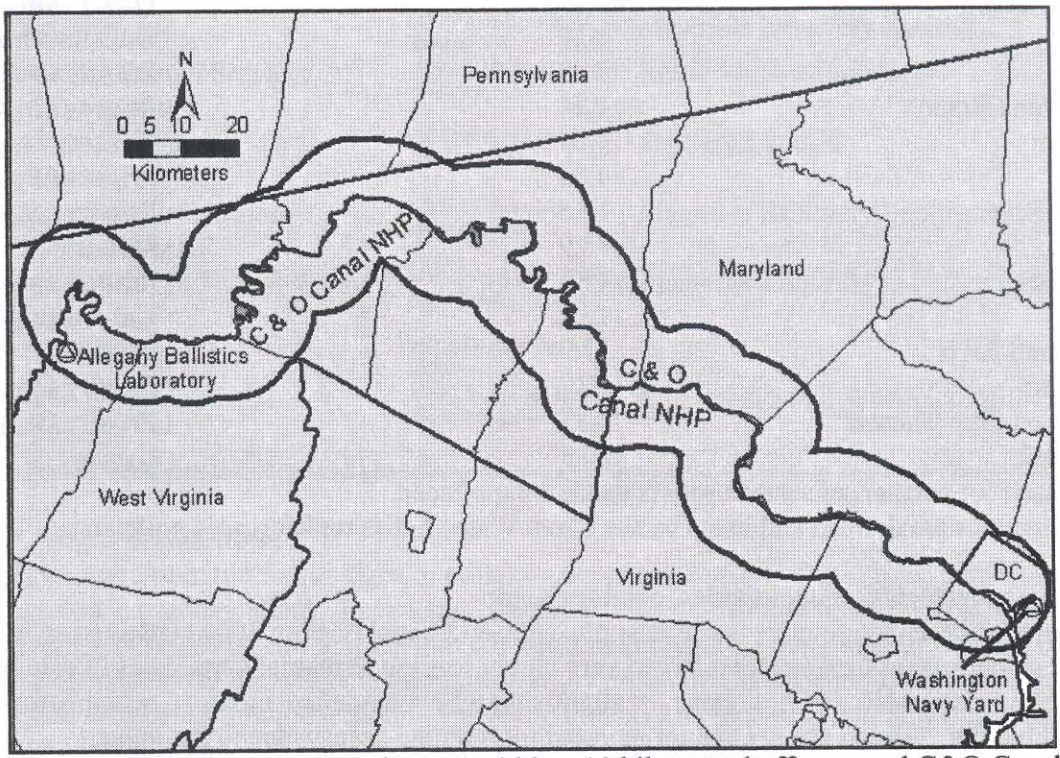

Figure 1. NPL Superfund site located within a 10 kilometer buffer around C&O Canal NHP.

C. Impaired waterbodies:

Twelve waterbodies contain sufficient quantities of contaminants to be listed as impaired by the EPA and Maryland, West Virginia and the District of Columbia under Section 303(d) (http://www.epa.gov/waters/data/downloads.html) in 2002 (Table 1). The Potomac and Shenandoah Rivers, Rock and Wills Creek, and Dalecarlia Tributary are impaired with contaminants upstream or adjacent to the C&O Canal property. Additionally, sedimentation, nutrient, pH, and/or pathogen impairments are present in portions of the Potomac, Monocacy, and Anacostia Rivers, Lower Watts and Broad Branch, Wills, Town, Evetts, Conococheague, Antietam, Catoctin, Seneca, and Rock Creeks, Difficult, Four mile, and Oxon Runs and Kingman Lake.

Table 1. Contaminant-impaired waterbodies listed by the EPA in 2002 within a 10 kilometer buffer around C&O Canal NHP.

Waterbody Name	River Length (km)	Size (km²)[a]	Impairment
Anacostia River	12.3	0.288	Unnamed Metals
	7.33	0.288	Priority Organics[b]
	12.3	0.288	Oil and Grease
Broad Branch	2.64		Priority Organics[b]
Dalecarlia Tributary		0.059	Priority Organics[b]
Kingman Lake	3.29		Oil and Grease
	3.29		Unnamed Metals
	3.29		Priority Organics[b]
Lower Watts Branch	1.74		Priority Organics[b]
Oxon Run	4.04		Unnamed Metals
	4.04		Priority Organics[b]
Potomac River	17.5		Priority Organics[b]
	56.9		Metals (Cd)
Rock Creek	15.1		Priority Organics[b]
	15.1		Unnamed Metals
Shenandoah River	12.9		PCBs
Tidal Basin	1.17		Priority Organics[b]
Washington Ship Channel	3.37		Priority Organics[b]
Wills Creek	10.8		Cyanide

[a] Size is listed for portions of surface waters that are impounded.
[b] Priority organics are defined and listed by the Clean Water Act as toxic organic pollutants.

D. Pesticides, herbicides, rodenticides, avicides used:
One pesticide or herbicide product that was applied at C&O Canal NHP in 2004 contained an active ingredient recognized as being moderately to very highly toxic to terrestrial vertebrates (Table 2). Toxicity rating classes are: 0 = not toxic; 1 = slightly toxic; 2 = moderately toxic; 3 = highly toxic; 4 = very highly toxic. Rating classes are not reported for reptilian species due to the limited availability of toxicity data for most active ingredients.

Table 2. Moderately to very highly toxic pesticides, herbicides, rodenticides, and avicides to terrestrial vertebrates that were applied at C&O Canal NHP property in 2004.

Active Ingredient	Product	Applied Acres	Mammals	Birds	Amphibians	Reference Cited[a]
Glyphosate	Roundup Ultra	50	0-1	0-1	0-2[b]	1, 2, 3

[a] References cited: 1. Sparling *et al.* 2000; Smith 1987; Hudson, *et al.* 1984; Schafer *et al.* 1983) 2. EPA Pesticide Registration website: http://cfpub.epa.gov/oppref/rereg/status.cfm?show=rereg 3. Pesticide Action Network of North America website: http://www.pesticideinfo.org/Index.html
[b] Toxicity ratings were derived from fish lethal concentrations to cause 50% mortality.

E. Solid waste or wastewater disposal sites:
There are eight solid waste acceptance facilities permitted by the Virginia's Department of the Environmental Quality and Maryland's Department of the Environment

(http://www.deq.virginia.gov/waste/s-waste.html & http://www.mde.state.md.us/Programs/LandPrograms/Solid_Waste/facilities/index.asp) located within 10 kilometers of the C&O Canal NHP (Table 3). In addition, 33 municipal wastewater treatment plants are located within the boundary of the 10 kilometer buffer surrounding the C&O Canal NHP (http://www.epa.gov/owm/mtb/cwns/index.htm).

Table 3. Permitted solid waste acceptance facilities within a 10 kilometer buffer around the C&O Canal NHP.

Facility Name	Address	Type	Ownership
Classified Waste Disposal System at CIA	Route 123 & 193, Langley, VA	Incineration/Energy Recovery Facility	Govt.
Con-Serv, Ind.	45713 Woodland Road, Sterling, VA	Materials Recovery Facility	Private
Dept. of Human Services Laboratory	1800 N. Edison St., Arlington, VA	RMW [a] Incinerator	Govt.
Loudon County Sanitary Landfill	906 Trailview Boulevard Leesburg, VA	Sanitary Landfill	Govt.
USA Waste of Virginia-Leesburg MRF	42228 Cochran Mill Rd., Leesburg, VA	Materials Recovery Facility	Private
Essroc CKD Industrial Waste LF	4120 Buckeystown Pike, Buckeystown, MD	Industrial Landfill	Private
MCRRF	21204 Martinsburg Road Dickerson, MD	WTE	Private
Forty West Municipal Landfill	12630 Earth Care Road Hagerstown, MD	Municipal Solid Waste Landfill	Govt.

[a] RMW includes all regulated medical waste.

F. Signs of pollution:

There have been numerous signs of pollution according to C&O Canal NHP personnel (Frias, NPS, personal communication). In October/November 2005 a manhole fixture was blown at the Potomac Interceptor releasing raw sewage into the area. Additionally, CSXT at Brunswick is being monitored for petrochemical pollutants in groundwater. At times the C&O Canal in Georgetown contains a green material of unknown origin. However, there is knowledge of contaminants leaking into the Tidal Basin from the Bureau of Engraving and Printing (Lorenzetti, NPS, personal communication).

G. Terrestrial vertebrate contaminant research or monitoring:

Current research is being conducted at Kenilworth Marsh and Kingman Lake along the Anacostia River to determine the concentration of metals and organochlorine residues in tree swallow eggs, nestlings, and food samples (DeMott, USGS, personal communication). Several recent and historic CEE-TV records are also located within this area.

Studies involving Pesticides and Industrial Contaminants

1. Clark, D.R., Jr., and A.J. Krynitsky. 1983. DDE in brown and white fat of hibernating bats. Environmental Pollution (Series A) 31:287-299.

Fourteen bats (big brown, *Eptesicus fuscus*, little brown, *Myotis lucifugus*, and eastern pipestrelle, *Pipistrellus subflavus*) were collected from mine tunnels at Round Top Mountain, MD in November 1978. Brown and white fat bodies were collected to determine DDE concentrations. Pipistrelles contained significantly lower concentrations of DDE than the other two species (pipestrelles = 14.2; big brown = 89.5; little brown = 151.7 μg/g lipid weight). DDE concentrations were significantly lower in brown fat tissues (11.9 μg/g) than white fat tissues (24.3 μg/g) on a wet weight basis. However, when DDE concentrations were compared on a lipid basis brown fat lipid contained significantly greater concentrations than white fat lipid (brown fat = 36.1μg/g; white fat = 28.3 μg/g).

2. New York State Department of Environmental Conservation. 1988. Wildlife Pathology Unit Necropsy Report #87-62-13.

On July 18, 1987, an adult male common grackle (*Quiscalus quiscula*) was found in Rockville, MD. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain and stomach contents. Concentrations of chlordane metabolite oxychlordane (29 μg/g ww) and and nonachlor (9.9 μg/g ww) were in the lethal range. The cause of death was attributed to organochlorine toxicosis.

3. New York State Department of Environmental Conservation. 1988. Wildlife Pathology Unit Necropsy Report #87-62-20.

In 1988, an immature male northern mockingbird (*Mimus polyglottus*) was found in Bethesda, MD. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (2.58 μg/g ww) and oxychlordane (4.52 μg/g ww) were in the lethal range. The cause of death was attributed to chlordane intoxication.

4. New York State Department of Environmental Conservation. 1989. Wildlife Pathology Unit Necropsy Report #89-07-33.

An adult male American robin (*Turdus migratorius*) was found in Bethesda, MD on April 23, 1989. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (5.51 μg/g ww) and oxychlordane (4.37 μg/g ww) were in the lethal range. The cause of death was attributed to organochlorinated pesticide.

5. New York State Department of Environmental Conservation. 1989. Wildlife Pathology Unit Necropsy Report #89-07-34.

An adult male American robin (*Turdus migratorius*) was found in Bethesda, MD on April 23, 1989. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (6.35 μg/g ww) and oxychlordane (4.10 μg/g ww) were in the lethal range. The cause of death was attributed to head trauma and possible chlordane intoxication.

6. New York State Department of Environmental Conservation. 1989. Wildlife Pathology Unit Necropsy Report #89-62-29.

An juvenile blue jay (*Cyanocitta cristata*) was found in College Park, MD on September 20, 1989. The bird was necropsied and found to contain elevated concentrations of organochlorine pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (5.07 µg/g ww), oxychlordane (3.89 µg/g ww), and transnonachlor (5.19 µg/g ww) were in the lethal range. The cause of death was attributed to organochlorine pesticide poisoning.

7. Rattner, B.A., M.J. Melancon, C.P. Rice, W. Riley Jr., J. Eisemann, and R.K. Hines. 1997. Cytochrome P450 and organochlorine contaminants in black-crowned night-herons from the Chesapeake Bay Region, USA. Environmental Toxicology and Chemistry 16:2315-2322.

In 1991, black-crowned night-heron (*Nycticorax nycticorax*) pipping embryos were collected from several locations including a colony that nest in trees above the Smithsonian Institute National Zoological Park and feed along the Potomac and Anacostia Rivers. Hepatic microsomal activities of benzyloxyresorufin-*O*-dealkylase and ethoxyresorufin-*O*-dealkylase (biomarkers of exposure to polyhalogenated pollutants) were elevated in pipping embryos from Rock Creek Park colony compared to the reference site (Chincoteague National Wildlife Refuge). Concentrations of organochlorine pesticides and metabolites in pipping embryos were greater from the Rock Creek Park than at the reference site, but below the known threshold for reproductive impairment. However, concentrations of total PCBs, 10 arylhydrocarbon receptor-active PCB congeners and estimated toxic equivalents were significantly greater in embryos collected from Rock Creek Park compared to the reference site, with values for toxic congeners 77 and 126 exceeding those observed in heron embryos from the Great Lakes.

8. Rattner, B.A., P.C. McGowan, N.H. Golden, J.S. Hatfield, P.C. Toschik, R.F. Lukei Jr., R. C. Hale, I. Schmitz-Afonso, and C.P. Rice. 2004. Contaminant exposure and reproductive success of ospreys (*Pandion haliaetus*) nesting in Chesapeake Bay regions of concern. Archives of Environmental Toxicology and Chemistry 47:126-140.

The Chesapeake Bay osprey (*Pandion haliaetus*) population has more than doubled in size since restrictions were placed on the production and use of DDT and other toxic organochlorine contaminants in the 1970's. Ospreys are now nesting in the most highly polluted portions of the Bay. In 2000, contaminant exposure and reproduction were monitored in ospreys nesting in the Anacostia and Potomac Rivers. A "sample egg" from each study nest was collected for contaminant analysis, and the fate of eggs remaining in each nest (n=14) was monitored at 7-10 day intervals from egg incubation through fledging of young. Ospreys fledged young in the Washington, DC study sites (observed success: 0.88 fledglings/active nest), although productivity was marginal for sustaining the local population in the Anacostia and Potomac Rivers. Concentrations of total PCBs, some arylhydrocarbon receptor-active PCB and polybrominated diphenyl ether congeners were often greater in sample eggs from Anacostia and Potomac Rivers compared to the South River reference site. Nonetheless, logistic regression analyses did not provide evidence linking marginal productivity to *p,p'*-DDE, total PCBs or toxic PCB congener exposure.

9. Southeastern Cooperative Wildlife Disease Study. 1992. Clinical Necropsy Records #68-92, College of Veterinary Medicine, University of Georgia.

In March 1992, an adult male American kestrel (*Falco sparverius*) was found in Arlington, VA. The concentration of DDE residue in the stomach contents was 2.17 µg/g and in the kestrel's brain was 6.7 µg/g. The cause of death was undetermined. However, the possibility of carbamate pesticides could not be ruled out.

10. Southeastern Cooperative Wildlife Disease Study. 2002. Clinical Necropsy Record #CC23-02 College of Veterinary Medicine, University of Georgia.

On December 25, 2001 a mortality event occurred at a 2-acre vacant lot in Rockville, MD. The mortality event involved 12 gray squirrels (*Sciurus carolinensis*), 1 opossum (*Didelphis virginiana*), 1 red fox (*Vulpes vulpes*), 1 blue jay (*Cyanocitta cristata*), and 1 crow (*Corvus sp.*). The squirrel carcasses were examined and 4 (2 male and 2 female) were frozen for further analysis. The pooled gastrointestinal tract contents of the 4 squirrels contained high concentrations of endosulfan (126 ppm). In light of the high endosulfan concentration in the gastrointestinal tract contents and the toxicity of this chlorinated hydrocarbon the cause of the mortality event was found to be endosulfan intoxication.

11. Tri-State Bird Rescue and Research, Inc. 1997. Oil Spill Response History. Newark, Delaware.

Beavers (*Castor canadensis*), Canada geese (*Branta canadensis*), snapping turtles (*Chelydra serpentina*), box turtles (*Terrapene carolina*), painted turtles (*Chrysemys picta*), and wood turtles (*Clemmys insculpta*), mallards (*Anas platyrhynchos*), Northern water snakes (*Nerodia sipedon*), barred owls (*Strix varia*), and wood ducks (*Aix sponsa*) were collected in 1993 to determine the presence of oil after the release of 380,000 gallons of no. 2 diesel fuel. Of the 51 individuals examined, 61% were released.

H. Toxic release facilities:

The EPA's Toxic Release Inventory Program lists 39 toxic release facilities that discharged contaminants within 10 kilometers of C&O Canal NHP from 1997 through 2003 (Figure 2) (http://www.epa.gov/triexplorer/facility.htm). Eleven of these facilities released persistent pollutants and chemicals listed by the EPA and United Nations (Table 4). The greatest diversity of persistent pollutants and chemicals were released from Potomac River and Dickerson Generating Stations discharging dioxins, lead and mercury. Lead was the priority pollutant released by ten facilities.

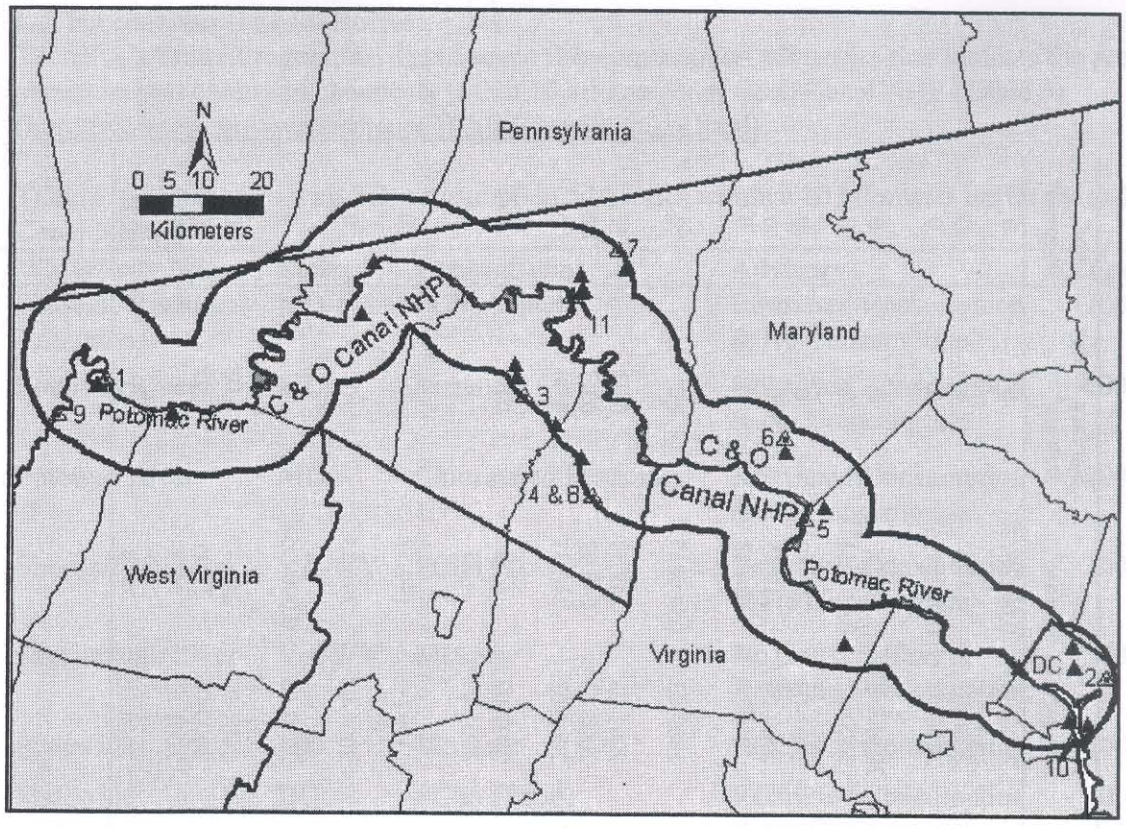

Figure 2. Toxic release sites (&) and priority contaminant release sites (L) listed by the EPA within a 10 kilometer buffer around C&O Canal NHP for 1997 through 2003.

Table 4. Mean quantity of priority contaminants released by EPA-listed toxic release sites for 1997 through 2003 within a 10 kilometer buffer around C&O Canal NHP.

Ref. No.	Site Name	Address	Contaminant Released	Years Released	Air Release[a]	Surface Water Release[a]	Land Disposal[a]
1	AES Warrior Run Inc.	11600 Mexico Farms Rd., Cumberland, MD	Dioxin Cmpds.	2000-03	0.0022877[b]	0	0
			Lead Cmpds	2000-03	14.23	0	0
2	Benning Generating Station	3400 Benning Rd., NE, Washington, DC	Dioxin Cmpds.	2000-02	0.0002836[b]	0	0
			Mercury	2000 & 03	4.25	0	0
3	Capitol Cement Corp.	1826 S Queen St., Martinsburg, WV	Dioxin Cmpds.	2000-03	0.0026511[b]	0	0
			Lead Cmpds.	2001-03	265.80	0	0
			Mercury	2000-03	139.45	0	0
4	Dalb, Inc.	105 Industrial Blvd., Kearneysville, WV	Lead Cmpds.	2002	134.13	0	0
5	Dickerson Generating Station	21200 Martinsburg Rd., Dickerson, MD	Dioxin Cmpds.	2000-03	0.0008172[b]	0	0
			Lead Cmpds.	2001-03	243.37	6.03	112.7
			Mercury	2000-03	243.03	0.03	1.65
6	EASTALCO Aluminum Co.	5601 Manor Woods Rd., Frederick, MD	Lead Cmpds.	2002-03	248.83	4.00	7.67
			Mercury	2001-02	6.05	0.01	0
7	Eastern Organ Pipe Inc.	403 N Prospect St., Hagerstown, MD	Lead Cmpds.	2001-03	4.33	0	0
8	Kidde Fire Fighting	215 Mildred St., Ranson, WV	Lead Cmpds.	1997-2003	144.57	0	0
9	NAV Ind. Res. Ord. Plant - Allegany Ballistics Lab.	WV State Rte. 956, Rocket Center, WV	Lead Cmpds.	2001-03	298.33	0	0
10	Potomac River Generating Station	1400 N Royal St., Alexandria, VA	Dioxin Cmpds.	2000-03	0.0007058[b]	0	0
			Lead Cmpds.	2001-03	245.77	9.03	0
			Mercury	2000-03	77.03	0.03	0
11	R. Paul Smith Power Station	15952 Lockwood Rd., Williamsport, MD	Lead Cmpds.	2001-03	37.3	0	2552.5
			Mercury	2000-03	41.9	0	20.18

[a] Units are in lbs/yr unless otherwise noted.
[b] Units are in g/yr.

I. Fish consumption advisories:
The EPA's Water Program has listed seven fish consumption advisories that indicate the presence of persistent pollutants and chemicals within 10 kilometers of C&O Canal NHP (Table 5) (http://www.epa.gov/waterscience/fish/advisories/index.html).

Table 5. Waterbodies with fish consumption advisories within a 10 kilometer buffer around C&O Canal NHP.

Waterbody Name	State	Contaminant	Advisory	Year Issued
Potomac River & Tributaries	MD/VA	PCBs (Total)	Restricted Consumption & No Consumption	2001/1999
Potomac River	MD	Mercury	Restricted Consumption & No Consumption	2004
Potomac River	MD	Chlorinated Pesticides	Restricted Consumption & No Consumption	2004
Shenandoah River	VA/WV	PCBs (Total)	Restricted Consumption & No Consumption	2004
Shenandoah River	VA/WV	Mercury	No Consumption & Restricted Consumption	2004
Statewide	MD	Mercury	Restricted Consumption	2004
Statewide	DC	PCBs (Total)	Restricted Consumption & No Consumption	2004 & 1993

III. CONCLUSIONS:

J. Persistent bio-accumulative toxic chemicals:
Numerous persistent pollutants and chemicals have been found or are being released within the 10 kilometers buffer surrounding C&O Canal NHP including, lead, mercury, dioxins and dioxin-like compounds, PCBs and organochlorine pesticides. Eisler (2000) has described the hazards of these contaminants to wildlife.

K. Critical areas and Sensitive Species:
There have been bald eagles (*Haliaeetus leucocephalus*) (federally threatened species) sighted in the park property boundary. Peregrine falcons have been released in the Maryland Heights Area of Harper's Ferry NHP adjacent to C&O Canal NHP. Additionally, osprey have been observed nesting along portions of the Potomac River, all three species being birds of prey are susceptible to priority organics found in the study area.

L. Additional priority contaminant monitoring/research:
The majority of contaminant exposure and effects information collected within 10 kilometers of the C&O Canal NHP has been derived from individual necropsy reports collected in the 1980's, which indicate the presence of organochlorinated pesticides in the vicinity. However, there have been a limited number of studies on fish-eating birds within the buffer area indicating the presence of PCBs, polyhalogenated compounds, and polybrominated diphenyl ethers. The surface waters that influence the area around the C&O Canal NHP indicate the presence of these and other priority organics.

Furthermore, the Washington Navy Yard and Allegany Ballistic Laboratory could be a source of additional contaminants. Since PCBs and organochlorinated pesticides are persistent, additional monitoring and research may aid in identifying the extent of exposure to other terrestrial vertebrates.

Fort McHenry National Monument and Historic Shrine

I. BACKGROUND

Size: 17.4 hectares

Designation: National Monument and Historic Shrine - August 11, 1939
National Park – March 3, 1925

Setting/habitat: Fort McHenry National Monument & Historic Shrine (NM & HS) is located in the Piedmont Plateau and Coastal Plains Provinces in Maryland. Using the National Oceanic and Atmospheric Administration's 250 m (1990 urban-enhanced) Land Use Land Cover data (1999), the environment surrounding Fort McHenry NM & HS is classified as: 73.7% urban or built-up; 16.2% water; 6.3% forested; 1.2% wetland; 2.0% barren lands; and 0.6% agricultural.

Past land uses: Military operations

II. CURRENT AND POTENTIAL ENVIRONMENTAL CONTAMINATION

A. Known contaminated sites:

There are no known contaminated sites within park boundaries. There are two Environmental Protection Agency (EPA) National Priorities List (NPL) Superfund sites within the 10 kilometer buffer surrounding the park boundary. The EPA's Clean Water Act Section 303(d) list 89.3% of the surface waters as impaired.

B. NPL Superfund sites:

The 68th Street Dump in Rosedale, MD is currently in the proposal stage of being listed as a NPL Superfund site (Figure 1). The public comment period ended in July 2003 and the EPA's Superfund Program is reviewing the data (http://epa.gov/reg3hwmd/npl/MDD980918387.htm) before making a decision. This site operated in the 1950s through the 1970s as an industrial and commercial landfill. Potentially hazardous substances identified by the EPA's Superfund Program at the landfill include volatile organic compounds (VOCs), polyaromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, and metals (http://www.epa.gov/superfund/sites/nplsnl/n0300338.pdf). Since 1982, the EPA's Superfund Program has removed a portion of the hazardous waste, including 23 drums containing cadmium and lead, 1 drum of paint sludge, and 40 drums of solvents (http://www.epa.gov/superfund/sites/nplsnl/n0300338.pdf). The landfill site is located on filled wetlands. Surface waters that are associated with this site include Herring Run, Moore's Run and Redhouse Run, all of which flow into the Back River. Lead, zinc and PAHs have been identified in Herring Run sediments (http://www.epa.gov/superfund/sites/nplsnl/n0300338.pdf) downstream from the superfund site.

The Curtis Bay Coast Guard Yard is located along Curtis Creek, a tributary to the Patapsco River, about 6 miles southeast and downstream of Fort McHenry (Figure 1). The site was added to the EPA's NPL list on September 5, 2002 (http://epa.gov/reg3hwmd/npl/MD4690307844.htm). The Coast Guard Yard began building and repairing ships in 1906, with a peak in production in the 1940s. Since the 1940s, production at the yard has declined. Potentially hazardous substances identified by the EPA's Superfund Program at this site include semi-volatile organic compounds (SVOCs), VOCs, PCBs, metals, pesticides, and dioxins (http://epa.gov/reg3hwmd/npl/MD4690307844.htm). Surface

waters that are associated with this site include Curtis Creek/Bay and Patapsco River. The sources of the potentially hazardous substances have not been contained and may continue to enter the surrounding surface waters (http://www.epa.gov/superfund/sites/nplsnl/n0304341.pdf).

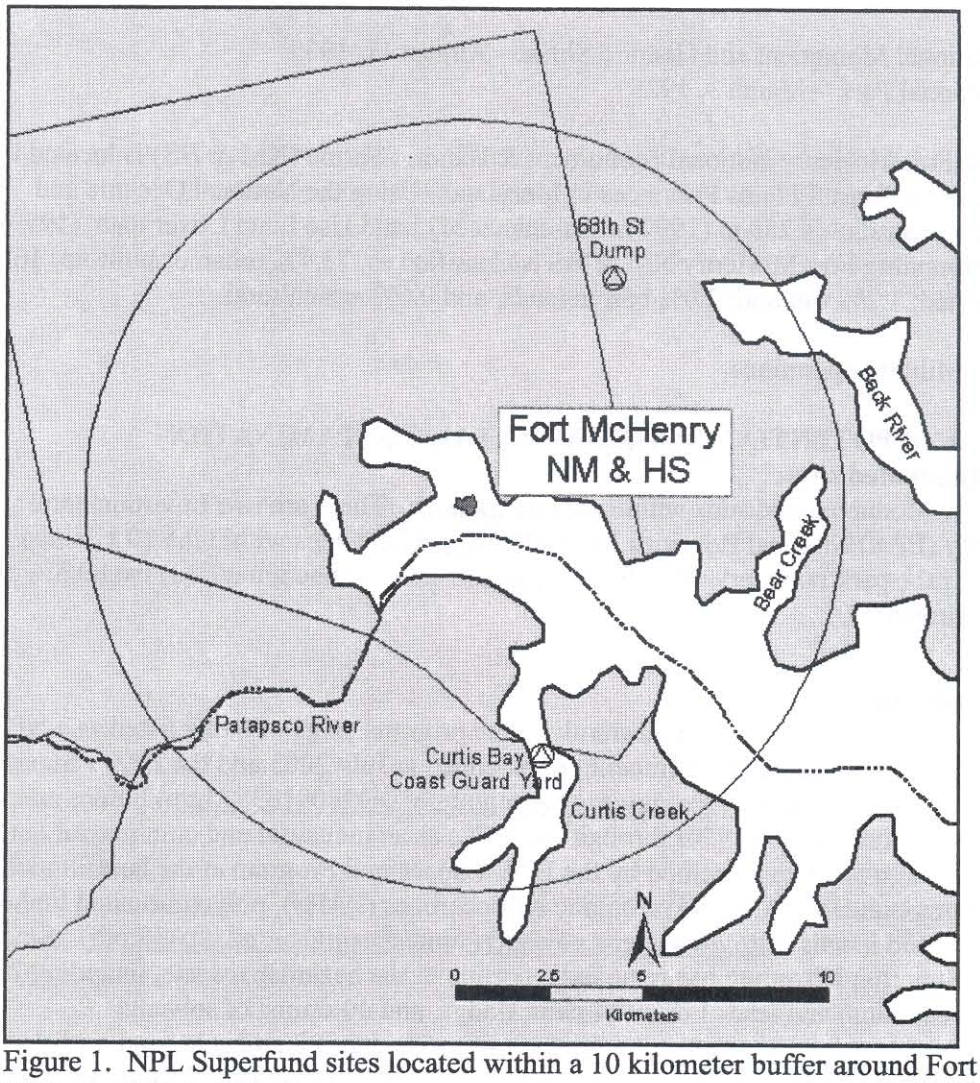

Figure 1. NPL Superfund sites located within a 10 kilometer buffer around Fort McHenry NM & HS.

C. Impaired waterbodies:

Seven waterbodies contain sufficient quantities of contaminants to be listed as impaired by the EPA and the State of Maryland under Section 303(d) (http://www.epa.gov/waters/data/downloads.html) in 2002 (Table 1). The Inner Harbor, Baltimore Harbor and Patapsco River are waterbodies listed as impaired upstream of Fort McHenry (Figure 2). Additionally, nutrient impairments affect portions of the Gwynn Falls, Back and Patapsco Rivers, Baltimore Harbor, and Piscataway Creek. Sedimentation and siltation impairments are present in portions of the Gwynn Falls, Back and Patapsco Rivers, Baltimore Harbor.

Table 1. Contaminant impaired waterbodies listed by the EPA in 2002 within a 10 kilometer buffer around Fort McHenry NM & HS.

Waterbody Name	River Length (km)	Size (km^2)[a]	Impairment
Back River	17.63	0.122	Chlordane
	1.21		Zn
Baltimore Harbor	3.66		Hg, Cu, Ni
	3.66		Total toxics
Bear Creek	2.50		PCBs
	3.36		Zn
Curtis Bay/Creek	3.52		PCBs
	3.52		Zn
Northwest Branch/Inner Harbor	1.15		PCBs
Patapsco River/Lower North Branch	8.17	0.106	Unnamed Metals

[a] Size is listed for portions of surface waters that are impounded.

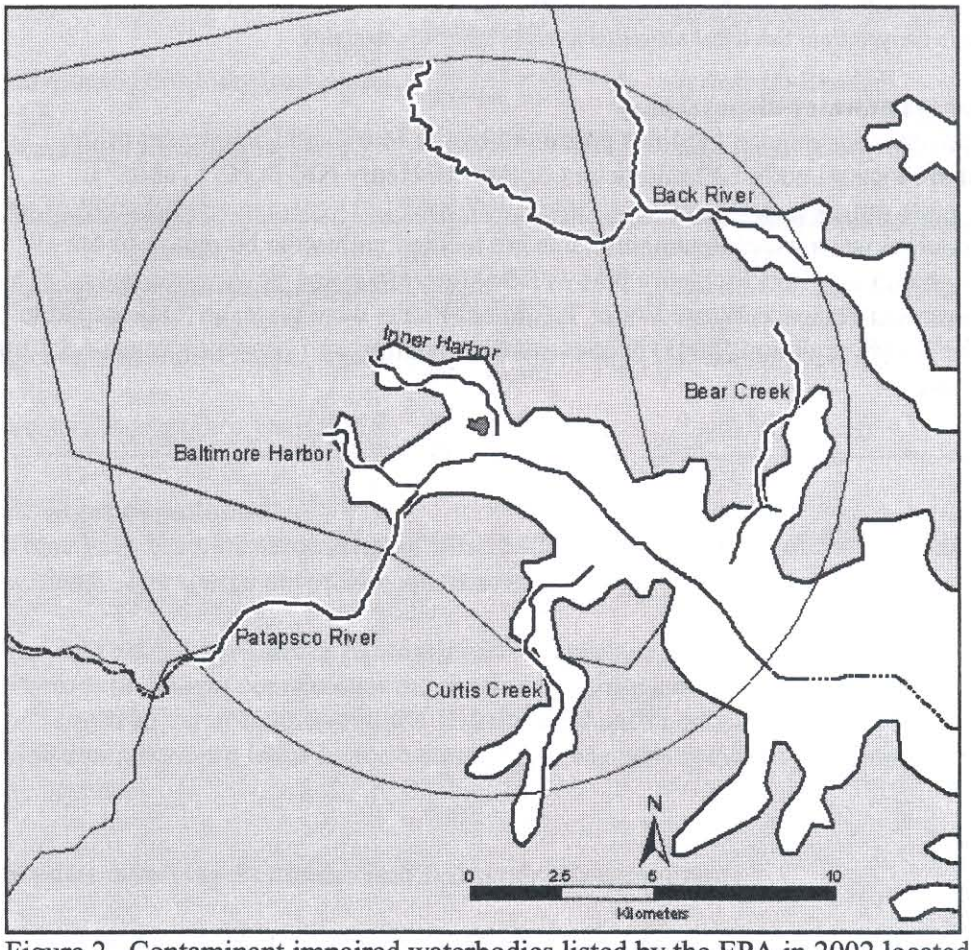

Figure 2. Contaminant impaired waterbodies listed by the EPA in 2002 located within a 10 kilometer buffer around Fort McHenry NM & HS.

D. Pesticides, herbicides, rodenticides, avicides used:
Two pesticide or herbicide products that were applied at Fort McHenry NM & HS in 2004 contained active ingredients recognized as being moderately to very highly toxic to terrestrial vertebrates (Table 2). Toxicity rating classes are: 0 = not toxic; 1 = slightly toxic; 2 = moderately toxic; 3 = highly toxic; 4 = very highly toxic. Rating classes are not reported for reptilian species due to the limited availability of toxicity data for most active ingredients.

Table 2. Moderately to very highly toxic pesticides, herbicides, rodenticides, and avicides to terrestrial vertebrates that were applied at Fort McHenry NM & HS property in 2004.

Active Ingredient	Product	Applied Acres	Mammals	Birds	Amphibians	Reference Cited[a]
Glyphosate	Roundup Pro	1.73	0-1	0-1	0-2[b]	1, 2, 3
Tetramethrin	Blitz-Em 2	1	1		3-4[b]	3

[a] References cited: 1. Sparling *et al.* 2000; Smith 1987; Hudson, *et al.* 1984; Schafer *et al.* 1983) 2. EPA Pesticide Registration website: http://cfpub.epa.gov/oppref/rereg/status.cfm?show=rereg 3. Pesticide Action Network of North America website: http://www.pesticideinfo.org/Index.html

[b] Toxicity ratings were derived from fish lethal concentrations to cause 50% mortality.

E. Solid waste or wastewater disposal sites:
There are 13 solid waste acceptance facilities permitted by the Maryland Department of the Environment that are located within 10 kilometers of Fort McHenry NM & HS (Table 3) (http://www.mde.state.md.us/assets/document/Solid%20Waste%20Acceptance%20Facilities.pdf). In addition, two municipal wastewater treatment plants are located within the boundary of the 10 kilometer buffer surrounding Fort McHenry NM & HS (http://cfpub.epa.gov/cwns/standard.cfm). Both the Back River and Patapsco Waste Water Treatment Plants were given an "unacceptable" score by the Chesapeake Bay Foundation (2003) because of the high nitrogen concentrations (> 8.1 mg/l) discharged at the sites.

Table 3. Permitted solid waste acceptance facilities within a 10 kilometer buffer around Fort McHenry NM & HS.

Facility Name	Address	Type	Ownership
Curtis Creek PF & TS	23 Stahl Rd., Baltimore, MD	Processing Facility & Transfer Station	Private
Baltimore Environmental PF	1437 West Hamburg St., Baltimore, MD	Processing Facility	Private
Baltimore Processing Center & Transfer Station	5800 Chemical Rd., Baltimore, MD	Processing Facility & Transfer Station	Private
Baltimore Regional WMI	3200 Hawkins Point Rd., Baltimore, MD	Medical Waste Incinerator	Private
BRESCO WTE	1801 Annapolis Rd., Baltimore, MD	Waste to Energy/MSW Incinerator	Private
CS&D Processing Facility	1100 Wicomico St., Baltimore, MD	Processing Facility	Private
Edison Processing Facility	1030 Edison Hwy., Baltimore, MD	Processing Facility	Private
Millenium HPP Industrial Waste LF	3901 Fort Armistead Rd., Baltimore, MD	Industrial Landfill	Private
Quarantine Road Municipal LF	6100 Quarantine Rd., Baltimore, MD	Municipal Solid Waste Landfill	Govt.
Stericycle, Inc. PF	5902 Chemical Rd., Baltimore, MD	Processing Facility & Transfer Station	Private
Univ. of MD @ Baltimore WMI	714 Lombard St., Baltimore, MD	Special Medical Waste Processing Facility	Govt.
Recovermat Mid-Atlantic, LLC PF	2202 Halethorpe Farm Rd., Baltimore, MD	Processing Facility	Private
Western Acceptance Facility TS	3310 Transway Rd., Baltimore, MD	Transfer Station	Govt.

F. Signs of pollution:
There have been localized areas of film observed on the surface of the water at the man-made wetland. The source of the film is unknown.

G. Terrestrial vertebrate contaminant research or monitoring:
There is no known contaminant monitoring or ecotoxicological research currently being conducted on terrestrial vertebrates within the 10 kilometer buffer surrounding Fort McHenry NM & HS. However, there is a lot of historic data. There has been previous contaminant research conducted on 11 species.

Studies involving Pesticides and Industrial Contaminants

1. Jarman, W. M., R. J. Norstrom, M. Simon, S. A. Burns, C. A. Bacon, and B. R. Simoneit. 1993. Organochlorines, including chlordane compounds and their metabolites, in peregrine-falcon, prairie-falcon, and clapper-rail eggs from the USA. Environmental Pollution 81:127-136.

Concentrations of DDT and its metabolites, and total PCBs (3.4 µg/g ww and 5.8 µg/g ww) were detected in a Peregrine falcon (*Falco peregrinus*) egg collected from the Key Bridge between 1986-1989. Concentration of heptachlor epoxide and several chlordane metabolites were generally low compared to eggs samples from other sites in the U.S.

2. New York State Department of Environmental Conservation. 1988. Wildlife Pathology Unit Necrospy Report #87-62-18.

In 1987, a dying blue jay (*Cyanocitta cristata*) was found in Baltimore. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. The cause of death was attributed to chlordane intoxication. Concentrations of chlordane metabolites heptachlor epoxide and oxychlordane were in the lethal range.

3. Rattner, B.A., M.J. Melancon, C.P. Rice, W. Riley Jr., J. Eisemann, and R.K. Hines. 1997. Cytochrome P450 and organochlorine contaminants in black-crowned night-herons from the Chesapeake Bay Region, USA. Environmental Toxicology and Chemistry 16:2315-2322. and Custer, T.W., J.W. Bickham, T.B. Lyne, T. Lewis, L.A. Ruedas, C. M. Custer, and M.J. Melancon. 1994. Flow cytometry for monitoring contaminant exposure in black-crowned night herons. Archives of Environmental Contamination and Toxicology 27:176-179.

In 1991, black-crowned night-heron (*Nycticorax nycticorax*) offspring (pipping embryos and nestlings) were collected from several locations including a colony in Baltimore Harbor. Hepatic microsomal activities of benzyloxyresorufin-*O*-dealkylase and ethoxyresorufin-*O*-dealkylase (biomarkers of exposure to polyhalogenated pollutants) were significantly elevated (up to sixfold and ninefold induction, respectively) in pipping embryos from the Baltimore Harbor colony compared to the reference site. Concentrations of organochlorine pesticides and metabolites in pipping embryos were greater than at the reference site, but below the known threshold for reproductive impairment. However, concentrations of total PCBs, 10 arylhydrocarbon receptor-active PCB congeners and estimated toxic equivalents were significantly greater (up to 37-fold) in embryos collected from Baltimore Harbor compared to the reference site, with values for toxic congeners 77 and 126 exceeding those observed in heron embryos from the Great Lakes. Organochlorine contaminant levels were greater in 10-day-old nestlings from Baltimore Harbor than the reference site, but had no apparent effect on monooxygenase activity or growth. There was no evidence of contaminant-induced genetic damage based on flow cytometry studies.

4. Rattner, B.A., P.C. McGowan, J.S. Hatfield, C.-S. Hong, and S.G. Chu. 2001. Organochlorine contaminant exposure and reproductive success of black-crowned night herons (*Nycticorax nycticorax*) nesting in Baltimore Harbor, Maryland. Archives of Environmental Contamination and Toxicology 41:73-82.

The declining size of the Baltimore Harbor black-crowned night-heron (*Nycticorax nycticorax*) colony was hypothesized to be linked to PCB exposure. In 1998, a "sample egg" was collected from 65 black-crowned night-heron nests (each containing ≥ three eggs) for contaminant analysis, and the remaining eggs in these 65 nests, plus four two-egg nests, were monitored for hatching and fledging success. Pesticide and metabolite concentrations, including *p,p'*-DDE, were well below thresholds

associated with adverse reproductive effects. Average concentration of total PCBs, 12 *Ah* receptor-active PCB congeners, and toxic equivalents in eggs from Baltimore Harbor were greater (up to 35-fold) than at the Holland Island reference site. Overall nest success at the Baltimore Harbor heronry was estimated by the Mayfield method to be 0.74, and the mean number of young fledged/hen was 2.05, which is within published productivity estimates for maintaining a stable black-crowned night-heron population. Processes other than poor reproduction may be responsible for the declining size of the Baltimore Harbor colony.

5. Rattner, B.A., P.C. McGowan, N.H. Golden, J.S. Hatfield, P.C. Toschik, R.F. Lukei Jr., R. C. Hale, I. Schmitz-Afonso, and C.P. Rice. 2004. Contaminant exposure and reproductive success of ospreys (*Pandion haliaetus*) nesting in Chesapeake Bay regions of concern. Archives of Environmental Toxicology and Chemistry. 47:126-140.

The Chesapeake Bay osprey population has more than doubled in size since restrictions were placed on the production and use of DDT and other toxic organochlorine contaminants in the 1970's. Ospreys are now nesting in the most highly polluted portions of the Bay, including Baltimore Harbor. In 2000, contaminant exposure and reproduction were monitored in ospreys nesting in the Harbor and the Patapsco River. A "sample egg" from each study nest was collected for contaminant analysis, and the fate of eggs remaining in each nest (n=14) was monitored at 7-10 day intervals from egg incubation through fledging of young. Ospreys fledged young in the Harbor (observed success: 1.07 fledglings/active nest), although productivity was marginal for sustaining the local population in the Harbor and the Patapsco River. Concentrations of total PCBs, some arylhydrocarbon receptor-active PCB and polybrominated diphenyl ether congeners, and perfluorooctanesulfonate were often greater in sample eggs from Baltimore Harbor compared to the South River reference site. Nonetheless, logistic regression analyses did not provide evidence linking marginal productivity to *p,p'*-DDE, total PCBs or toxic PCB congener exposure.

Studies involving Metals

1. Beyer, W.N., G. Miller and J.W. Simmers. 1990. Trace elements in soil and biota in confined disposal facilities for dredged materials. Environmental Pollution 65:19-32.

In 1985, house mice (*Mus musculus*) (n=6) were collected from various confined disposal facilities including one located at the Masonville deposition site in Baltimore Harbor. Of the 5 sites studied, whole body concentrations of lead, copper, zinc, cadmium, arsenic and selenium were greatest in Baltimore Harbor, although statistical differences among sites was not examined.

2. DeMent, S.H., J.J. Chosolm, J.C. Barber and J.D. Standberg. 1986. Lead exposure in an "urban" Peregrine Falcon and its Avian Prey. Journal of Wildlife Disease 22:238-244.

A dead 7-year old peregrine falcon from Baltimore was necropsied, and a *Pseudomonas* infection was found to be the immediate cause of death. However, lead concentrations in liver and kidney (0.74 and 1.40 ppm) were cause for concern. A survey of urban rock doves (*Columbia livia*) was undertaken, and these peregrine falcon prey were found to have markedly elevated blood lead concentrations (0.29-17 ppm) compared to control doves (0.01-0.07 ppm). Liver and kidney

concentrations of lead in urban rock doves was elevated (>3 ppm). Lead exposure of the falcon was not thought to be a contributing factor to the infection.

3. DeMent, S.H., J.J. Chisolm, M.A. Eckhaus, and J.D. Strandberg. 1987. Toxic lead exposure in the urban rock dove. Journal of Wildlife Disease 23:273-278.

Thirteen adult rock doves (*Columbia livia*) were collected at the Baltimore Zoo in the late 1980's. Three of the doves with high blood and tissue lead had lead shot in their gizzard. Renal inclusion bodies were associated with kidney lead concentrations.

4. Tome, M. Unpublished observations of metals in liver tissue of ducks collected from Baltimore Harbor.

Between 1987 and 1989, various species of waterfowl were collected from Baltimore Harbor and Rhode River to assess metal concentrations in liver. Concentrations of lead were consistently greater and are considered to be "elevated" in liver of black ducks (*Anas rubripes*), mallards (*Anas platyrhynchos*), canvasbacks (*Aythya valisineria*), and scaup (*Aythya* spp.) from Baltimore Harbor compared to birds collected from the Rhode River. Concentrations of cadmium, chromium, mercury and selenium in liver were similar among the two study sites.

5. Golden, N.H., B.A. Rattner, P.C. McGowan, K.C. Parsons, and M.A. Ottinger. 2003. Concentrations of metals in feathers and blood of nestling black-crowned night-herons (*Nyticorax nycticorax*) in Chesapeake and Delaware Bays. Bulletin of Environmental Contamination and Toxicology 70:385-393.

Blood and feather samples were collected from black-crowned night-herons nesting in Baltimore Harbor in 1998 and subjected to metals analysis. Concentrations of heavy metals were in the low to moderate range compared to the reference site. Notably, lead concentrations in feathers were moderately elevated compared to the reference site, and could possibly pose a threat to nestling survival.

H. Toxic release facilities:

The EPA's Toxic Release Inventory Program lists sixty-two toxic release facilities that discharged contaminants within 10 kilometers of Fort McHenry NM & HS from 1997 through 2003 (http://www.epa.gov/triexplorer/facility.htm). Eighteen of these sixty-two facilities released five of the fifteen persistent pollutants and chemicals listed by the EPA and United Nations (Table 4). Lead compounds were released by seventeen of these facilities, the greatest release being from Bethlehem Steel and the Gould Street Generating Station. Five facilities released dioxin and/or dioxin-like compounds in this time frame. There are three facilities located within 1.6 kilometers of Fort McHenry, which released hazardous substances. One facility, Gould Street Generating Station, released lead and dioxin compounds into the air (http://www.epa.gov/triexplorer/facility.htm).

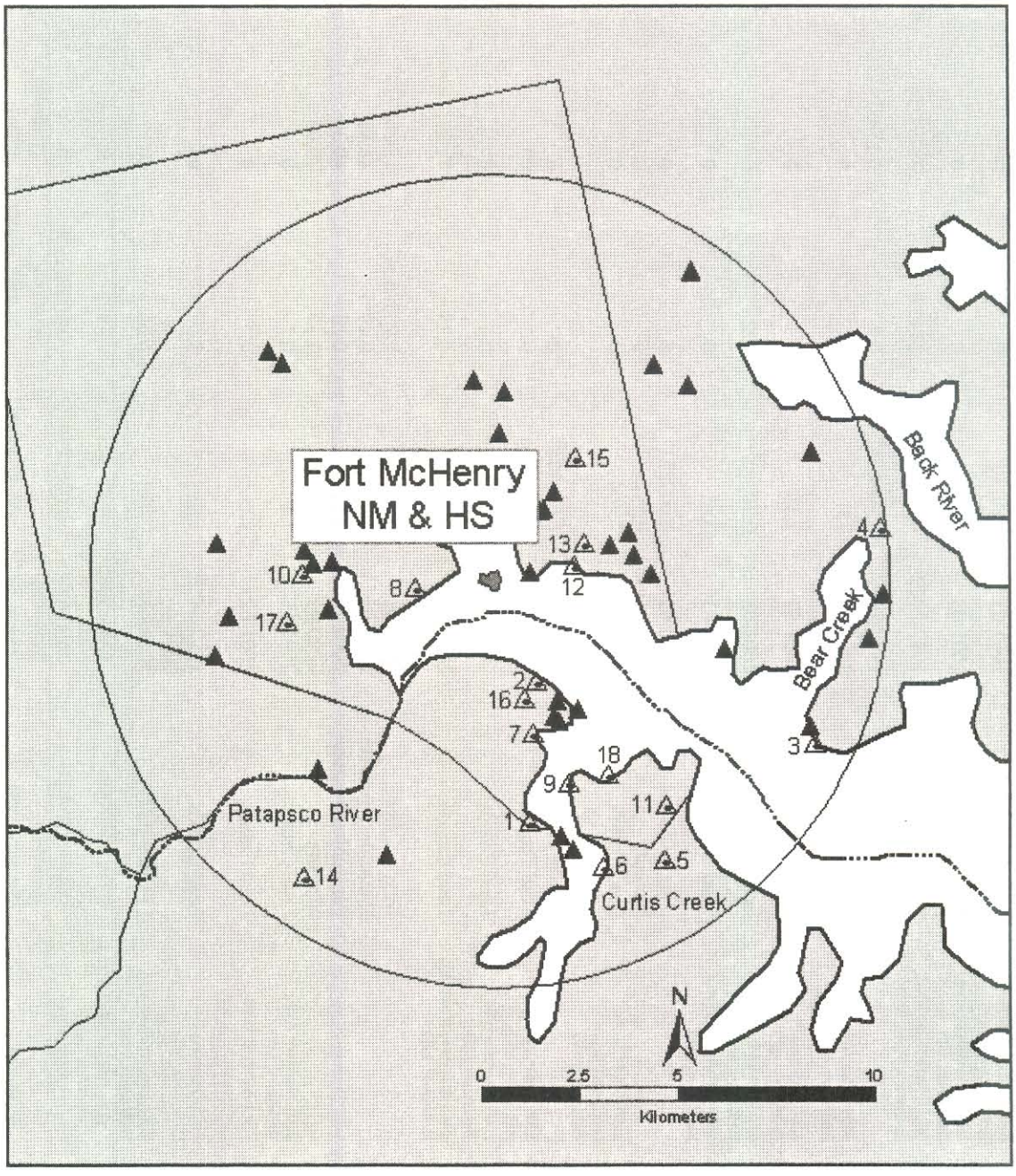

Figure 3. Toxic release sites (▲) and priority contaminant release sites (3) listed by the EPA within a 10 kilometer buffer around Fort McHenry NM & HS for 1997 through 2003.

Table 4. Mean quantity of priority contaminants released by EPA-listed toxic release sites for 1997 through 2003 within a 10 kilometer buffer around Fort McHenry NM & HS.

Ref. No.	Site Name	Address	Contaminant Released	Years Released	Air Release[a]	Surface Water Release[a]	Land Disposal[a]
1	Aramada Hess Corp.	6200 Pennington Ave., Baltimore, MD	Lead Cmpds.	2001-03	1.01	0	0
2	Atotech USA Inc.	1900 Chesapeake Ave., Baltimore, MD	Lead Cmpds.	2001-03	1.73	0	0
3	Bethlehem Steel Corp.	5111 North Point Blvd., Sparrow's Point, MD	Lead Cmpds.	1997-2003	672.19	2340.81	38291.54
			Dioxin Cmpds.	1997-2003	0.006654[b]	0	0.1583741[b]
4	CHC Ind., Cleaners Hangar Co.	8801 Wise Ave., Baltimore, MD	Lead Cmpds.	2001-02	25	0	0
5	Eastalco Aluminum Co.	4000 Hawkins Pt. Rd., Baltimore, MD	Lead Cmpds.	2001-03	2.10	0	0
6	Erachem Comilog Inc.	610 Pittman Rd., Baltimore, MD	Lead Cmpds.	2001-03	0.20	122	0
7	FMC Corp.	1701 E Patapsco Ave., Baltimore, MD	Lead Cmpds.	2001-03	4.41	0	0
			Dioxin Cmpds.	2000-03	0.000221[b]	0	0
8	Gould Street Generating Station	2105 Gould St. & McComas St., Baltimore, MD	Mercury	2001-03	0.57	0	0
			Lead Cmpds.	2001-02	759.4	0	0
			Dioxin Cmpds.	2001-02	0.000278[b]	0	0
9	Grace Davison	5500 Chemical Rd., Baltimore, MD	Lead Cmpds.	2002-03	3.80	0	67
10	Kaydon Ring & Seal Inc	1600 Wicomoco St., Baltimore, MD	Lead Cmpds.	2003	4.92	0	0
11	Millenium Inorganic Chemicals Inc.	3941 Fort Armistead Rd., Baltimore, MD	Lead Cmpds.	2001-03	0	0.25	71.27
			Dioxin Cmpds.	2000-03	0.000182[b]	0.0098564[b]	1.6302723[b]
			Hexachlorobenzene	2000-03	0	0.20	46.85
			Pentachlorobenzene	2000	0	0.20	40.30
			Mercury	2000-01	0.55	1.15	79.65
12	New NGC Inc.	2301 Newkirk Ave., Baltimore, MD	Lead Cmpds.	2001-03	1.1	0.1	0
13	Northrop Grumman ES BWI Site	7323 Aviation Blvd., Linthicum, MD	Lead Cmpds.	2001-02	129	0	0
14	North American Truck Group	2122 Broening Hwy., Baltimore, MD	Lead Cmpds.	1997, 99 & 2001	18.67	3.5	0
15	Pemco Corp.	5601 Eastern Ave., Baltimore, MD	Lead Cmpds.	2001-03	2.03	0.06	0

Table 4. Mean quantity of priority contaminants released by EPA-listed toxic release sites for 1997 through 2003 within a 10 kilometer buffer around Fort McHenry NM & HS.

Ref. No.	Site Name	Address	Contaminant Released	Years Released	Air Release[a]	Surface Water Release[a]	Land Disposal[a]
16	Sasol N.A. Inc.	3441 Fairfield Rd., Baltimore, MD	Dioxin Cmpds.	2000-03	0.000163b	0.00002352b	0
17	Sherwin-Williams Co.	2325 Hollins Ferry Rd., Baltimore, MD	Lead Cmpds.	1997-2003	5.96	2.83	0
18	U. S. Gypsum	5500 Quarantine Rd., Baltimore, MD	Lead Cmpds.	2001-03	0.60	0	0
			Mercury	2003	0.05	0	0

[a] Units are in lbs/yr unless otherwise noted.
[b] Units are in g/yr.

I. Fish consumption advisories:
The EPA's Water Program has listed three fish consumption advisories that indicate the presence of persistent pollutants and chemicals within 10 kilometers of Fort McHenry NM & HS (Table 5) (http://www.epa.gov/waterscience/fish/advisories/index.html).

Table 5. Waterbodies with fish consumption advisories within a 10 kilometer buffer around Fort McHenry NM & HS.

Waterbody Name	State	Contaminant	Advisory	Year Issued
Back River	MD	Chlorinated Pesticides	Restricted and No Consumption	2004
Back River	MD	PCBs (Total)	Restricted and No Consumption	2004
Baltimore Harbor & Patapsco River	MD	Chlorinated Pesticides	No Consumption	2001 & 2004
Baltimore Harbor & Patapsco River	MD	PCBs (Total)	Restricted and No Consumption	1993 & 2004
Statewide	MD	Mercury	Restricted Consumption	2004

III. CONCLUSIONS:

J. Persistent bio-accumulative toxic chemicals:
Numerous persistent pollutants and chemicals have been found or are being released within the 10 kilometer buffer surrounding Fort McHenry NM & HS including, chlordane, chlorinated pesticides, PCBs, dioxins and dioxin-like compounds, hexa- and pentachlorobenzene, lead and mercury. Eisler (2000) has described the hazards of these contaminants to wildlife.

K. Critical areas and Sensitive Species:
The man-made wetland may provide habitat for numerous terrestrial vertebrates while individuals are exposed to surface water from Baltimore Harbor (Patapsco River). These surface waters may include contaminants from toxic release facilities in close proximity, evidenced by the impairment of a portion of this water upstream. In addition, this area may receive runoff from surrounding urban areas. And finally, bald eagles (*Haliaeetus leucocephalus*), a federally threatened species have been sighted over the park.

L. Additional priority contaminant monitoring/research:
Since the 1980s, monitoring and research of pesticides and industrial contaminants has only occurred with avian species. These studies primarily have looked at organochlorine pesticides and their metabolites and PCBs, with all but one study showing elevated or greater concentrations than reference sites. Surface waters surrounding Fort McHenry NM & HS also indicate the presence of these contaminants (i.e. impaired waterbodies and fish advisories). Furthermore, the Curtis Bay Coast Guard Yard has not yet contained the hazardous substances present at the site, and could be a possible source of PCBs, dioxins and pesticides. Since PCBs and organochlorine pesticides are persistent, additional monitoring and research may aid in identifying the extent of exposure to other terrestrial vertebrates. In addition to continuing ecotoxicology research on avian species, raccoon

(*Procyon lotor*), red fox (*Vulpes vulpes*), and muskrat (*Ondatra zibethicus*) have been sighted at the Fort McHenry wetland and may accumulate these contaminants from food items. Reptiles and amphibians that have been sighted at the national monument and may benefit from further research of PCBs or organochlorine pesticides exposure include black snake (*Elaphe guttata*), garter snake (*Thamnophis sirtalis*), snapping turtle (*Chelydra serpentina*) and bullfrog (*Rana catesbeiana*).

Zinc, mercury, nickel and copper have all been listed as metals impairing surface waters within this area. Three studies have looked at metals (Beyer *et al.* 1990, Golden *et al.* 2003, Tome *unpublished*), with only Beyer *et al.* (1990) finding greater concentrations of lead, zinc, copper, cadmium, arsenic, and selenium in the house mouse. Additional research of the exposure and effects of heavy metals on terrestrial vertebrates may help identify the extent of metal accumulations among a variety of taxa. Even though lead is being released by toxic release facilities it was not found to be impairing waterbodies or accumulating in fish. However, research conducted within 10 kilometers of Fort McHenry NM & HS has indicated that terrestrial vertebrates, mainly avian species, have been exposed to lead.

Fredericksburg and Spotsylvania National Military Park

I. BACKGROUND

Size: 3389 hectares

Designation: National Military Park – February 14, 1927

Setting/habitat: Fredericksburg and Spotsylvania National Military Park (NMP) is located in the Piedmont and Coastal Plain Physiographic Provinces of Virginia. Using the National Oceanic and Atmospheric Administration's 250 m (1990 urban-enhanced) Land Use Land Cover data (1999), the environment surrounding Fredericksburg and Spotsylvania NMP is classified as: 66.2% forested; 20.5% agricultural; 9.5% urban or residential; 2.0% barren lands; 1.2% water; and 0.6% wetlands.

Past land uses: Farming, residential, and industrial operations.

II. CURRENT AND POTENTIAL ENVIRONMENTAL CONTAMINATION

A. Known Contaminated sites:

There are two old dump sites located at the Carver Farm which were previously covered that could be a potential source of contaminants within Fredericksburg and Spotsylvania NMP. A small percentage (2.58%) of the surface waters within 10 kilometers of the park are listed as impaired by the Environmental Protection Agency (EPA).

B. NPL Superfund sites:

There are no current EPA National Priorities List (NPL) Superfund sites that require further remedial action located within 10 kilometers of Fredericksburg and Spotsylvania NMP.

C. Impaired waterbodies:

The EPA and the Virginia Department of Environment Quality (VADEQ) under Section 303(d) listed five waterbodies as impaired in 2002 (http://www.epa.gov/waters/data/downloads.html) within 10 kilometers of Fredericksburg and Spotsylvania NMP. The Rappahannock River is impaired from both nutrients and low dissolved oxygen. Additionally, Deep, Terry's, and Claiborne Runs and Mattaponi Rivers are all impaired with pathogens. There are no waterbodies impaired by contaminants within 10 kilometers of Fredericksburg and Spotsylvania NMP.

D. Pesticides, herbicides, rodenticides, avicides used:

Five pesticide or herbicide products that were applied at Fredericksburg and Spotsylvania NMP in 2004 contained active ingredients that are recognized as being moderately to very highly toxic to terrestrial vertebrates (Table 1). Toxicity rating classes are: 0 = not toxic; 1 = slightly toxic; 2 = moderately toxic; 3 = highly toxic; 4 = very highly toxic. Rating classes are not reported for reptilian species due to the limited availability of toxicity data for most active ingredients.

Table 1. Moderately to very highly toxic pesticides, herbicides, rodenticides, and avicides to terrestrial vertebrates that were applied at Fredericksburg and Spotsylvania NMP property in 2004.

Active Ingredient	Product	Applied Acres	Mammals	Birds	Amphibians	Reference Cited[a]
Glyphosate	Roundup	691	0-1	0-1	0-2[b]	1, 2, 3
	Roundup Pro	8				
	Accord	12.84				
	Roundup Ultra Max	19				
Metolachlor	Dual II	255	1	0-1	1-2[b]	1, 2, 3

[a] References cited: 1. Sparling *et al.* 2000; Smith 1987; Hudson, *et al.* 1984; Schafer *et al.* 1983) 2. EPA Pesticide Registration website: http://cfpub.epa.gov/oppref/rereg/status.cfm?show=rereg 3. Pesticide Action Network of North America website: http://www.pesticideinfo.org/Index.html

[b] Toxicity ratings were derived from fish lethal concentrations to cause 50% mortality.

E. Solid waste or wastewater disposal sites:

There are three permitted solid waste disposal sites located within the 10 kilometer buffer around Fredericksburg and Spotsylvania NMP (Table 2) (http://www.deq.virginia.gov/waste/aswrs.html). There are four wastewater treatment facilities located within 10 kilometers of Fredericksburg and Spotsylvania NMP, including Massaponax, Little Falls Run, Fredericksburg and Thornburg Regional Wastewater Treatment Facilities (http://cfpub.epa.gov/cwns/standard.cfm).

Table 2. Permitted solid waste facilities within a 10 kilometer buffer around Fredericksburg and Spotsylvania NMP.

Facility Name	Address	Type	Ownership
Livingston Sanitary Landfill No. 2	P.O. Box 116, Spotsylvania,VA	Sanitary Landfill	Govt.
Mary Washington College	1301 College Avenue, Fredericksburg, VA	RMW[a] Alternate Treatment	Private
Mary Washington Hospital	1001 Sam Perry Drive, Fredericksburg, VA	RMW[a] Steam Sterilization	Private

[a] RMW includes all regulated medical waste.

F. Terrestrial vertebrate contaminant research or monitoring:

No current contaminant monitoring or ecotoxicological research projects are being conducted on terrestrial vertebrates within the 10 kilometer buffer surrounding Fredericksburg and Spotsylvania NMP. However, Stafford *et. al.* (1978) determined the kepone residue in a bald eagle liver and carcass from Spotsylvania.

1. Stafford, C. J., W. L. Reichel, D. M. Swineford, R. M. Prouty, and M. L. Gay. 1978. Gas-liquid chromatographic determination of Kepone in field-collected avian tissues and eggs. *Journal of the Association of Official Analytical Chemists* 61(1):8-14.

Bald eagle (*Haliaeetus leucocephalus*) liver and carcasses collected (1968-1975) in Virginia and Maryland areas, including Spotsylvania, VA (n=2), were analyzed for kepone residues. Spotsylvania bald eagle liver and tissue contained 83 and 21.0 µg/g ww kepone, respectively. This was in a higher concentration of kepone residues than other areas in the region and greater than eagles from Oklahoma and Minnesota (controls).

G. Toxic release facilities:

The EPA's Toxic Release Inventory Program lists five toxic release facilities that discharged contaminants within 10 kilometers of Fredericksburg and Spotsylvania NMP from 1997 through 2003 (http://www.epa.gov/triexplorer) (Figure 1). One facility released a priority persistent chemicals/pollutant listed by the EPA. From 1997 to 2001 Colonial Circuits Inc., manufacturer of electrical equipment, released an average of 49.25 lbs/yr of lead by way of air pathways and 385 lbs/yr of lead by way of land disposal.

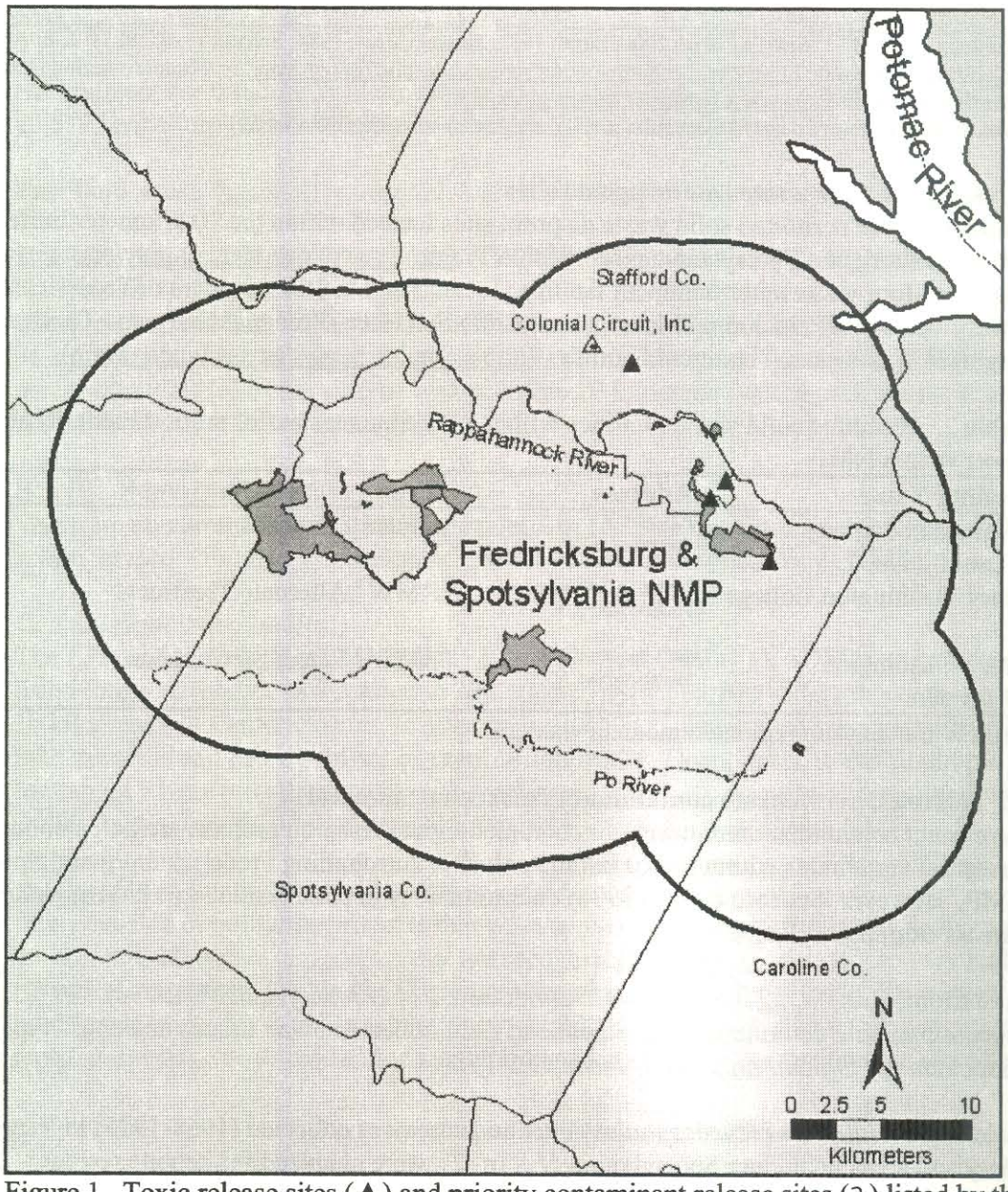

Figure 1. Toxic release sites (▲) and priority contaminant release sites (3) listed by the EPA within a 10 kilometer buffer around Fredericksburg and Spotsylvania NMP for 1997 through 2003.

H. Fish consumption advisories:
The EPA's Water Program has listed two fish consumption advisories within 10 kilometers of Fredericksburg and Spotsylvania NMP (http://www.epa.gov/waterscience/fish/advisories/index.html).

Table 5. Waterbodies with fish consumption advisories within a 10 kilometer buffer around Fredericksburg and Spotsylvania NMP.

Waterbody Name	State	Contaminant	Advisory	Year Issued
Lake Anna	VA	PCBs (Total)	Restricted and No Consumption	2004
Rappahannock River	VA	PCBs (Total)	Restricted and No Consumption	2004

III. CONCLUSIONS:

I. Persistent bio-accumulative toxic chemicals:
Lead is the only persistent bio-accumulative toxic chemical, released from a TRI site, identified during this compilation of data within 10 kilometers of Fredericksburg and Spotsylvania NMP. However, high PCB levels in fish tissue from Lake Anna and Rappahannock River have caused fish consumption advisories to be issued.

J. Critical Areas and Sensitive Species:
No critical areas or sensitive species have been reported within the park boundary. However, a bald eagle, federally threatened species, was collected from Spotsylvania in the 1970's.

K. Additional priority contaminant monitoring/research:
The Fredericksburg and Spotsylvania NMP was not found to have current sources for contamination within 10 kilometers of its boundary in this study. Upon discovery of a contaminated site, samples from terrestrial vertebrates should be collected to determine the level of exposure.

George Washington Memorial Parkway

I. BACKGROUND

Size: 2984 hectares

Designation: First section was Commemorated 1932

Setting/habitat: George Washington Memorial Parkway (MP) is located in the Piedmont Plateau and Coastal Plain Provinces in Virginia. Using the National Oceanic and Atmospheric Administration's 250 m (1990 urban-enhanced) Land Use Land Cover data (1999), the environment surrounding the George Washington MP is classified as: 87.0% urban or built-up; 9.0% forested; 2.1% agricultural; 1.7% water; 0.2% wetlands; and 0.1% barren lands.

Past land uses: Prior to NPS acquisition much of the property was used for rock quarrying, military operations, and agriculture.

II. CURRENT AND POTENTIAL ENVIRONMENTAL CONTAMINATION

A. Known contaminated sites:

There are no known contaminated sites within the George Washington MP boundaries. There is one Environmental Protection Agency (EPA) National Priorities List (NPL) Superfund site, the Washington Navy Yard. The EPA has listed 18.99% of the surface water within this buffer as impaired.

B. NPL Superfund sites:

The Washington Navy Yard contains 28.9 ha along the Anacostia River in Washington, DC (Figure 1). The Washington Navy Yard existed since 1799 and operated as a ship building/repair and naval gun factory until 1961 when it became an administrative facility (http://cfpub.epa.gov/supercpad/cursites/srchsites.cfm). During its operation as a ship building/repair and naval gun factory the waste generated included polycyclic aromatic hydrocarbons (PAHs), heavy metals, polychlorinated biphenyls (PCBs), and dioxins. Since 1998, the EPA's Superfund Program has removed a portion of the hazardous waste, including lead paint, PCBs, and mercury. However, dioxins, heavy metals, and PAHs still exist in portions of the site. The Anacostia River is the primary surface water feature associated with the Washington Navy Yard. The storm water system, with nine outfalls into the Anacostia River, has been documented to contain lead and PCBs.

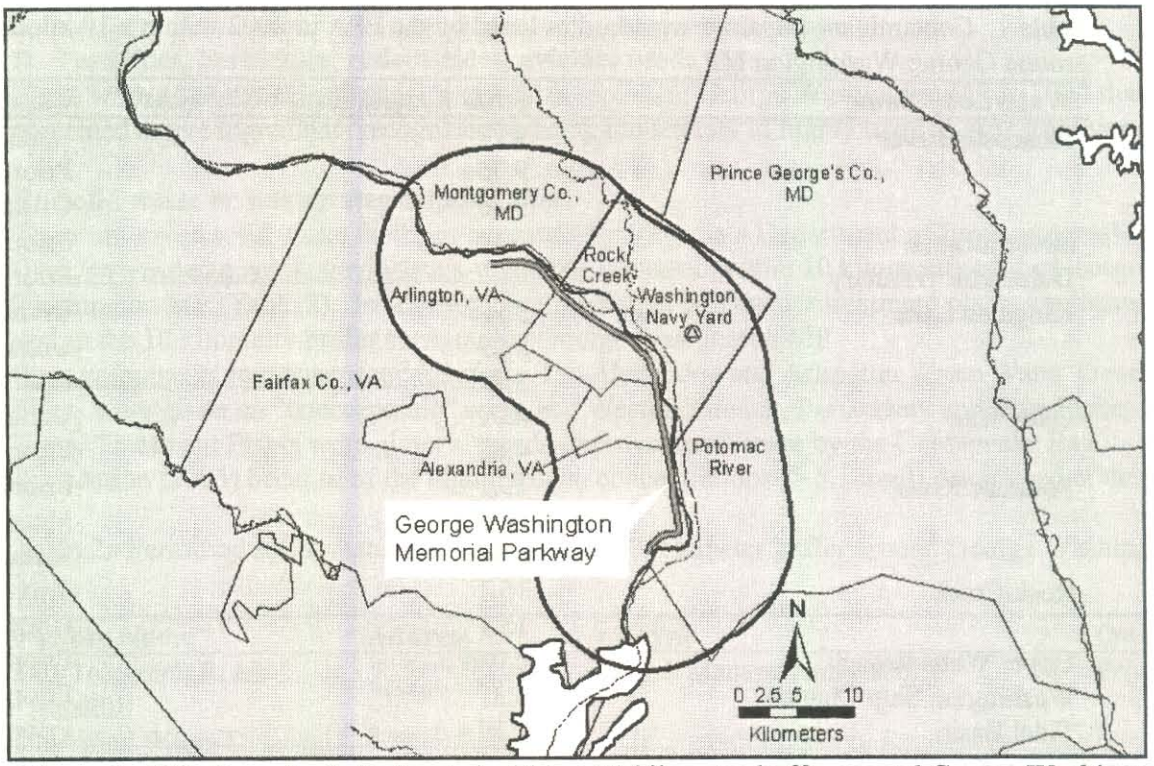

Figure 1. NPL Superfund site located within a 10 kilometer buffer around George Washington MP.

C. Impaired waterbodies:

Ten waterbodies contain sufficient quantities of contaminants to be listed as impaired by the EPA and the Maryland, Virginia and the District of Columbia under Section 303(d) (http://www.epa.gov/waters/data/downloads.html) in 2002 (Table 1). All of the waterbodies listed as impaired are upstream or adjacent to the George Washington MP (Figure 2). Additionally, nutrient impairments affect portions of the Potomac River. Sedimentation and siltation impairments are present in portions of the Potomac and Anacostia Rivers, Upper Watts Branch, and Kingman Lake.

Table 1. Contaminant-impaired waterbodies listed by the EPA in 2002 within a 10 kilometer buffer around George Washington MP.

Waterbody Name	River Length (km)	Size (km²)[a]	Impairment
Anacostia River	9.75		Unnamed Metals
	9.75		Priority Organics[b]
	9.75		Oil and Grease
Broad Branch	2.64		Priority Organics[b]
Dalecarlia Tributary		0.059	Priority Organics[b]
Kingman Lake	3.29		Oil and Grease
	3.29		Unnamed Metals
	3.29		Priority Organics[b]
Oxon Run	4.62		Unnamed Metals
	4.62		Priority Organics[b]
Potomac River	19.1		Priority Organics[b]
	24.8		Metals (Cu)
	3.46		Metals (Cd and Cr)
Rock Creek	15.1		Priority Organics[b]
	15.1		Unnamed Metals
Upper Watts Branch	0.014		Priority Organics[b]
Washington Ship Channel	3.37		Priority Organics[b]
Tidal Basin	1.17		Priority Organics[b]

[a] Size is listed for portions of surface waters that are impounded.
[b] Priority organics are defined and listed by the Clean Water Act as toxic organic pollutants.

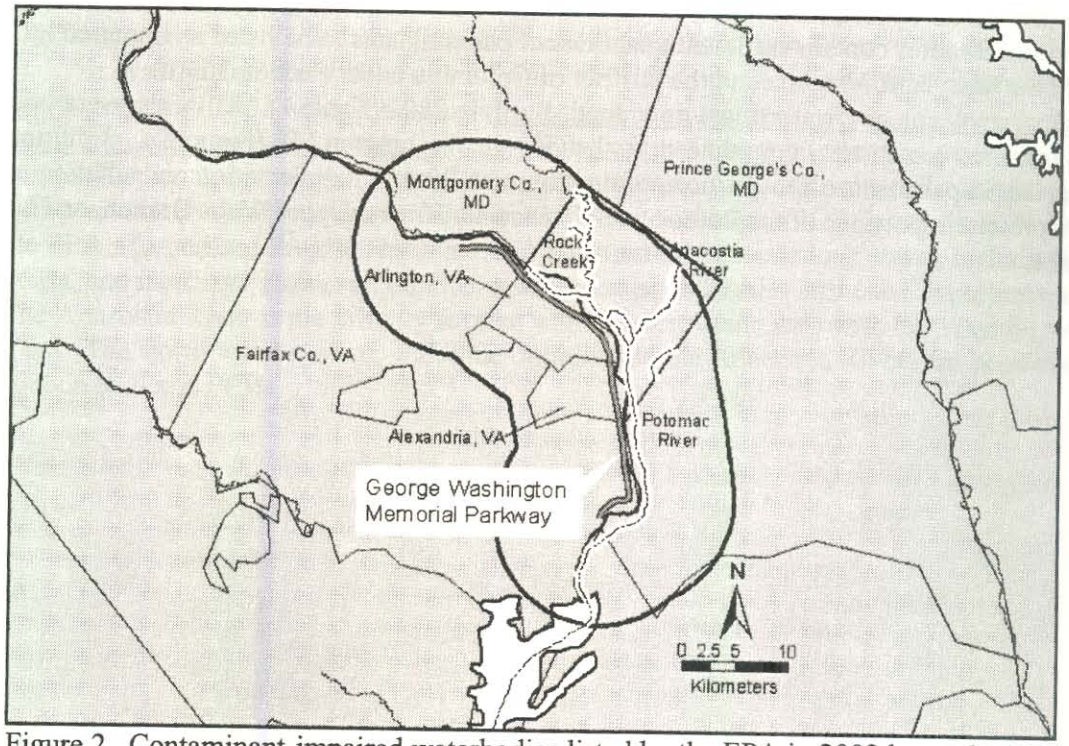

Figure 2. Contaminant-impaired waterbodies listed by the EPA in 2002 located within a 10 kilometer buffer around George Washington MP.

Studies involving Pesticides and Industrial Contaminants

1. New York State Department of Environmental Conservation. 1987. Wildlife Pathology Unit Necropsy Report #87-41-33(B).

A male red-shouldered hawk (*Buteo lineatus*) was found in Temple Hills, MD on March 18, 1987. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (1.93 µg/g ww) and transnonachlor (1.35 µg/g ww) were elevated, and dieldrin (11.3 µg/g ww) was in the lethal range. The cause of death was attributed to dieldrin intoxication.

2. New York State Department of Environmental Conservation. 1987. Wildlife Pathology Unit Necropsy Report #87-62-23.

In July 1987, a male common grackle (*Quiscalus quiscula*) was found in Accokeek, MD. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. Concentrations of chlordane metabolites oxychlordane (29 µg/g ww) and nonachlor (9.9 µg/g ww) were in the lethal range. The cause of death was attributed to organochlorine toxicosis.

3. New York State Department of Environmental Conservation. 1988. Wildlife Pathology Unit Necropsy Report #87-62-20.

In 1988, an immature male northern mockingbird (*Mimus polyglottus*) was found in Bethesda, MD. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (2.58 µg/g ww) and oxychlordane (4.52 µg/g ww) were in the lethal range. The cause of death was attributed to chlordane intoxication.

4. New York State Department of Environmental Conservation. 1989. Wildlife Pathology Unit Necropsy Report #89-07-33.

On April 23, 1989, an adult male American robin (*Turdus migratorius*) was found in Potomac, MD. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (5.51 µg/g ww) and oxychlordane (4.37 µg/g ww) were in the lethal range. The cause of death was attributed to chlordane intoxication.

5. New York State Department of Environmental Conservation. 1989. Wildlife Pathology Unit Necropsy Report #89-07-34.

An adult male American robin (*Turdus migratorius*) was found in Bethesda, MD on April 23, 1989. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (6.35 µg/g ww) and oxychlordane (4.10 µg/g ww) were in the lethal range. The cause of death was attributed to head trauma and possible chlordane intoxication.

6. Rattner, B.A., M.J. Melancon, C.P. Rice, W. Riley Jr., J. Eisemann, and R.K. Hines. 1997. Cytochrome P450 and organochlorine contaminants in black-crowned night-herons from the Chesapeake Bay Region, USA. Environmental Toxicology and Chemistry 16:2315-2322.

In 1991, black-crowned night-heron (*Nycticorax nycticorax*) pipping embryos were collected from several locations including a colony that nest in trees above the Smithsonian Institute National Zoological Park and feed along the Potomac and Anacostia Rivers. Hepatic microsomal activities of benzyloxyresorufin-*O*-dealkylase and ethoxyresorufin-*O*-dealkylase (biomarkers of exposure to polyhalogenated pollutants) were elevated in pipping embryos from Rock Creek Park colony compared to the reference site (Chincoteague National Wildlife Refuge). Concentrations of organochlorine pesticides and metabolites in pipping embryos were greater from the Rock Creek Park than at the reference site, but below the known threshold for reproductive impairment. However, concentrations of total PCBs, 10 arylhydrocarbon receptor-active PCB congeners and estimated toxic equivalents were significantly greater in embryos collected from Rock Creek Park compared to the reference site, with values for toxic congeners 77 and 126 exceeding those observed in heron embryos from the Great Lakes.

7. Rattner, B.A., P.C. McGowan, N.H. Golden, J.S. Hatfield, P.C. Toschik, R.F. Lukei Jr., R. C. Hale, I. Schmitz-Afonso, and C.P. Rice. 2004. Contaminant exposure and reproductive success of ospreys (*Pandion haliaetus*) nesting in Chesapeake Bay regions of concern. Archives of Environmental Toxicology and Chemistry 47:126-140.

The Chesapeake Bay osprey (*Pandion haliaetus*) population has more than doubled in size since restrictions were placed on the production and use of DDT and other toxic organochlorine contaminants in the 1970's. Ospreys are now nesting in the most highly polluted portions of the Bay. In 2000, contaminant exposure and reproduction were monitored in ospreys nesting in the Anacostia and Potomac Rivers. A "sample egg" from each study nest was collected for contaminant analysis, and the fate of eggs remaining in each nest (n=14) was monitored at 7-10 day intervals from egg incubation through fledging of young. Ospreys fledged young in the Washington, DC study sites (observed success: 0.88 fledglings/active nest), although productivity was marginal for sustaining the local population in the Anacostia and Potomac Rivers. Concentrations of total PCBs, some arylhydrocarbon receptor-active PCB and polybrominated diphenyl ether congeners were often greater in sample eggs from Anacostia and Potomac Rivers compared to the South River reference site. Nonetheless, logistic regression analyses did not provide evidence linking marginal productivity to *p,p'*-DDE, total PCBs or toxic PCB congener exposure.

8. Southeastern Cooperative Wildlife Disease Study. 1992. Clinical Necropsy Record #68-92, College of Veterinary Medicine, University of Georgia.

In March 1992, an adult male American kestrel (*Falco sparverius*) was found in Arlington, VA. The the concentration of DDE residue in the stomach contents was 2.17 ppm and in the kestrel's brain was 6.7 µg/g. The cause of death was undetermined. However, the possibility of carbamate pesticides could not be ruled out.

9. Stafford, C. J., W. L. Reichel, D. M. Swineford, R. M. Prouty, and M. L. Gay. 1978. Gas-liquid chromatographic determination of Kepone in field-collected avian tissues and eggs. *Journal of the Association of Official Analytical Chemists* 61(1):8-14.

Bald eagle (*Haliaeetus leucocephalus*) liver and carcasses collected (1968-1975) in Virginia and Maryland areas, including Accokeek, MD (n=2), were analyzed for kepone residues. Accokeek bald eagle liver and tissue contained 16.0 and 2.2 µg/g kepone, respectively. This was in the intermediate range of kepone residues from all areas and greater than eagles from Oklahoma and Minnesota (controls).

H. Toxic release facilities:

The EPA's Toxic Release Inventory Program lists nine toxic release facilities that discharged contaminants within 10 kilometers of George Washington MP from 1997 through 2003 (http://www.epa.gov/triexplorer/facility.htm). Of the nine facilities, three released persistent pollutants and chemicals listed by the EPA and United Nations (Table 3). The greatest diversity of pollutants and chemicals were released from Potomac River Generating Station including dioxins, lead and mercury.

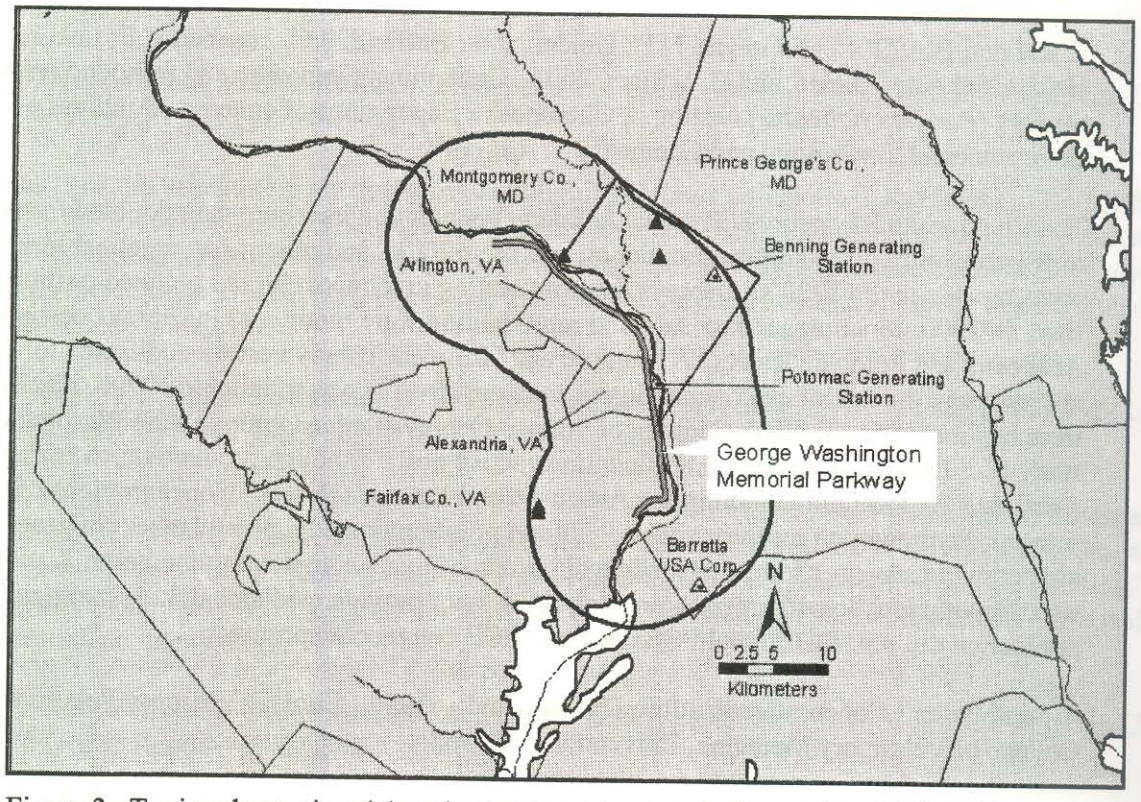

Figure 3. Toxic release sites (&) and priority contaminant release sites (3) listed by the EPA within a 10 kilometer buffer around George Washington MP for 1997 through 2003.

Table 3. Mean quantity of priority contaminants released by EPA-listed toxic release sites for 1997 through 2003 within a 10 kilometer buffer around George Washington MP.

Site Name	Address	Contaminant Released	Years Released	Air Release[a]	Surface Water Release[a]	Land Disposal[a]
Benning Generating Station	3400 Benning Rd., NE, Washington, DC	Dioxin Cmpds.	2000-02	0.0002836[b]	0	0
		Mercury	2000 & 03	4.5	0	0
Beretta USA Corp.	17601 Beretta Dr., Accokeek, MD	Lead Cmpds.	1997	0	2500	0
Potomac River Generating Station	1400 N Royal St., Alexandria, VA	Dioxin Cmpds.	2000-03	0.0463549[b]	0	0
		Mercury	2000-03	182.3	0.1	0
		Lead Cmpds.	2001-03	245.8	9	0

[a] Units are in lbs/yr unless otherwise noted.
[b] Units are in g/yr.

I. Fish consumption advisories:

The EPA's Water Program has listed four fish consumption advisories indicating the presence of persistent pollutants and chemicals within 10 kilometers of George Washington MP (Table 4) (http://www.epa.gov/waterscience/fish/advisories/index.html).

Table 4. Waterbodies with fish consumption advisories within a 10 kilometer buffer around George Washington MP.

Waterbody Name	State	Contaminant	Advisory	Year Issued
Potomac River	MD/VA	PCBs (Total)	Restricted & No Consumption	1999, 2001 & 2004
Potomac River	MD	Chlorinated Pesticides	Restricted & No Consumption	2001 & 2004
Statewide	MD	Mercury	Restricted Consumption	2004
Statewide	DC	PCBs (Total)	Restricted Consumption & No Consumption	1993 & 2004

III. CONCLUSIONS:

J. Persistent bio-accumulative toxic chemicals:

Numerous persistent pollutants and chemicals have been found or are being released within the 10 kilometer buffer surrounding George Washington MP including, lead, mercury, dioxins and dioxin-like compounds, PCBs and organochlorine pesticides. Eisler (2000) has described the hazards of these contaminants to wildlife.

K. Critical areas and Sensitive Species:

The Roaches Run Waterfowl Sanctuary, located adjacent to the Reagan National Airport, may provide habitat for some terrestrial vertebrates. However, previous observations by NPS employees indicated there was little wildlife use of the area (Kangas, personal communication). The Dyke Marsh Wildlife Preserve, located south of Alexandria, VA, is an area used by a variety of terrestrial vertebrates, with a majority being avian species. Almost all of the surface water flow through the marsh is from the Potomac River, which could expose individuals to priority organics and metals. The Potomac River Generating Station that releases dioxins and dioxin-like compounds, lead and

Gettysburg National Military Park & Eisenhower National Historic Site

I. BACKGROUND

Size: Gettysburg NMP: 2428 hectares
Eisenhower NHS: 271 hectares

Designation: Gettysburg National Military Park – February 11, 1895
Eisenhower National Historic Landmark – April 1966
Eisenhower National Historic Site – November 27, 1967

Setting/habitat: Gettysburg National Military Park (NMP)/Eisenhower National Historic Site (NHS) is located in the Gettysburg-Newark Lowland Section of the Northern Piedmont Province, consisting of low, rolling hills. Using the National Oceanic and Atmospheric Administration's 250 m (1990 urban-enhanced) Land Use Land Cover data (1999), the environment surrounding Gettysburg NMP/Eisenhower NHS is classified as: 82.8% agricultural; 14.6% forested; 2.0% urban or built-up; 0.5% barren lands; and 0.1% water.

Past land uses: Military activities and subsistence farming

II. CURRENT AND POTENTIAL ENVIRONMENTAL CONTAMINATION

A. Known Contaminated sites:
There are no known contaminated sites located on Gettysburg NMP/Eisenhower NHS property. There are two Environmental Protection Agency (EPA) National Priorities List (NPL) Superfund sites located within 10 kilometers of Gettysburg NMP/Eisenhower NHS. However, most remedial action has been completed at these sites. A small percentage (< 1%) of the surface waters within 10 kilometers of the park are listed as impaired by the Environmental Protection Agency (EPA).

B. NPL Superfund sites:
There are no current NPL Superfund sites that require further remedial action. However, at the Shriver's Corner site (Straban Township) and the Westinghouse Elevator Co. Plant (Gettysburg) (http://cfpub.epa.gov/supercpad/cursites/srchsites.cfm) continued groundwater treatment to remove volatile organic compounds to reach drinking water standards is required.

C. Impaired waterbodies:
The EPA and the Pennsylvania Department of Environmental Protection (PADEP) under Section 303(d) (http://www.epa.gov/waters/data/downloads.html) listed two waterbodies as impaired in 2002 within 10 kilometers of Gettysburg NMP/Eisenhower NHS. The Willoughby Run and Upper Monacacy are not impaired by contaminants but are impaired from low dissolved oxygen and from siltation.

D. Pesticides, herbicides, rodenticides, avicides used:
Fourteen pesticide or herbicide products that were applied at Gettysburg NMP/Eisenhower NHS in 2004 contained active ingredients that are recognized as being moderately to very highly toxic to terrestrial vertebrates (Table 1). Toxicity rating classes are: 0 = not toxic; 1 = slightly toxic; 2 = moderately toxic; 3 = highly toxic; 4 = very highly toxic. Rating classes are not reported for reptilian species due to the limited availability of toxicity data for most active ingredients.

Table 1. Moderately to very highly toxic pesticides, herbicides, rodenticides, and avicides to terrestrial vertebrates that were applied at Gettysburg NMP/Eisenhower NHS property in 2004.

Active Ingredient	Product	Applied Acres	Mammals	Birds	Amphibians	Reference Cited[a]
2,4-Dichlorophenoxyacetic Acid	Weedone LV4 Solventless	227	2	2	1	1, 3
2-Methoxy-3,6-Dichlorobenzoic Acid	Banvel Herbicide	37.16	1	2	0	1, 3
Fluazifop-Butyl	Fusilade DX	16	0-1	0-1	4[b]	1
Glyphosate	Accord Concentrate	14.82	0-1	0-1	0-2[b]	1, 2, 3
	Roundup Pro	46.40				
	Touchdown	101.66				
	Glyphomax Plus	24				
	Roundup	20				
	Glypro	12.5				
	Roundup Weathermax	24				
Linuron	Lorox DF	20	0-1	1-2	1-2[b]	1, 2, 3
Metolachlor	Dual II Magnum	181	1	0-1	1-2[b]	1, 2, 3
Pendimethalin	Prowl 3.3 EC	114.06	0-1	1	2-3[b]	1, 2, 3
Propiconazole	Tilt	29.7	1	1	2-3[b]	1, 3

[a] References cited: 1. Sparling *et al.* 2000; Smith 1987; Hudson, *et al.* 1984; Schafer *et al.* 1983) 2. EPA Pesticide Registration website: http://cfpub.epa.gov/oppref/rereg/status.cfm?show=rereg 3. Pesticide Action Network of North America website: http://www.pesticideinfo.org/Index.html

[b] Toxicity ratings were derived from fish lethal concentrations to cause 50% mortality.

E. Solid waste or wastewater disposal sites:

There are no permitted solid waste disposal sites located within the 10 kilometer buffer around Gettysburg NMP/Eisenhower NHS (http://www.dep.state.pa.us/dep/deputate/airwaste/wm/default.htm). There are three wastewater treatment facilities located within this same area (http://cfpub.epa.gov/cwns/standard.cfm). Both the Littlestown Borough and New Oxford Municipal facilities were given an "unacceptable" score by the Chesapeake Bay Foundation (2003) because of the high nitrogen concentrations (> 8.1 mg/l) discharged at the sites. In addition, the Gettysburg Municipal Authority operates the Rock Creek Facility that was designated as "needing improvement" due to high nitrogen concentrations (5.1-8.0 mg/l).

F. Terrestrial vertebrate contaminant research or monitoring:

Currently, there is no known contaminant monitoring or ecotoxicological research being conducted on terrestrial vertebrates within the 10 kilometer buffer surrounding Gettysburg NMP/Eisenhower NHS. Historically, research has been conducted to determine the level of metals in white-tailed deer collected within 1 kilometer of Gettysburg NMP and from throughout Adams County.

III. CONCLUSIONS:

I. Persistent bio-accumulative toxic chemicals:

There are no persistent bio-accumulative toxic chemicals being released by TRI sites or cause impairments in waterbodies within the buffer. However, active fish consumption advisories in Maryland and Pennsylvania for mercury indicate that this metal may be present. Eisler (2000) has described the hazards of these contaminants to wildlife.

J. Critical Area and Sensitive Species:

The bald eagle (*Haliaeetus leucocephalus*) is a federally threatened species that has been sighted over the park. Additionally, the least shrew (*Cryptotis parva*) is a threatened species in Pennsylvania that has been identified within Gettysburg NMP. They inhabit fields and meadows (http://animaldiversity.ummz.umich.edu/site/accounts/information/cryptotis_parva.html), where their diet includes insects, earthworms, slugs and snails. The carnivorous food habits may leave this species susceptible to contaminant exposure.

K. Additional priority contaminant monitoring/research:

The Gettysburg NMP/Eisenhower NHS were found to have current sources for contamination within 10 kilometers of their boundaries in this study. The pesticide and herbicide use (primarily from the agricultural leases) at these sites is moderate with some of the active ingredients being potentially toxic to amphibians. In light of this information, runoff streams and fields should be surveyed after application of pesticides and herbicides and monitoring of amphibian populations should take place to estimate the effect of these contaminants. Historically, NPL Superfund Sites were located within 10 kilometers. However, those sites have been or are undergoing remediation. Metal levels have been analyzed in white-tailed deer from the area. Except for Palmerton, PA, levels of metals were comparable to other counties in Pennsylvania. Upon discovery of a contaminated site, samples from terrestrial vertebrates should be collected to determine the level of exposure.

Harper's Ferry National Historical Park

I. BACKGROUND

Size: 1539 hectares

Designation: National Historical Park - May 29, 1963
National Monument - June 30, 1944

Setting/habitat: Harper's Ferry National Historical Park (NHP) is located where the Shenandoah and Potomac Rivers converge in the Piedmont Province of Maryland, West Virginia and Virginia. Using the National Oceanic and Atmospheric Administration's 250 m (1990 urban-enhanced) Land Use Land Cover data (1999), the environment surrounding Harper's Ferry NHP is classified as: 66.6% agricultural; 25.0% forested; 4.9% urban; 2.9% water; and 0.6% barren lands.

Past land uses: Military Operations and Industrial Community

II. CURRENT AND POTENTIAL ENVIRONMENTAL CONTAMINATION

A. Known contaminated sites:

The Environmental Protection Agency (EPA) has listed one contaminant-impaired waterbody, Shenandoah River, within the 10 kilometer that surrounds Harper's Ferry NHP. Overall, only 20.4% of the surface waters within 10 kilometers of the park are listed as impaired by the EPA under the Clean Water Act Section 303(d).

B. NPL Superfund sites:

There are no current EPA National Priorities List (NPL) Superfund sites located within 10 kilometers of Harper's Ferry NHP.

C. Impaired waterbodies:

The Shenandoah River contained sufficient quantities of PCBs to be listed as impaired by the EPA and West Virginia Department of Environmental Protection (WVDEP) under Section 303(d) (http://www.epa.gov/waters/data/downloads.html) in 2002 for 19.5 kilometers. The Shenandoah River flows through Harper's Ferry NHP property (Figure 1). Additionally, nutrient and sedimentation/siltation impairments affect portions of the Antietam and Catoctin Creeks and the Potomac River.

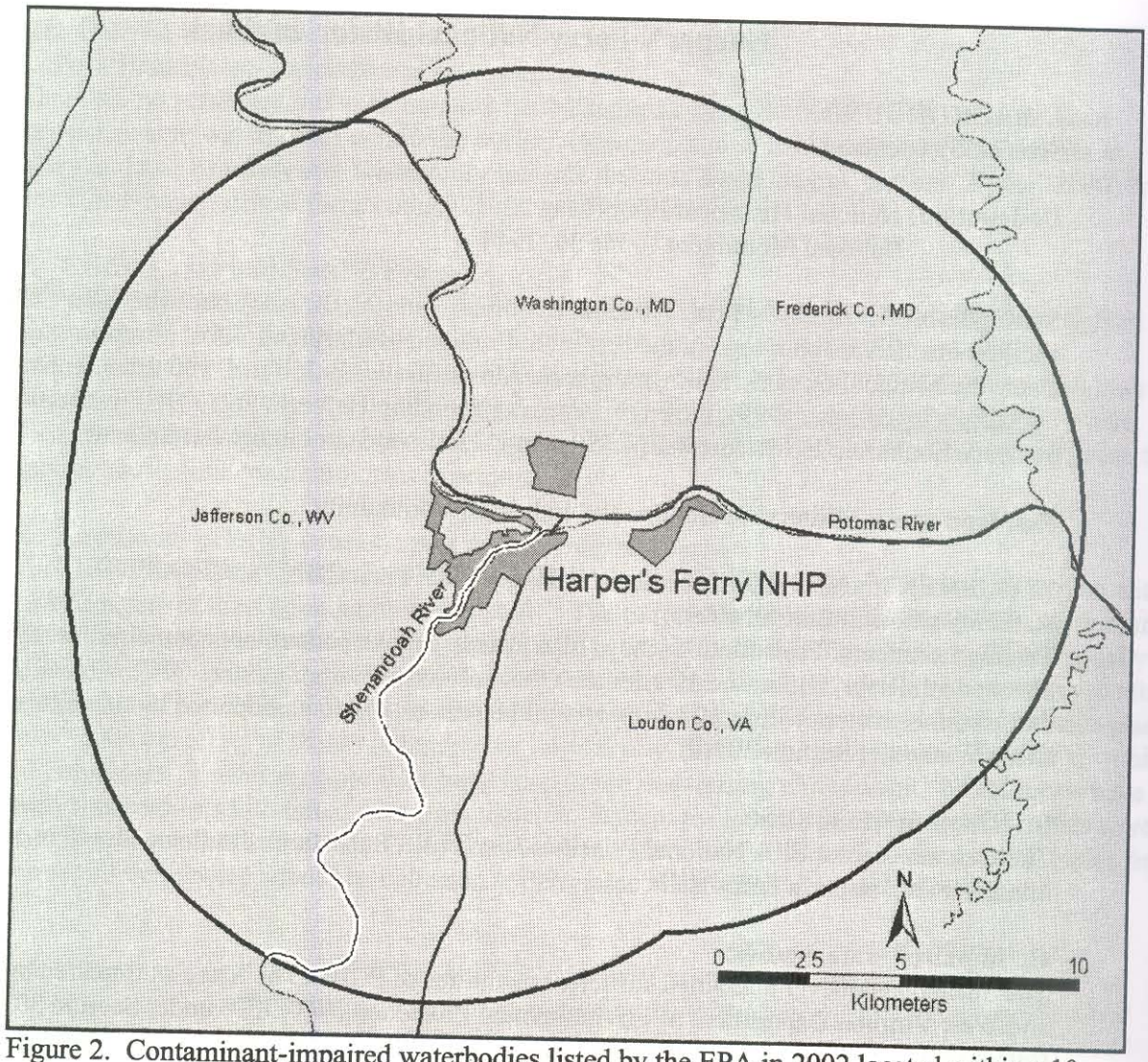

Figure 2. Contaminant-impaired waterbodies listed by the EPA in 2002 located within a 10 kilometer buffer around Harper's Ferry NHP.

D. Pesticides, herbicides, rodenticides, avicides used:
Six pesticide or herbicide products that were applied at Harper's Ferry NHP in 2004 contained active ingredients recognized as being moderately to very highly toxic to terrestrial vertebrates (Table 1). Toxicity rating classes are: 0 = not toxic; 1 = slightly toxic; 2 = moderately toxic; 3 = highly toxic; 4 = very highly toxic. Rating classes are not reported for reptilian species due to the limited availability of toxicity data for most active ingredients.

Table 1. Moderately to very highly toxic pesticides, herbicides, rodenticides, and avicides to terrestrial vertebrates that were applied at Harper's Ferry NHP property in 2004.

Active Ingredient	Product	Applied Acres	Mammals	Birds	Amphibians	Reference Cited[a]
2,4-Dichlorophenoxyacetic Acid	2,4-D Lo V Ester Weed Killer	48	2	2	1	1, 3
Glyphosate	Roundup Pro	5.25	0-1	0-1	0-2[b]	1, 2, 3
	Roundup Weathermax	137.6				
Metolachlor	Dual Magnum	48	1	0-1	1-2[b]	1, 2, 3
Oryzalin	Surflan A.S.	1.1	0	1-2	2[b]	1, 2, 3
Pendimethalin	Prowl 3.3 EC	137.6	0-1	1	2-3[b]	1, 2, 3

[a] References cited: 1. Sparling *et al.* 2000; Smith 1987; Hudson, *et al.* 1984; Schafer *et al.* 1983) 2. EPA Pesticide Registration website: http://cfpub.epa.gov/oppref/rereg/status.cfm?show=rereg 3. Pesticide Action Network of North America website: http://www.pesticideinfo.org/Index.html

[b] Toxicity ratings were derived from fish lethal concentrations to cause 50% mortality.

E. Solid waste or wastewater disposal sites:

There are no solid waste acceptance facilities that are permitted located within 10 kilometers of Harper's Ferry NHP (http://www.deq.viriginia.gov/waste/aswrs.html). However, at least four municipal wastewater treatment plants are located within the boundary of the 10 kilometer buffer, including Harper's Ferry, Sandy Hook, Charles Towne, and Brunswick Wastewater Treatment Facilities (http://cfpub.epa.gov/cwns/standard.cfm).

E. Terrestrial vertebrate contaminant research or monitoring:

Currently, there are no known contaminant monitoring or ecotoxicological research data collected on terrestrial vertebrates within the 10 kilometer buffer surrounding Harper's Ferry NHP.

F. Toxic release facilities:

The EPA's Toxic Release Inventory Program lists three toxic release facilities that discharged contaminants (http://www.epa.gov/triexplorer/facilities.htm) within 10 kilometers of Harper's Ferry NHP from 1997 through 2003 (Figure 2). Two of these facilities released lead or lead compounds by way of air pathways (Table 2).

Table 2. Mean quantity of priority contaminants released by EPA-listed toxic release sites for 1997 through 2003 within a 10 kilometer buffer around Harper's Ferry NHP.

Site Name	Address	Contaminant Released	Years Released	Air Release[a]	Surface Water Release[a]	Land Disposal[a]
Kidde Fire Fighting	205 N Mildred St., Ranson, WV	Lead Cmpds.	1997-02	148	0	0
Dalb Inc.	105 Industrial Blvd. Kearneysville, WV	Lead Cmpds.	2002	134	0	0

[a] Units are in lbs/yr unless otherwise noted.

[b] Units are in g/yr.

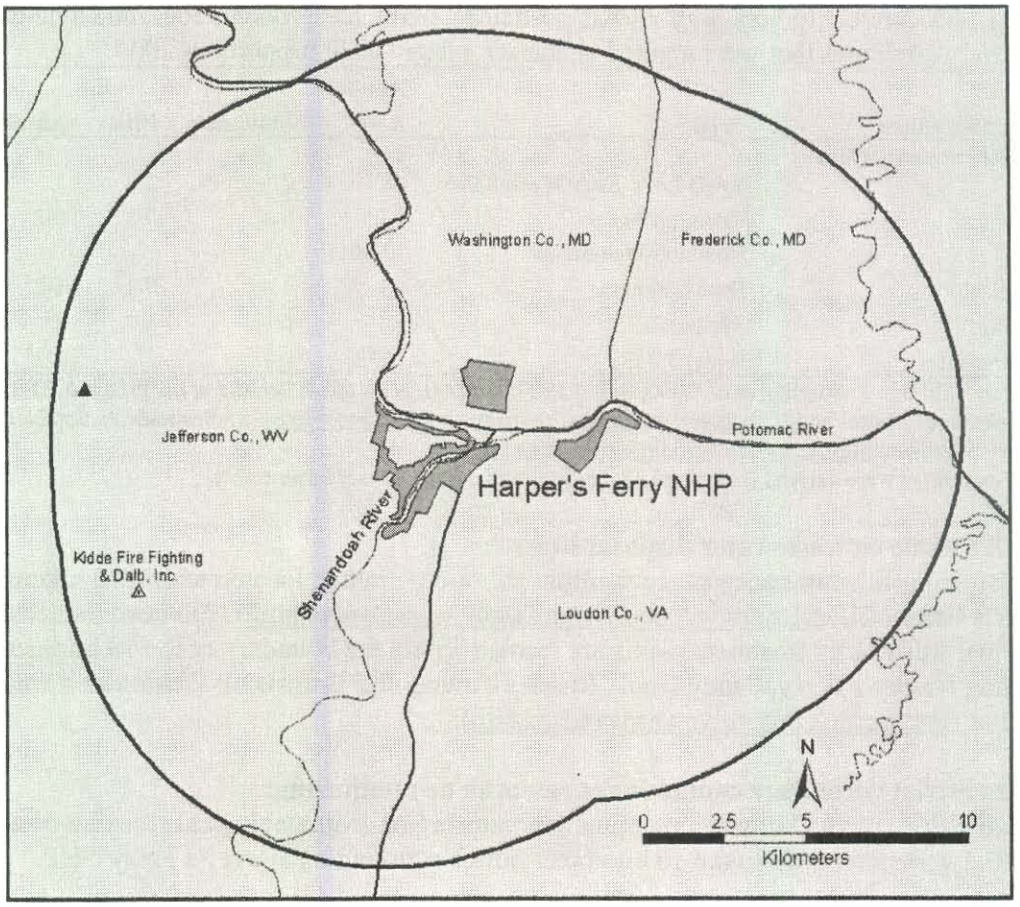

Figure 2. Toxic release sites (▲) and priority contaminant release sites (3) listed by the EPA within a 10 kilometer buffer around Harper's Ferry NHP for 1997 through 2003.

H. Fish consumption advisories:

The EPA's Water Program has listed two fish consumption advisories that indicate the presence of persistent pollutants and chemicals within 10 kilometers of Harper's Ferry NHP (Table 3) (http://www.epa.gov/waterscience/fish/advisories/index.html).

Table 3. Waterbodies with fish consumption advisories within a 10 kilometer buffer around Harper's Ferry NHP.

Waterbody Name	State	Pollutant	Advisory	Year Issued
Shenandoah River	WV/VA	PCBs	No Consumption	1993 & 2004
Statewide	MD	Mercury	Restricted Consumption	2004

III. CONCLUSIONS:

I. Persistent bio-accumulative toxic chemicals:

Lead and PCBs have been found or are being released within the 10 kilometer buffer surrounding Harper's Ferry NHP. Eisler (2000) has described the hazards of these contaminants to wildlife.

J. Critical Areas and Sensitive Species:
Peregrine falcons (*Falco peregrinus*) have been released at the Maryland Heights backcountry area of Harper's Ferry NHP. This critical area towers over the junction of the Shenandoah and Potomac Rivers. Bald eagles (*Haliaeetus leucocephalus*) have also been sighted over Harper's Ferry NHP.

K. Additional priority contaminant monitoring/research:
There have been no studies examining contaminants in terrestrial vertebrates. However, the presence of lead and PCBs (i.e. impaired waterbodies and fish advisories) in the Shenandoah River indicate these pollutants may be available to terrestrial vertebrates at Harper's Ferry NHP. The exposure of terrestrial vertebrates to these persistent contaminants has not been looked at and future research may aid in identifying the risk. In particular, with the release of peregine falcons within Harper's Ferry property, monitoring of the PCB residues in tissue and eggs may be warranted.

Hopewell Furnace National Historic Site

I. BACKGROUND

Size: 343 hectare

Designation: Hopewell Furnace National Historic Site - September 19, 1985
Hopewell Village National Historic Site - August 3, 1938

Setting/habitat: Hopewell Furnace National Historic Site (NHS) is located in the Schuylkill River Watershed with French Creek being the primary drainage to the Schuylkill River. Hopewell Furnace NHS consists of steep slopes or rolling hills typical of the Northern Piedmont Province. Using the National Oceanic and Atmospheric Administration's 250 m (1990 urban-enhanced) Land Use Land Cover data (1999), the environment surrounding Hopewell Furnace NHS is classified as: 45.8% forested; 43.6% agricultural; 10.1% urban or built-up; 0.4% water; and 0.1% barren lands.

Past land uses: This property operated as an iron plantation and farming community until 1883. The property remained in private ownership until 1938 when it became designated as a national historic site.

II. CURRENT AND POTENTIAL ENVIRONMENTAL CONTAMINATION

A. Known contaminated sites:

There are no known contaminated sites located on or within 10 kilometers of Hopewell Furnace NHS property. The Environmental Protection Agency (EPA) has listed 26.68% of the surface waters within 10 kilometers of the park as impaired under the Clean Water Act Section 303(d).

B. NPL Superfund sites:

There are currently no Environmental Protection Agency (EPA) National Priorities List (NPL) Superfund sites that have not completed remediation actions.

C. Impaired waterbodies:

The Schuylkill River is the only waterbody within the 10 kilometer buffer of Hopewell Furnace NHS that is impaired by contaminants according to the EPA and Pennsylvania Department of Environmental Protection (PADEP) (http://www.epa.gov/waters/data/downloads.html) (Figure 1). Under Section 303(d) this waterbody is contaminated for 27.05 kilometers with PCBs, pesticides and metals. In addition, the Conestoga Creek, French Creek, Manatawny Creek and Schuylkill River are impaired by nutrients, low dissolved oxygen, and/or thermal modifications.

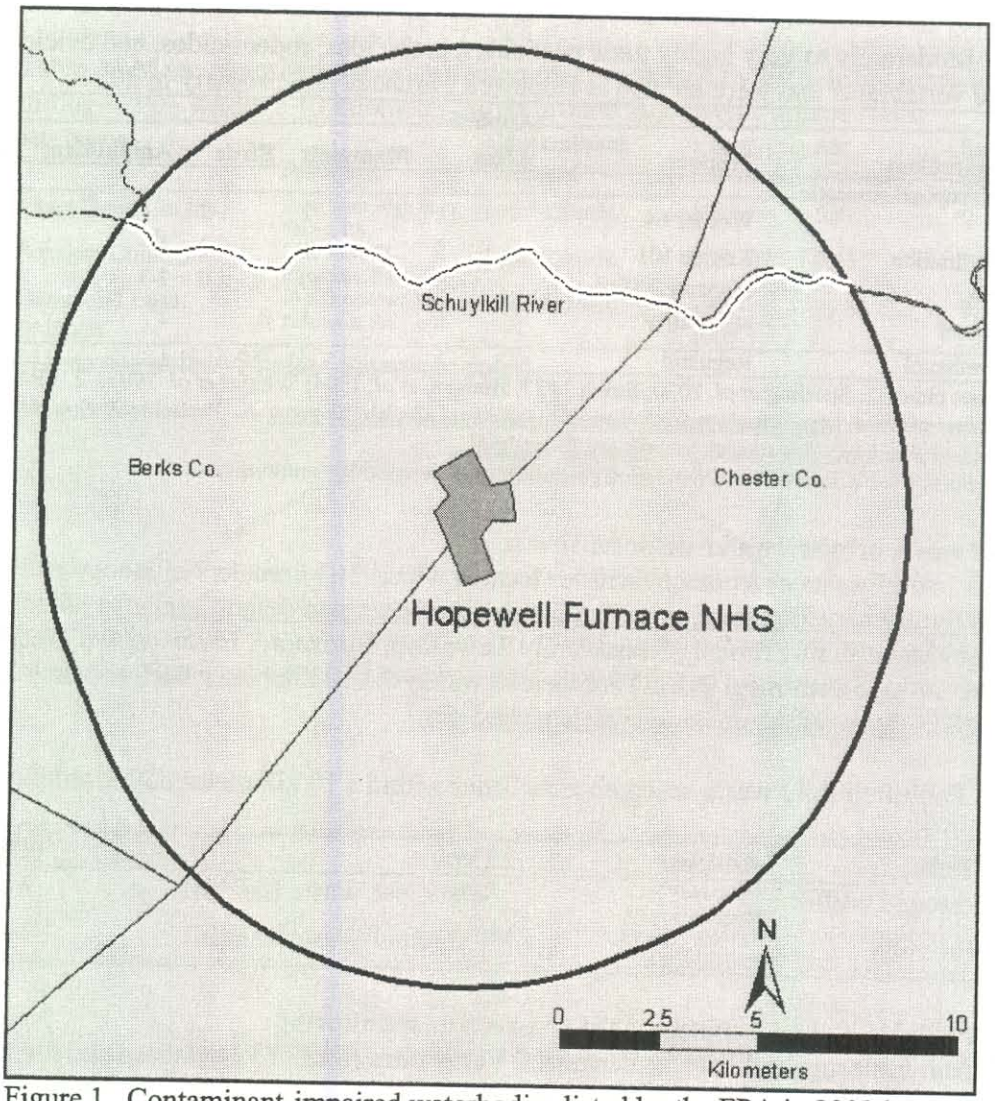

Figure 1. Contaminant-impaired waterbodies listed by the EPA in 2002 located within a 10 kilometer buffer around Hopewell Furnace NHS.

D. Pesticides, herbicides, rodenticides, avicides used:
Five pesticide or herbicide products that were applied at Hopewell Furnace NHS in 2004 contained active ingredients recognized as being moderately to very highly toxic to terrestrial vertebrates (Table 1). Toxicity rating classes are: 0 = not toxic; 1 = slightly toxic; 2 = moderately toxic; 3 = highly toxic; 4 = very highly toxic. Rating classes are not reported for reptilian species due to the limited availability of toxicity data for most active ingredients.

Table 3. Mean quantity of priority contaminants released by EPA-listed toxic release sites for 1997 through 2003 within a 10 kilometer buffer around Hopewell Furnace NHS.

Site Name	Address	Contaminant Released	Years Released	Air Release[a]	Surface Water Release[a]	Land Disposal[a]
Flagg Brass Co. Inc.	1020 West High St., Stowe, PA	Lead Cmpds.	1997	500	0	0
Sensient Colors Inc.	2529 Main St., Birdsboro, PA	Lead Cmpds.	2001-02	0.45	2.60	12.50
Hammond Lead Products	10 S Grosstown Rd., Pottstown, PA	Lead Cmpds.	1997-2003	29.33	0.5 (2003 only)	0

[a] Units are in lbs/yr unless otherwise noted.

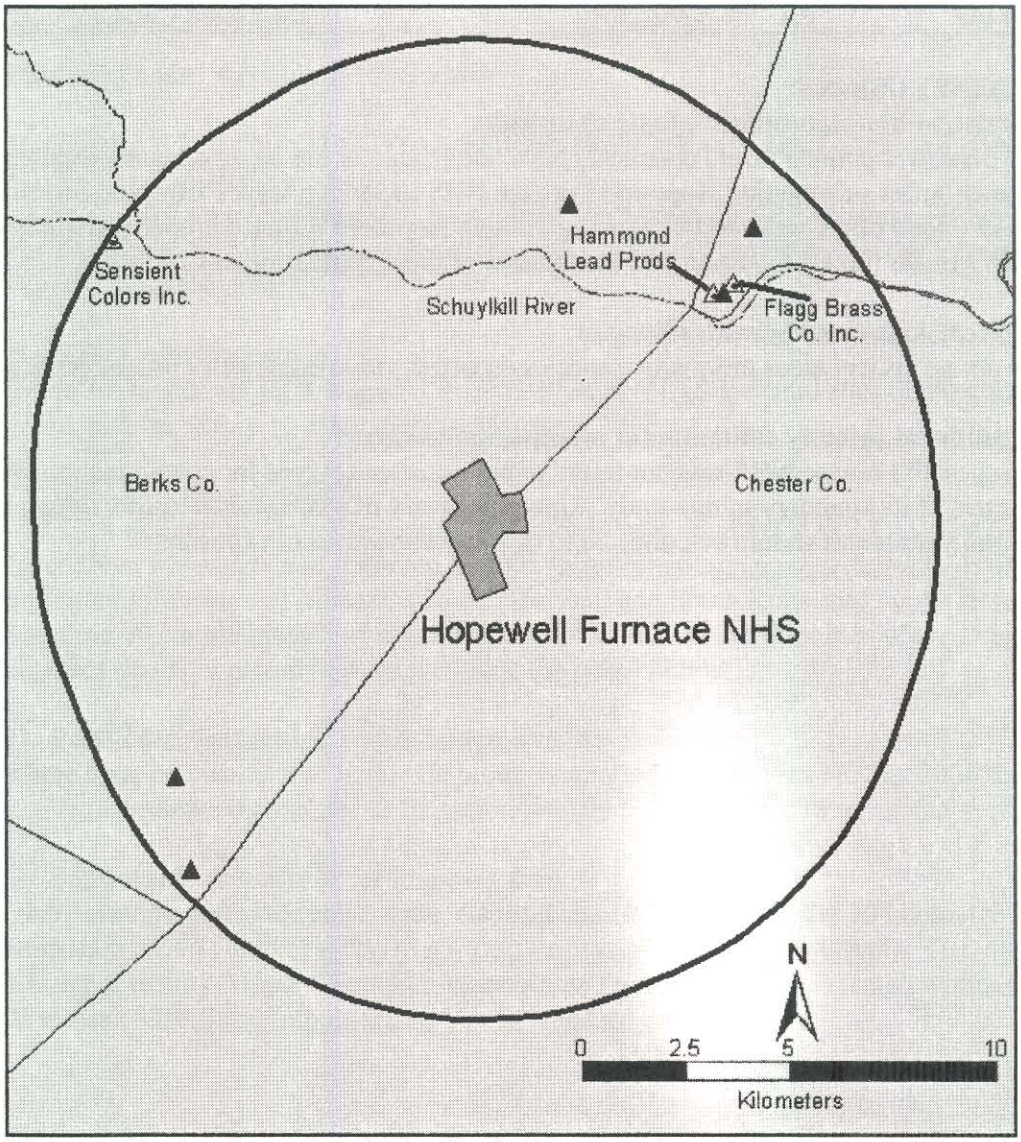

Figure 2. Toxic release sites (▲) and priority contaminant release sites (3) listed by the EPA within a 10 kilometer buffer around Hopewell Furnace NHS for 1997 through 2003.

H. Fish consumption advisories:
The EPA's Water Program has listed two fish consumption advisories that indicate the presence of persistent pollutants and chemicals within 10 kilometers of Hopewell Furnace NHS (Table 4) (http://www.epa.gov/waterscience/fish/advisories/index.html).

Table 4. Waterbodies with fish consumption advisories within a 10 kilometer buffer around Hopewell Furnace NHS.

Waterbody Name	State	Pollutant	Advisory	Year Issued
Schuylkill River	PA	PCBs	Restricted & No Consumption	1993-1999
Statewide	PA	Mercury	Restricted Consumption	2001

III. CONCLUSIONS:

I. Persistent bio-accumulative toxic chemicals:
Three persistent pollutants and chemicals have been found or are being released within the 10 kilometer buffer surrounding Hopewell Furnace NHS including, lead, PCBs, and mercury. However, none of the waterbodies flowing through Hopewell Furnace property are listed as impaired by EPA. Eisler (2000) has described the hazards of these contaminants to wildlife.

J. Critical Areas and Sensitive Species:
There are no critical areas or sensitive species reported within Hopewell Furnace NHS's boundary.

K. Additional priority contaminant monitoring/research:
The Hopewell Furnace NHS was not found to have current sources for contamination within 10 kilometers of its boundary in this study. Upon discovery of a contaminated site, samples from terrestrial vertebrates should be collected to determine the level of exposure.

Manassas National Battlefield Park

I. BACKGROUND

Size: 2053 hectares

Designation: National Battlefield Park–1940

Setting/habitat: Manassas National Battlefield Park (NBP) is located in the Piedmont Province of Virginia. Using the National Oceanic and Atmospheric Administration's 250 m (1990 urban-enhanced) Land Use Land Cover data (1999), the environment surrounding Manassas NBP is classified as: 37.8% agricultural; 31.7% urban or residential; 29.5% forested; 0.5% water; and 0.4% barren lands.

Past land uses: Agricultural operations

II. CURRENT AND POTENTIAL ENVIRONMENTAL CONTAMINATION

B. Known Contaminated sites:

There are no known contaminated sites located on Manassas NBP property. However, 3.67% of the surface waters within 10 kilometers of the park are listed as impaired by the Environmental Protection Agency (EPA).

B. NPL Superfund sites:

There are no current EPA National Priorities List (NPL) Superfund sites that require further remedial action located within 10 kilometers of Manassas NBP.

C. Impaired waterbodies:

The EPA and the Virginia Department of Environment Quality (VADEQ) under Section 303(d) listed three waterbodies as impaired in 2002 (http://www.epa.gov/waters/data/downloads.html) within 10 kilometers of Manassas NBP. The Bull and South Runs, and Popes Head Creek are not impaired by contaminants but are impairing the biological communities of the streams. Bull Run's segment that is impaired does begin inside the park boundaries.

D. Pesticides, herbicides, rodenticides, avicides used:

There were no pesticide or herbicide products applied at Manassas NBP in 2004 that contained active ingredients recognized as being moderately to highly toxic to terrestrial vertebrates.

E. Solid waste or wastewater disposal sites:

There are four permitted solid waste disposal sites located within the 10 kilometer buffer around Manassas NBP (Table 1) (http://www.deq.virginia.gov/waste/aswrs.html). There is one wastewater treatment facility, Upper Occoquan Wastewater Treatment Facility located within 10 kilometer of Manassas NBP (http://cfpub.epa.gov/cwns/standard.cfm).

Table 1. Permitted solid waste disposal sites within a 10 kilometer buffer around Manassas NBP.

Facility Name	Address	Type	Ownership
Loudon Yard Waste Composting Facility	44150 Wade Dr., Chantilly, VA	Yard Waste Composting Facility	Private
Manassas Transfer Station	8305 Quarry Rd., Manassas, VA	Transfer Station	Govt.
Prince William Hospital RMW Facility	8700 Sudley Rd., Manassas, VA	RMW Steam Sterilization	Private
Upper Occoquan Sewer Authority Landfill	14631 Compton Rd., Centerville, VA	Captive Industrial Landfill	Govt.

[a] RMW includes all regulated medical waste.

F. Terrestrial vertebrate contaminant research or monitoring:
No current contaminant monitoring or ecotoxicological research projects have been conducted on terrestrial vertebrates within the 10 kilometer buffer surrounding Manassas NBP. Birdsall *et al.* (1986) determined lead concentrations in tissues of amphibians within the 10 kilometer buffer surrounding Manassas NBP.

1. Birdsall, C.W., C. E. Grue, and A. Anderson. 1986. Lead concentrations in bullfrog *Rana catesbeiana* and green frog *R. clamitans* tadpoles inhabiting highway drainages. Environmental Pollution (Series A) 40:233-247.

In 1982 lead concentrations were determined in green frog and bull frog tadpoles from highway ditches, including Fairfax County, VA. Frog tissues from both species collected in drainages along highways contained much higher concentrations of lead than those collected from control ponds in Maryland (Highway = bull frog range = 0.7 to 270 µg/g dw; green frog range = 4.8 to 240 µg/g dw. Control = bull frog range = 2.6 to 6.0 µg/g dw; green frog range = 0.90 to 8.9 µg/g dw).

H. Toxic release facilities:
The EPA's Toxic Release Inventory Program lists eight toxic release facilities that discharged contaminants within 10 kilometers of Manassas NBP from 1997 through 2003 (http://www.epa.gov/triexplorer) (Figure 1). Three of these facilities released priority persistent contaminants or pollutants listed by the EPA or United Nations (Table 2).

Table 2. Mean quantity of priority contaminants released by EPA-listed toxic release sites for 1997 through 2003 within a 10 kilometer buffer around Manassas NBP.

Ref. No.	Site Name	Address	Contaminant Released	Years Released	Air Release[a]	Surface Water Release[a]	Land Disposal[a]
1	Atlantic Research Corp.	5945 Wellington Rd., Gainesville, VA	Lead Cmpds.	2001-03	0.97	0	0
2	Benchmark Electronics	8500 Phoenix Drive, Manassas, VA	Lead Cmpds.	2001	1	0	0
3	Hanson Pipe and Products, Inc.	7816 Bethlehem Rd., Manassas, VA	Lead Cmpds.	2001-03	1.51	0	0

[a] Units are in lbs/yr unless otherwise noted.

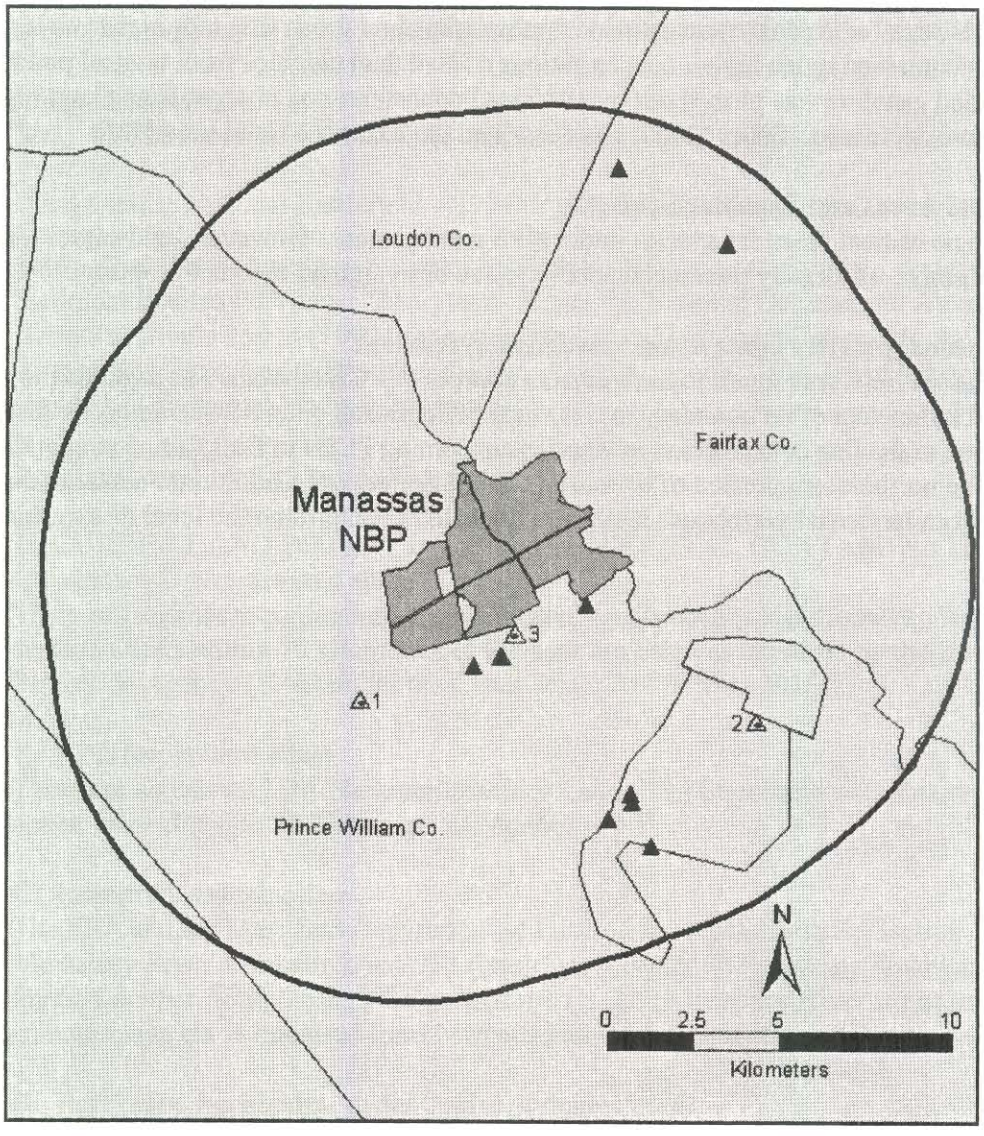

Figure 1. Toxic release sites (▲) and priority contaminant release sites (3) listed by the EPA within a 10 kilometer buffer around Manassas NBP for 1997 through 2003.

H. Fish consumption advisories:

The EPA's Water Program (http://www.epa.gov/waterscience/fish/advisories/index.html) has listed a fish consumption advisory within 10 kilometers of Manassas NBP. Bull Run fish tissue contained sufficient concentrations of PCBs to warrant restricted and no consumption in 2004.

III. CONCLUSIONS:

I. Persistent bio-accumulative toxic chemicals:

No persistent pollutants or chemicals are the cause of impaired waterbodies within 10 kilometers of Manassas NBP. However, a fish consumption advisory was issued because of the amount of PCBs in fish tissue from Bull Run. Lead is the only persistent bio-accumulative toxic chemical being released by TRI sites and the amount of lead released by way of air at three TRI sites is a very low

amount. Birdsall *et al.* (1986) determined that bull frog and green frog tadpoles from highway drainages contained much higher concentrations of lead than tadpoles from control ponds. However, since leaded gasoline was phased out by 1986 lead concentrations in organisms along highways should have decreased. Eisler (2000) has described the hazards of lead to wildlife.

J. Critical Areas and Sensitive Species:
There are no critical areas for species under NPS management. However, bald eagles (*Haliaeetus leucocephalus*), a federally threatened species, have been sighted over the property.

K. Additional priority contaminant monitoring/research:
The Manassas NBP was found to have current sources of PCBs that may be available to wildlife within 10 kilometers of its boundary in this study. Monitoring may be warranted for piscivorous species due to the fish consumption advisories concerning PCBs in Bull Run, a stream that runs through the northeastern portion of the park. Upon discovery of a additional contaminated sites, samples from terrestrial vertebrates should be collected to determine the level of exposure.

Monacacy National Battlefield

I. BACKGROUND

Size: 667 hectares

Designation: National Battlefield – 1934 (legislative boundary)

Setting/habitat: Monocacy National Battlefield (NB) is located in the Lowland Section of the Piedmont Plateau Province of Maryland. Using the National Oceanic and Atmospheric Administration's 250 m (1990 urban-enhanced) Land Use Land Cover data (1999), the environment surrounding Monocacy NB is classified as: 63.8% agricultural; 18.3% urban or residential; 16.5% forested; 1.3% barren lands; 0.2% water.

Past land uses: Agricultural and military operations

II. CURRENT AND POTENTIAL ENVIRONMENTAL CONTAMINATION

C. Known Contaminated sites:

There are no known contaminated sites located on Monocacy NB property. With only 5.87% of the surface waters within 10 kilometers of the park are listed as impaired by the Environmental Protection Agency (EPA) under the Clean Water Act Section 303(d).

B. NPL Superfund sites:

There are no current EPA National Priorities List (NPL) Superfund sites that require further remedial action located within 10 kilometers of Monocacy NB.

C. Impaired waterbodies:

The EPA and the Maryland Department of Environment (MDE) under Section 303(d) listed Monacacy River as impaired in 2002 (http://www.epa.gov/waters/data/downloads.html), including the portion that flows through the park property. The Monacacy River is not impaired by contaminants but is impaired from both nutrients and sedimentation/siltation.

D. Pesticides, herbicides, rodenticides, avicides used:

Seven pesticide or herbicide products that were applied at Monocacy NB in 2004 contained active ingredients recognized as being moderately to very highly toxic to terrestrial vertebrates (Table 1). Toxicity rating classes are: 0 = not toxic; 1 = slightly toxic; 2 = moderately toxic; 3 = highly toxic; 4 = very highly toxic. Rating classes are not reported for reptilian species due to the limited availability of toxicity data for most active ingredients.

Table 1. Moderately to very highly toxic pesticides, herbicides, rodenticides, and avicides to terrestrial vertebrates that were applied at Monocacy NB property in 2004.

Active Ingredient	Product	Applied Acres	Mammals	Birds	Amphibians	Reference Cited[a]
2,4-Dichlorophenoxyacetic Acid	Crossbow	64	2	2	1	1, 3
2-Methoxy-3,6-Dichlorobenzoic Acid	Banvel	31	1	2	0	1, 3
Glyphosate	Roundup Ultra Max	446	0-1	0-1	0-2[b]	1, 2, 3
	Roundup Pro	30				
	Rodeo	26				
Metolachlor	Dual II Magnum	324	1	0-1	1-2[b]	1, 2, 3
Pendimethalin	Prowl	90	0-1	1	2-3[b]	1, 2, 3

[a] References cited: 1. Sparling *et al.* 2000; Smith 1987; Hudson, *et al.* 1984; Schafer *et al.* 1983) 2. EPA Pesticide Registration website: http://cfpub.epa.gov/oppref/rereg/status.cfm?show=rereg 3. Pesticide Action Network of North America website: http://www.pesticideinfo.org/Index.html

[b] Toxicity ratings were derived from fish lethal concentrations to cause 50% mortality.

E. Solid waste or wastewater disposal sites:

Five permitted solid waste disposal sites are located within the 10 kilometer buffer around Monocacy NB (Table 2) (http://www.mde.state.md.us/assets/document/ALL_SOLID_WASTE_FACILITIES.pdf). There are four wastewater treatment facilities located within 10 kilometers of Monocacy NB, including the Ballenger Creek, Frederick City, Mill Bottom, and White Rock Wastewater Treatment Facilities. Ballenger Creek and Frederick City Wastewater Treatment Facilities both produce flow into the Monocacy River upstream of the battlefield (http://cfpub.epa.gov/cwns/standard.cfm).

Table 2. Permitted solid waste disposal sites within a 10 kilometer buffer around Monocacy NB.

Facility Name	Address	Type	Ownership
EASTALCO Ind. Waste Landfill	5601 Manor Wood Dr., Frederick, MD	Industrial Landfill	Private
Essroc CKD Ind. Waste Landfill	4120 Buckeystown Pike, Buckeystown, MD	Industrial Landfill	Private
Fort Detrick Municipal Landfill	Rosemont Ave. & Shookstown Rd., Frederick, MD	Municipal Solid Waste Landfill	Govt.
Fort Detrick Incinerator Complex	Beasley Dr., Frederick, MD	Special Medical Waste Incinerator	Govt.
Site B Municipal Landfill	9031 Reichs Ford Rd., Frederick, MD	Municipal Solid Waste Landfill	Govt.

F. Terrestrial vertebrate contaminant research or monitoring:

No current contaminant monitoring or ecotoxicological research projects are being conducted on terrestrial vertebrates within the 10 kilometer buffer surrounding Monocacy NB. Historically, the concentration of PCBs in mink has been determined for areas surrounding the park land (O'Shea *et al.*1981).

O'Shea, T.J., T.E. Kaiser, G.R. Askins, and J. A. Chapman. 1981. Polychlorinated Biphenyls in a wild mink population. Worldwide Furbearer Conference Proceedings 3:1746-1752.

Mink (*Mustela vison*), harvested by trappers in Western Maryland in winter of 1978-79, were analyzed for polychlorinated biphenyl (PCB) residues in liver, brain and muscle. Mink livers from Frederick and Carroll Counties contained detectable quanitities of PCBs in 7 of 10 individuals (female ($n = 4$), PCB range = 0.74 to 2.2 µg/g ww; male ($n = 3$), PCB range = 1.1 to 2.0 µg/g ww). PCB residue in brain and muscle were only detectable in two individuals (1 male and 1 female) and one individual (male), respectively. PCB residues in the liver of mink from this study were above the threshold for reproductive impairment. In addition, organochlorine pesticides and metabolites were detected in mink tissues from Western Maryland in low enough concentrations to not warrant any concern.

I. Toxic release facilities:

The EPA's Toxic Release Inventory Program lists 11 toxic release facilities that discharged contaminants within 10 kilometers of Monocacy NB from 1997 through 2003 (http://www.epa.gov/triexplorer) (Figure 1). Three of these facilities released priority persistent contaminants or pollutants listed by the EPA or United Nations (Table 3).

Table 3. Mean quantity of priority contaminants released by EPA-listed toxic release sites for 1997 through 2003 within a 10 kilometer buffer around Monocacy NB.

Site Name	Address	Contaminant Released	Years Released	Air Release[a]	Surface Water Release[a]	Land Disposal[a]
EASTALCO Aluminum Co.	5601 Manor Woods Rd., Frederick, MD	Lead Cmpds.	2001-03	248.83	4	7.67
		Mercury Cmpds.	2001-02	6.05	0.01	0
Essrock Cement Corp.	4120 Buckeystown Pike, Frederick, MD	Dioxin Cmpds.	2000-02	0.00456[b]	0	0
		Lead Cmpds.	2001-02	242.25	0	4685.8
		Mercury Cmpds.	2000-02	26	0	2.33
Patapsco Designs, Inc.	5350 Partners Ct., Frederick, MD	Lead Cmpds.	2001-03	0.11	0	0

[a] Units are in lbs/yr unless otherwise noted.
[b] Units are in g/yr.

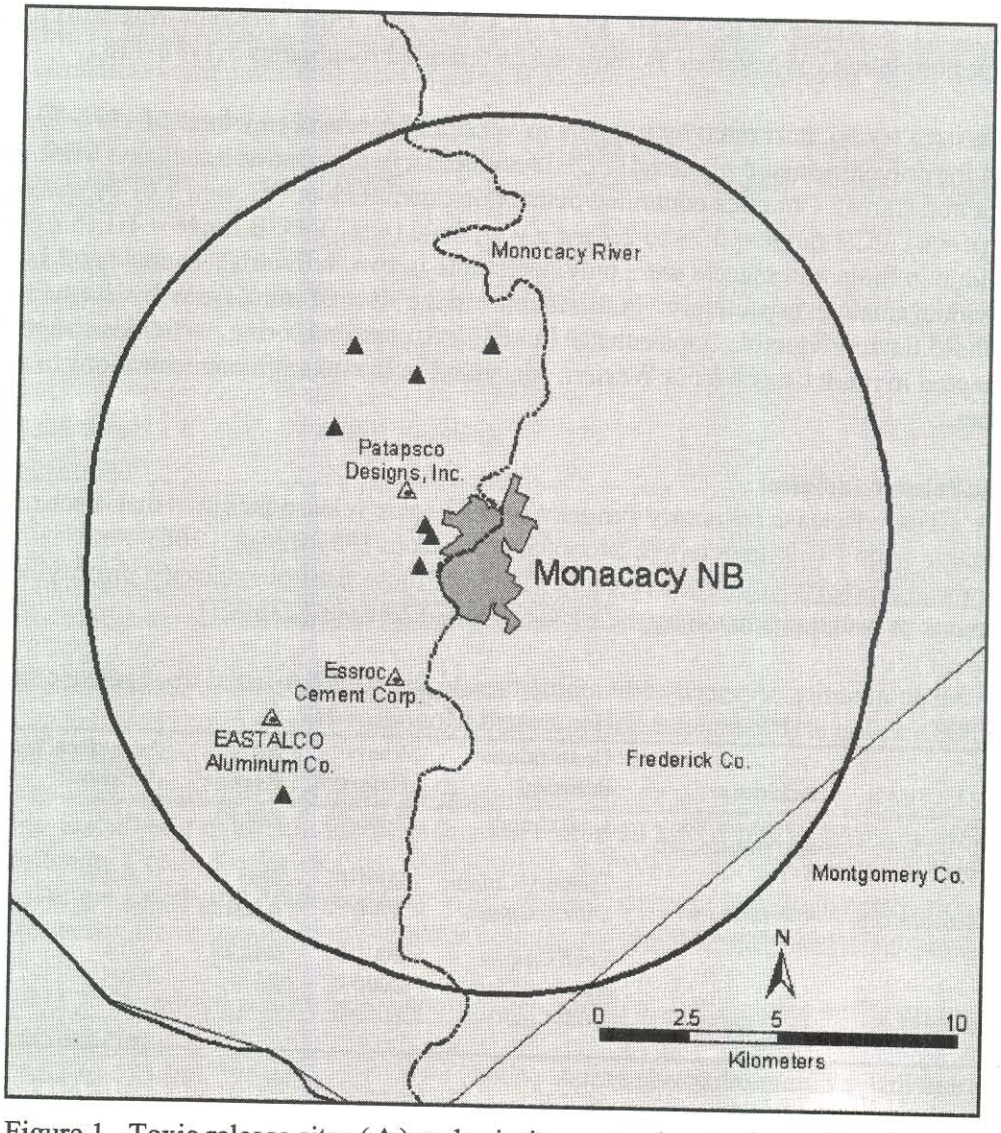

Figure 1. Toxic release sites (▲) and priority contaminant release sites (3) listed by the EPA within a 10 kilometer buffer around Monocacy NB for 1997 through 2003.

H. Fish consumption advisories:

The EPA's Water Program has listed one fish consumption advisory that indicates the presence of persistent pollutants and chemicals within 10 kilometers of Monocacy NB. This is a statewide restricted consumption advisory for Maryland due to mercury issued in 2004 (http://www.epa.gov/waterscience/fish/advisories/index.html).

III. CONCLUSIONS:

I. Persistent bio-accumulative toxic chemicals:

Three persistent bio-accumulative toxic chemicals (dioxin, lead and mercury) are being released by TRI sites within 10 kilometers of Monocacy NB. An active fish consumption advisory in Maryland for mercury indicates the presence of some of these pollutants as well. Eisler (2000) has described the hazards of these contaminants to wildlife. However, the State of Maryland has not found any of

the waterways impaired by persistent bio-accumulative toxic chemicals within 10 kilometers of Monocacy NB.

J. Critical Areas and Sensitive Species:
There were no critical areas reported in Monocacy NB. However, the bald eagle (*Haliaeetus leucocephalus*), a federally threatened species, have been reported within the park boundary.

K. Additional priority contaminant monitoring/research:
The Monocacy NB was not found to have current sources for contamination within 10 kilometers of its boundary in this study. However, mink collected from 1978-79 did contain PCB residues above the threshold for reproductive impairment. Levels of this widespread contaminant have not recently been determined for any species in this area. Analysis of tissue from this and other species may help in determining if PCB levels have stabilized or are changing in this region. Upon discovery of a contaminated site, samples from terrestrial vertebrates should be collected to determine the level of exposure.

National Mall & Memorial Parks

I. BACKGROUND

Size: 2683 hectares

Designation: 1853 through present

Setting/habitat: The National Mall and Memorial Parks are located in the Piedmont Plateau and Coastal Plains Provinces in the District of Columbia. Using the National Oceanic and Atmospheric Administration's 250 m (1990 urban-enhanced) Land Use Land Cover data (1999), the environment surrounding the National Mall and Memorial Parks is classified as: 98.7% urban or built-up; and 1.3% water.

Past land uses: The National Mall previously was the location of a railway station. Some units were created with fill dating back to the 1880's.

II. CURRENT AND POTENTIAL ENVIRONMENTAL CONTAMINATION

A. Known contaminated sites:

There are no known contaminated sites within park boundaries. There is one Environmental Protection Agency (EPA) National Priorities List (NPL) Superfund site, Washington Navy Yard. Additionally, 31.2% of the surface water located within the 10 kilometer buffer surrounding the park boundary is impaired according to EPA's 303(d) list of impaired waterbodies.

B. NPL Superfund sites:

The Washington Navy Yard contains 28.9 ha along the Anacostia River in Washington, DC (Figure 1). The Washington Navy Yard has operated since 1799 as a ship building/repair and naval gun factory (http://cfpub.epa.gov/supercpad/cursites/srchsites.cfm). In 1961 the facility became an administrative facility. Throughout its operation as a ship building/repair and naval gun factory the waste generated included polycyclic aromatic hydrocarbons (PAHs), heavy metals, polychlorinated biphenyls (PCBs), and dioxins. Since 1998, the EPA's Superfund Program has removed a portion of the hazardous waste, including lead paint, PCBs, and mercury. However, dioxins, other metals, and PAHs still exist in portions of the site. The Anacostia River is the primary surface water feature associated with the Washington Navy Yard. The storm water system, with nine outfalls into the Anacostia River, has been documented to contain lead and PCBs.

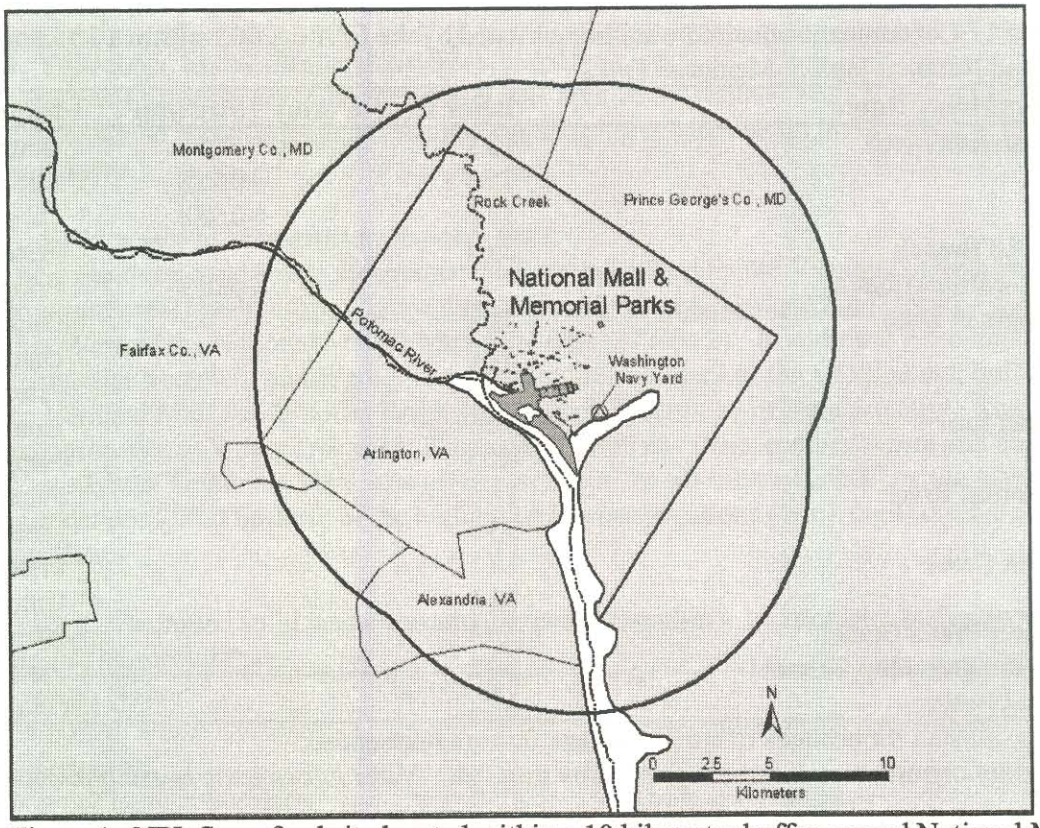

Figure 1. NPL Superfund site located within a 10 kilometer buffer around National Mall & Memorial Parks.

C. Impaired waterbodies:

Ten waterbodies contain sufficient quantities of contaminants to be listed as impaired by the EPA and Maryland, Virginia and the District of Columbia under Section 303(d) (http://www.epa.gov/waters/data/downloads.html) in 2002 (Table 1). Tidal Basin and Washington Ship Channel are impaired waterbodies that flow through the park property (Figure 2). Additionally, nutrient impairments affect portions of the Potomac River. Sedimentation and siltation impairments are present in portions of the Potomac and Anacostia Rivers, Upper Watts Branch, and Kingman Lake.

Table 1. Contaminant-impaired waterbodies listed by the EPA in 2002 within a 10 kilometer buffer around National Mall & Memorial Parks.

Waterbody Name	River Length (km)	Size (km²)[a]	Impairment
Anacostia River	12.3	0.288	Unnamed Metals
	7.33	0.288	Priority Organics[b]
	12.3	0.288	Oil and Grease
Broad Branch	2.64		Priority Organics[b]
Dalecarlia Tributary		0.059	Priority Organics[b]
Kingman Lake	3.29		Oil and Grease
	3.29		Unnamed Metals
	3.29		Priority Organics[b]
Oxen Run	4.25		Unnamed Metals
	4.25		Priority Organics[b]
Potomac River	17.6		Priority Organics[b]
	3.95		Metals (Cu)
Rock Creek	15.1		Priority Organics[b]
	15.1		Unnamed Metals
Lower Watts Branch	2.73		Priority Organics[b]
Washington Ship Channel	3.37		Priority Organics[b]
Tidal Basin	1.17		Priority Organics[b]

[a] Size is listed for portions of surface waters that are impounded.
[b] Priority organics are defined and listed by the Clean Water Act as toxic organic pollutants.

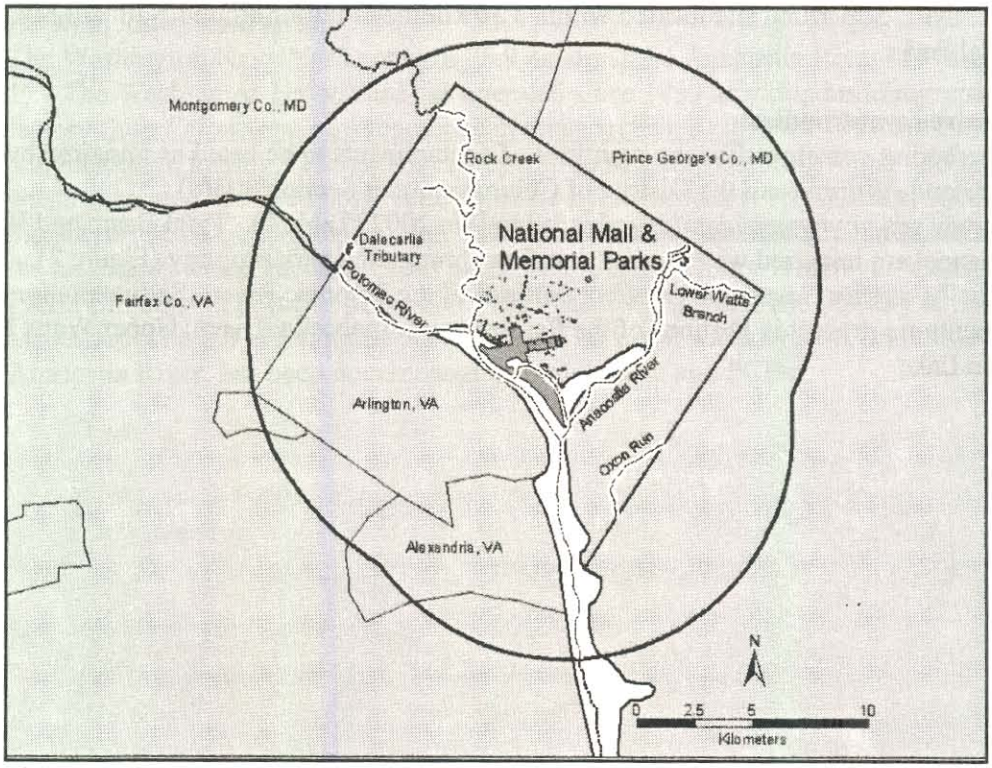

Figure 2. Contaminant-impaired waterbodies listed by the EPA in 2002 located within a 10 kilometer buffer around National Mall & Memorial Parks.

D. Pesticides, herbicides, rodenticides, avicides used:
There were no pesticide or herbicide products applied at National Mall & Memorial Parks in 2004 that contained active ingredients recognized as being moderately to highly toxic to terrestrial vertebrates.

E. Solid waste or wastewater disposal sites:
There are three solid waste acceptance facilities permitted by the Virginia's Department of the Environmental Quality (http://www.deq.virginia.gov/waste/s-waste.html) located within 10 kilometers of the National Mall & Memorial Parks (Table 2). In addition, three municipal wastewater treatment plants are located within the boundary of the 10 kilometer buffer surrounding the National Mall & Memorial Parks (http://cfpub.epa.gov/cwns/standard.cfm). The Alexandria and Arlington Waste Water Treatment Plants were given an "unacceptable" score and the Blue Plains Waste Water Treatment Plant was given a score of "needs improvement" by the Chesapeake Bay Foundation (2003) because of the high nitrogen concentrations (> 5.1 mg/l) discharged at the facilities.

Table 2. Permitted solid waste acceptance facilities within a 10 kilometer buffer around the National Mall & Memorial Parks.

Facility Name	Address	Type	Ownership
Classified Waste Disposal System at CIA	Route 123 & 193, Langley, VA	Incineration/Energy Recovery Facility	Govt.
Dept. of Human Services Laboratory	1800 N. Edison St., Arlington, VA	RMW Incinerator	Govt.
Potomac CDD MRF	625 Burnside Place, Alexandria, VA	Materials Recovery Facility	Private

[a] RMW includes all regulated medical waste.

F. Signs of pollution:
There have been no signs of pollution according to National Mall & Memorial Parks personnel. However, there is knowledge of contaminants leaking into the Tidal Basin from the Bureau of Engraving and Printing (Lorenzetti, NPS, personal communication).

G. Terrestrial vertebrate contaminant research or monitoring:
Current research is being conducted at Kenilworth Marsh and Kingman Lake along the Anacostia River to determine the concentration of metals and organochlorine residues in tree swallow eggs, nestlings, and food samples (DeMott, personal communication). Several recent and historic CEE-TV records are also located within this area.

Studies involving Pesticides and Industrial Contaminants

1. New York State Department of Environmental Conservation. 1987. Wildlife Pathology Unit Necropsy Report #87-41-32(B).

In 1987, a male red-shouldered hawk (*Buteo lineatus*) was found in College Park, MD. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (7.36 µg/g ww), transnonachlor

(3.49 µg/g ww), and oxychlordane (11.3 µg/g ww) were in the lethal range. The cause of death was attributed to chlordane intoxication.

2. New York State Department of Environmental Conservation. 1987. Wildlife Pathology Unit Necropsy Report #87-41-33(B).

A male red-shouldered hawk (*Buteo lineatus*) was found in Temple Hills, MD on March 18, 1987. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (1.93 µg/g ww) and transnonachlor (1.35 µg/g ww) were elevated, and dieldrin (11.3 µg/g ww) was in the lethal range. The cause of death was attributed to dieldrin intoxication.

3. New York State Department of Environmental Conservation. 1987. Wildlife Pathology Unit Necropsy Report #87-62-21.

In July 1987, a female blue jay (*Cyanocitta cristata*) was found in Cheverly, MD. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (2.84 µg/g ww), oxychlordane (4.76 µg/g ww) and transnonachlor (7.42 µg/g ww) were elevated. The cause of death was attributed to chlordane intoxication.

4. New York State Department of Environmental Conservation. 1988. Wildlife Pathology Unit Necropsy Report #87-62-20.

In 1988, an immature male northern mockingbird (*Mimus polyglottus*) was found in Bethesda, MD. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (2.58 µg/g ww) and oxychlordane (4.52 µg/g ww) were in the lethal range. The cause of death was attributed to chlordane intoxication.

5. New York State Department of Environmental Conservation. 1988. Wildlife Pathology Unit Necropsy Report #88-39-20.

An adult male American kestrel (*Falco sparverius*) was found in College Park, MD on July 12, 1988.
The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (2.64 µg/g ww) and oxychlordane (2.63 µg/g ww) were in the lethal range, while dieldrin levels (1.13 µg/g ww) were in the hazardous range. The cause of death was attributed to chlorinated hydrocarbon intoxication.

6. New York State Department of Environmental Conservation. 1988. Wildlife Pathology Unit Necropsy Report #88-39-22.

In July 1988, a male blue jay (*Cyanocitta cristata*) was found in Suitland, MD. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its

brain. Concentrations of chlordane metabolites heptachlor epoxide (4.52 µg/g ww), oxychlordane (4.62 µg/g ww) and dieldrin (1.79 µg/g ww) were elevated. The cause of death was attributed to chlorinated hydrocarbons intoxication.

7. New York State Department of Environmental Conservation. 1989. Wildlife Pathology Unit Necropsy Report #89-07-34.

An adult male American robin (*Turdus migratorius*) was found in Bethesda, MD on April 23, 1989. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (6.35 µg/g ww) and oxychlordane (4.10 µg/g ww) were in the lethal range. The cause of death was attributed to head trauma and possible chlordane intoxication.

8. Rattner, B.A., M.J. Melancon, C.P. Rice, W. Riley Jr., J. Eisemann, and R.K. Hines. 1997. Cytochrome P450 and organochlorine contaminants in black-crowned night-herons from the Chesapeake Bay Region, USA. Environmental Toxicology and Chemistry 16:2315-2322.

In 1991, black-crowned night-heron (*Nycticorax nycticorax*) pipping embryos were collected from several locations including a colony that nest in trees above the Smithsonian Institute National Zoological Park and feed along the Potomac and Anacostia Rivers. Hepatic microsomal activities of benzyloxyresorufin-*O*-dealkylase and ethoxyresorufin-*O*-dealkylase (biomarkers of exposure to polyhalogenated pollutants) were elevated in pipping embryos from Rock Creek Park colony compared to the reference site (Chincoteague National Wildlife Refuge). Concentrations of organochlorine pesticides and metabolites in pipping embryos were greater from the Rock Creek Park than at the reference site, but below the known threshold for reproductive impairment. However, concentrations of total PCBs, 10 arylhydrocarbon receptor-active PCB congeners and estimated toxic equivalents were significantly greater in embryos collected from Rock Creek Park compared to the reference site, with values for toxic congeners 77 and 126 exceeding those observed in heron embryos from the Great Lakes.

9. Rattner, B.A., P.C. McGowan, N.H. Golden, J.S. Hatfield, P.C. Toschik, R.F. Lukei Jr., R. C. Hale, I. Schmitz-Afonso, and C.P. Rice. 2004. Contaminant exposure and reproductive success of ospreys (*Pandion haliaetus*) nesting in Chesapeake Bay regions of concern. Archives of Environmental Toxicology and Chemistry 47:126-140.

The Chesapeake Bay osprey (*Pandion haliaetus*) population has more than doubled in size since restrictions were placed on the production and use of DDT and other toxic organochlorine contaminants in the 1970's. Ospreys are now nesting in the most highly polluted portions of the Bay. In 2000, contaminant exposure and reproduction were monitored in ospreys nesting in the Anacostia and Potomac Rivers. A "sample egg" from each study nest was collected for contaminant analysis, and the fate of eggs remaining in each nest (n=14) was monitored at 7-10 day intervals from egg incubation through fledging of young. Ospreys fledged young in the Washington, DC study sites (observed success: 0.88 fledglings/active nest), although productivity was marginal for sustaining the local population in the Anacostia and Potomac Rivers. Concentrations of total PCBs, some arylhydrocarbon receptor-active PCB and polybrominated diphenyl ether congeners were often greater in sample eggs from Anacostia and Potomac Rivers compared to the South River reference

site. Nonetheless, logistic regression analyses did not provide evidence linking marginal productivity to *p,p'*-DDE, total PCBs or toxic PCB congener exposure.

11. Southeastern Cooperative Wildlife Disease Study. 1992. Clinical Necropsy Record #68-92, College of Veterinary Medicine, University of Georgia.

In March 1992, an adult male American kestrel (*Falco sparverius*) was found in Arlington, VA. The the concentration of DDE residue in the stomach contents was 2.17 µg/g and in the kestrel's brain was 6.7 µg/g. The cause of death was undetermined. However, the possibility of carbamate pesticides could not be ruled out.

Studies involving Metals

1. Scanlon, P.F. 1979. Ecological implications of heavy metal contamination of roadside habitats. Southeastern Association Fish & Wildlife Agencies 33:136-145.

Soil, vegetation, earthworms and small mammals were collected along Virginia highway roadsides in 1975 to analyze for lead, cadmium, nickel and zinc. There were significantly higher levels of lead in *Microtus* and *Peromyscus* individuals collected from I 95 (23.07 and 21.96 µg/g dw) than control areas, > 500 m from Fairfax County roadways (3.92 and 2.39 µg/g dw). *Blarina* tissues from I 95 contained higher levels of lead, cadmium, and zinc (72.56, 1.71 and 139.20 µg/g dw) than from control areas (7.28, 0.66 and 112.81 µg/g dw). Individuals of the genus *Mus* from I 95 (64.25 µg/g dw) contained significantly higher levels of lead than two highways in Montgomery County, VA with less traffic (US 460 = 21.73 and VA 114 = 11.32 µg/g dw).

H. Toxic release facilities:

The EPA's Toxic Release Inventory Program lists nine toxic release facilities that discharged contaminants within 10 kilometers of National Mall & Memorial Parks from 1997 through 2003 (Figure 3) (http://www.epa.gov/triexplorer/facility.htm). Three of these facilities released persistent pollutants and chemicals listed by the EPA and United Nations (Table 3). The greatest diversity of persistent pollutants and chemicals were released from Potomac River Generating Station releasing dioxins, lead and mercury.

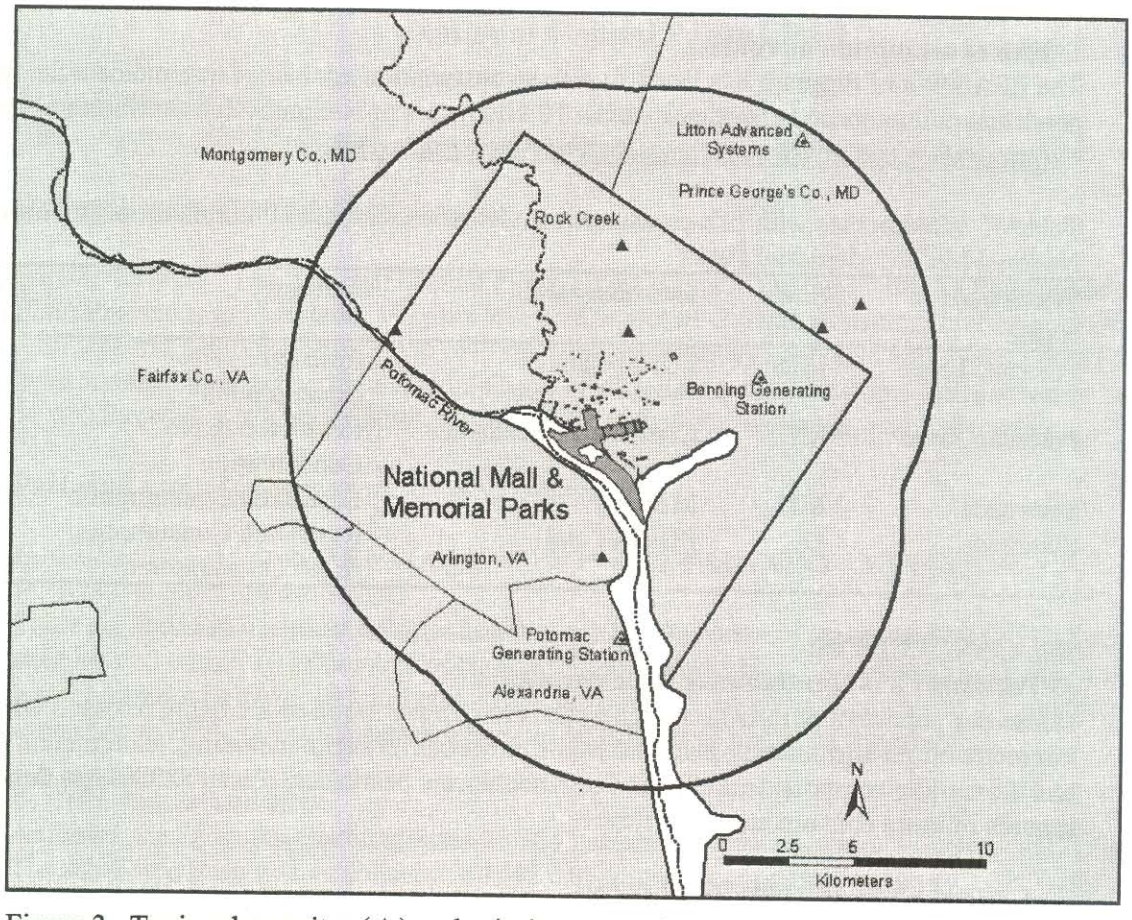

Figure 3. Toxic release sites (▲) and priority contaminant release sites (3) listed by the EPA within a 10 kilometer buffer around National Mall & Memorial Parks for 1997 through 2003.

Table 3. Mean quantity of priority contaminants released by EPA-listed toxic release sites for 1997 through 2003 within a 10 kilometer buffer around National Mall & Memorial Parks.

Site Name	Address	Contaminant Released	Years Released	Air Release[a]	Surface Water Release[a]	Land Disposal[a]
Benning Generating Station	3400 Benning Rd., NE, Washington, DC	Dioxin Cmpds.	2000-02	0.0002836[b]	0	0
Potomac River Generating Station	1400 N Royal St., Alexandria, VA	Mercury	2000 & 03	4.5	0	0
		Dioxin Cmpds.	2000-03	0.0463549[b]	0	0
Litton Advanced Systems	5115 Calvert Rd., College Park, MD	Mercury	2000-03	182.3	0.1	0
		Lead Cmpds.	2001-03	245.8	9	0
		Lead Cmpds.	2001	21.96	0	0

[a] Units are in lbs/yr unless otherwise noted.
[b] Units are in g/yr.

I. Fish consumption advisories:

The EPA's Water Program has listed four fish consumption advisories that indicate the presence of persistent pollutants and chemicals within 10 kilometers of National Mall & Memorial Parks (Table 4) (http://www.epa.gov/waterscience/fish/advisories/index.html).

Table 4. Waterbodies with fish consumption advisories within a 10 kilometer buffer around National Mall & Memorial Parks.

Waterbody Name	State	Contaminant	Advisory	Year Issued
Potomac River	MD/VA	PCBs (Total)	Restricted & No Consumption	1999, 2001 & 2004
Potomac River	MD	Chlorinated Pesticides	Restricted & No Consumption	2001 & 2004
Statewide	MD	Mercury	Restricted Consumption	2004
Statewide	DC	PCBs (Total)	Restricted Consumption & No Consumption	1993 & 2004

III. CONCLUSIONS:

J. Persistent bio-accumulative toxic chemicals:

Numerous persistent pollutants and chemicals have been found or are being released within the 10 kilometer buffer surrounding National Malls & Memorial Parks including, lead, mercury, dioxins and dioxin-like compounds, PCBs and organochlorine pesticides. Eisler (2000) has described the hazards of these contaminants to wildlife.

K. Critical areas and Sensitive Species:

There have been bald eagles (*Haliaeetus leucocephalus*), a federally threatened species, sighted over the park property. However, there is no evidence of nesting or resident species of concern. There were no critical areas reported for the National Mall & Memorial Parks.

L. Additional priority contaminant monitoring/research:

The majority of contaminant exposure and effects information collected within 10 kilometers of the National Mall & Memorial Parks has been derived from individual necropsy reports collected in the 1980's, which indicate the presence of chlordane and dieldrin in the vicinity. However, there have been a limited number of studies on fish-eating birds within the buffer area indicating the presence of PCBs, polyhalogenated compounds, and polybrominated diphenyl ethers. Additionally, there has been one study (Scanlon 1979) that determined the concentration of metals residues in small mammals. The surface waters that influence the area around the National Mall & Memorial Parks indicate the presence of these and other priority organics. Furthermore, the Washington Navy Yard could be a source of additional contaminants. Since PCBs and organochlorine pesticides are persistent, additional monitoring and research may aid in identifying the extent of exposure to other terrestrial vertebrates.

National Capital Parks - East

I. BACKGROUND

Size: Approx. 4047 hectares

Designation: Various times for each unit

Setting/habitat: The National Capital Parks – East is located in the Piedmont Plateau and Coastal Plain Provinces in Maryland, Virginia and the District of Columbia. Using the National Oceanic and Atmospheric Administration's 250 m (1990 urban-enhanced) Land Use Land Cover data (1999), the environment surrounding the National Capital Parks-East is classified as: 72.9% urban or built-up; 18.6% forested; 5.9% agricultural; 0.9% barren lands; 0.9% wetlands; and 0.8% water.

Past land uses: Military operations and urban setting

II. CURRENT AND POTENTIAL ENVIRONMENTAL CONTAMINATION

A. Known contaminated sites:

There are four Environmental Protection Agency (EPA) National Priorities List (NPL) Superfund sites located within 10 kilometers of National Capital Parks-East. Additionally, 26.3% of the surface water located within the 10 kilometer buffer surrounding the parks' boundaries are impaired according to EPA's Clean Water Act Section 303(d) list of impaired waterbodies.

B. NPL Superfund sites:

Andrews Air Force Base encompasses 1764.4 hectares in Prince George's County, MD (Figure 1). The Air Force Base was established in 1942 and continues to operate as the 89th Air Wing (http://cfpub.epa.gov/supercpad/cursites/srchsites.cfm). There have been 73 sites or areas of concern identified and further investigations are continuing. Draft remedial investigations have been reviewed for Leroy's Lane Landfill, a spill/disposal area, Fire Training Area 4, East Side Service Station, and two other landfills. Field investigations are ongoing for additional sites (*e.g.,* Fire Training Areas 1 & 2, sludge disposal area, and hangar 13). Contaminants identified in these areas include lead, mercury, cadmium, volatile organic compounds (VOCs), semi-volatile organic compounds (semi-VOCs; *e.g.,* benzo(a)pyrene), and polychlorinated biphenyls (PCBs). Piscataway Creek and its tributaries are the surface waters that drain the area. Piscataway Creek, which supports wetlands and fisheries, has previously been identified as having elevated concentrations of lead and VOCs.

Beltsville Agricultural Research Center is a research facility operated by the US Department of Agriculture encompassing 2630.5 hectares in northern Prince George's County (Figure 1; http://cfpub.epa.gov/supercpad/cursites/srchsites.cfm). Initially 166 areas of concern were identified. However, only 59 sites were recommended for further investigation. Currently, six of these sites have remedial investigations underway. Initial investigations of soil, surface water and sediments indicated elevated levels of PCBs, heavy metals, polyaromatic hydrocarbons (PAHs) and pesticides. Surface water features in the vicinity include Paint Branch, Little Paint Branch, Beaver Dam Creek and Indian Creek which flow into the Anacostia River.

Fort George G. Meade (5463.3 hectares) has operated as a military installation in Anne Arundel County, MD since 1917 (http://cfpub.epa.gov/supercpad/cursites/srchsites.cfm). Currently, the site operates as tenant organization support for the four branches of the military and other federal agencies. Fort Meade has identified the Defense Reutilization and Marketing Office (DRMO), active sanitary landfill, clean fill dump, and post laundry facility as contaminated by VOCs, pesticides, PCBs, heavy metals, PAHs and unexploded ordinances. Surface water features that could be affected include Little Patuxent River and its tributaries. Removal actions have been completed for the DRMO site and remedial investigations are being conducted at other contaminated sites.

The Washington Navy Yard contains 28.9 ha along the Anacostia River in Washington, DC (Figure 1). The Washington Navy Yard has operated since 1799 as a ship building/repair and naval gun factory (http://cfpub.epa.gov/supercpad/cursites/srchsites.cfm). In 1961 the facility became an administrative facility. Throughout its operation as a ship building/repair and naval gun factory the waste generated included polycyclic aromatic hydrocarbons (PAHs), heavy metals, PCBs, and dioxins. Since 1998, the EPA's Superfund Program has removed a portion of the hazardous waste, including lead paint, PCBs, and mercury. However, dioxins, other metals, and PAHs still exist in portions of the site. The Anacostia River is the primary surface water feature associated with the Washington Navy Yard. The storm water system, with nine outfalls into the Anacostia River, has been documented to contain lead and PCBs.

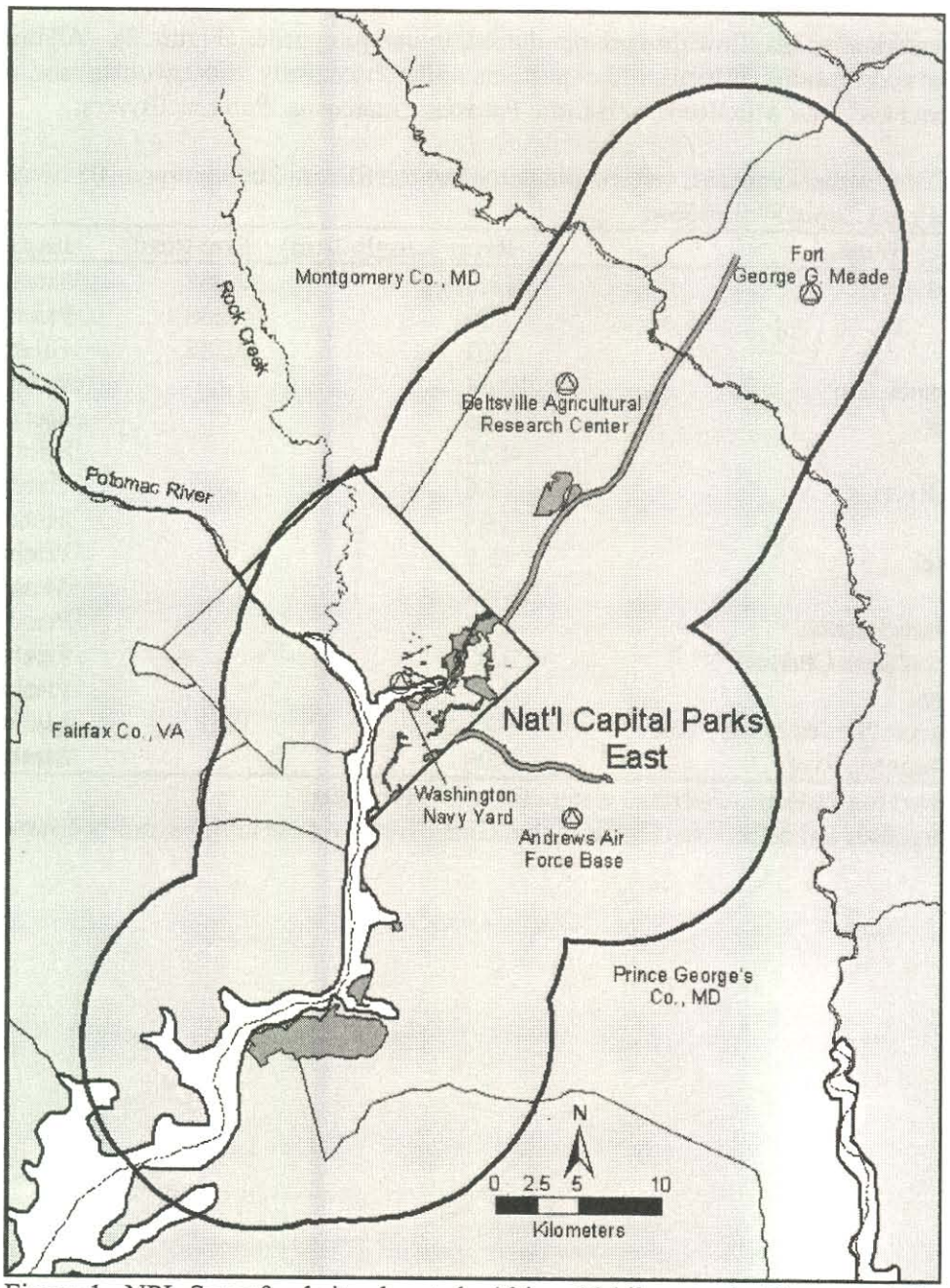

Figure 1. NPL Superfund sites located within a 10 kilometer buffer around National Capital Parks-East.

C. Impaired waterbodies:

In 2002, ten of 15 waterbodies listed as impaired by the EPA and Maryland, Virginia and the District of Columbia under the Clean Water Act Section 303(d) (http://www.epa.gov/waters/data/downloads.html) contained contaminant impairments (Table 1). The Little Patuxent River/Dorsey Run, Broad and Lower Watts Branch, Oxon Run, Rock Creek, Washington Ship Channel, and Middle Patuxent, Potomac, and Anacostia Rivers are contaminant-

impaired waterbodies that flow through or adjacent to park properties (Figure 2). Additionally, nutrient and sediment impairments affect portions of the Piscataway, Mattawoman, and Accotink Creeks, Oxen and Four Mile Runs, and Little Patuxent, Anacostia, Potomac Rivers.

Table 1. Contaminant-impaired waterbodies listed by the EPA in 2002 within a 10 kilometer buffer around National Capital Parks-East.

Waterbody Name	River Length (km)	Size (km^2)[a]	Impairment
Anacostia River	12.3	0.288	Metals (Unnamed)
	7.33	0.288	Priority Organics[b]
	12.3	0.288	Oil and Grease
Broad Branch	2.64		Priority Organics[b]
Oxon Run	4.25		Metals (Unnamed)
	4.25		Priority Organics[b]
Potomac River	17.6		Priority Organics[b]
	3.95		Metals (Cu)
Rock Creek	15.1		Priority Organics[b]
	15.1		Metals (Unnamed)
Lower Watts Branch	2.73		Priority Organics[b]
Washington Ship Channel	3.37		Priority Organics[b]
Tidal Basin	1.17		Priority Organics[b]
Little Patuxent River/Dorsey Run	123.25	0.21	Metals (Cd)
Middle Patuxent River	5.98		Metals (Zn)

[a] Size is listed for portions of surface waters that are impounded.
[b] Priority organics are defined and listed by the Clean Water Act as toxic organic pollutants.

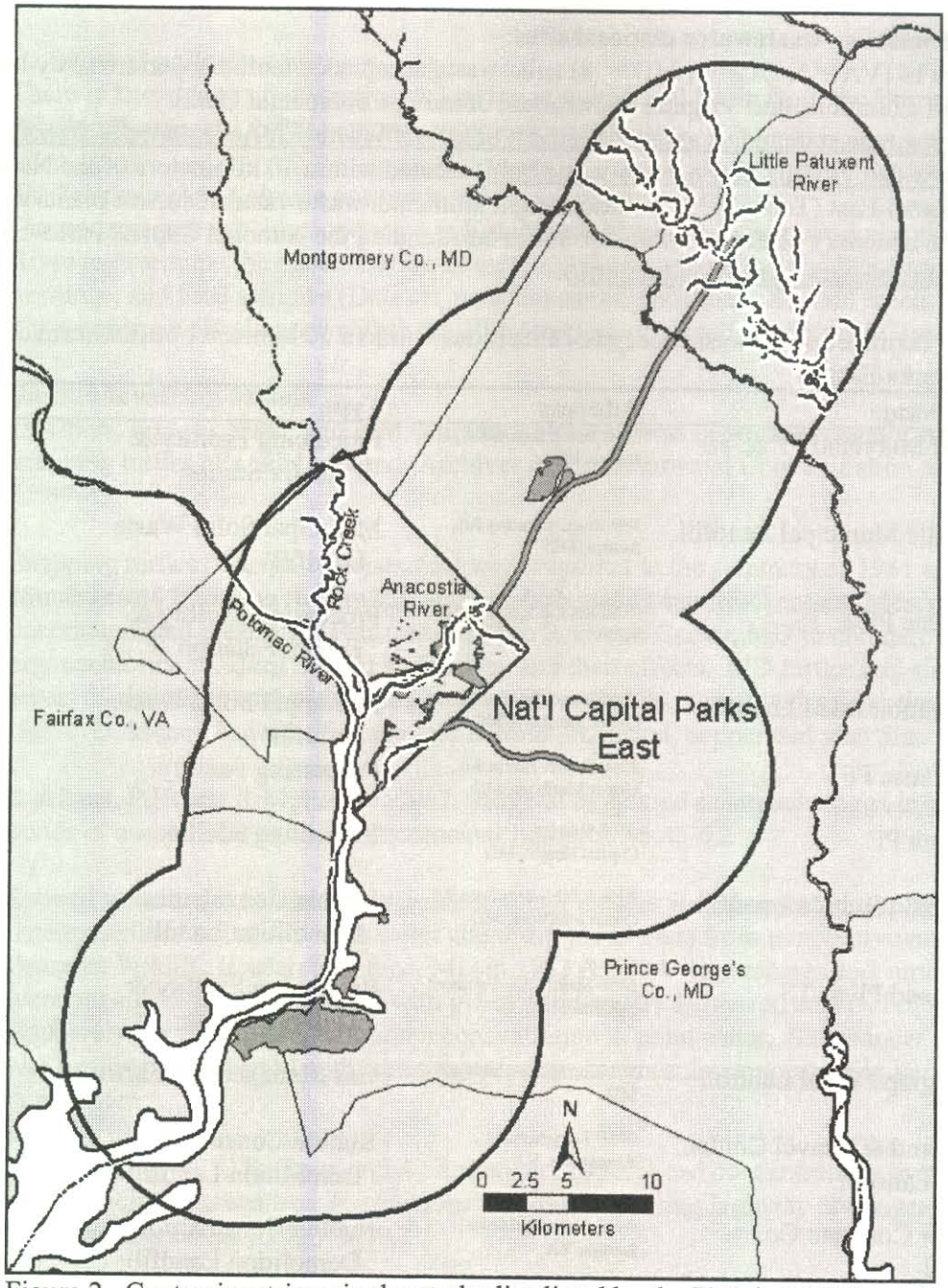

Figure 2. Contaminant-impaired waterbodies listed by the EPA in 2002 located within a 10 kilometer buffer around National Capital Parks-East.

D. Pesticides, herbicides, rodenticides, avicides used:
There were no pesticide or herbicide products applied at National Capital Parks-East in 2004 that contained active ingredients recognized as being moderately to highly toxic to terrestrial vertebrates.

E. Solid waste or wastewater disposal sites:
There are 14 (VA = 5, DC = 1, MD = 8) solid waste acceptance facilities permitted by Maryland, District of Columbia, and Virginia Department of the Environmental Quality (http://www.mde.state.md.us/assets/document/Solid%20Waste%20Acceptance%20Facilities.pdf, http://www.deq.virginia.gov/waste/s-waste.html) located within 10 kilometers of the National Capital Parks-East (Table 2). In addition, eight municipal wastewater treatment plants are located within the boundary of the 10 kilometer buffer surrounding the National Capital Parks-East (http://cfpub.epa.gov/cwns/standard.cfm).

Table 2. Permitted solid waste acceptance facilities within a 10 kilometer buffer around the National Capital Parks-East.

Facility Name	Address	Type	Ownership
Garnet of Maryland PF & TS	8077 Brock Bridge Rd., Jessup, MD	Processing Facility & Transfer Station	Private
Millersville Municipal Landfill	389 Burns Crossing Rd., Severn, MD	Municipal Solid Waste Landfill	Govt.
Ameriwaste PF & TS	7150 Kit Kat Rd., Elkridge, MD	Processing Facility & Transfer Station	Private
Brown Station Road Landfill	3500 Brown Station Rd., Upper Marlboro, MD	Municipal Solid Waste Landfill	Govt.
Dower House PF	5900 Dower House Rd., Upper Marlboro, MD	Processing Facility	Private
Kenilworth PF	4516 S Street, Capital Height, MD	Processing Facility	Private
Ritchie Land Rubble Landfill	2001 Ritchie Marlboro Rd., Upper Marlboro, MD	Rubble/Construction Demolition Landfill	Private
Sheriff Road PF & TS	5800 Sheriff Rd., Fairmont Heights, MD	Processing Facility & Transfer Station	Private
BFI Telegraph Road Landfill	101 Norris Lane, Baltimore, MD	Gas Management Facility	Private
Hilltop Sand & Gravel Co. Inc. Debris Landfill	7950 Telegraph Rd., Alexandria, VA	Rubble/Construction Demolition Landfill	Private
Rainwater Concrete Co. Landfill	9917 Richmond Hwy., Lorton, VA	Rubble/Construction Demolition Landfill	Private
Vanguard Research, Inc. Plasma Energy Pyrolosis System	8384 Terminal Rd., Lorton, VA	RMW[a] Alternate Treatment	Private
Dept. of Human Services Laboratory	1800 N. Edison St., Arlington, VA	RMW[a] Incinerator	Govt.
Fort Totten Transfer Station	4900 Bates Rd., NE, Washington, DC	Transfer Station	Govt.

[a] RMW includes all regulated medical waste.

F. Signs of pollution:
There is knowledge of contaminants leaking into the Tidal Basin from the Bureau of Engraving and Printing (Lorenzetti, NPS, personal communication).

G. Terrestrial vertebrate contaminant research or monitoring:
Current research is being conducted at Kenilworth Marsh and Kingman Lake along the Anacostia River to determine the concentration of metals and organochlorine residues in tree swallow eggs, nestlings, and food samples (DeMott, personal communication). Several recent and historic CEE-TV records are also located within the 10 kilometers surrounding National Capital Parks-East.

Studies involving Metals
1. Albers, P.H., L. Sileo, and B.M. Mulhern. 1986. Effects of environmental contaminants on snapping turtles of a tidal wetland. Archives of Environmental Contamination and Toxicology 15:39-49.

Snapping turtles (*Chelydra serpentina*) were captured in the summers of 1981 and 1982 from contaminated locations (freshwater and brackish water) near Hackensack Meadowlands, NJ and an uncontaminated location at Patuxent Wildlife Research Center, MD to compare metal and organochlorine residues in liver and kidney and their effects. MD turtles had significantly higher levels of chromium and nickel, and had significantly less copper and zinc in the liver than NJ turtles. However, kidney had significantly less chromium, nickel, copper and zinc than NJ turtles.

2. Albers, P.H. and R.M. Prouty. 1987. Survival of spotted salamander eggs in temporary woodland ponds of coastal Maryland. Environmental Pollution 46:45-61.

Spotted salamander (*Ambstoma maculatum*) egg masses were counted and survival of embryos was determined and correlated with water chemistry parameters from temporary woodland ponds at Patuxent Wildlife Research Refuge, MD in 1983 & 1984. Egg masses and survivorship of embryos were not significantly correlated with pH of pond water. However, survival of embryos was negatively correlated with aluminum concentration in pond water. Salamander egg mass abundance was positively correlated with water temperature, magnesium concentration and total chlorophyll of pond water.

3. Birdsall, C.W., C.E. Grue, and A. Anderson. 1986. Lead concentrations in bullfrog *Rana catesbeiana* and green frog *R. clamitans* tadpoles inhabiting highway drainages. Environmental Pollution (Series A) 40:233-247.

In 1982, lead concentrations were determined for bullfrog (*Rana catesbeiana*) and green frog (*R. clamitans*) tadpoles from highway drainages in Prince George's and Anne Arundel Counties, MD and Fairfax County, VA and control ponds at Patuxent Wildlife Research Center, MD. Tadpoles collected from highway drainages had higher concentrations of lead (Range: bullfrog (n = 8) = 0.7 - 270 µg/g ww; green frog (n = 17) = 4.8 - 240 µg/g ww) than tadpoles collected from control ponds (Range: bullfrog = 2.6 - 6.0 µg/g ww; green frog = 0.9 - 8.9 µg/g ww). There was a positive correlation between lead levels in tadpoles and daily traffic volume of highways.

4. Clark Jr., D.R. 1979. Lead concentrations: Bats vs. terrestrial small mammals collected near a major highway. Environmental Science & Technology 13:338-340.

Lead concentrations were determined for small mammals (meadow voles (*Microtus pennsylvanicus*), white-footed mice (*Peromyscus leucopus*), short-tailed shrews (*Blarina brevicada*)) adjacent to the Baltimore-Washington (B-W) Parkway and small mammals and bats (big brown bats (*Eptesicus fuscus*) and little brown bats (*Myotis lucifugus*)) adjacent to or in the Montpelier Barn, Laurel, MD in 1976. Big and little brown bats contained higher concentrations of lead (Mean: big brown = 38.12 µg/g ww; little brown = 16.97 µg/g ww) than meadow voles or white-footed mice from B-W Parkway (Mean: meadow voles = 1.45 µg/g ww; white-footed mice = 4.91 µg/g ww) and Montpelier Barn (Mean: meadow voles = 0.84 µg/g ww; white-footed mice = 1.16 µg/g ww) and short-tailed shrews from Montpelier Barn (Mean = 1.85 µg/g ww). However, short-tailed shrews from B-W Parkway contained greater lead concentrations (Mean = 26.20 µg/g ww) than little brown bats.

5. Grue, C.E., T.J. O'Shea, and D.J. Hoffman. 1984. Lead concentrations and reproduction in highway-nesting barn swallows. Condor 86:383-389.

In 1979, lead concentrations and associated hematological parameters and reproductive success was determined for barn swallows (*Hirundo rustica*) from the Baltimore-Washington (B-W) Parkway and a reference location (farm in Howard County, MD). Lead concentrations from adult barn swallow parts were greater in B-W Parkway individuals (Mean: stomach contents = 5.8 µg/g dw; carcasses = 7.19 µg/g dw; feathers = 59.65 µg/g dw) than the reference colony individuals (Mean: stomach contents = 1.0 µg/g dw; carcasses = 4.25 µg/g dw; feathers = 21.5 µg/g dw). Lead concentrations from nestling barn swallow parts were similar between colonies, but significantly less than adults (Mean: B-W Parkway: stomach contents = 3.2 µg/g dw; carcasses = 1.5 µg/g dw; feathers = 2.5 µg/g dw and Reference Colony: stomach contents = 2.3 µg/g dw; carcasses = 0.69 µg/g dw; feathers = 2.3 µg/g dw). The δ-aminolevulinic acid dehydratase (ALAD) activity was greater in adult reference swallows than adult B-W Parkway swallows. However, hemoglobin and hematocrit levels were not significantly different between the two colonies. Nestling ALAD, hemoglobin, hematocrit levels were not significantly different between colonies, but ALAD activity and lower hemoglobin and hematocrit levels were significantly higher than adults. B-W Parkway swallow reproductive success did not seem to be impaired.

6. Hall, R.J. and B.M. Mulhern. 1984. Are anuran amphibians heavy metal accumulators? Pages 123-133 *in*: R.A. Seigel, L.E. Hunt, J.L. Knight, L. Malaret, and N.L. Zuschlag, editors. Vertebrate Ecology and Systematics. Museum of Natural History, University of Kansas, Lawrence, Kansas.

Adult and larval amphibians (*Rana catesbeiana, R. clamitus, Rana spp., Bufo spp.*) were collected in the early 1980's from the Patuxent Wildlife Research Center to determine heavy metal concentrations in tissues. Tadpoles and adult frogs had similar concentrations of cadmium (Range: adult = 0.10-0.36 µg/g ww; tadpole = 0.10-0.24 µg/g) and were comparable to other uncontaminated areas. However, adult toads contained greater cadmium concentrations than frogs (Range = 0.64-26 µg/g dw). Tadpole copper body burdens were similar to other uncontaminated areas (Range = 0.93-3.2 µg/g dw) and adult frogs and toads (Range: frogs = 1.2-3.5 µg/g ww; toads = 2.1-5.0 µg/g ww). Reported lead concentrations for tadpole frogs ranged between 14.0-23.0 µg/g dw, adult frogs 1.6-11 µg/g; adult toads 0.73-75 µg/g. Mercury concentrations, which ranged from 0.04-0.1 µg/g ww in

Zn = 91.0; As = 0.83; Cd = 0.08; Hg = 0.44; Pb = <0.07 µg/g ww). All kidney residues in the Clinton, MD individual were similar to other osprey (Cu = 0.16; As = 0.10; Cd = 0.16; Hg = 0.19 µg/g ww).

12. White, D.H., J.R. Bean, and J.R. Longcore. 1977. Nationwide residues of mercury, lead, cadmium, arsenic, and selenium in starlings, 1973. Pesticides Monitoring Journal 11:35-39.

In 1973, European starlings (*Sternus vulgaris*) were collected from 51 sites nationwide, including Patuxent, MD, as part of the National Pesticide Monitoring Program to determine mercury, lead, cadmium, arsenic, and selenium residues. Patuxent's starlings contained comparable concentrations of lead, cadmium, arsenic and selenium as other areas in the United States (Mean = 1.10 Pb µg/g ww; 0.08 Cd; 0.06 As; 0.36 Se). Approximately 60% of the starling tissue analyzed throughout the United States contained no detectable concentrations of mercury including starlings from Patuxent, MD.

Studies involving Pesticides and Industrial Contaminants

1. Albers, P.H., L. Sileo, and B.M. Mulhern. 1986. Effects of environmental contaminants on snapping turtles of a tidal wetland. Archives of Environmental Contamination and Toxicology 15:39-49.

Snapping turtles (*Chelydra serpentina*) were captured in the summers of 1981 and 1982 from contaminated locations (freshwater and brackish water) near Hackensack Meadowlands, NJ and an uncontaminated location at Patuxent Wildlife Research Center, MD to compare metal and organochlorine residues in liver and kidney and their effects. Female MD turtles had significantly lower levels of DDE than male NJ turtles from brackish waters and male and female MD turtles had significantly lower levels of PCBs in their visceral fat than male NJ turtles from brackish waters. Both male and female MD turtles had greater ALAD activity and lower hemoglobin values than all NJ turtles.

2. Balcomb, R. 1983. Secondary poisoning of red-shouldered hawks with carbofuran. Journal of Wildlife Management 47:1129-1132.

On May 7, 1981 a pair of red-shouldered hawks (*Buteo lineatus*) were found in a cornfield treated with Furadan ® 10 granules (10% carbofuran). The female was sacrificed for necropsy and pesticide residue analysis. The stomach contents contained the remains of a northern short-tailed shrew (*Blarina brevicauda*) and common grackle (*Quiscalus quiscula*). The gastrointestinal tissue contained 49.6 µg carbofuran. The male was treated and released after recovery.

3. Cain, B.W. and C.M. Bunck. 1983. Residues of organochlorine compounds in starlings (*Sturnus vulgaris*), 1979. Environmental Monitoring and Assessment 3:161-172.

In 1979, European starlings (*Sternus vulgaris*) were collected from 112 sites nationwide, including Prince George's County, MD, as part of the National Pesticide Monitoring Program to determine organochlorine insecticide residues. Prince George's County's starlings contained (µg/g ww) 0.44

A turkey vulture (*Cathartes aura*) and Northern harrier (*Circus cyaneus*) were found dead in Prince George's County, MD on January 25, 1989 and reported to NWHC. Acetylcholinesterase inhibition in the brain tissue was reported for the individuals. The cause of death was attributed to carbofuran (carbamate) poisoning.

9. National Wildlife Health Center. 1995. Diagnostic and Epizootic Databases, Quarterly Wildlife Mortality Reports, Case # 13842, Madison, WI.

A bald eagle (*Haliaeetus leucocephalus*) was found dead in Prince George's County, MD on August 16, 1995 and reported to NWHC. Acetylcholinesterase inhibition in the brain tissue was reported for the individual. The cause of death was attributed to carbofuran (carbamate) poisoning.

10. New York Department of Environmental Conservation. 1987. Wildlife Pathology Unit Necropsy Report #87-41-32(B).

In 1987, a male red-shouldered hawk (*Buteo lineatus*) was found in College Park, MD. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (7.36 µg/g ww), transnonachlor (3.49 µg/g ww), and oxychlordane (11.3 µg/g ww) were in the lethal range. The cause of death was attributed to chlordane intoxication.

11. New York Department of Environmental Conservation. 1987. Wildlife Pathology Unit Necropsy Report #87-41-33(B).

A male red-shouldered hawk (*Buteo lineatus*) was found in Temple Hills, MD on March 18, 1987. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (1.93 µg/g ww) and transnonachlor (1.35 µg/g ww) were elevated, and dieldrin (11.3 µg/g ww) was in the lethal range. The cause of death was attributed to dieldrin intoxication.

12. New York Department of Environmental Conservation. 1987. Wildlife Pathology Unit Necropsy Report #87-62-21.

On July 18, 1987, a female blue jay (*Cyanocitta cristata*) was found in Beltsville, MD. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (4.62 µg/g ww) and oxychlordane (6.83 µg/g ww) were above the minimum lethal level. The cause of death was attributed to chlordane intoxication.

13. New York Department of Environmental Conservation. 1987. Wildlife Pathology Unit Necropsy Report #87-62-23.

In July 1987, a male grackle (*Quiscalus spp.*) was found debilitated in Accokeek, MD. The bird later died and was necropsied. Brain acetylcholinesterase activity was in the normal range and the contents of the gastrointestinal tract contained no detectable levels of toxins. The cause of death was a probable poisoning based on the behavior of the bird at capture but the toxin was undetermined.

14. New York Department of Environmental Conservation. 1987. Wildlife Pathology Unit Necropsy Report #87-62-12.

On August 28, 1987, a male European starling (*Sternus vulgaris*) was found debilitated in Largo, MD. The bird later died and was necropsied. Brain acetylcholinesterase activity was in the normal range and the contents of the gastrointestinal tract contained no detectable levels of toxicants. The cause of death was undetermined.

15. New York Department of Environmental Conservation. 1988. Wildlife Pathology Unit Necropsy Report #88-39-20.

An adult male American kestrel (*Falco sparverius*) was found in College Park, MD on July 12, 1988.
The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (2.64 μg/g ww) and oxychlordane (2.63 μg/g ww) were in the lethal range, while dieldrin levels (1.13 μg/g ww) were in the hazardous range. The cause of death was attributed to chlorinated hydrocarbon intoxication.

16. New York Department of Environmental Conservation. 1988. Wildlife Pathology Unit Necropsy Report #88-39-22.

In July 1988, a male blue jay (*Cyanocitta cristata*) was found in Suitland, MD. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (4.52 μg/g ww), oxychlordane (4.62 μg/g ww) and dieldrin (1.79 μg/g ww) were elevated. The cause of death was attributed to chlorinated hydrocarbon intoxication.

17. New York Department of Environmental Conservation. 1988. Wildlife Pathology Unit Necropsy Report #88-39-23.

A male barred owl (*Strix varia*) was found lethargic in Seabrook, MD on July 27, 1988. The bird later died and was necropsied. The brain was found to contain elevated concentrations of chlorinated hydrocarbon pesticides. Concentrations of chlordane metabolites heptachlor epoxide (2.41 μg/g ww) and oxychlordane (3.20 μg/g ww) may potentially be lethal. Other organochlorines were also detected (DDE, dieldrin, PCBs, transnonachlor). The cause of death was attributed to chlorinated hydrocarbon intoxication.

18. New York Department of Environmental Conservation. 1990. Wildlife Pathology Unit Necropsy Report #90-22-26.

An adult female cattle egret (*Bubulcus ibis*) was found debilitated in Clinton, MD on April 10, 1990. The bird later died and was necropsied. The brain was found to contain elevated concentrations of chlorinated hydrocarbon pesticides. Concentrations of dieldrin (3.28 μg/g ww) and DDE (39.21

µg/g ww) may have been lethal. The cause of death was attributed to organochlorinated pesticide intoxication.

19. Rattner, B.A., M.J. Melancon, C.P. Rice, W. Riley Jr., J. Eisemann, and R.K. Hines. 1997. Cytochrome P450 and organochlorine contaminants in black-crowned night-herons from the Chesapeake Bay Region, USA. Environmental Toxicology and Chemistry 16:2315-2322.

In 1991, black-crowned night-heron (*Nycticorax nycticorax*) pipping embryos were collected from several locations including a colony that nest in trees above the Smithsonian Institute National Zoological Park and feed along the Potomac and Anacostia Rivers. Hepatic microsomal activities of benzyloxyresorufin-*O*-dealkylase and ethoxyresorufin-*O*-dealkylase (biomarkers of exposure to polyhalogenated pollutants) were elevated in pipping embryos from Rock Creek Park colony compared to the reference site (Chincoteague National Wildlife Refuge). Concentrations of organochlorine pesticides and metabolites in pipping embryos were greater from the Rock Creek Park than at the reference site, but below the known threshold for reproductive impairment. However, concentrations of total PCBs, 10 arylhydrocarbon receptor-active PCB congeners and estimated toxic equivalents were significantly greater in embryos collected from Rock Creek Park compared to the reference site, with values for toxic congeners 77 and 126 exceeding those observed in heron embryos from the Great Lakes.

20. Rattner, B.A., P.C. McGowan, N.H. Golden, J. Hatfield, P.C. Toschik, R.F. Lukei Jr., R.C. Hale, I. Schmitz-Afonso, and C.P. Rice. 2004. Contaminant exposure and reproductive success of ospreys (*Pandion haliaetus*) nesting in Chesapeake Bay regions of concern. Archives of Environmental Contamination and Toxicology 47:126-140.

The Chesapeake Bay osprey (*Pandion haliaetus*) population has more than doubled in size since restrictions were placed on the production and use of DDT and other toxic organochlorine contaminants in the 1970's. Ospreys are now nesting in the most highly polluted portions of the Bay. In 2000, contaminant exposure and reproduction were monitored in ospreys nesting in the Anacostia and Potomac Rivers. A "sample egg" from each study nest was collected for contaminant analysis, and the fate of eggs remaining in each nest (n=14) was monitored at 7-10 day intervals from egg incubation through fledging of young. Ospreys fledged young in the Washington, DC study sites (observed success: 0.88 fledglings/active nest), although productivity was marginal for sustaining the local population in the Anacostia and Potomac Rivers and may be linked to pesticide concentrations. Concentrations of total PCBs, some arylhydrocarbon receptor-active PCB and polybrominated diphenyl ether congeners were often greater in sample eggs from Anacostia and Potomac Rivers compared to the South River reference site. Nonetheless, logistic regression analyses did not provide evidence linking marginal productivity to *p,p'*-DDE, total PCBs or toxic PCB congener exposure.

21. Southeast Cooperative Wildlife Disease Study. 1992. Clinical Necropsy Records #68-92, College of Veterinary Medicine, University of Georgia.

In March 1992, an adult male American kestrel (*Falco sparverius*) was found in Arlington, VA. The the concentration of DDE residue in the stomach contents was 2.17 µg/g and in the kestrel's brain was 6.7 µg/g. The cause of death was undetermined. However, the possibility of carbamate pesticides could not be ruled out.

22. Stafford C.J., W.L. Reichel, D.M. Swineford, R.M. Prouty, and M.L. Gay. 1978. Gas-liquid chromatographic determination of kepone in field-collected avian tissues and eggs. Journal of the Association of Offical Analytical Chemists 61:8-14.

Bald eagle (*Haliaeetus leucocephalus*) liver and carcasses collected (1968-1975) in Virginia and Maryland areas, including Accokeek, MD (n=2), were analyzed for kepone residues. Accokeek bald eagle liver and tissue contained 16.0 and 2.2 µg/g kepone, respectively. This was in the intermediate range of kepone residues from all areas and greater than eagles from Oklahoma and Minnesota (controls).

23. Yorks, A.L. 1999. Effects of polychlorinated biphenyls (PCBs) on reproduction, physiological processes, and biomarkers in tree swallows (*Tachycineta bicolor*). Ph.D. Dissertation, University of Maryland, Baltimore, 280 pp.

Patuxent Wildlife Research Center was one of ten sites selected for a study on the effects of PCBs on tree swallows (*Tachycineta bicolor*) from 1995 through 1997. PCB concentrations were determined for eggs (n = 6), twelve-day-old nestlings (n = 2), and food items (n = 8). In addition, biomarkers of exposure (hepatic cytochromes P450-associated monooxygenase activities (BROD and EROD)) were quantified. PCB concentrations in nestlings ranged from 0.04 – 1.20 µg/g ww (mean = 0.294 µg/g ww) and in eggs ranged from 0.37 – 0.99 µg/g ww (mean = 0.6950 µg/g ww). Body burdens of PCBs were correlated with sediment, egg, and food item concentrations. The cytochrome P450 induction assays yielded EROD and BROD activities of 33.73 and 21.80 pmol product/min/mg microsomal protein. All values from this site were low when compared to the other nine sites.

H. Toxic release facilities:

The EPA's Toxic Release Inventory Program lists 36 toxic release facilities that discharged contaminants within 10 kilometers of National Capital Parks-East from 1997 through 2003 (Figure 3) (http://www.epa.gov/triexplorer/facility.htm). Ten of these facilities released persistent pollutants and chemicals listed by the EPA and United Nations (Table 3). The greatest diversity of persistent pollutants and chemicals were released from Potomac River Generating Station releasing dioxins, lead and mercury. Lead was the most commonly released priority persistent pollutant being discharged by nine of the ten facilities.

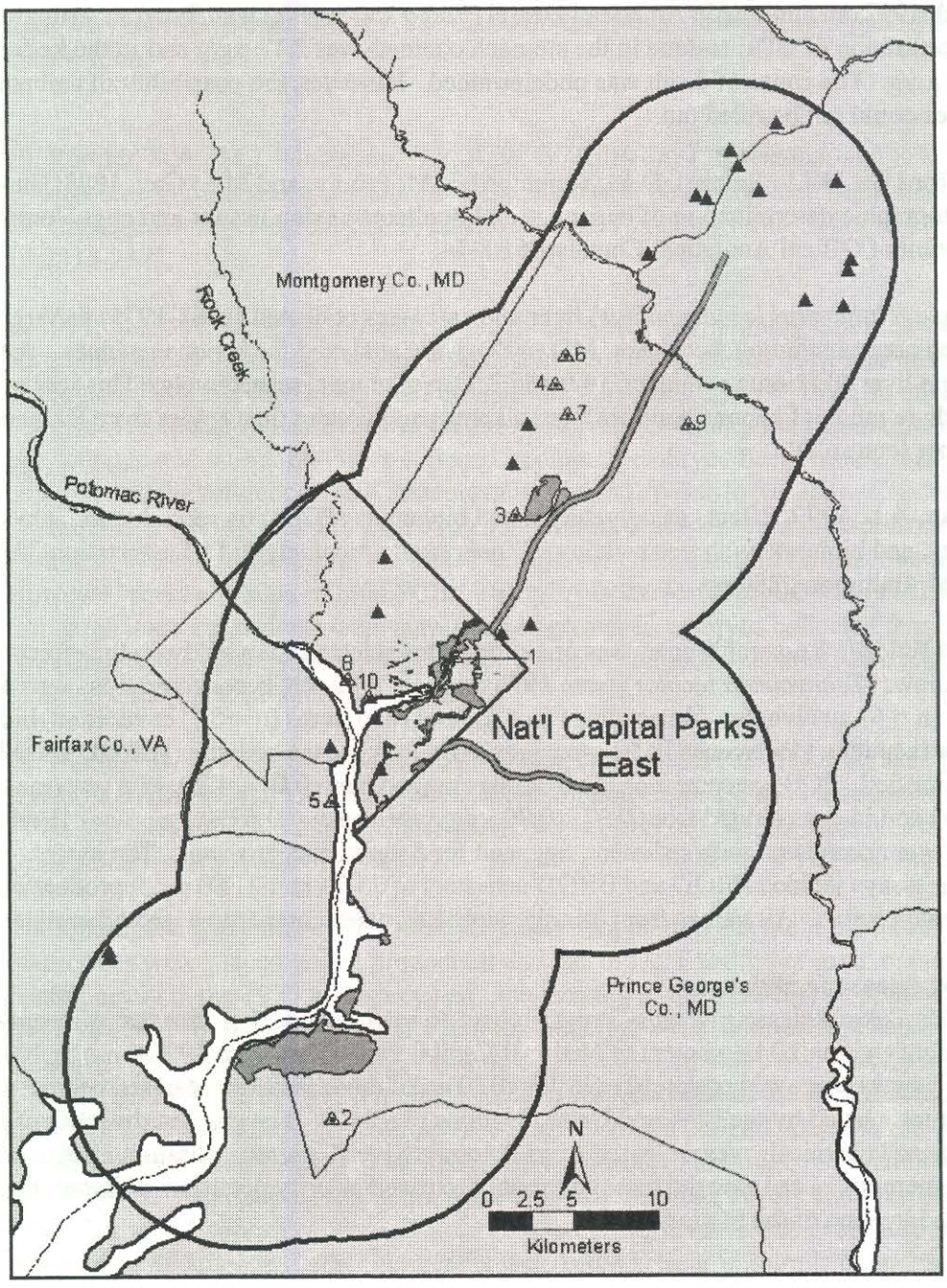

Figure 3. Toxic release sites (▲) and priority contaminant release sites (3) listed by the EPA within a 10 kilometer buffer around National Capital Parks-East for 1997 through 2003.

Table 3. Mean quantity of priority contaminants released by EPA-listed toxic release sites for 1997 through 2003 within a 10 kilometer buffer around National Capital Parks-East.

Ref. No.	Site Name	Address	Contaminant Released	Years Released	Air Release[a]	Surface Water Release[a]	Land Disposal[a]
1	Benning Generating Station	3400 Benning Rd., NE, Washington, DC	Dioxin Cmpds.	2000-02	0.0002836[b]	0	0
			Mercury	2000 & 03	4.25	0	0
2	Beretta USA Corp.	17601 Beretta Dr., Accokeek, MD	Lead Cmpds.	1997	0	2500	0
3	Litton Advanced Systems	5115 Calvert Rd., College Park, MD	Lead Cmpds.	2001	21.96	0	0
4	Perkinelmer Fluid Sciences	11642 Old Baltimore Pike, Beltsville, MD	Lead Cmpds.	2001-03	148.00	0	0
5	Potomac River Generating Station	1400 N Royal St., Alexandria, VA	Dioxin Cmpds.	2000-03	0.0007058[b]	0	0
			Mercury	2001-03	219.4	0.1	0
			Lead Cmpds.	2001-03	245.77	9.03	0
6	Rockwood Pigments Inc., North America	7011 Muirkirk Rd., Beltsville, MD	Lead Cmpds.	1997-2003	0	6.97	0
7	USDA ARS Beltsville Agricultural Research Center	10300 Baltimore Ave., Building 003, Rm 117, Beltsville, MD	Lead Cmpds.	2001-03	8.71	0	1719.80
			Mercury	2000	150.00	0.10	0
8	U.S. Dept. of the Treasury Bureau of Engraving & Printing	14th & C St, SW, Washington, DC	Lead Cmpds.	2002-03	0.005562	0	0
9	U.S. DOI US Fish & Wildlife Patuxent Research Refuge	12100 Beech Forest Rd., Laurel, MD	Lead Cmpds.	2001	0	0	20024
10	U.S. GSA FPS Pistol Range Building 202	SE Federal Center 3rd & M St., SE, Washington, DC	Lead Cmpds.	2001	0.0008	0	0

[a] Units are in lbs/yr unless otherwise noted.
[b] Units are in g/yr.

I. Fish consumption advisories:

The EPA's Water Program has listed four fish consumption advisories that indicate the presence of persistent pollutants and chemicals within 10 kilometers of National Capital Parks-East (Table 4) (http://www.epa.gov/waterscience/fish/advisories/index.html).

Table 4. Waterbodies with fish consumption advisories within a 10 kilometer buffer around National Capital Parks-East.

Waterbody Name	State	Contaminant	Advisory	Year Issued
Potomac River	MD/VA	PCBs (Total)	Restricted Consumption & No Consumption	1999 & 2004
Potomac River	MD	Chlorinated Pesticides	Restricted Consumption & No Consumption	2004
Statewide	MD	Mercury	Restricted Consumption	2004
Statewide	DC	PCBs (Total)	Restricted Consumption & No Consumption	1993 & 2004

III. CONCLUSIONS:

J. Persistent bio-accumulative toxic chemicals:

Numerous persistent pollutants and chemicals have been found or are being released within the 10 kilometer buffer surrounding National Capital Parks-East including, lead, mercury, PCBs, benzo(a)pyrene, dioxins, dieldrin, chlordane, and other organochlorinated pesticides. Eisler (2000) has described the hazards of these contaminants to wildlife.

K. Critical areas and sensitive species:

There have been bald eagles (*Haliaeetus leucocephalus*), a federally threatened species, sighted over or near the park property. Furthermore, Kingman Lake and Kenilworth Marsh provide habitat for migratory birds, reptiles and amphibians. These and other nearby surface water features contain priority pollutants, such as PCBs, chlorinated pesticides and dioxins that may place individuals at risk.

L. Additional priority contaminant monitoring/research:

The majority of contaminant exposure and effects information collected within 10 kilometers of the National Capital Parks-East has been collected before 1990. These reports indicate that historically lead, organochlorinated pesticides, PCBs were a problem in the areas. However, very few studies have been conducted recently and of the data recently collected lead, PCBs, and organochlorine pesticides and metabolites were found to still be a problem in some areas (NYDEC 1990, Rattner *et al.* 1997, Vyas *et al.* 2000, Rattner *et al.* 2004). All of the recent records were derived from avian species (Rattner et al. 1997, Yorks 1999, Vyas et al. 2000, Johnson et al. 2001, Rattner et al. 2004). The surface waters that influence the area around the National Capital Parks-East indicate the presence of these and other priority pollutants. Furthermore, the Washington Navy Yard, Andrews Air Force Base, Beltsville Agricultural Research Center, and Fort George G. Meade could be sources of additional contaminants. Since PCBs and organochlorine pesticides are persistent, additional monitoring and research may aid in identifying the extent of exposure to other groups of terrestrial vertebrates. In a risk assessment, Syracuse Research Corporation and National Oceanic Atmospheric Administration (2000) suggest that dioxins and furans, lead, methyl mercury, total DDT, and PCBs may be impacting green herons, a fish-eating species, and PCBs may be impacting raccoons along the Anacostia River.

Petersburg National Battlefield

I. BACKGROUND

Size: 1108 hectares

Designation: National Battlefield – August 24, 1962
National Military Park – July 3, 1926

Setting/habitat: Petersburg National Battlefield (NB) is located in the Coastal Plain Province of Virginia. Using the National Oceanic and Atmospheric Administration's 250 m (1990 urban-enhanced) Land Use Land Cover data (1999), the environment surrounding Petersburg NB is classified as: 44.4% forested; 29.5% urban or residential; 19.4% agricultural; 3.2% water; 3.0% wetlands; and 0.5% barren lands.

Past land uses: Agricultural and military operations

II. CURRENT AND POTENTIAL ENVIRONMENTAL CONTAMINATION

A. Known Contaminated sites:

Potentially contaminated sites have been identified on Petersburg NB property. The Eastern Front old dump site may be leaching contaminants into the surrounding environment. Fort Lee's motor pool is located adjacent to the park boundary and has created an occasional source for petroleum contamination in the surrounding area (Blumenshine, NPS, personal communication). Additionally, 28.44% of the surface waters within 10 kilometers of the park are listed as impaired by the Environmental Protection Agency (EPA) under the Clean Water Act Section 303(d).

B. NPL Superfund sites:

There are no current EPA National Priorities List (NPL) Superfund sites that require further remedial action located within 10 kilometers of Petersburg NB.

C. Impaired waterbodies:

The EPA and the Virginia Department of Environment Quality (VADEQ) under Section 303(d) listed several waterbodies as impaired in 2002 (http://www.epa.gov/waters/data/downloads.html) within 10 kilometers of Petersburg NB. Most of the waterbodies (Blackwater River/Swamp, Bailey, Swift and Rowanity Creek, and Appomattox and James River) are impaired by nutrients, pathogens and/or pH levels. However, James River is impaired for 22.5 kilometers due to fish consumption advisories from kepone and polychlorinated biphenyls (PCBs) within 10 kilometers of Petersburg NB (Figure 1).

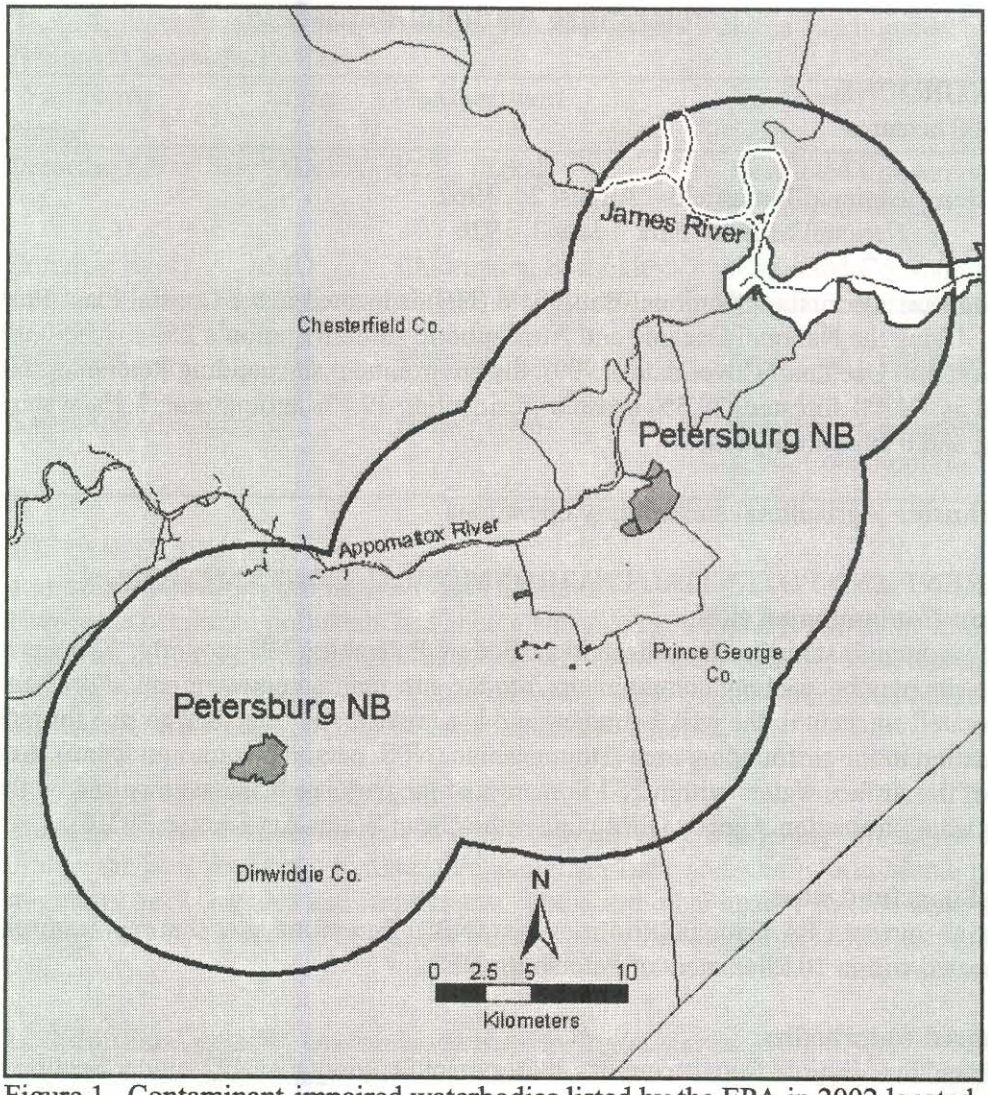

Figure 1. Contaminant-impaired waterbodies listed by the EPA in 2002 located within a 10 kilometer buffer around Petersburg NB.

D. Pesticides, herbicides, rodenticides, avicides used:

Three pesticide or herbicide products that were applied at Petersburg NB in 2004 contained an active ingredient recognized as being moderately to very highly toxic to terrestrial vertebrates (Table 1). Toxicity rating classes are: 0 = not toxic; 1 = slightly toxic; 2 = moderately toxic; 3 = highly toxic; 4 = very highly toxic. Rating classes are not reported for reptilian species due to the limited availability of toxicity data for most active ingredients.

Table 1. Moderately to very highly toxic pesticides, herbicides, rodenticides, and avicides to terrestrial vertebrates that were applied at Petersburg NB property in 2004.

Active Ingredients	Product	Applied Acres	Mammals	Birds	Amphibians	Reference Cited
Glyphosate	Roundup Pro	6.24	0-1	0-1	0-2[b]	1, 2, 3
	Accord	11.79				
	Forest Star by Agristar	1.5				

[a] References cited: 1. Sparling *et al.* 2000; Smith 1987; Hudson, *et al.* 1984; Schafer *et al.* 1983) 2. EPA Pesticide Registration website: http://cfpub.epa.gov/oppref/rereg/status.cfm?show=rereg 3. Pesticide Action Network of North America website: http://www.pesticideinfo.org/Index.html

[b] Toxicity ratings were derived from fish lethal concentrations to cause 50% mortality.

E. Solid waste or wastewater disposal sites:

There are two permitted solid waste disposal sites located within the 10 kilometer buffer around Petersburg NB (http://www.deq.virginia.gov/waste/s-waste.html) (Table 2). There are two wastewater treatment facilities located within 10 kilometers of Petersburg NB, including Hopewell and South Central Regional (Petersburg) Wastewater Treatment Facilities (http://cfpub.epa.gov/cwns/standard.cfm).

Table 2. Permitted solid waste disposal sites within a 10 kilometer buffer around Petersburg NB.

Facility Name	Address	Type	Ownership
Dinwiddie County Transfer Station	14016 Boydton Plank Rd Dinwiddie, VA	Transfer Station	Govt.
Petersburg City Sanitary Landfill	103 West Tabb Street Petersburg, VA	Sanitary Landfill	Govt.

F. Terrestrial vertebrate contaminant research or monitoring:

There have been a number of past contaminant monitoring or ecotoxicological research projects conducted on terrestrial vertebrates within the 10 kilometer buffer surrounding Petersburg NB. Many of these records were derived from the National Pesticide Monitoring Program initiated in 1967 to assess the organochlorine pesticide levels in the environment.

Studies involving Pesticides and Industrial Contaminants

1. Bryant, C.P., R.W. Young, and R.L. Kirkpatrick. 1978. Kepone residues in body tissues of raccoons collected along the James River, East of Hopewell, Virginia. Virginia Journal of Science 29:57.

In 1975 a chemical manufacturing plant was identified in contamination of Baileys Creek and James River with kepones. In 1977, brain, liver and adipose tissue of five raccoons (*Procyon lotor*) from the aforementioned area were analyzed for kepone residue and compared to raccoons from a reference location. Kepone levels were greater in the James River and Baileys Creek (mean ± SE; brain = 0.026 ± 0.001 µg/g ww; liver = 0.093 ± 0.110 µg/g ww; and adipose tissue = 0.018 ± 0.009 µg/g ww) than the reference location. However, the kepone levels were well below 1 µg/g ww. Therefore, kepones may not be entering the James River raccoon population.

2. Bunck, C.M., R.M. Prouty, and A.J. Krynitsky. 1987. Residues of organochlorine pesticides and polychlorobiphenyls in starlings (*Sturnus vulgaris*), from the continental United States, 1982. Environmental Monitoring and Assessment 8:59-75.

In 1982 starlings were collected from 139 sites nationwide, including Prince George County, as part of the National Pesticide Monitoring Program to determine organochlorine insecticide residues. Prince George County's starlings contained (µg/g ww) 0.30 DDE, 0.07 PCBs, dieldrin not detected, 0.01 HCB, Mirex not detected, 0.02 heptachlor epoxide, and oxychlordane and *trans*-Nonachlor not detected.

3. Cain, B.W. and C.M. Bunck. 1983. Residues of organochlorine compounds in starlings (*Sturnus vulgaris*), 1979. Environmental Monitoring and Assessment 3:161-172.

In 1979 starlings were collected from 112 sites nationwide, including Prince George County, as part of the National Pesticide Monitoring Program to determine organochlorine insecticide residues. Prince George County's starlings contained (µg/g ww) 0.14 DDE, DDT not detected, 0.04 dieldrin, 0.29 PCBs, 0.02 heptachlor epoxide, 0.03 HCB, Mirex not detected, and 0.11 chlordane isomers.

4. Martin W.E. 1969. Organochlorine insecticide residues in starlings. Pesticides Monitoring Journal 3:102-114.

Starlings (*Sturnus vulgaris*) were collected from 128 sites throughout the United States, including Prince George, Chesterfield and Henrico Counties, as part of the National Pesticide Monitoring Program to determine organochlorine insecticide residues. Between 1967-1968 Prince George and Chesterfield Counties' starlings averaged (µg/g ww) 0.367 DDE, 0.073 DDD, 0.111 DDT, 0.551 DDT and metabolites, and 0.015 dieldrin residues. Starlings collected in winter in these counties contained 0.069 µg/g ww heptachlor epoxide, 0.016 µg/g ww lindane, and < 0.010 µg/g ww BHC. In the same timespan Henrico County's starlings averaged (µg/g ww) 0.330 DDE, 0.013 DDD, 0.040 DDT, 0.353 DDT and metabolites, and 0.055 dieldrin residues. Starlings collected in winter in this county contained 0.110 µg/g ww heptachlor epoxide, <0.010 µg/g ww lindane, and < 0.010 µg/g ww BHC.

5. Martin, W.E. and P.R. Nickerson. 1972. Organochlorine residues in starlings-1970. Pesticides Monitoring Journal 6:33-40.

In 1970 starlings (*Sturnus vulgaris*) were collected from 125 sites throughout the United States, including Prince George County, as part of the National Pesticide Monitoring Program to determine organochlorine insecticide residues. Prince George County's starlings contained (µg/g ww) 0.940 DDE, 0.014 DDD, 0.077 DDT, 1.031 DDT and metabolites, 0.79 estimated PCBs, 0.022 dieldrin, 0.055 heptachlor epoxide, and 0.011 BHC.

6. Nickerson, P.R. and K.R. Barbehenn. 1975. Organochlorine residues in starlings, 1972. Pesticides Monitoring Journal 8:247-254.

In 1972 starlings (*Sturnus vulgaris*) were collected from 130 sites nationwide, including Prince George County, as part of the National Pesticide Monitoring Program to determine organochlorine

insecticide residues. Prince George County's starlings contained (µg/g ww) 1.610 DDE, 0.008 DDD, 0.056 DDT, 1.670 DDT and metabolites, 0.520 estimated PCBs, 0.130 dieldrin, traces of BHC and CHB, and heptachlor epoxide and oxychlordane were not detected.

7. Virginia Department of Game & Inland Fisheries. 1985. Wildlife Kill Report # 3-85, Williamsburg, VA.

A bald eagle (*Haliaeetus leucocephalus*) was found alive, but debilitated in a peanut field treated with organophosporus and carbamate pesticides in Prince George County, VA on May 23, 1985. The bird showed signs of intoxication, i.e. drooping wings and head. It was treated with atropine, recovered and released.

8. Virginia Department of Game & Inland Fisheries. 1993. Wildlife Kill Report # 16-93, Williamsburg, VA.

On June 1, 1993 four dead gray squirrels (*Sciurus carolinensis*) were collected from a Henrico County yard. Liver tissues were analyzed for residues and an acetylcholinesterase activity assay was performed. Findings indicated significant levels of brodifacoum, a rodenticide.

9. White, D.H. 1976. Nationwide residues or organochlorine in starlings, 1974. Pesticides Monitoring Journal 10:10-17.

In 1974 starlings (*Sturnus vulgaris*) were collected from 126 sites nationwide, including Prince George County, as part of the National Pesticide Monitoring Program to determine organochlorine insecticide residues. Prince George County's starlings contained (µg/g ww) 0.10 DDE, 0.010 DDD, 0.035 DDT, 0.007 dieldrin, 0.27 estimated PCBs, 0.013 heptachlor epoxide, 0.007 BHC, 0.24 HCB, and 0.017 oxychlordane.

10. White, D.H. 1979. Nationwide residues of organochlorine compounds in starlings (*Sturnus vulgaris*), 1976. Pesticides Monitoring Journal 12:193-197.

In 1976 starlings (*Sturnus vulgaris*) were collected from 126 sites nationwide, including Prince George County, as part of the National Pesticide Monitoring Program to determine organochlorine insecticide residues. Prince George County's starlings contained (µg/g ww) 0.38 DDE, DDT not detected, 0.02 dieldrin, 0.11 estimated PCBs, 0.02 heptachlor epoxide, 0.04 HCB, and 0.05 chlordane isomers.

Studies involving Metals

1. National Wildlife Health Center. 1991. Diagnostic and Epizootic Databases, Quarterly Wildlife Mortality Report # 10115. Madison, WI.

On April 24, 1991 three adult male mallards (*Anas platyrhynchos*) were collected from Prince George County, VA. Liver lead concentrations of two of these birds were 10.77 µg/g dw and 1.65 µg/g dw. Although one of these individuals had elevated lead concentrations in the liver, it is not considered in the toxic range.

J. Toxic release facilities:

The EPA's Toxic Release Inventory Program lists 28 toxic release facilities that discharged contaminants within 10 kilometers of Petersburg NB from 1997 through 2003 (http://www.epa.gov/triexplorer) (Figure 2). Nine of those facilities released Priority Persistent Bio-accumulative Toxic Chemicals or Persistent Organic Pollutants listed by the EPA or United Nations. Lead was released most frequently by the facilities, discharged by eight facilities (Table 3). Three facilities (Hopewell Cogeneration Facility, James River Cogeneration Co., and Stone Container Corp.) released three priority organic pollutants. However, most of these releases were by way of air emissions.

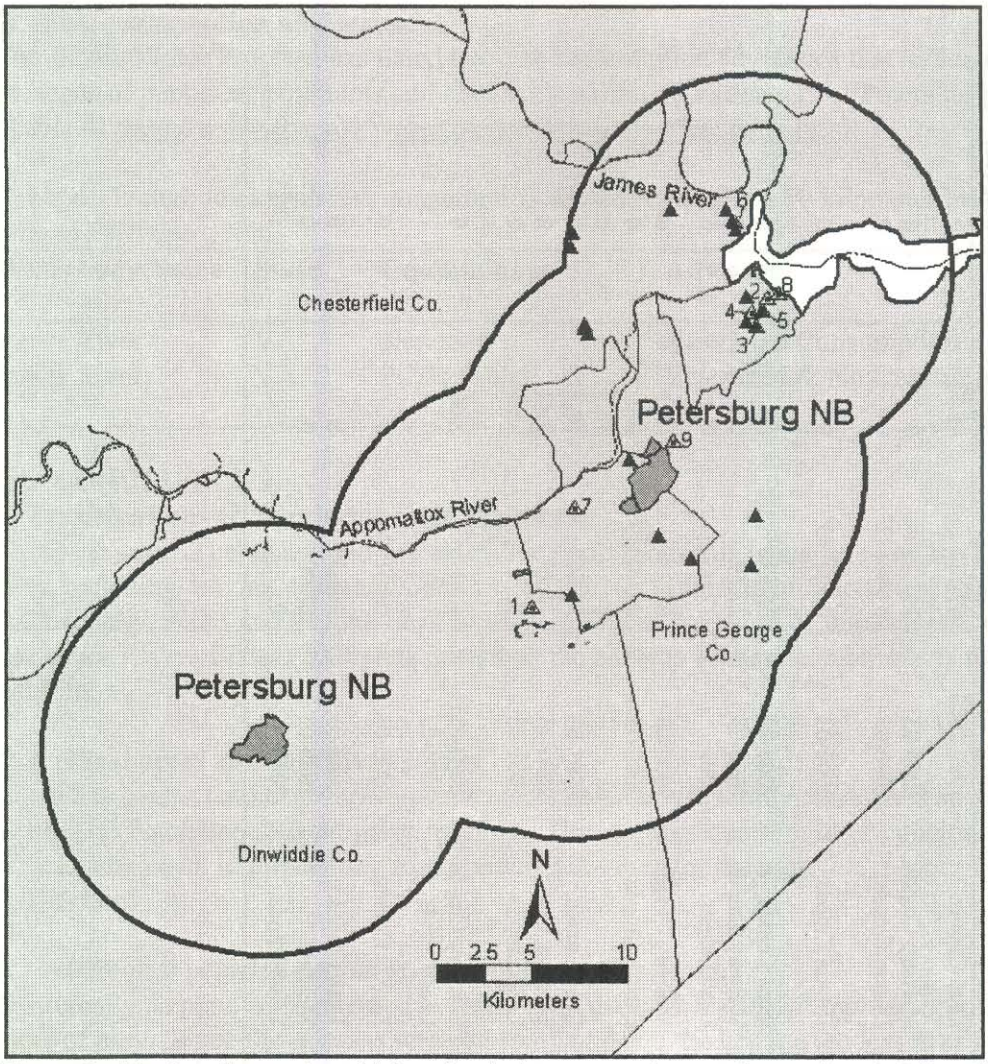

Figure 2. Toxic release sites (▲) and priority contaminant release sites (3) listed by the EPA within a 10 kilometer buffer around Petersburg NB for 1997 through 2003.

Table 3. Mean quantity of priority contaminants released by EPA-listed toxic release sites for 1997 through 2003 within a 10 kilometer buffer around Petersburg NB.

Ref. No.	Site Name	Address	Contaminant Released	Years Released	Air Release[a]	Surface Water Release[a]	Land Disposal[a]
1	Chaparral (Va) Inc.	25801 Hofheimer Way, Petersburg, VA	Lead Cmpds.	1999-2003	677.80	48.0	0
			Mercury Cmpds.	2000-03	243.25	0	0
2	Honeywell International Inc., Honeywell Plant	Rte. 10 & Industrial St., Hopewell, VA	Dioxin Cmpds.	2000-03	0.000682[b]	0	0
3	Hopewell Cogeneration Facility	1114 Hercules Rd., Hopewell, VA	Dioxin Cmpds.	2000-03	0.000363[b]	0	0
			Lead Cmpds.	2000-03	36.59	0	0
			Mercury Cmpds.	2000-03	27.59	0	0
4	Hopewell Power Station	107 Terminal St., Hopewell, VA	Lead Cmpds.	2001	17.00	0	0
			Mercury Cmpds.	2000-03	0.50	0	0
5	James River Cogeneration Co., Inc.	912 E Randolph Rd., Hopewell, VA	Dioxin Cmpds.	2000-03	0.000539[b]	0	0
			Lead Cmpds.	2001-03	17.04	10.71	0
			Mercury Cmpds.	2000-03	25.25	0.32	0
6	Philip Morris USA, Inc. – Park 500 Site	4100 Bermuda Hundred Rd., Chester, VA	Lead Cmpds.	2001-03	50.3	18.5	0
			Mercury Cmpds.	2000-03	7.90	2.00	0
7	Pre Con Inc.	220 S Perry St., Petersburg, VA	Lead Cmpds.	2001-03	1.00	0	133.33
8	Stone Container Corp.	910 Industrial St., Hopewell, VA	Dioxin Cmpds.	2000-03	0.001504[b]	0	0
			Lead Cmpds.	2001-03	988.33	0	0
			Mercury	2000-03	68.00	0	0
9	U.S. Army Fort Lee-Range	ATZM-DEL-EMO, 1816 Shop Rd., Fort Lee, VA	Lead Cmpds.	2003	0	0	3185

[a] Units are in lbs/yr unless otherwise noted.
[b] Units are in g/yr.

Table 3. Mean quantity of priority contaminants released by EPA-listed toxic release sites for 1997 through 2003 within a 10 kilometer buffer around Petersburg NB.

Ref. No.	Site Name	Address	Contaminant Released	Years Released	Air Release[a]	Surface Water Release[a]	Land Disposal[a]
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2	Honeywell International Inc., Honeywell Plant	Rte. 10 & Industrial St., Hopewell, VA	Dioxin Cmpds.	2000-03	0.000682[b]	0	0
3	Hopewell Cogeneration Facility	1114 Hercules Rd., Hopewell, VA	Dioxin Cmpds.	2000-03	0.000363[b]	0	0
			Lead Cmpds.	2000-03	36.59	0	0
			Mercury Cmpds.	2000-03	27.59	0	0
4	Hopewell Power Station	107 Terminal St., Hopewell, VA	Lead Cmpds.	2001	17.00	0	0
			Mercury Cmpds.	2000-03	0.50	0	0
5	James River Cogeneration Co., Inc.	912 E Randolph Rd., Hopewell, VA	Dioxin Cmpds.	2000-03	0.000539[b]	0	0
			Lead Cmpds.	2001-03	17.04	10.71	0
			Mercury Cmpds.	2000-03	25.25	0.32	0
6	Philip Morris USA, Inc. – Park 500 Site	4100 Bermuda Hundred Rd., Chester, VA	Lead Cmpds.	2001-03	50.3	18.5	0
			Mercury Cmpds.	2000-03	7.90	2.00	0
7	Pre Con Inc.	220 S Perry St., Petersburg, VA	Lead Cmpds.	2001-03	1.00	0	133.33
8	Stone Container Corp.	910 Industrial St., Hopewell, VA	Dioxin Cmpds.	2000-03	0.001504[b]	0	0
			Lead Cmpds.	2001-03	988.33	0	0
			Mercury	2000-03	68.00	0	0
9	U.S. Army Fort Lee-Range	ATZM-DEL-EMO, 1816 Shop Rd., Fort Lee, VA	Lead Cmpds.	2003	0	0	3185

[a] Units are in lbs/yr unless otherwise noted.
[b] Units are in g/yr.

H. Fish consumption advisories:
The EPA's Water Program has listed two fish consumption advisories that indicate the presence of persistent pollutants and chemicals within 10 kilometers of Petersburg NB (Table 4) (http://www.epa.gov/waterscience/fish/advisories/index.html).

Table 4. Waterbodies with fish consumption advisories within a 10 kilometer buffer around Petersburg NB.

Waterbody Name	State	Contaminant	Advisory	Year Issued
James River	VA	Kepone	Restricted Consumption	2004
James River	VA	PCBs (Total)	Restricted & No Consumption	2002 & 2004

III. CONCLUSIONS:

I. Persistent bio-accumulative toxic chemicals:
There are several persistent bio-accumulative toxic chemicals being released by TRI sites, including dioxins, lead, and mercury within 10 kilometers of Petersburg NB. Additionally, PCBs and kepone have been identified as the cause of impairments along the James River. Eisler (2000) has described the hazards of these contaminants to wildlife.

J. Critical areas and sensitive species:
There has been a bald eagle (*Haliaeetus leucocephalus*) (federally threatened species) nesting on Petersburg NB property recently. This nesting area should be considered a critical area when implementing management activities for the park (i.e., pesticide application).

K. Additional priority contaminant monitoring/research:
Historically, kepone were released at Hopewell, VA which affected reproduction in some birds of prey. Since the releases were discontinued and the kepone are less available to higher vertebrates, the area's birds of prey are recovering. However, kepone and PCBs have previously been identified in fish tissue in the James River and the river is currently under fish consumption advisories. Additionally, potentially kepones may become bio-available if activities stir up river sediments (e.g. dredging). Fish-eating species (e.g, bald eagles and osprey) in this area could potentially be affected by consuming contaminated fish. Monitoring of kepone and PCB levels in terrestrial vertebrates, (e.g. fish-eating species) may be warranted. No additional contaminant sites were found within 10 kilometers of Petersburg NB property in this study. Upon discovery of a contaminated site, samples from terrestrial vertebrates should be collected to determine the level of exposure.

Prince William Forest Park

I. BACKGROUND

Size: 67391 hectares

Designation: Prince William Forest Park – June 22, 1948
Chopawamsic Recreational Demonstration Area – November 14, 1936

Setting/habitat: Prince William Forest Park (FP) is located in the Piedmont and Coastal Plain Provinces of Virginia. Using the National Oceanic and Atmospheric Administration's 250 m (1990 urban-enhanced) Land Use Land Cover data (1999), the environment surrounding Prince William FP is classified as: 60.8% forested; 32.1% urban; 4.6% agricultural; 0.9% water; 0.9% barren lands; and 0.7% wetlands.

Past land uses: Military, agricultural, and mining operations.

II. CURRENT AND POTENTIAL ENVIRONMENTAL CONTAMINATION

A. Known contaminated sites:

The Environmental Protection Agency (EPA) has listed one National Priorities List (NPL) Superfund site, the Marine Corps Combat Development Command, within the 10 kilometer that surrounds Prince William FP. Additionally, 8.31% of the surface waters located within this area are listed as impaired by the EPA under the Clean Water Act Section 303(d).

B. NPL Superfund sites:

The Marine Corps Combat and Development Command is a 56,000 acre facility containing 224 potential sites located in Quantico, VA (Figure 1). The Combat and Development Command began operation to train personnel in technical maneuvers and to develop and research military equipment in 1917. Pesticides (dieldrin, 4,4,-DDD and 4,4,-DDT), PCB-126, and numerous metals have been identified in the soil and surface water at locations on the facility (e.g., Old Landfill, Defense Reutilization Marketing Office, and Former Rifle Range). Numerous removal actions have been completed or are scheduled for completion at the base. The primary surface water features that have the potential to be affected include the Potomac River, Chopawamsic, Aquia, Cannon and Tank Creeks, and Cedar, Deadwood and Goslin Runs.

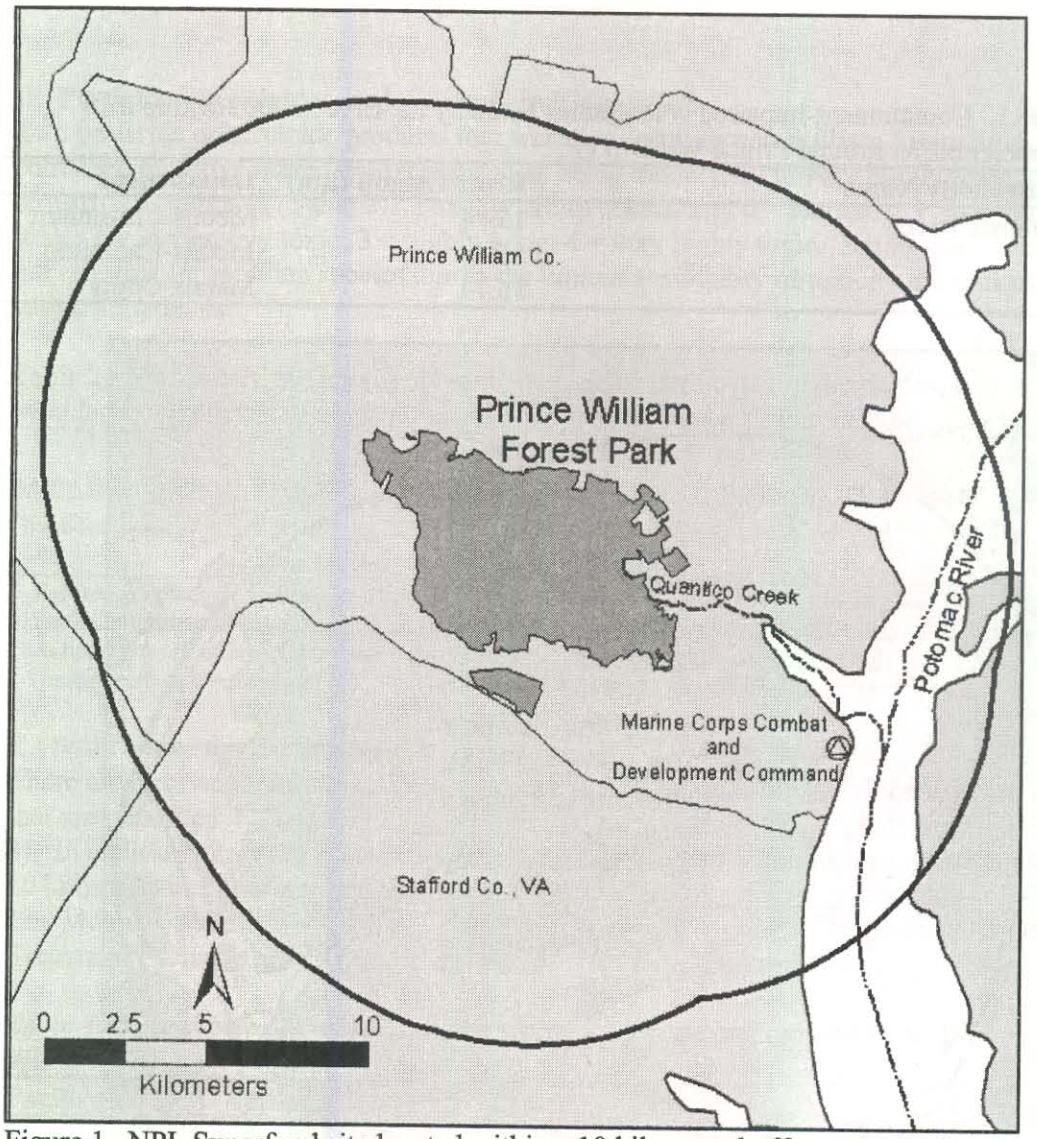

Figure 1. NPL Superfund site located within a 10 kilometer buffer around Prince William FP.

C. Impaired waterbodies:

The Potomac River is the only surface water feature within 10 km of Prince William FP that contained sufficient quantities of contaminants to be listed as impaired by the EPA and Virginia Department of Environmental Quality (VADEQ) under Section 303(d) (http://www.epa.gov/waters/data/downloads.html) in 2002 (Table 1). None of these impaired waters flow through Prince William FP (Figure 2). Additionally, nutrient and sedimentation/siltation impairments affect portions of the Mattawoman Creek and the Potomac River.

Table 1. Contaminant-impaired waterbodies listed by the EPA in 2002 within a 10 kilometer buffer around Prince William FP.

Waterbody Name	River Length (km)	Impairment
Potomac River	15.74	Metals-Chromium
	15.74	Metals-Cadmium
	15.74	Metals-Copper

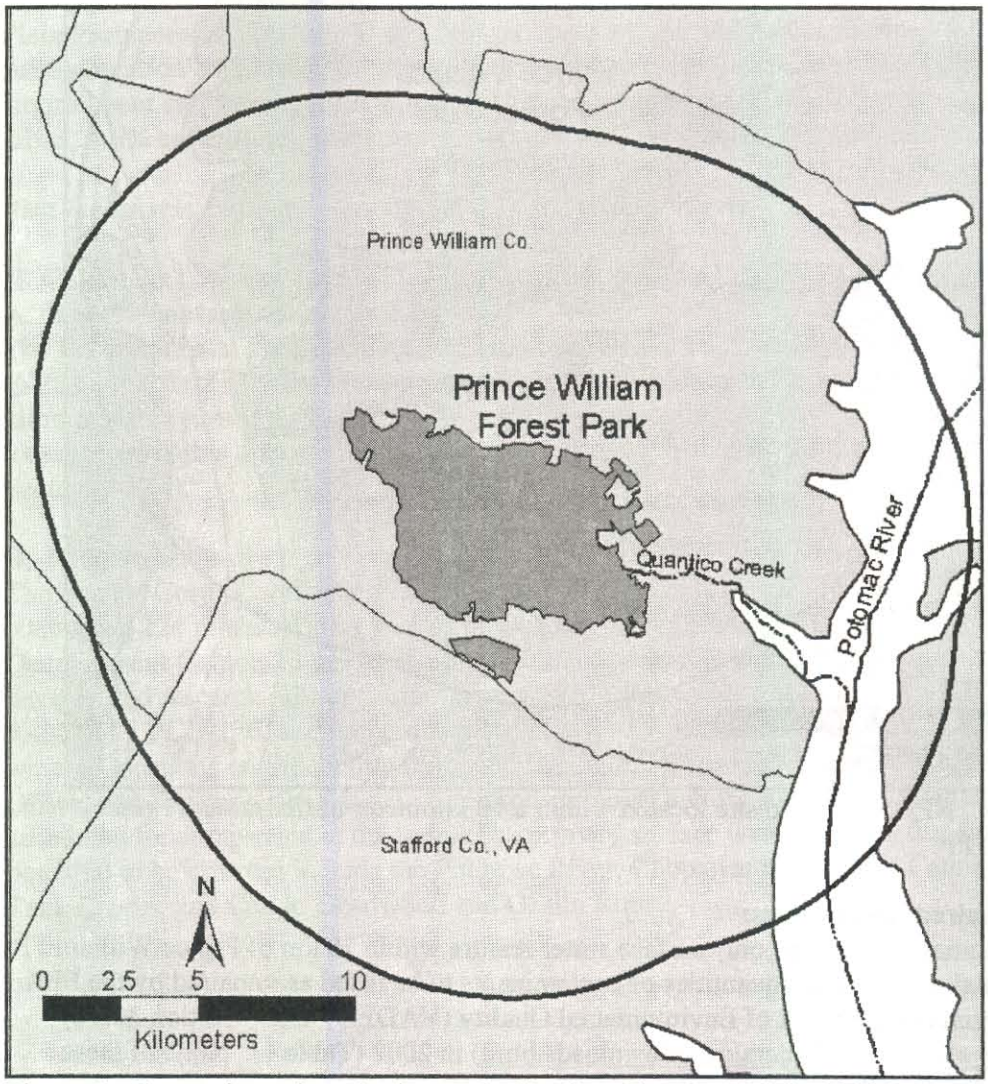

Figure 2. Contaminant-impaired waterbodies listed by the EPA in 2002 located within a 10 kilometer buffer around Prince William FP.

D. Pesticides, herbicides, rodenticides, avicides used:
Two pesticide or herbicide products that were applied at Prince William FP in 2004 contained an active ingredient recognized as being moderately to very highly toxic to terrestrial vertebrates (Table 2). Toxicity rating classes are: 0 = not toxic; 1 = slightly toxic; 2 = moderately toxic; 3 = highly toxic; 4 = very highly toxic. Rating classes are not reported for reptilian species due to the limited availability of toxicity data for most active ingredients.

Table 2. Moderately to very highly toxic pesticides, herbicides, rodenticides, and avicides to terrestrial vertebrates that were applied at Prince William FP property in 2004.

Active Ingredients	Product	Applied Acres	Mammals	Birds	Amphibians	Reference Cited[a]
Glyphosate	Rodeo	4.19	0-1	0-1	0-2[b]	1, 2, 3
	Roundup Pro	23.02				

[a] References cited: 1. Sparling *et al.* 2000; Smith 1987; Hudson, *et al.* 1984; Schafer *et al.* 1983) 2. EPA Pesticide Registration website: http://cfpub.epa.gov/oppref/rereg/status.cfm?show=rereg 3. Pesticide Action Network of North America website: http://www.pesticideinfo.org/Index.html

[b] Toxicity ratings were derived from fish lethal concentrations to cause 50% mortality.

E. Solid waste or wastewater disposal sites:
There are three solid waste facilities located within 10 kilometers of Prince William FP that are permitted by VADEQ (http://www.deq.virginia.gov/waste/s-waste.html) (Table 3). In addition, there are at least five waste water treatment facilities located within the 10 kilometer buffer around Prince William FP (http://cfpub.epa.gov/cwns/standard.cfm). The Mooney, Dale City #1 and #8, Aquia Regional, and Quantico-Mainside Waste Water Treatment Facilities are all located downstream from the park property.

Table 3. Permitted solid waste facilities within a 10 kilometer buffer around Prince William FP.

Facility Name	Address	Type	Ownership
Potomac Landfill	3730 Greentree Lane, Dumfries, VA	Construction & Demolition Debris Landfill	Private
Independent Hill Sanitary Landfill	4379 Ridgewood Center Dr., Prince William, VA	Sanitary Landfill	Govt.
Prince William County YWCF Balls Ford Rd.	4379 Ridgewood Center Dr., Prince William, VA	Yard Waste Composting Facility	Govt.

F. Terrestrial vertebrate contaminant research or monitoring:
At the present time no terrestrial vertebrate contaminant monitoring or research is being conducted on Prince William FP property. In the past anuran reproductive success has been monitored at the pyrite mine runoff ponds located within Prince William FP with

breeding occurring in ponds with low metals and unsuccessful reproduction occurring at ponds with high metal concentrations (Lee, personal communication).

1. Southeastern Cooperative Wildlife Disease Study. 1991. Clinical Necropsy Record # 132-91, College of Veterinary Medicine, University of Georgia.

A case of a European Starling (*Sturnus vulgaris*) death from Triangle, VA was investigated. There was 20% acetylcholinesterase inhibition, indicating exposure to organophosphorus or carbamate pesticides.

G. Toxic release facilities:

The EPA's Toxic Release Inventory Program lists five toxic release facilities that discharged contaminants (http://www.epa.gov/triexplorer/facilities.htm) within 10 kilometers of Prince William FP from 1997 through 2003 (Figure 3). Two of these facilities released priority persistent chemicals/pollutants listed by either the EPA or United Nations (Table 4).

Table 4. Mean quantity of priority contaminants released by EPA-listed toxic release sites for 1997 through 2003 within a 10 kilometer buffer around Prince William FP.

Site Name	Address	Contaminant Released	Years Released	Air Release[a]	Surface Water Release[a]	Land Disposal[a]
Possum Point Power Station	19000 Possum Point Rd., Dumfries, VA	Dioxin Cmpds.	2000-03	0.00234281[b]	0	0
		Lead Cmpds.	2001-03	1213.33	13.33	9066.67
		Mercury Cmpds.	2000-03	169	10.5	27.5
U.S. Marine Corps Base Quantico	3250 Catlin Ave., Quantico, VA	Lead Cmpds.	2001-03	352.17	0	55028.9

[a] Units are in lbs/yr unless otherwise noted.
[b] Units are in g/yr.

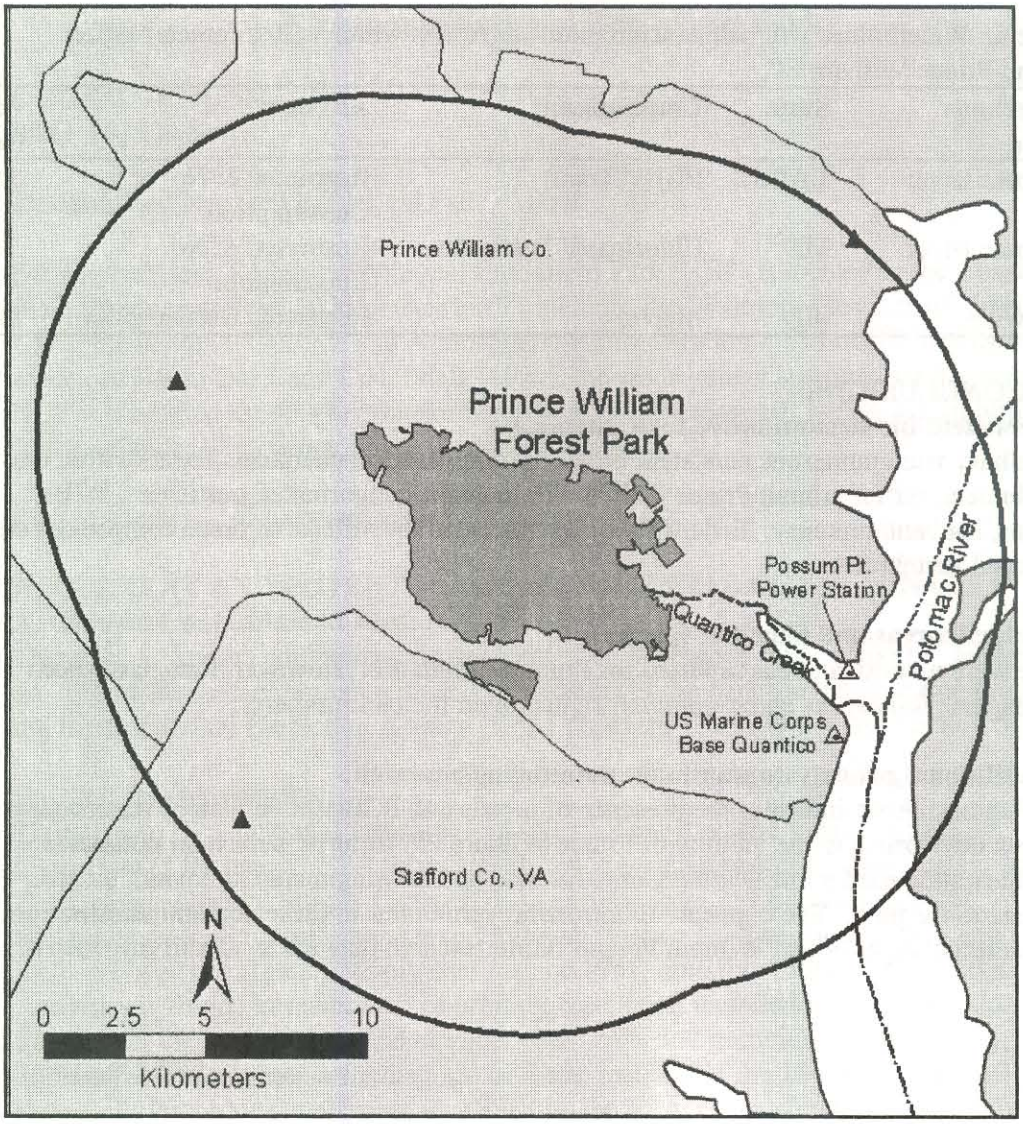

Figure 3. Toxic release sites (#) and priority contaminant release sites (I) listed by the EPA within a 10 kilometer buffer around Prince William FP for 1997 through 2003.

H. Fish consumption advisories:

The EPA's Water Program has listed three fish consumption advisories that indicate the presence of persistent pollutants and chemicals within 10 kilometers of Prince William FP (Table 5) (http://www.epa.gov/waterscience/fish/advisories/index.html).

Table 5. Waterbodies with fish consumption advisories within a 10 kilometer buffer around Prince William FP.

Waterbody Name	State	Contaminant	Advisory	Year Issued
Potomac River	VA/MD	PCBs (Total)	Restricted & No Consumption	2004
Potomac River	MD	Chlorinated Pesticides	Restricted & No Consumption	2004
Statewide	MD	Mercury	Restricted Consumption	2004

III. CONCLUSIONS:

I. Persistent bio-accumulative toxic chemicals:

There have been numerous persistent bio-accumulative toxic chemicals found within the 10 kilometer buffer around Prince William FP, including chlorinated pesticides, PCBs, dioxins, lead and mercury. Eisler (2000) has described the effects of these compounds on terrestrial vertebrates.

J. Critical areas and Sensitive Species:

There were no critical areas reported for Prince William FP. However, there have been bald eagles (*Haliaeetus leucocephalus*) sighted over the park property.

K. Additional priority contaminant monitoring/research:

The Potomac River indicates the presence of metals and PCBs (i.e. impaired waterbodies and fish advisories) in the vicinity of Prince William FP. Priority persistent pollutants have been identified at the Marine Corps Combat and Development Command, located adjacent to the park. The exposure of terrestrial vertebrates to these contaminants has not been determined at Prince William FP and future research may aid in identifying the risk.

Richmond National Battlefield Park

I. BACKGROUND

Size: 1019 hectares

Designation: National Battlefield Park - March 2, 1936

Setting/habitat: Richmond National Battlefield Park (NBP) is located in the Coastal Plain Province and the 10 kilometer buffer includes the Piedmont Province of Virginia. Using the National Oceanic and Atmospheric Administration's 250 m (1990 urban-enhanced) Land Use Land Cover data (1999), the environment surrounding Richmond NBP is classified as: 43.4% urban or residential; 37.5% forested; 14.5% agricultural; 2.0%wetlands; 1.9% water; and 0.7% barren lands.

Past land uses: Military and agricultural operations

II. CURRENT AND POTENTIAL ENVIRONMENTAL CONTAMINATION

A. Known Contaminated sites:

There are no known contaminated sites located on Richmond NBP property. However, 14.76% of the surface waters within 10 kilometers of the park are listed as impaired by the Environmental Protection Agency (EPA) under the Clean Water Act Section 303d.

B. NPL Superfund sites:

There is one EPA National Priorities List (NPL) Superfund site located within 10 kilometers of Richmond NBP (http://cfpub.epa.gov/supercpad/cursites/srchsites.cfm). The Defense General Supply Center (DLA) encompasses 259 hectares south of Richmond, VA along Jefferson Davis Highway (Figure 1). The site operated as a Defense Logistics Agency supply center since 1941, repairing military equipment. Activities involved in restoration of military equipment included shipping and storing flammable, toxic, corrosive, and oxidizer chemicals, and pesticides. Additionally, Area 50 Landfill was a location for disposal of waste material in the 1960s and early 1970s. Potentially hazardous substances identified by the EPA's Superfund Program include pesticides, volatile organic compounds (VOCs), metals, and polycyclic aromatic hydrocarbons (PAHs). Since 1993, clean-up at the facility has included treating groundwater at the Acid Neutralization Pits and Former Fire Training Area, excavating soils in the National Guard Area, and proposals have been submitted for remedial actions for the Former Pesticides Building.

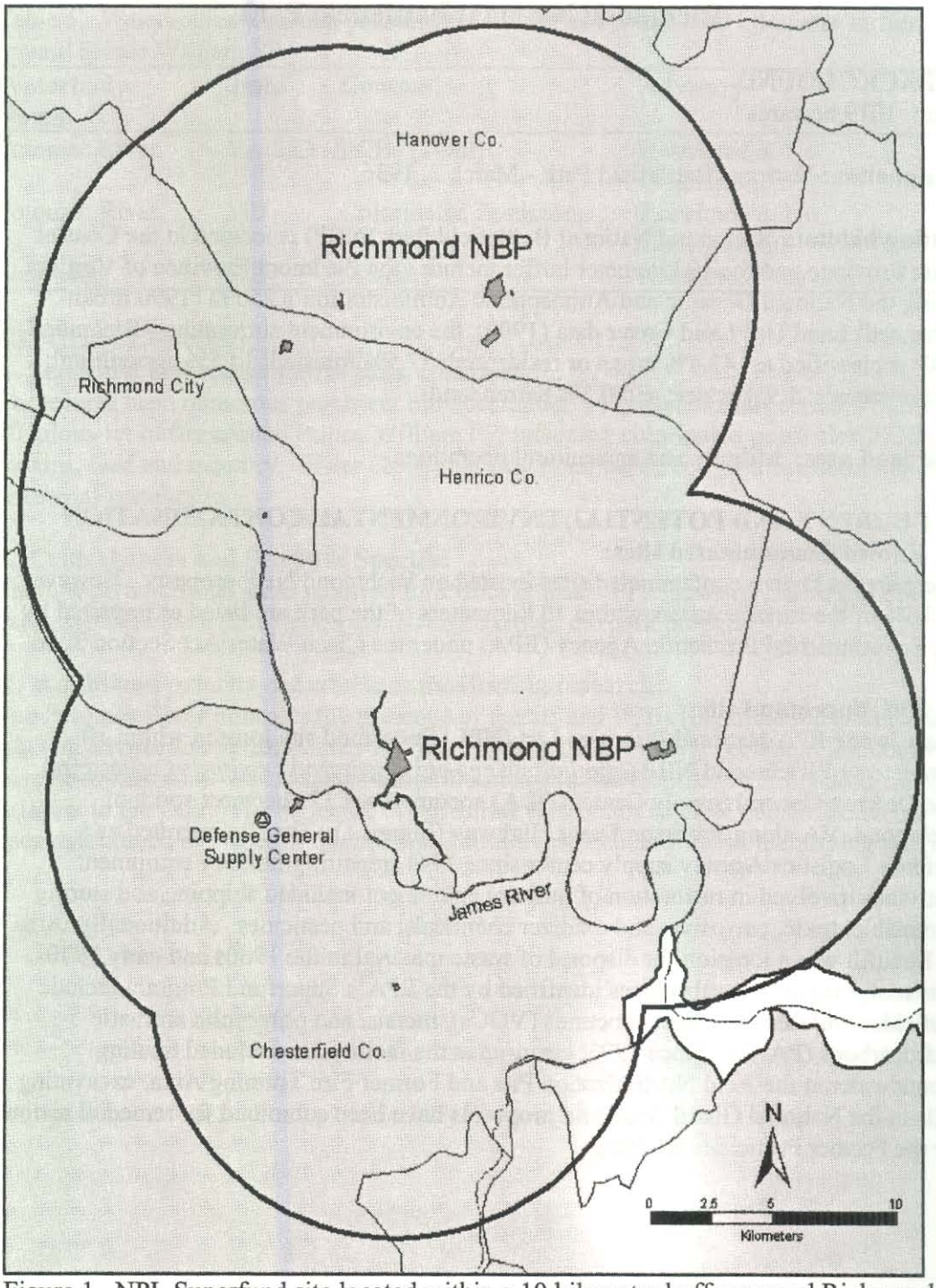

Figure 1. NPL Superfund site located within a 10 kilometer buffer around Richmond NBP.

C. Impaired waterbodies:

The EPA and the Virginia Department of Environment Quality (VADEQ) under Section 303(d) listed nine waterbodies as impaired in 2002

(http://www.epa.gov/waters/data/downloads.html) within 10 kilometers of Richmond NBP. The James River (45.7 kilometers) is the only waterbody within this area impaired from contaminants. It is listed as impaired due to a fish consumption advisory from high levels of kepone and polychlorinated biphenyls (PCBs). Impaired portions of the James River flow adjacent to Richmond NBP (Figure 2). Additionally, pathogen and pH impairments are listed for Matadequin, Swift, and Four Mile Creeks, White Oak Swamp, Upham Block, and Chickahominy and Appomattox Rivers.

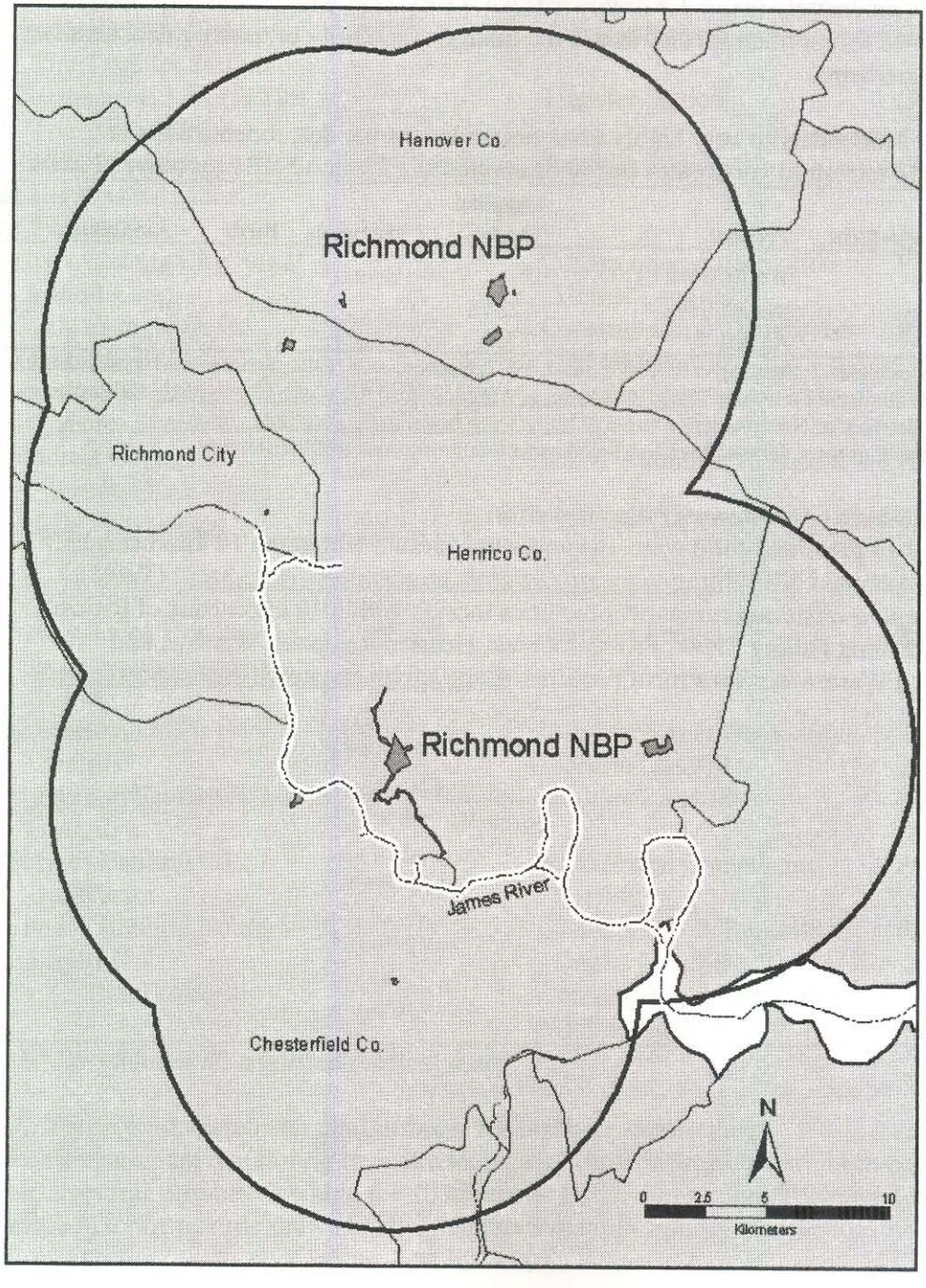

Figure 2. Contaminant-impaired waterbodies listed by the EPA in 2002 located within a 10 kilometer buffer around Richmond NBP.

D. Pesticides, herbicides, rodenticides, avicides used:
Three pesticide or herbicide products that were applied at Richmond NBP in 2004 contained active ingredients recognized as being moderately to very highly toxic to terrestrial vertebrates (Table 1). Toxicity rating classes are: 0 = not toxic; 1 = slightly toxic; 2 = moderately toxic; 3 = highly toxic; 4 = very highly toxic. Rating classes are not reported for reptilian species due to the limited availability of toxicity data for most active ingredients.

Table 1. Moderately to very highly toxic pesticides, herbicides, rodenticides, and avicides to terrestrial vertebrates that were applied at Richmond NBP property in 2004.

Active Ingredient	Product	Applied Acres	Mammals	Birds	Amphibians	Reference Cited[a]
Allethrin	Wasp Freeze PT515	1	1	0	3-4[b]	1, 3
Glyphosate	Roundup Pro	122.75	0-1	0-1	0-2[b]	1, 2, 3
	Accord	7.59				

[a] References cited: 1. Sparling *et al.* 2000; Smith 1987; Hudson, *et al.* 1984; Schafer *et al.* 1983) 2. EPA Pesticide Registration website: http://cfpub.epa.gov/oppref/rereg/status.cfm?show=rereg 3. Pesticide Action Network of North America website: http://www.pesticideinfo.org/Index.html

[b] Toxicity ratings were derived from fish lethal concentrations to cause 50% mortality.

E. Solid waste or wastewater disposal sites:
There are 16 permitted solid waste disposal sites located within the 10 kilometer buffer around Richmond NBP (http://www.deq.virginia.gov/waste/s-waste.html) (Table 2). There are five wastewater treatment facilities located within 10 kilometers of Richmond NBP, including Falling Creek, Proctors Creek, Henrico Regional, Warsaw, and Richmond Wastewater Treatment Facilities (http://cfpub.epa.gov/cwns/standard.cfm).

Table 2. Permitted solid waste disposal sites within a 10 kilometer buffer around Richmond NBP.

Facility Name	Address	Type	Ownership
BFI Old Dominion Sanitary Landfill	2001 Charles City Rd Richmond, VA	Sanitary Landfill	Private
Chesterfield-N Waste Tire Transfer Station	P.O. Box 40 Chesterfield, VA	Transfer Station	Govt.
Chesterfield-S Waste Tire Transfer Station	P.O. Box 40 Chesterfield, VA	Transfer Station	Govt.
City of Richmond Hopkins Rd Transfer Station	900 East Broad St Richmond, VA	Transfer Station	Govt.
Cox's Charles City Road Landfill, Inc.	5200 Hatcher St Richmond, VA	Construction & Demolition Debris Landfill	Private
Cox's Darbytown Rd Landfill, Inc.	5200 Hatcher St Richmond, VA	Construction & Demolition Debris Landfill	Private
Incende, Inc. RMW Transfer Station	1306 Bellwood Rd Chesterfield, VA	Transfer Station	Private
Medical College of Virginia Chem Clave	P.O. Box 48 Richmond, VA	RMW Alternate Treatment	Private
Qualla Road Demo Landfill	7550 Qualla Rd Chesterfield, VA	Construction & Demolition Debris Landfill	Private
RECO Industries	710 Hospital St. Richmond, VA	Materials Recovery Facility	Private
Safety Kleen Systems, Inc.-Chester Transfer Station	P.O. Box 1098 Chester, VA	Transfer Station	Private
Shoosmith Debris Landfill	11800 Lewis Rd Chester, VA	Construction & Demolition Debris Landfill	Private
Shoosmith Sanitary Landfill	11800 Lewis Rd Chester, VA	Sanitary Landfill	Private
Simons Hauling Co.-Darbytown	4510 Oakley's Lane Richmond, VA	Yard Waste Composting Facility	Private
Simons Hauling Debris Landfill	P.O. Box 7733 Richmond, VA	Construction & Demolition Debris Landfill	Private
Taylor Road Landfill	5200 Hatcher St. Richmond, VA	Construction & Demolition Debris Landfill	Private

[a] RMW includes all regulated medical waste.

F. Terrestrial vertebrate contaminant research or monitoring:

Past contaminant monitoring or ecotoxicological research projects have been conducted on terrestrial vertebrates within the 10 kilometer buffer surrounding Richmond NBP. In addition to the records shown below, numerous records without specific location

information were placed in the VA state capitol, Richmond. These records are not included below.

Studies Involving Pesticides and Industrial Contaminants

1. Martin W.E. 1969. Organochlorine insecticide residues in starlings. Pesticides Monitoring Journal 3:102-114.

Starlings (*Sturnus vulgaris*) were collected from 128 sites throughout the United States, including Henrico County, as part of the National Pesticide Monitoring Program to determine organochlorine insecticide residues. Between 1967-1968 Henrico County's starlings averaged (µg/g ww) 0.330 DDE, 0.013 DDD, 0.040 DDT, 0.353 DDT and metabolites, and 0.055 dieldrin residues. Starlings collected in winter in this county contained 0.110 µg/g ww heptachlor epoxide, <0.010 µg/g ww lindane, and < 0.010 µg/g ww BHC.

2. Southeastern Cooperative Wildlife Disease Study. 1998. Clinical Necropsy Record # 126-98, College of Veterinary Medicine, University of Georgia.

In June 1998, eight squirrels and several birds were found dead in West Richmond, VA. Two adult female gray squirrels (*Sciurus carolinensis*) were collected and pooled liver tissues analyzed. Bromodiolone (4.94 µg/g ww) and diphacinone (3.41 µg/g ww) toxicosis, both anticoagulant rodenticides, were determined to be the cause of the squirrel deaths.

3. Virginia Department of Game & Inland Fisheries. 1993. Wildlife Kill Report # 16-93, Williamsburg, VA.

On June 1, 1993, four dead gray squirrels (*Sciurus carolinensis*) were collected from a Henrico County yard. Liver tissues were analyzed for residues and an acetylcholinesterase activity assay was performed to identify potential exposure to organophosphorus and carbamate pesticides. Findings indicated significant levels of brodifacoum, a rodenticide.

G. Toxic release facilities:

The EPA's Toxic Release Inventory Program lists 58 toxic release facilities that discharged contaminants within 10 kilometers of Richmond NBP from 1997 through 2003 (http://www.epa.gov/triexplorer) (Figure 3). Fifteen of these facilities released Priority Persistent Bio-accumulative Toxic Chemicals and/or Persistent Organic Pollutants listed by EPA or the United Nations (Table 2). The most widespread persistent pollutant or chemical released in the region was lead, released by 13 of the 15 facilities. Three facilities (Congentrix of Richmond, Wabash Aluminum Alloys, and Chesterfield Power Station) released three persistent pollutants or chemicals, including dioxin, lead, mercury and PCBs.

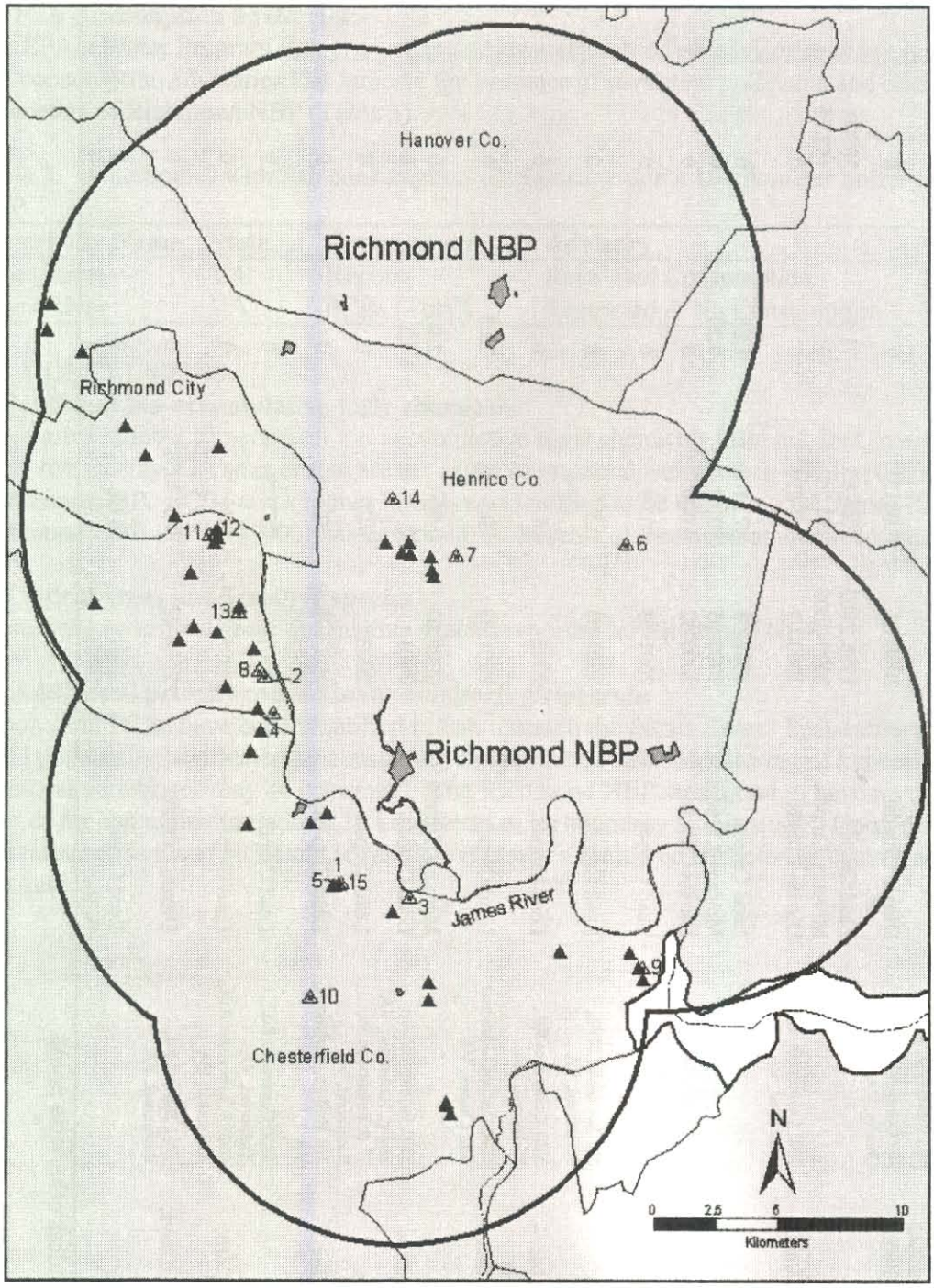

Figure 3. Toxic release sites (#) and priority contaminant release sites (I) listed by the EPA within a 10 kilometer buffer around Richmond NBP for 1997 through 2003.

Table 2. Mean quantity of priority contaminants released by EPA-listed toxic release sites for 1997 through 2003 within a 10 kilometer buffer around Richmond NBP.

Ref. No.	Site Name	Address	Contaminant Released	Years Released	Air Release[a]	Surface Water Release[a]	Land Disposal[a]
1	Alsco Metals Corp.	1701 Reymet Rd., Richmond, VA	Dioxin Cmpds.	2000-03	0.00155[b]	0	0
2	Charter-triad Terminals, LLC. Richmond Terminal	4110 Deepwater Terminal Rd., Richmond, VA	Lead Cmpds.	2001-03	0.55	6	0
3	Chesterfield Power Station	500 Coxendale Rd., Chester, VA	Dioxin Cmpds.	2000-03	0.00131[b]	0	0
			Lead Cmpds.	1998-2003	5066.67	71.5	38500
			Mercury Cmpds.	2000-2003	684.75	0	152.25
4	Congentrix of Richmond, Inc.	5001 Commerce Rd., Richmond, VA	Dioxin Cmpds.	2000-03	0.13298[b]	0	0
			Lead Cmpds.	2001-03	27.11	8.88	0
			Mercury Cmpds.	2000-03	50.12	0.20	0
5	Kaiser Bellwood Corp.	1901 Reymet Rd., Richmond, VA	Dioxin Cmpds.	2000-02	0.000273[b]	0	0
6	Infineon Technologies Richmond	6000 Technology Blvd., Sandston, VA	Lead Cmpds.	2001-03	13.07	0	0
7	Interconnections Inc., Richmond, VA	821 Southlake Blvd., Richmond, VA	Lead Cmpds.	2001-03	0.50	0	0
8	Philip Morris USA, Inc. – Manufacturing Center	3601 Commerce Rd., Richmond, VA	Lead Cmpds.	2003	14.4	0	0
9	Philip Morris USA, Inc. – Park 500 Site	4100 Bermuda Hundred Rd., Chester, VA	Lead Cmpds.	2001-03	50.3	18.5	0
			Mercury Cmpds.	2000-03	7.90	2.00	0
10	Rehrig International	1301 Battery Brooke Pkwy., Richmond, VA	Lead Cmpds.	2001	0	0.3	0
11	Reynolds Metals Co.	7th & Bainbridge St., Richmond, VA	Lead Cmpds.	2003	0.20	0	0
12	Sampson Coatings, Inc.	301 Hull St., Richmond, VA	Lead Cmpds.	1997-98 & 2002-03	129.75	0	0
13	Sonoco Prods. Co.	1850 Commerce Rd., Richmond, VA	Lead Cmpds.	2001	257.28	0	0
14	Viasystems Techs. Corp. ,LLC	4500 S. Laburnum Ave., Richmond, VA	Lead Cmpds.	1998-2001	8.13	0	0
15	Wabash Aluminum Alloys, LLC	1711 Reymet Rd., Richmond, VA	Dioxin Cmpds.	2000-02	0.003058[b]	0	0
			Lead Cmpds.	2001	0.16	0	0
			PCBs	2001	1.24	0	0

[a] Units are in lbs/yr unless otherwise noted.
[b] Units are in g/yr.

H. Fish consumption advisories:
The EPA's Water Program (http://www.epa.gov/waterscience/fish/advisories/index.html) has listed two fish consumption advisories that indicate the presence of persistent pollutants and chemicals within 10 kilometers of Richmond NBP (Table 3).

Table 3. Waterbodies with fish consumption advisories within a 10 kilometer buffer around Richmond NBP.

Waterbody Name	State	Contaminant	Advisory	Year Issued
James River	VA	Kepone	Restricted Consumption	2004
James River	VA	PCBs (Total)	Restricted & No Consumption	2002 & 2004

III. CONCLUSIONS:

I. Persistent bio-accumulative toxic chemicals:
There are a number of persistent bio-accumulative toxic chemicals (dioxins, lead, mercury, and PCBs) being released by TRI sites or that are the cause of impaired waterbodies within 10 kilometers of Richmond NBP. PCBs and kepones have been identified to be impairing the James River adjacent to Richmond NBP. Eisler (2000) has described the hazards of these contaminants to wildlife.

J. Critical areas and sensitive species
There were no critical areas or sensitive species reported for Richmond NBP.

K. Additional priority contaminant monitoring/research:
Kepone and PCBs have been identified in fish tissue in the James River. Fish-eating species in the area could potentially be affected by consuming contaminated fish. Monitoring of kepone and PCB levels in terrestrial vertebrates may be warranted. The Richmond NBP was found to have no other current sources for contamination within 10 kilometers of its boundary in this study. Upon discovery of a contaminated site, samples from terrestrial vertebrates should be collected to determine the level of exposure.

Rock Creek Park

I. BACKGROUND

Size: 710 hectares

Designation: Rock Creek Park - September 27, 1890
Meridian Hill Park - June 25, 1910
Montrose Park - March 2, 1911
Rock Creek & Potomac Parkway - March 4, 1913
Dumbarton Oaks Park - December 2, 1940

Setting/habitat: Rock Creek Park is located in the Piedmont Plateau and Coastal Plains Provinces in the District of Columbia. Using the National Oceanic and Atmospheric Administration's 250 m (1990 urban-enhanced) Land Use Land Cover data (1999), the environment surrounding Rock Creek Park is classified as: 98.8% urban or built-up; and 1.2% water.

Past land uses: Prior to NPS acquisition Rock Creek Park was used for subsistent agriculture.

II. CURRENT AND POTENTIAL ENVIRONMENTAL CONTAMINATION

A. Known contaminated sites:

There are no known contaminated sites within park boundaries. There is one Environmental Protection Agency (EPA) National Priorities List (NPL) Superfund site, Washington Navy Yard. The EPA has listed 33.27% of the surface waters in the 10 kilometer buffer as impaired.

B. NPL Superfund sites:

The Washington Navy Yard contains 28.9 ha along the Anacostia River in Washington, DC (Figure 1). The Washington Navy Yard existed since 1799 and operated as a ship building/repair and naval gun factory until 1961 when it became an administrative facility (http://cfpub.epa.gov/supercpad/cursites/srchsites.cfm). During its operation as a ship building/repair and naval gun factory the waste generated included polycyclic aromatic hydrocarbons (PAHs), heavy metals, polychlorinated biphenyls (PCBs), and dioxins. Since 1998, the EPA's Superfund Program has removed a portion of the hazardous waste, including lead paint, PCBs, and mercury. However, dioxins, other metals, and PAHs still exist in portions of the site. The Anacostia River is the primary surface water feature associated with the Washington Navy Yard. The storm water system, with nine outfalls into the Anacostia River, has been documented to contain lead and PCBs.

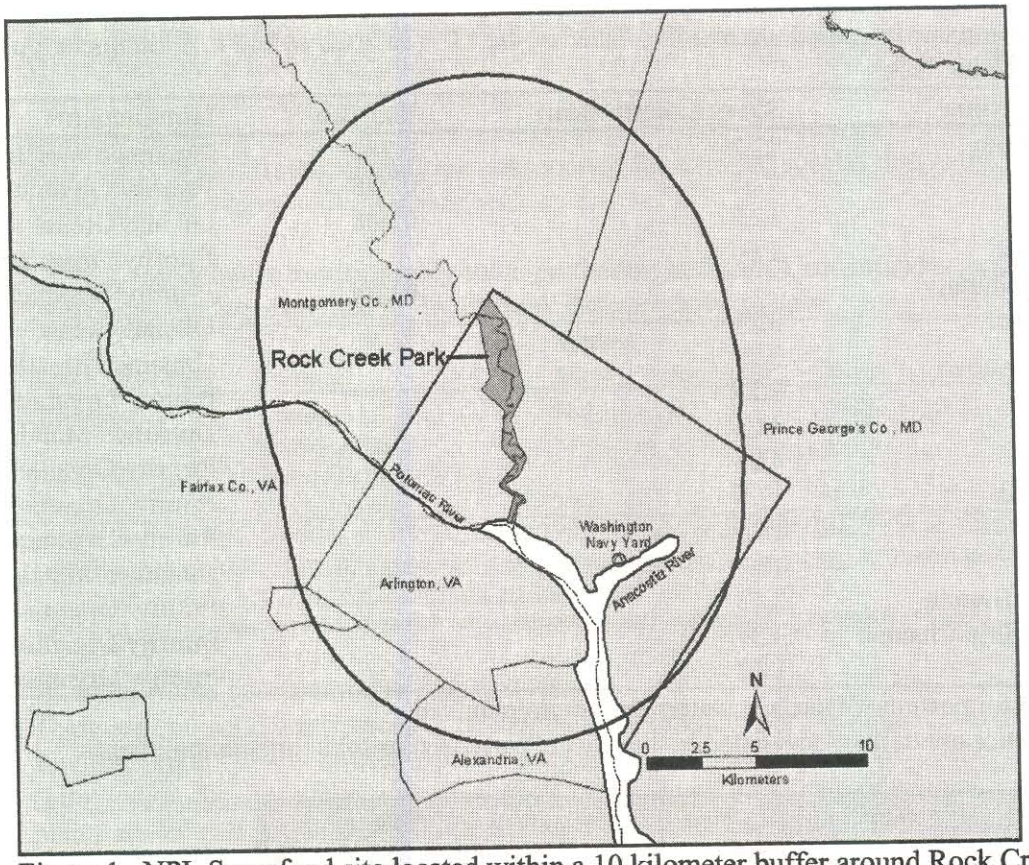

Figure 1. NPL Superfund site located within a 10 kilometer buffer around Rock Creek Park.

C. Impaired waterbodies:

Ten waterbodies contain sufficient quantities of contaminants to be listed as impaired by the EPA and the Maryland, Virginia and the District of Columbia under Section 303(d) (http://www.epa.gov/waters/data/downloads.html) in 2002 (Table 1). Rock Creek and Broad Branch are impaired waterbodies that flow through the park property (Figure 2). Additionally, nutrient impairments affect portions of the Potomac River. Sedimentation and siltation impairments are present in portions of the Potomac and Anacostia Rivers, Upper Watts Branch, and Kingman Lake.

Table 1. Contaminant-impaired waterbodies listed by the EPA in 2002 within a 10 kilometer buffer around Rock Creek Park.

Waterbody Name	River Length (km)	Size (km^2)[a]	Impairment
Anacostia River	12.3	0.288	Unnamed Metals
	7.33	0.288	Priority Organics[b]
	12.3	0.288	Oil and Grease
Broad Branch	2.64		Priority Organics[b]
Dalecarlia Tributary		0.059	Priority Organics[b]
Kingman Lake	3.29		Oil and Grease
	3.29		Unnamed Metals
	3.29		Priority Organics[b]
Oxon Run	4.25		Unnamed Metals
	4.25		Priority Organics[b]
Potomac River	17.6		Priority Organics[b]
Rock Creek	15.1		Priority Organics[b]
	15.1		Unnamed Metals
Upper Watts Branch	2.73		Priority Organics[b]
Washington Ship Channel	3.37		Priority Organics[b]
Tidal Basin	1.17		Priority Organics[b]

[a] Size is listed for portions of surface waters that are impounded.
[b] Priority organics are defined and listed by the Clean Water Act as toxic organic pollutants.

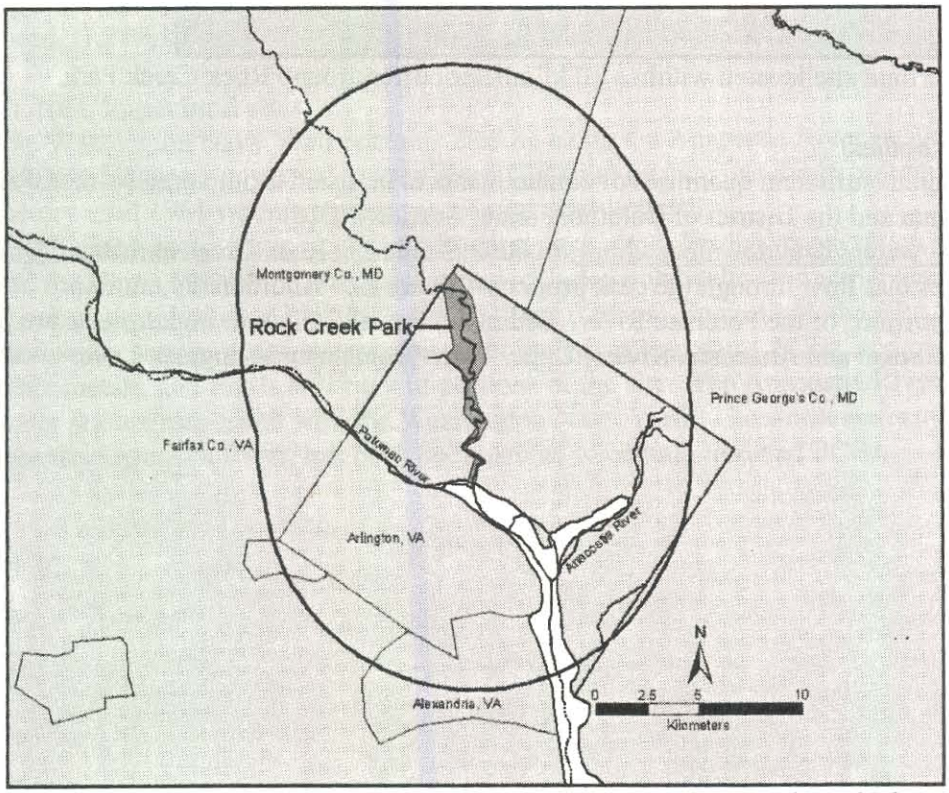

Figure 2. Contaminant-impaired waterbodies listed by the EPA in 2002 located within a 10 kilometer buffer around Rock Creek Park.

D. Pesticides, herbicides, rodenticides, avicides used:
Three pesticide or herbicide products that were applied at Rock Creek Park in 2004 contained active ingredients recognized as being moderately to very highly toxic to terrestrial vertebrates (Table 2). Toxicity rating classes are: 0 = not toxic; 1 = slightly toxic; 2 = moderately toxic; 3 = highly toxic; 4 = very highly toxic. Rating classes are not reported for reptilian species due to the limited availability of toxicity data for most active ingredients.

Table 2. Moderately to very highly toxic pesticides, herbicides, rodenticides, and avicides to terrestrial vertebrates that were applied at Rock Creek Park property in 2004.

Active Ingredient	Product	Applied Acres	Mammals	Birds	Amphibians	Reference Cited[a]
Glyphosate	Accord	52.1	0-1	0-1	0-2[b]	1, 2, 3
	Roundup Pro	78				
Pyrethrins	Bronco Equine Fly Spray plus Citronella	3.87	1-2	1	4[b]	1

[a] References cited: 1. Sparling *et al.* 2000; Smith 1987; Hudson, *et al.* 1984; Schafer *et al.* 1983) 2. EPA Pesticide Registration website: http://cfpub.epa.gov/oppref/rereg/status.cfm?show=rereg 3. Pesticide Action Network of North America website: http://www.pesticideinfo.org/Index.html

[b] Toxicity ratings were derived from fish lethal concentrations to cause 50% mortality.

E. Solid waste or wastewater disposal sites:
There are two solid waste acceptance facilities permitted by the Virginia's Department of the Environmental Quality located within 10 kilometers of Rock Creek Park (Table 3) (http://www.deq.virginia.gov/waste/s-waste.html). In addition, two municipal wastewater treatment plants are located within the 10 kilometer buffer surrounding Rock Creek Park (http://cfpub.epa.gov/cwns/standard.cfm). The Arlington Waste Water Treatment Plant was given an "unacceptable" score and the Blue Plains Waste Water Treatment Facility was given a "needs improvement" score by the Chesapeake Bay Foundation (2003) because of the high nitrogen concentrations (> 5.1 mg/l) discharged at the sites.

Table 3. Permitted solid waste acceptance facilities within a 10 kilometer buffer around Rock Creek Park.

Facility Name	Address	Type	Ownership
Classified Waste Disposal System at CIA	Route 123 & 193, Langley, VA	Incineration/Energy Recovery Facility	Govt.
Dept. of Human Services Laboratory	1800 N. Edison St., Arlington, VA	RMW Incinerator	Govt.

[a] RMW includes all regulated medical waste.

F. Signs of pollution:
There are no current signs of pollution within the Rock Creek Park boundary. However, there was a fish kill attributed to a pesticide company upstream affecting nine miles of Rock Creek in 2000. Additionally, Connecticut Avenue Bridge that overpasses the Rock Creek and Potomac Parkway is undergoing lead remediation.

G. Terrestrial vertebrate contaminant research or monitoring:
Current research to determine metal and organochlorine residue concentrations in tree swallow eggs, nestlings, and food samples is being conducted at Kenilworth Marsh and Kingman Lake (DeMott, personal communication). However, there is both historic and/or recent data previously collected on avian, mammalian, and amphibian species.

Studies involving Pesticides and Industrial Contaminants

1. New York State Department of Environmental Conservation. 1987. Wildlife Pathology Unit Necropsy Report #87-41-32(B).

A male red-shouldered hawk (*Buteo lineatus*) was found in College Park, MD in 1987. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (7.36 µg/g ww), transnonachlor (3.49 µg/g ww), and oxychlordane (11.3 µg/g ww) were in the lethal range. The cause of death was attributed to chlordane intoxication.

2. New York State Department of Environmental Conservation. 1988. Wildlife Pathology Unit Necropsy Report #87-62-20.

In 1988, an immature male northern mockingbird (*Mimus polyglottus*) was found in Bethesda, MD. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (2.58 µg/g ww) and oxychlordane (4.52 µg/g ww) were in the lethal range. The cause of death was attributed to chlordane intoxication.

3. New York State Department of Environmental Conservation. 1988. Wildlife Pathology Unit Necropsy Report #88-39-20.

An adult male American kestrel (*Falco sparverius*) was found in College Park, MD on July 12, 1988. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (2.64 µg/g ww) and oxychlordane (2.63 µg/g ww) were in the lethal range, while dieldrin levels (1.13 µg/g ww) were in the hazardous range. The cause of death was attributed to chlorinated hydrocarbon intoxication.

4. New York State Department of Environmental Conservation. 1989. Wildlife Pathology Unit Necropsy Report #89-07-34.

An adult male American robin (*Turdus migratorius*) was found in Bethesda, MD on April 23, 1989. The bird was necropsied and found to contain elevated concentrations of chlorinated hydrocarbon pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (6.35 µg/g ww) and oxychlordane (4.10 µg/g ww) were in the lethal range. The cause of death was attributed to head trauma and possible chlordane intoxication.

5. New York State Department of Environmental Conservation. 1989. Wildlife Pathology Unit Necropsy Report #89-62-29.

An juvenile blue jay (*Cyanocitta cristata*) was found in College Park, MD on September 20, 1989. The bird was necropsied and found to contain elevated concentrations of organochlorine pesticides in its brain. Concentrations of chlordane metabolites heptachlor epoxide (5.07 μg/g ww), oxychlordane (3.89 μg/g ww), and transnonachlor (5.19 μg/g ww) were in the lethal range. The cause of death was attributed to organochlorine pesticide poisoning.

6. Rattner, B.A., M.J. Melancon, C.P. Rice, W. Riley Jr., J. Eisemann, and R.K. Hines. 1997. Cytochrome P450 and organochlorine contaminants in black-crowned night-herons from the Chesapeake Bay Region, USA. Environmental Toxicology and Chemistry 16:2315-2322.

In 1991, black-crowned night-heron (*Nycticorax nycticorax*) pipping embryos were collected from several locations including a colony that nest in trees above the Smithsonian Institute National Zoological Park and feed along the Potomac and Anacostia Rivers. Hepatic microsomal activities of benzyloxyresorufin-*O*-dealkylase and ethoxyresorufin-*O*-dealkylase (biomarkers of exposure to polyhalogenated pollutants) were elevated in pipping embryos from Rock Creek Park colony compared to the reference site (Chincoteague National Wildlife Refuge). Concentrations of organochlorine pesticides and metabolites in pipping embryos were greater from the Rock Creek Park than at the reference site, but below the known threshold for reproductive impairment. However, concentrations of total PCBs, 10 arylhydrocarbon receptor-active PCB congeners and estimated toxic equivalents were significantly greater in embryos collected from Rock Creek Park compared to the reference site, with values for toxic congeners 77 and 126 exceeding those observed in heron embryos from the Great Lakes.

7. Rattner, B.A., P.C. McGowan, N.H. Golden, J.S. Hatfield, P.C. Toschik, R.F. Lukei Jr., R. C. Hale, I. Schmitz-Afonso, and C.P. Rice. 2004. Contaminant exposure and reproductive success of ospreys (*Pandion haliaetus*) nesting in Chesapeake Bay regions of concern. Archives of Environmental Toxicology and Chemistry 47:126-140.

The Chesapeake Bay osprey (*Pandion haliaetus*) population has more than doubled in size since restrictions were placed on the production and use of DDT and other toxic organochlorine contaminants in the 1970's. Ospreys are now nesting in the most highly polluted portions of the Bay. In 2000, contaminant exposure and reproduction were monitored in ospreys nesting in the Anacostia and Potomac Rivers. A "sample egg" from each study nest was collected for contaminant analysis, and the fate of eggs remaining in each nest (n=14) was monitored at 7-10 day intervals from egg incubation through fledging of young. Ospreys fledged young in the Washington, DC study sites (observed success: 0.88 fledglings/active nest), although productivity was marginal for sustaining the local population in the Anacostia and Potomac Rivers. Concentrations of total PCBs, some arylhydrocarbon receptor-active PCB and polybrominated diphenyl ether congeners were often greater in sample eggs from Anacostia and Potomac Rivers compared to the South River reference site. Nonetheless, logistic regression analyses did not provide evidence linking marginal productivity to *p,p'*-DDE, total PCBs or toxic PCB congener exposure.

8. Southeastern Cooperative Wildlife Disease Study. 1992. Clinical Necropsy Record #68-92, College of Veterinary Medicine, University of Georgia.

In March 1992, an adult male American kestrel (*Falco sparverius*) was found in Arlington, VA. The the concentration of DDE residue in the stomach contents was 2.17 μg/g and in the kestrel's brain was 6.7 μg/g. The cause of death was undetermined. However, the possibility of carbamate pesticides could not be ruled out.

9. Southeastern Cooperative Wildlife Disease Study. 2002. Clinical Necropsy Record #CC23-02, College of Veterinary Medicine, University of Georgia.

On December 25, 2001 a mortality event occurred at a 2-acre vacant lot in Rockville, MD. The mortality event involved 12 gray squirrels (*Sciurus carolinensis*), 1 opossum (*Didelphis virginiana*), 1 red fox (*Vulpes vulpes*), 1 blue jay (*Cyanocitta cristata*), and 1 crow (*Corvus sp.*). The squirrel carcasses were examined and 4 (2 male and 2 female) were frozen for further analysis. The pooled gastrointestinal tract contents of the 4 squirrels contained high concentrations of endosulfan (126 ppm). In light of the high endosulfan concentration in the gastrointestinal tract contents and the toxicity of this chlorinated hydrocarbon the cause of the mortality event was found to be endosulfan intoxication.

Studies involving Metals

1. Scanlon, P.F. 1979. Ecological implications of heavy metal contamination of roadside habitats. Southeastern Association Fish & Wildlife Agencies 33:136-145.

Soil, vegetation, earthworms and small mammals were collected along Virginia highway roadsides in 1975 to analyze for lead, cadmium, nickel and zinc. There were significantly higher levels of lead in *Microtus* and *Peromyscus* individuals collected from I 95 (23.07 and 21.96 μg/g dw) than control areas, > 500 m from Fairfax County roadways (3.92 and 2.39 μg/g dw). *Blarina* tissues from I 95 contained higher levels of lead, cadmium, and zinc (72.56, 1.71 and 139.20 μg/g dw) than from control areas (7.28, 0.66 and 112.81 μg/g dw). Individuals of the genus *Mus* from I 95 (64.25μg/g dw) contained significantly higher levels of lead than two highways in Montgomery County, VA with less traffic (US 460 = 21.73 and VA 114 = 11.32 μg/g dw).

H. Toxic release facilities:

The EPA's Toxic Release Inventory Program lists six toxic release facilities that discharged contaminants within 10 kilometers of Rock Creek Park from 1997 through 2003 (http://www.epa.gov/triexplorer/facility.htm). Two of these facilities released persistent pollutants and chemicals listed by the EPA and United Nations (Table 4). The Potomac River Generating Station released the greatest diversity of persistent pollutants and chemicals, including dioxins, lead and mercury.

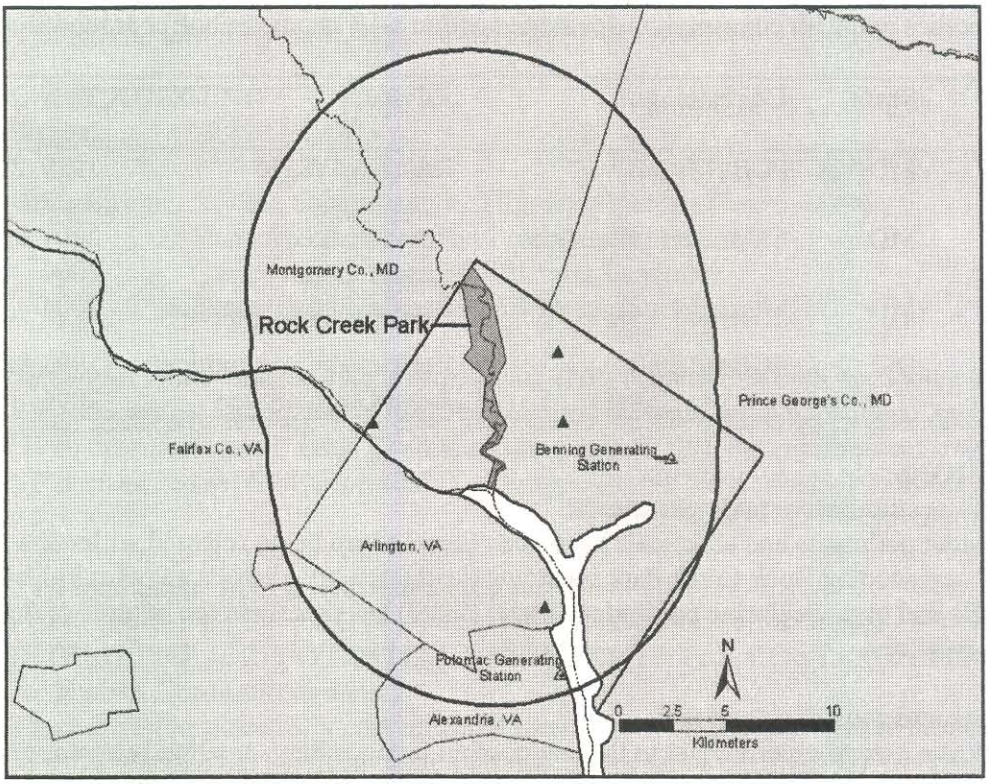

Figure 3. Toxic release sites (▲) and priority contaminant release sites (0) listed by EPA within a 10 kilometer buffer around Rock Creek Park for 1997 through 2003.

Table 4. Mean quantity of priority contaminants released by EPA-listed toxic release sites for 1997 through 2003 within a 10 kilometer buffer around Rock Creek Park.

Site Name	Address	Contaminant Released	Years Released	Air Release[a]	Surface Water Release[a]	Land Disposal[a]
Benning Generating Station	3400 Benning Rd., NE, Washington, DC	Dioxin Cmpds.	2000-02	0.0002836[b]	0	0
		Mercury	2000 & 03	4.50	0	0
Potomac River Generating Station	1400 N Royal St., Alexandria, VA	Dioxin Cmpds.	2000-03	0.0463549[b]	0	0
		Mercury	2000-03	182.3	0.1	0
		Lead Cmpds.	2001-03	245.8	9	0

[a] Units are in lbs/yr unless otherwise noted.
[b] Units are in g/yr.

I. Fish consumption advisories:

The EPA's Water Program has listed four fish consumption advisories that indicate the presence of persistent pollutants and chemicals within 10 kilometers of Rock Creek Park (Table 5) (http://www.epa.gov/waterscience/fish/advisories/index.html).

Table 5. Waterbodies with fish consumption advisories within a 10 kilometer buffer around Rock Creek Park.

Waterbody Name	State	Contaminant	Advisory	Year Issued
Potomac River	MD/VA	PCBs (Total)	Restricted & No Consumption	1999, 2001 & 2004
Potomac River	MD	Chlorinated Pesticides	Restricted & No Consumption	2001 & 2004
Statewide	MD	Mercury	Restricted Consumption	2004
Statewide	DC	PCBs (Total)	Restricted Consumption & No Consumption	1993 & 2004

III. CONCLUSIONS:

J. Persistent bio-accumulative toxic chemicals:

Numerous persistent pollutants and chemicals have been found or are being released within the 10 kilometer buffer surrounding Rock Creek Park including, lead, mercury, dioxins and dioxin-like compounds, PCBs and organochlorine pesticides. Eisler (2000) has described the hazards of these contaminants to wildlife.

K. Critical areas and sensitive species:

Rock Creek Park is a natural environment in the center of an urban setting, creating habitat for many urban species of wildlife. Bald eagles (*Haliaeetus leucocephalus*), a federally threatened species, have been reported on park property.

L. Additional priority contaminant monitoring/research:

The majority of contaminant exposure and effects information collected within 10 kilometers of the Rock Creek Park has been derived from individual necropsy reports collected in the 1980's, which indicate the presence of chlordane, dieldrin and endosulfan in the vicinity. However, there have been a limited number of studies on fish-eating birds within the buffer area indicating the presence of PCBs, polyhalogenated compounds, and polybrominated diphenyl ethers. Metal residue data was collected more than 25 years ago from mammals within the 10 kilometer buffer of Rock Creek Park, but recent data does not exist for metals or mammals from this area. The surface waters that influence the area around the Rock Creek Park indicate the presence of metals and priority organics. Furthermore, the Washington Navy Yard could be a source of additional contaminants. Since PCBs and organochlorine pesticides are persistent, additional monitoring and research may aid in identifying the extent of exposure to other terrestrial vertebrates.

Shenandoah National Park

I. BACKGROUND

Size: 79,890 hectares

Designation: Skyline Drive - National Register/Historic Places - 1996
Shenandoah Wilderness - October 20,1976
Camp Hoover - National Historic Landmark
Shenandoah National Park - December 1936

Setting/habitat: Shenandoah National Park (NP) is located in both the Valley and Ridge and the Blue Ridge Provinces in Virginia. Using the National Oceanic and Atmospheric Administration's 250 m (1990 urban-enhanced) Land Use Land Cover data (1999), the environment surrounding Shenandoah NP is classified as: 60.8% forested; 31.5% agricultural; 6.6% urban or built-up; 0.5% barren lands; and 0.5% water.

Past land uses: Agricultural operations

II. CURRENT AND POTENTIAL ENVIRONMENTAL CONTAMINATION

A. Known Contaminated sites:

There are a few potentially contaminated sites located on Shenandoah NP property, including old landfills and sewage treatment plant outfalls. There are two current Environmental Protection Agency (EPA) National Priorities List (NPL) Superfund sites that require further remedial action located within 10 kilometers of Shenandoah NP. Additionally, 25.25% of the surface waters that flow through the park and its 10 kilometer buffer are considered impaired by EPA under the Clean Water Act Section 303(d).

B. NPL Superfund sites:

Avtex Fibers, Inc. is a 178.1 hectare plant that was used for the manufacturing of synthetic fibers from 1940 to 1989 at which time it was shut down due to polychlorinated biphenyl (PCB) contamination of the Shenandoah River. The plant is located in Warren County along the South Fork of the Shenandoah River, the primary surface water feature (Figure 1). Contaminants to the surrounding groundwater and soil include carbon disulfide, ammonia, arsenic, antimony, phenol, lead, and PCBs. Open basins of sludge and fly ash waste, open viscose (thick solution of cellulose xanthate) basins, and an open landfill exist at the site and could be potential threat to wildlife. Remedial or removal actions conducted thus far include removing chemicals left after the abandonment of the facility, demolition of buildings and removal of debris, and closure of approximately three quarters of the open basins. A remedial action cleanup plan is being prepared for the viscose basins, landfill and contaminated soils.

Greenwood Chemical Company is a 7.3 acre site in Albemarle County that produced industrial, agricultural, pharmaceutical, and photographic chemicals from 1940s to 1985 when there was a toluene vapor explosion and fire at the plant (Figure 1). Prior to clean-up the site contained soils, lagoons, groundwater and buildings contaminated by volatile organic compounds, semi-volatile organic compounds, and arsenic. However, beginning in 1987 cleanup of the site has included removal of buried and surface drums, draining and capping lagoons, removal of lagoon sludge, removal of containerized chemicals, and removal of contaminated soil. Treatment of contaminated groundwater has begun and remains the only concern.

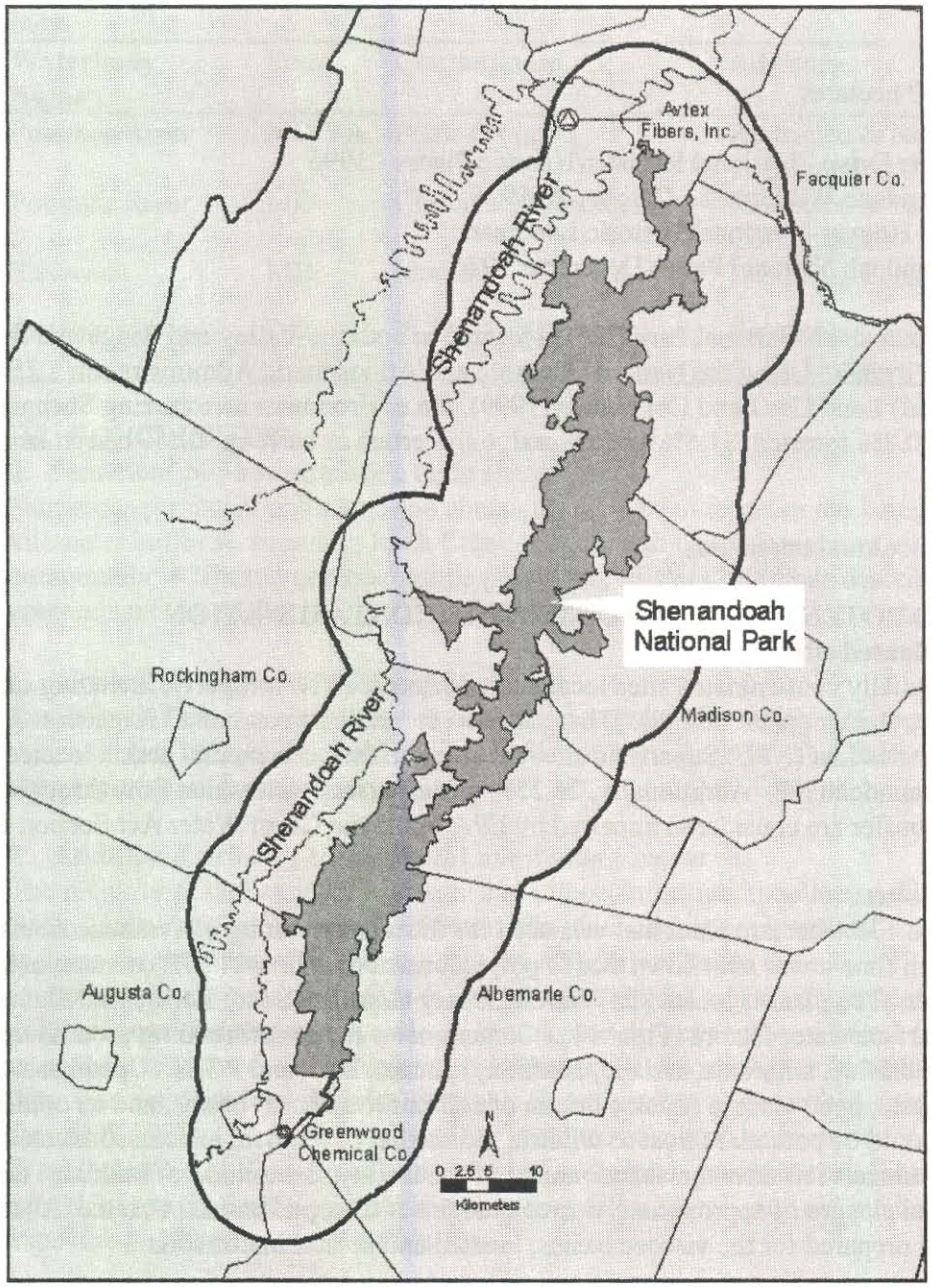

Figure 1. NPL Superfund sites located within a 10 kilometer buffer around Shenandoah NP.

C. Impaired waterbodies:

The EPA and the Virginia Department of Environment Quality (VADEQ) under Section 303(d) listed (http://www.epa.gov/waters/data/downloads.html) ten waterbodies as impaired in 2002 within 10 kilometers of Shenandoah NP. The Quail and Cub Runs, Polecat Draft, Mill, Hawksbill and Naked Creeks, and North, Middle, and Rappahannock Rivers are not impaired by contaminants but are impaired from nutrients, low dissolve oxygen and pathogens. Contaminant impairments are associated

with the South Fork of the Shenandoah River (South River) and include PCBs (156.9 kilometers) and mercury (179.1 kilometers) (Figure 2). However, the impaired waterbodies are located outside of the park boundary.

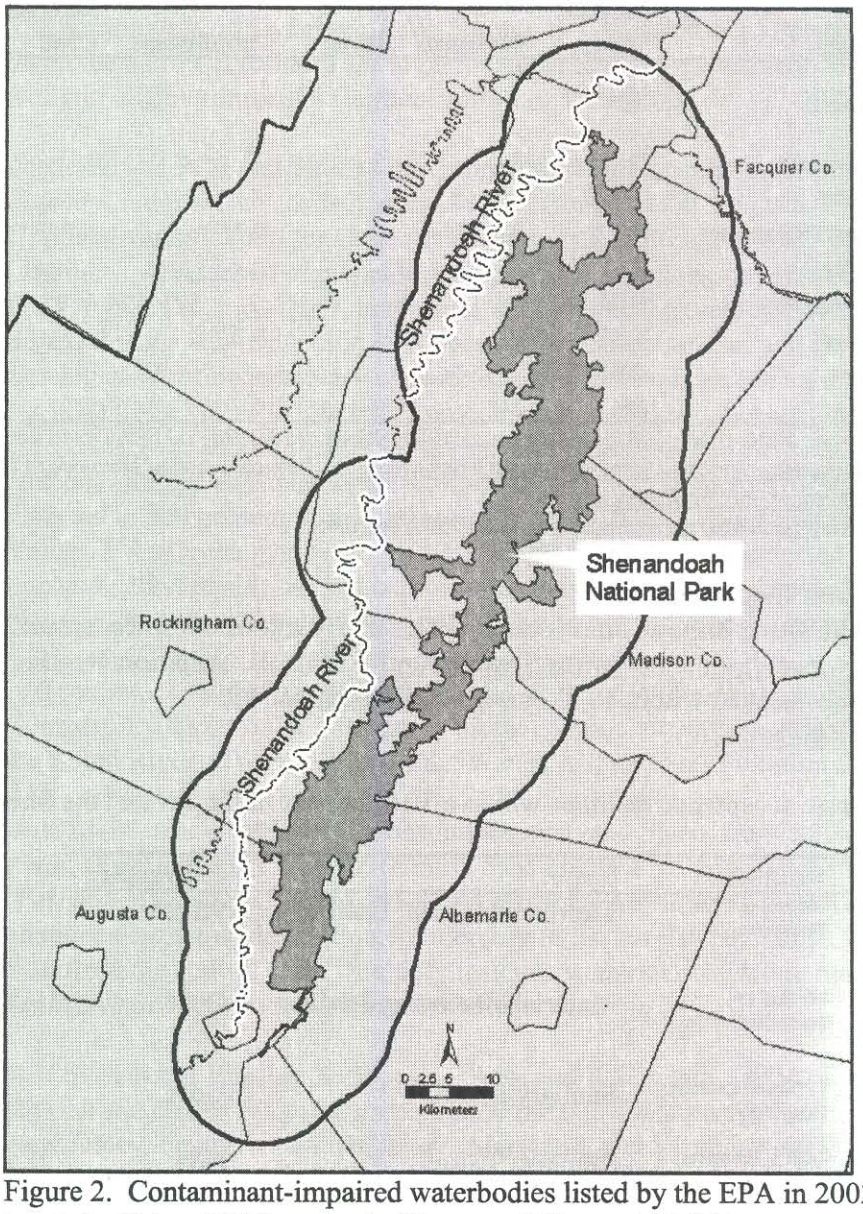

Figure 2. Contaminant-impaired waterbodies listed by the EPA in 2002 located within a 10 kilometer buffer around Shenandoah NP.

D. Pesticides, herbicides, rodenticides, avicides used:

Nine pesticide or herbicide products that were applied at Shenandoah NP in 2004 contained active ingredients recognized as being moderately to very highly toxic to terrestrial vertebrates (Table 1). Toxicity rating classes are: 0 = not toxic; 1 = slightly toxic; 2 = moderately toxic; 3 = highly toxic; 4 = very highly toxic. Rating classes are not reported for reptilian species due to the limited availability of toxicity data for most active ingredients.

Table 1. Moderately to very highly toxic pesticides, herbicides, rodenticides, and avicides to terrestrial vertebrates that were applied at Shenandoah NP property in 2004.

Active Ingredient	Product	Applied Acres	Mammals	Birds	Amphibians	Reference Cited
2-Methoxy-3,6-Dichlorobenzoic Acid	Vanquish	12	1	2	0	1, 3
Ammonium Soaps / Fatty Acids	Weed-Aside	31.3	2	2	3[b]	1
	M-Pede	160.2				
Glyphosate	Accord Concentrate	28.72	0-1	0-1	0-3[b]	1, 2, 3
	E-Z-Ject	1				
	Roundup Pro	41.4				
Imazapyr	Aresenal	2.57	0	1	0-3[b]	1, 3
	Stalker	3.51				
Imidacloprid	Pointer	2.5	2-3	3-4	0[b]	1

[a] References cited: 1. Sparling *et al.* 2000; Smith 1987; Hudson, *et al.* 1984; Schafer *et al.* 1983) 2. EPA Pesticide Registration website: http://cfpub.epa.gov/oppref/rereg/status.cfm?show=rereg 3. Pesticide Action Network of North America website: http://www.pesticideinfo.org/Index.html

[b] Toxicity ratings were derived from fish lethal concentrations to cause 50% mortality.

E. Solid waste or wastewater disposal sites:

There are five permitted solid waste disposal sites located within the 10 kilometer buffer around Shenandoah NP (http://www.deq.virginia.gov/waste/s-waste.html) (Table 2). Additionally, there are 13 wastewater treatment facilities located within 10 kilometers of Shenandoah NP (http://cfpub.epa.gov/cwns/standard.cfm).

Table 2. Permitted solid waste acceptance facilities within a 10 kilometer buffer around the Shenandoah NP.

Facility Name	Address	Type	Ownership
EI Dupont Waynesboro Nurseries Landfill	400 Dupont Blvd, Waynesboro, VA	Captive Industrial Landfill	Private
Greene County MRF & Co – Compost	PO Box 358, Stanardsville, VA	Materials Recovery Facility	Govt.
Page County Sanitary Landfill	117 South Court St., Luray, VA	Sanitary Landfill	Govt.
Warren County Transfer Station	4460 S. Laburnum Ave., Richmond, VA	Transfer Station	Govt.
Waynesboro City Sanitary Landfill MSW Balefill	PO Box 1028, Waynesboro, VA	Sanitary Landfill	Govt.

F. Terrestrial vertebrate contaminant research or monitoring:

Based on the CEE-TV database and additional literature searches conducted, a limited number of contaminant monitoring or ecotoxicological research projects have been conducted on terrestrial vertebrates within the 10 kilometer buffer surrounding Shenandoah NP.

1. Blumton, A.K., J.D. Fraser, R.W. Young, S. Goodbred, S.L. Porter, and D.L. Luukkonen. 1990. Pesticide and PCB residues for loggerhead shrikes in the Shenandoah Valley, Virginia, 1985-88. Bulletin of Environmental Contaminants and Toxicology 45:697-702.

Pesticide and PCB residue was determined for eight abandoned or failed loggerhead shrike (*Lanius ludovicianus*) clutches collected in 1985-87 from nests in Augusta, Rockingham, Shenandoah, and Highland Counties and for seven shrike carcasses collected in 1987-88 from Augusta and Rockingham Counties. Residues of organochlorine pesticides including oxychlordane, *o,p'*-DDE, *p,p'*-DDE, *o,p'*-DDT, *p,p'*-DDT, *p,p'*-DDD, heptachlor epoxide, methoxychlor, endrin, dieldrin, hexachlorobenzene, mirex, lindane, *cis*-nonachlor, *trans*-nonachlor, *cis*-chlordane, and *trans*-chlordane were detected in eggs and organochlorine pesticides were detected in carcasses including oxychlordane, *o,p'*-DDE, *p,p'*-DDE, *o,p'*-DDT, *p,p'*-DDT, heptachlor epoxide, endrin, dieldrin, hexachlorobenzene, mirex, lindane, *alpha*-chlordane, and *beta*-chlordane. Oxychlordane and *p,p'*-DDE were detected in 100% of the eggs from clutches (Range: oxychlordane = 0.02-0.10 µg/g ww; DDE = 0.46-26.00 µg/g ww) and *p,p'*-DDE was detected in 100 percent of the carcasses (Range = 0.06-2.03 µg/g ww) collected from Shenandoah Valley, VA. Organophosphate and carbamate residues were detected in carcasses including dursban, diazinon, ethyl parathion, and carbofuran. Aroclor 1260 was detected in 63% of the failed or abandoned clutches (Range = 0.24-1.30 µg/g ww), but was not detected in carcasses collected.

2. Cocking, D., R. Hayes, M.L. King, M.J. Rohrer, R. Thomas, and D. Ward. 1991. Compartmentalization of mercury in biotic components of terrestrial flood plain ecosystems adjacent to the South River at Waynesboro, VA. Water, Air, and Soil Pollution 57-58:171-180.

In 1983-84, small mammals, invertebrates, soil, and plants were collected from the South River Flood Plain, Waynesboro, VA above (control) and below a mercury point source. White-footed mice (*Peromyscus leucopus*) and short-tailed shrews (*Blarina brevicauda*) from the downstream sites contained higher concentrations of mercury in tissues (Mean: mouse = 2.17 µg/g; shrew = 27.5 µg/g) than from the control sites. Mercury residues were not detected in meadow voles (*Microtus pennsylvanicus*) from the downstream sites.

3. U.S. Fish and Wildlife Service, Y. Zhao, and K.E. Clark. 2004. Organochlorine pesticides, PCBs, dioxins and metals in post-term peregrine falcon (*Falco peregrinus*) eggs from the Mid-Atlantic states: New Jersey, Pennsylvania, Delaware, Maryland, and Virginia – 1993-1999. USFWS, Washington Office Project ID: 985000.1. U.S. Fish and Wildlife Service, Virginia Field Office, Gloucester, VA. 42 Pp.

In 1994, two addled peregrine falcon eggs were measured for eggshell thinning and one egg was collected from Shenandoah NP to determine organochlorine pesticide, PCB, dioxin and metal concentrations as part of a study including other Mid-Atlantic areas. Peregrine falcon eggs showed an 8.80 and 9.87% shell thinning from pre-1947 measurements. Egg contents contained low levels of mercury (1.01 µg/g dw) and other metals (Cu = 2.38 µg/g dw; Fe = 1.22; Mg = 426; Mn = 1.96; Zn = 65.4) below the levels associated with reproductive impairment. Organochlorine pesticides were below

levels (β-BHC = 0.00391; *cis*-nonachlor = 0.00575; dieldrin = 0.0641; endrin = 0.0234; oxychlordane = 0.146; *trans*-nonachlor = 0.047; HCB = 0.005; heptachlor epoxide = 0.0663; mirex = 0.116; DDD = 0.0331; DDE = 2.1 μg/g ww) that have been associated with adverse effects in peregrine falcons. Dioxin-like toxicants were lower than the level reported by EPA to cause developmental impairment and embryo mortality in American kestrels.

G. Toxic release facilities:

The EPA's Toxic Release Inventory (TRI) Program lists 11 toxic release facilities that discharged contaminants within 10 kilometers of Shenandoah NP from 1997 through 2003 (Figure 3) (http://www.epa.gov/triexplorer/facility.htm). However, Du Pont Front Royal Plant was the only TRI site that released priority contaminants or pollutants listed by the EPA or United Nations. Du Pont released on average 5.14 lbs/yr of lead compounds between 1997 and 2003 and released on average 1.18 lbs/yr of mercury into the atmosphere from 2000-03.

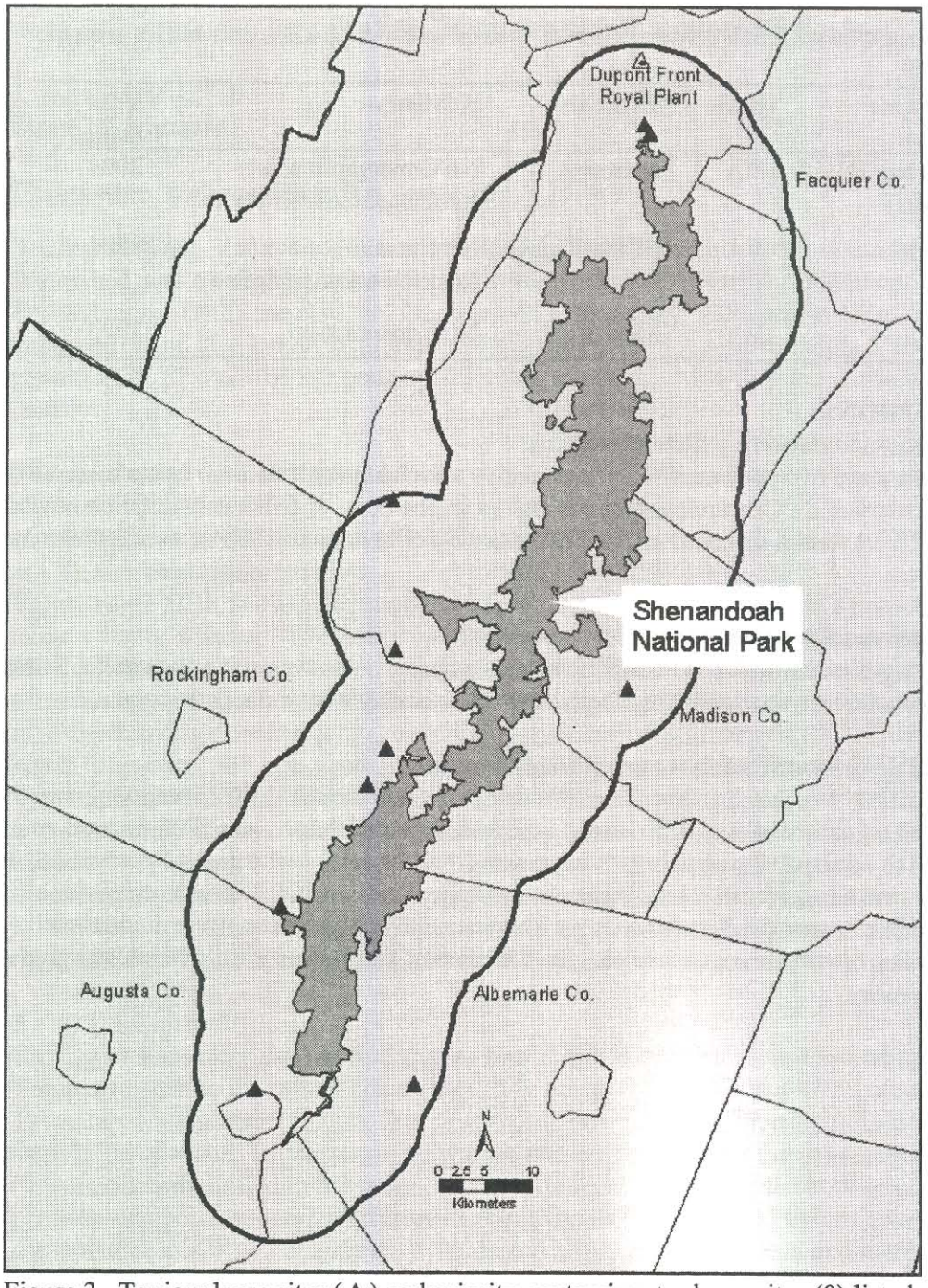

Figure 3. Toxic release sites (▲) and priority contaminant release sites (0) listed by the EPA within a 10 kilometer buffer around Shenandoah NP for 1997 through 2003.

H. Fish consumption advisories:

The EPA's Water Program has listed three fish consumption advisories that indicate the presence of persistent pollutants and chemicals within 10 kilometers of Shenandoah NP (Table 3) (http://www.epa.gov/waterscience/fish/advisories/index.html).

Table 3. Waterbodies with fish consumption advisories within a 10 kilometer buffer around Shenandoah NP.

Waterbody Name	State	Pollutant	Advisory	Year Issued
Shenandoah River (North and South Forks)	VA	Mercury	No Consumption & Restricted Consumption	2004
Shenandoah River	VA	PCBs (Total)	No Consumption & Restricted Consumption	2004
South River	VA	Mercury	No Consumption	1993

III. CONCLUSIONS:

I. Persistent bio-accumulative toxic chemicals:

Lead and mercury are two persistent bio-accumulative toxic chemicals that are being released by TRI sites, while mercury and PCBs are causes of impaired waterbodies and fish consumption advisories (Shenandoah River) within the area. Eisler (2000) has described the hazards of these contaminants to wildlife.

J. Critical Areas and Sensitive Species:

There were no reported critical areas for NPS managed species. However, the Shenandoah Salamander (*Plethodon shenandoah*), a federally endangered species, occurs within the park property.

K. Additional priority contaminant monitoring/research:

The Shenandoah NP was found to have current sources for contamination, PCBs and mercury, within 10 kilometers of its boundary in this study, mainly the Shenandoah River. Even though these contaminants were not found to be impairing populations of terrestrial vertebrates in the present study, both mercury and PCBs may cause reproductive impairment or mortality in individuals. Monitoring of the levels of these contaminants in terrestrial vertebrates may be warranted. Upon discovery of additional contaminated sites or point sources, samples from terrestrial vertebrates should be collected to determine the level of exposure.

1897 to 1976, disposing of asbestos waste into quarries on both the plant and park property. In 1997, asbestos debris was identified by NPS employees while installing a fiber-optic cable. Upon further investigation other contaminants, including polychlorinated biphenyls (PCBs) 1254 & 1260, furans, benzo (a) pyrene, and lead, were identified at locations throughout the site (PMC Environmental 1998). This site is not listed as a National Priority List (NPL) Superfund site. However, at present a Remedial Investigation has been completed. Besides the asbestos release site located on park property, within 10 kilometers of Valley Forge NHP the Environmental Protection Agency (EPA) has listed two NPL Superfund sites and 44.29% of surface waters as impaired in 2002 under Section 303(d) of the Clean Water Act. In addition, there may be some lead contaminated around some park structures due to removal of lead-based paints (M. Carfioli, NPS, personal communication).

B. NPL Superfund sites:

The Crater Resources site has operated as four disposal quarries since 1919 where the Alan Wood Steel Company began to deposit its coking facility's waste. This site occupies 50 acres in Upper Merion Township, Montgomery County (http://www.epa.gov/superfund/sites/nplfs/fs0301193.pdf) (Figure 1). Deposition of waste (tar wastes, solid wastes, and waste ammonia liquor) continued until 1980. Contaminants identified in the groundwater, sediments and soils at the bottom of the quarries include phenolic compounds, polycyclic aromatic compounds (i.e. benzo (a) pyrene), volatile organic compounds (VOCs), dibenzofuran, cyanide and heavy metals (i.e. lead and mercury). Groundwater associated with the site contains elevated levels of cyanide, ammonia, and phenol (http://cfpub.epa.gov/supercpad/cursites/ccontinfo.cfm?id=0301193). Gulph Creek and Schuylkill River are surface waters that are listed as impaired by the EPA within 1.5 kilometers of this site. However, this site has not been documented as being the source of contamination in those waterbodies. Remedial action has been identified and a plan of action has been approved, including contaminated soil removal and capping the quarries (http://www.epa.gov/superfund/sites/nplfs/fs0301193.pdf).

Valley Forge National Historical Park

I. BACKGROUND

Size: 1403 hectare

Designation: National Historical Park - July 4, 1976

Setting/habitat: Valley Forge National Historic Park (NHP) is located in the Schuylkill River Watershed, and consists of steep slopes or rolling hills in the Northern Piedmont Province of Pennsylvania. Using the National Oceanic and Atmospheric Administration's 250 m (1990 urban-enhanced) Land Use Land Cover data (1999), the environment surrounding Valley Forge NHP is classified as: 67.4% urban or built-up; 23.4% agricultural; 7.9% forested; 1.1% water; and 0.3% barren lands.

Past land uses: 1893-1976 State Park

II. CURRENT AND POTENTIAL ENVIRONMENTAL CONTAMINATION

A. Known contaminated sites:

Valley Forge NHP in 1976 acquired an asbestos insulation manufacturer's property, adjacent to the current visitor's center. The Asbestos Manufacturing Company (Keene Manufacturing) operated from 1897 to 1976, disposing of asbestos waste into quarries on both the plant and park property. In 1997, asbestos debris was identified by NPS employees while installing a fiber-optic cable. Upon further investigation other contaminants, including polychlorinated biphenyls (PCBs) 1254 & 1260, furans, benzo (a) pyrene, and lead, were identified at locations throughout the site (PMC Environmental 1998). This site is not listed as a National Priority List (NPL) Superfund site. However, at present a Remedial Investigation has been completed. Besides the asbestos release site located on park property, within 10 kilometers of Valley Forge NHP the Environmental Protection Agency (EPA) has listed two NPL Superfund sites and 44.29% of surface waters as impaired in 2002 under Section 303(d) of the Clean Water Act. In addition, there may be some lead contaminated around some park structures due to removal of lead-based paints (M. Carfioli, NPS, personal communication).

B. NPL Superfund sites:

The Crater Resources site has operated as four disposal quarries since 1919 where the Alan Wood Steel Company began to deposit its coking facility's waste. This site occupies 50 acres in Upper Merion Township, Montgomery County (http://www.epa.gov/superfund/sites/nplfs/fs0301193.pdf) (Figure 1). Deposition of waste (tar wastes, solid wastes, and waste ammonia liquor) continued until 1980. Contaminants identified in the groundwater, sediments and soils at the bottom of the quarries include phenolic compounds, polycyclic aromatic compounds (i.e. benzo (a) pyrene), volatile organic compounds (VOCs), dibenzofuran, cyanide and heavy metals (i.e. lead and mercury). Groundwater associated with the site contains elevated levels of cyanide, ammonia, and phenol (http://cfpub.epa.gov/supercpad/cursites/ccontinfo.cfm?id=0301193). Gulph Creek and Schuylkill River are surface waters that are listed as impaired by the EPA within 1.5 kilometers of this site. However, this site has not been documented as being the source of contamination in those waterbodies. Remedial action has been identified and a plan of action has been approved, including contaminated soil removal and capping the quarries (http://www.epa.gov/superfund/sites/nplfs/fs0301193.pdf).

The Malvern TCE site operated from 1952 to 1992 as a solvent reclamation facility. This two-acre site, in East Whiteland Township, Chester County, Pennsylvania, consists of two areas; (http://www.epa.gov/superfund/sites/nplfs/fs0300868.pdf) the main plant and the formal disposal area (Figure 1). These two areas have VOC, trichloroethylene (TCE), perchloroethylene (PCE), and 1, 1, 1 trichloroethane (1,1,1-TCA) contaminated soil and groundwater associated with them. Lead and mercury have also been listed (http://cfpub.epa.gov/supercpad/cursites/ccontinfo.cfm?id=0300868) as contaminants to the groundwater at this site. Little Valley Creek is an impaired surface water listed by the EPA within 1.5 kilometers of this site. In 2000 residences were hooked up to the public water supply. In Spring 2004 the design plan for soil vapor extraction was completed (http://www.epa.gov/superfund/sites/nplfs/fs0300868.pdf).

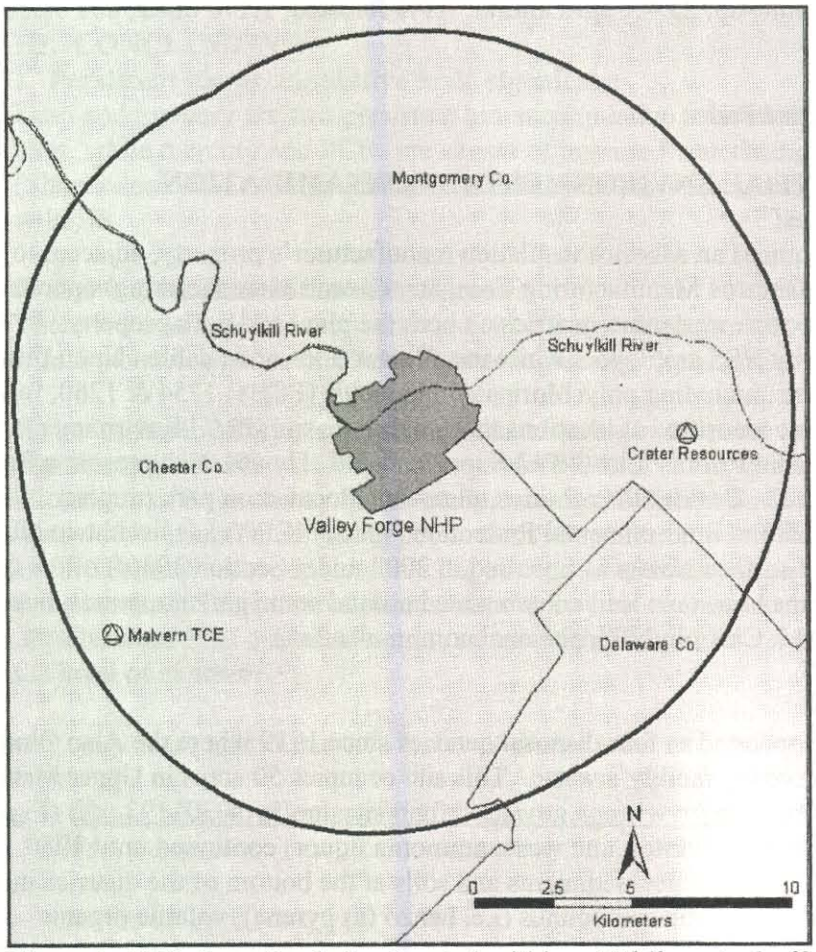

Figure 1. NPL Superfund sites located within a 10 kilometer buffer around Valley Forge NHP.

C. Impaired waterbodies:

Four waterbodies contained sufficient quantities of contaminants to be listed as impaired by the EPA and Pennsylvania Department of Environmental Protection (PADEP) under Section 303(d) (http://www.epa.gov/waters/data/downloads.html) in 2002 (Table 1). Both the Schuylkill River and Valley Creek flow through Valley Forge NHP property (Figure 2). Additionally, nutrient impairments

affect portions of the Perkiomen and Skippack Creek. Sedimentation and siltation impairments are present in portions of the Perkiomen Creek and Schuylkill River.

Table 1. Contaminant-impaired waterbodies listed by the EPA in 2002 within a 10 kilometer buffer around Valley Forge NHP.

Waterbody Name	River length (km)	Size (km^2)[a]	Impairment
Gulph Creek	3.99	0.007	Metals
Schuylkill River	45.97		PCBs
	45.97		Chlordane
	45.97		Metals
Trout Creek	0.74		Unknown
(Little) Valley Creek	35.68		PCBs
	24.39		Metals

[a] Size is listed for portions of surface water that are impounded.

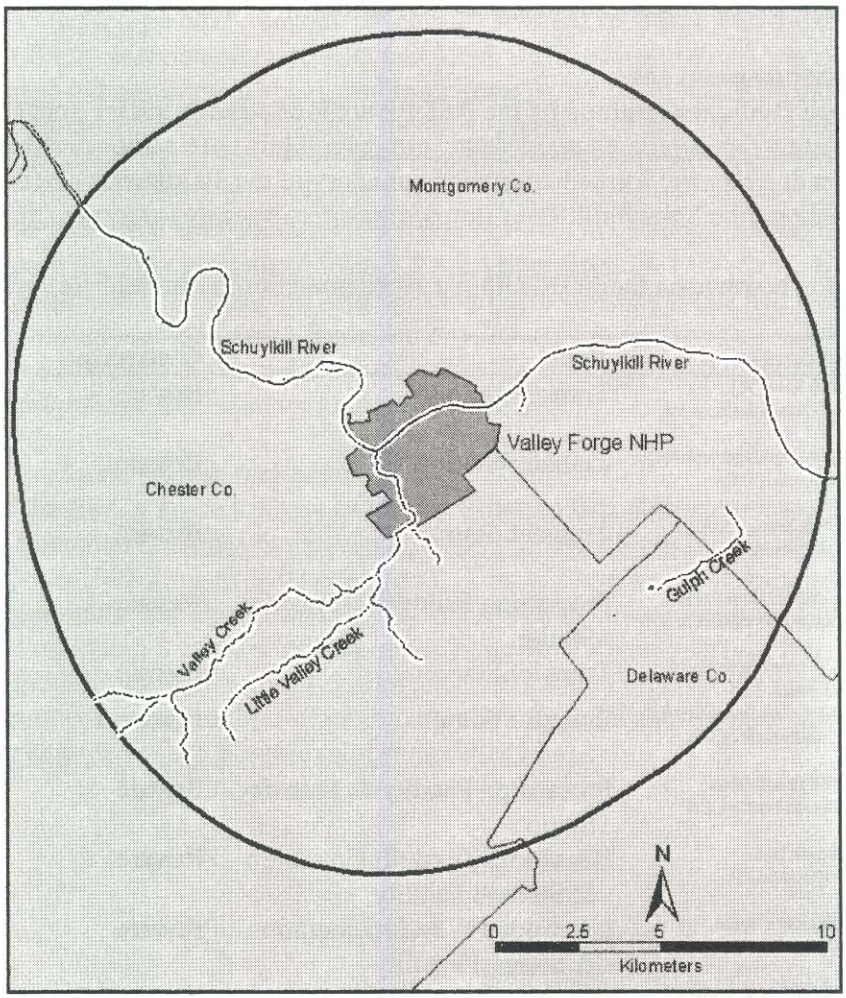

Figure 2. Contaminant-impaired waterbodies listed by the EPA in 2002 located within a 10 kilometer buffer around Valley Forge NHP.

D. Pesticides, herbicides, rodenticides, avicides used:
One pesticide or herbicide product that was applied at Valley Forge NHP in 2004 contained an active ingredient recognized as being moderately to very highly toxic to terrestrial vertebrates (Table 2). Toxicity rating classes are: 0 = not toxic; 1 = slightly toxic; 2 = moderately toxic; 3 = highly toxic; 4 = very highly toxic. Rating classes are not reported for reptilian species due to the limited availability of toxicity data for most active ingredients.

Table 2. Moderately to very highly toxic pesticides, herbicides, rodenticides, and avicides to terrestrial vertebrates that were applied at Valley Forge NHP property in 2004.

Active Ingredient	Product	Applied Acres	Mammals	Birds	Amphibians	Reference Cited[a]
Glyphosate	Roundup Pro	5	0-1	0-1	0-2[b]	1, 2, 3

[a] References cited: 1. Sparling *et al.* 2000; Smith 1987; Hudson, *et al.* 1984; Schafer *et al.* 1983) 2. EPA Pesticide Registration website: http://cfpub.epa.gov/oppref/rereg/status.cfm?show=rereg 3. Pesticide Action Network of North America website: http://www.pesticideinfo.org/Index.html

[b] Toxicity ratings were derived from fish lethal concentrations to cause 50% mortality.

E. Solid waste or wastewater disposal sites:
Eleven solid waste acceptance facilities permitted by the PADEP are located near Valley Forge NHP (Table 3) (http://www.dep.state.pa.us/dep/deputate/airwaste/wm/default.htm). In addition, at least three municipal wastewater treatment plants are located within the boundary of the 10 kilometer buffer and upstream of Valley Forge NHP on the Schuylkill River (http://cfpub.epa.gov/cwns/standard.cfm).

Table 3. Permitted solid waste acceptance facilities within a 10 kilometer buffer around Valley Forge NHP.

Facility Name	Address	Type	Ownership
BFI River Road Transfer Station	400 River Rd., W Conshohocken, PA	Transfer Station	Private
Onyx Waste Service Transfer Station	310 Washington Street, Norristown, PA	Transfer Station	Private
Great Valley Recycling Transfer	6th & Merion Streets, Bridgeport, PA	Transfer Station	Private
Modern Recycling Systems	215 East Dekalb Pike, King of Prussia, PA	Processing Facility & Transfer Station	Private
Chester Valley Transfer	257 North Marshall Rd, Malvern, PA	Transfer Station	Private
ADC Recycling Corp. Transfer Facility	1060 Conshohocken Rd, Conshohocken, PA	Transfer Station	Private
L & S Demo Recycling	884 Brook Road, Conshohocken, PA	Processing Facility & Transfer Station	Private
T-Thermal Company	Brook Road, Plymouth, PA	Hazardous Waste Incineration & Storage Facility	Private
Lonza	900 River Road, Conshohocken, PA	Hazardous Waste Incineration & Storage Facility	Private
Delaware Cty. Resource Recovery Facility	10 Highland Avenue, Chester, PA	Waste to Energy/Resource Recovery Facility	Municipal
Montenay Energy	1155 Conshohocken Rd, Conshohocken, PA	Waste to Energy/Resource Recovery Facility	Municipal

F. Terrestrial vertebrate contaminant research or monitoring:
Currently, there are no known contaminant monitoring or ecotoxicological research projects being conducted on terrestrial vertebrates within the 10 kilometer buffer surrounding Valley Forge NHP. However, assessments to determine the extent of contamination from the asbestos release site have been conducted and will continue to be monitored. Historically, assessments on PCB contamination have been conducted for the Valley Creek area, including fish sampling (Carfioli, pers. comm.). Previous contaminant research has been conducted in the Valley Forge NHP property on the tree swallow (*Tachycineta bicolor)* (Yorks 1999).

Studies Involving Pesticides and Industrial Contaminants

1. Yorks, A.L. 1999. Effects of polychlorinated biphenyls (PCBs) on reproduction, physiological processes, and biomarkers in tree swallows (*Tachycineta bicolor)*. Dissertation, University of Maryland, College Park, MD. 280 pp.

Valley Forge NHP was one of ten sites selected for a study on the effects of PCBs on tree swallows (*Tachycineta bicolor*) in 1995 and 1996. PCB concentrations were determined for eggs (n = 8), twelve-day-old nestlings (n = 11), and food items (n = 38). In addition, biomarkers of exposure (hepatic cytochromes P450-associated monooxygenase activities (BROD and EROD)) were quantified. To determine the effect of PCBs on reproduction and physiological processes, nesting success, and offspring growth and survival were recorded. There was little evidence of abnormal development or reproduction even though PCB concentrations in nestlings ranged from 0.70 - 1.30 ppm (mean = 0.91 ppm) and in eggs ranged from 1.3 – 2.4 ppm (mean = 1.89 ppm). Body burdens of PCBs were correlated with sediment, egg, and food item concentrations and were greater at Valley Forge than uncontaminated sites in Berks County, PA (mean = 0.17 ppm) and Prince George's County, MD (mean = 0.30 ppm). Some evidence of modest cytochrome P450 induction, which is indicative of exposure to polyhalogenated contaminants, was observed.

E. Toxic release facilities:
The EPA's Toxic Release Inventory Program lists 32 toxic release facilities that discharged contaminants (http://www.epa.gov/triexplorer/facilities.htm) within 10 kilometers of Valley Forge NHP from 1997 through 2003 (Figure 3). Two of these facilities released three of the fifteen persistent pollutants and chemicals listed by the EPA and United Nations (Table 4). One facility, Cromby Generating Station is located on the Schuylkill River upstream from Valley Forge NHP. There are four facilities located within 1.6 kilometers of Valley Forge, which released hazardous substances. However, none of these facilities discharged persistent pollutants or chemicals (http://www.epa.gov/triexplorer/facilities.htm).

Table 4. Mean quantity of priority contaminants released by EPA-listed toxic release sites for 1997 through 2003 within a 10 kilometer buffer around Valley Forge NHP.

Site Name	Address	Contaminant Released	Years Released	Air Release[a]	Surface Water Release[a]	Land Disposal[a]
Cromby Generating Station	100 Cromby Rd., Phoenixville, PA	Dioxin Cmpds.	2000-03	0.00143[b]	0	0
		Mercury Cmpds.	2000-02	41.15	0	0
		Lead Cmpds.	2001-03	539.9	0	0
ISG Plate LLC Conshohocken Facility	Conshohocken Rd., Conshohocken, PA	Lead Cmpds.	2001-02	0.62	10.23	0

[a] Units are in lbs/yr unless otherwise noted.
[b] Units are in g/yr.

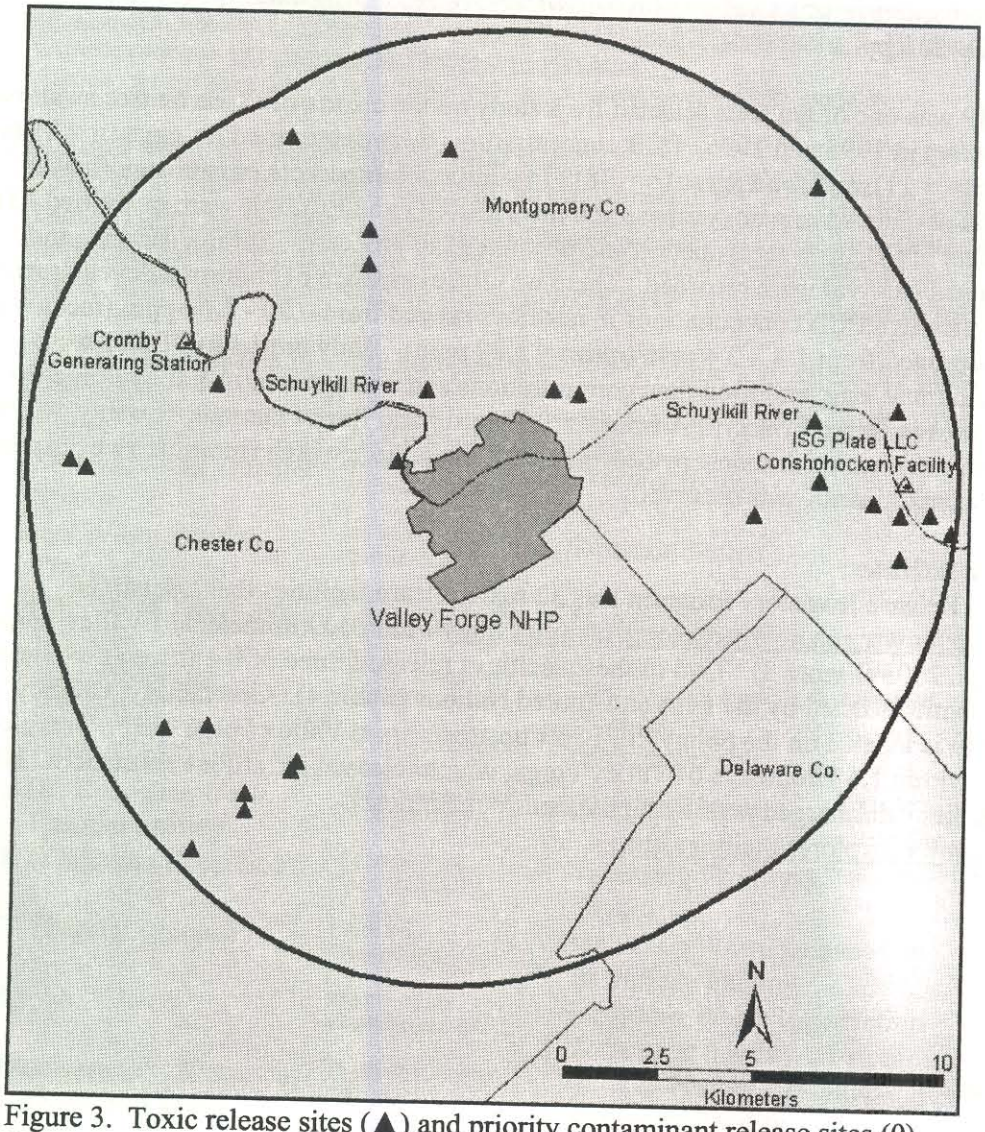

Figure 3. Toxic release sites (▲) and priority contaminant release sites (0) listed by the EPA within a 10 kilometer buffer around Valley Forge NHP for 1997 through 2003.

H. Fish consumption advisories:
The EPA's Water Program has listed two fish consumption advisories that indicate the presence of persistent pollutants and chemicals within 10 kilometers of Valley Forge NHP (Table 5) (http://www.epa.gov/waterscience/fish/advisories/index.html).

Table 5. Waterbodies with fish consumption advisories within a 10 kilometer buffer around Valley Forge NHP.

Waterbody Name	State	Pollutant	Advisory	Year Issued
Schuylkill River	PA	PCBs	Restricted & No Consumption	1993-1999
Statewide	PA	Mercury	Restricted Consumption	2001

III. CONCLUSIONS:

I. Persistent bio-accumulative toxic chemicals:
Numerous persistent pollutants and chemicals have been found or are being released within the 10 kilometer buffer surrounding Valley Forge NHP including, chlordane, PCBs, dioxins and furans, benzo(a)pyrene, lead and mercury. Eisler (2000) has described the hazards of these contaminants to wildlife.

J. Critical areas and sensitive species:
There were no critical areas reported for Valley Forge NHP. However, bald eagles (*Haliaeetus leucocephalus*) have been sighted over park property in the past.

K. Additional priority contaminant monitoring/research:
Only one study has examined contaminants (i.e. PCBs) in terrestrial vertebrates. This study looked at PCBs levels in tree swallows, showing elevated concentrations compared to uncontaminated reference sites. Valley Creek and Schuylkill River also indicate the presence of these contaminants (i.e. impaired waterbodies and fish advisories) in the area. Furthermore, the Asbestos Release Site inside Valley Forge NHP could be a possible source of PCBs. Since PCBs are persistent, additional monitoring and research may aid in identifying the extent of PCB exposure to other terrestrial vertebrates. Other contaminants identified in the area of interest around Valley Forge NHP include dioxins, furans, benzo(a)pyrene, lead and mercury. The exposure of terrestrial vertebrates to these contaminants has not been looked at and future research may aid in identifying the risk. And finally, the road system within the park is a potential contaminant threat. Specifically, numerous spills from tankers releasing oil and hazardous material into the environment have occurred along Route 23, a winding roadway through the center of the park. When the opportunity arises, NPS staff should pursue actions that re-route hazardous material transport around the park.

Wolf Trap National Park for the Performing Arts

I. BACKGROUND

Size: 52.6 hectares

Designation: National Park – 1966

Setting/habitat: Wolf Trap National Park (NP) for the Performing Arts is located in the Piedmont Province of Virginia, which consists of low to moderate slopes and wide uplands. Using the National Oceanic and Atmospheric Administration's 250 m (1990 urban-enhanced) Land Use Land Cover data (1999), the environment surrounding Wolf Trap NP is classified as: 87.9% urban or residential; 6.9% forested; 3.9% agricultural; 1.2% water; and 0.1% barren lands.

Past land uses: Weekend Farm

II. CURRENT AND POTENTIAL ENVIRONMENTAL CONTAMINATION

A. Known Contaminated sites:

There are no known contaminated sites located on Wolf Trap NP property. However, 8.74% of the surface water within a 10 kilometer area of Wolf Trap NP is listed as impaired by the EPA.

B. NPL Superfund sites:

There are no current Environmental Protection Agency (EPA) National Priorities List (NPL) Superfund sites that require further remedial action located within 10 kilometers of Wolf Trap NP.

C. Impaired waterbodies:

The EPA and the Maryland Department of Environment (MDE) under Section 303(d) listed five waterbodies as impaired in 2002 (http://www.epa.gov/waters/data/downloads.html) within 10 kilometers of Wolf Trap NP. The Potomac River and Cabin John Creek are not impaired by contaminants but are impaired from both nutrients and siltation. Additionally, Four Mile, Accotink and Difficult Runs are impaired by pathogens (fecal coliform) within 10 kilometers of Wolf Trap NP. However, the impaired portions of these streams do not cross the boundary of the park.

D. Pesticides, herbicides, rodenticides, avicides used:

There were no pesticide or herbicide products applied at Wolf Trap NP in 2004 that contained active ingredients recognized as being moderately to highly toxic to terrestrial vertebrates.

E. Solid waste or wastewater disposal sites:

There are three solid waste facilities permitted by Virginia's Department of Environmental Quality (http://www.deq.virginia.gov/waste/s-waste.html) located within 10 kilometers of the Wolf Trap NP (Table 1). No major wastewater treatment facilities are located within the 10 kilometer buffer around Wolf Trap NP (http://cfpub.epa.gov/cwns/standard.cfm).

Table 1. Permitted solid waste facilities within a 10 kilometer buffer around Wolf Trap NP.

Facility Name	Address	Type	Ownership
Classified Waste Disposal System at CIA	Route 123 & 193, Langley, VA	Incineration/Energy Recovery Facility	Govt.
INOVA	3300 Gallows Rd., Falls Church, VA	RMW Alternate Treatment	Private
USA Waste of Virginia-Fairfax MRF	1505 Moran Rd., Sterling, VA	Materials Recovery Facility	Private

[a] RMW includes all regulated medical waste.

F. Terrestrial vertebrate contaminant research or monitoring:
No known current or past contaminant monitoring or ecotoxicological research projects have been conducted on terrestrial vertebrates within the 10 kilometer buffer surrounding Wolf Trap NP. However, contaminant exposure data is available for one incident from the Tri-State Bird Rescue and Research.

Tri-State Bird Rescue and Research, Inc. 1997. Oil Spill Response History. Newark, Delaware.

Beavers (*Castor canadensis*), Canada geese (*Branta canadensis*), snapping turtles (*Chelydra serpentina*), box turtles (*Terrapene carolina*), painted turtles (*Chrysemys picta*), and wood turtles (*Clemmys insculpta*), mallards (*Anas platyrhynchos*), Northern water snakes (*Nerodia sipedon*), barred owls (*Strix varia*), and wood ducks (*Aix sponsa*) were collected in 1993 to determine the presence of oil after the release of 380,000 gallons of no. 2 diesel fuel. Of the 51 individuals examined, 61% were released.

G. Toxic release facilities:
The EPA's Toxic Release Inventory Program lists two toxic release facilities that discharged contaminants within 10 kilometers of Wolf Trap NP from 1997 through 2003 (http://www.epa.gov/triexplorer) (Figure 1). Both BP Products and Motiva have terminals within the Fairfax city limits, but are not identified as releasing persistent pollutants or chemicals into the environment.

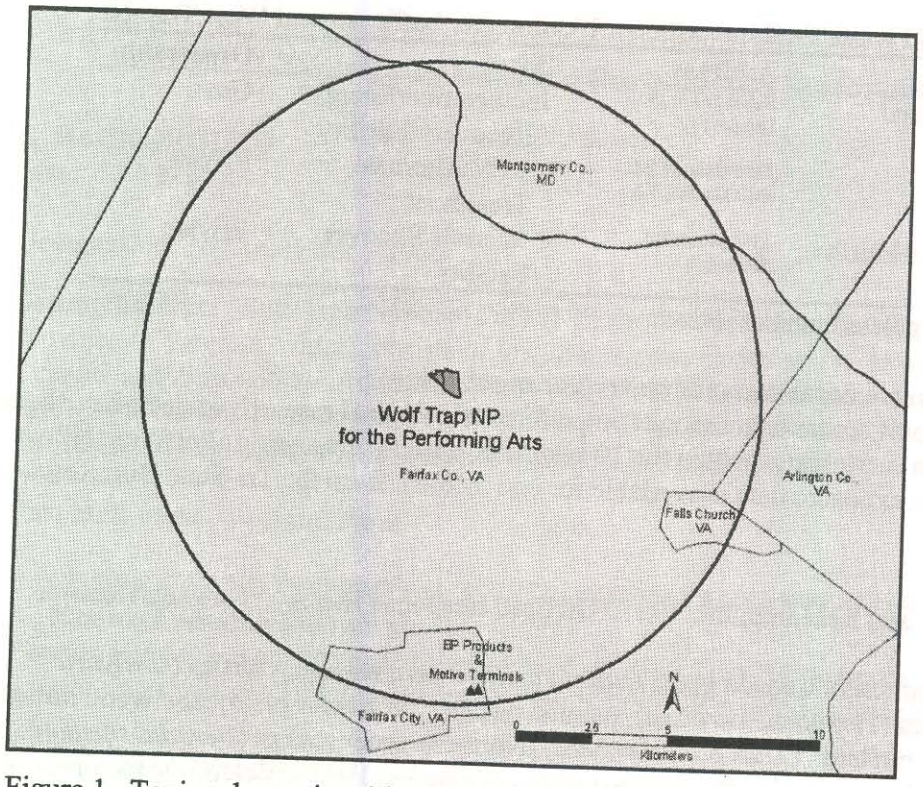

Figure 1. Toxic release sites (#) listed by the EPA within a 10 kilometer buffer around Wolf Trap NP for 1997 through 2003.

H. Fish consumption advisories:
The EPA's Water Program has listed one fish consumption advisory that indicates the presence of persistent pollutants and chemicals within 10 kilometers of Wolf Trap NP. This is a statewide restricted consumption advisory for Maryland due to mercury issued in 2004 (http://www.epa.gov/waterscience/fish/advisories/index.html).

III. CONCLUSIONS:

I. Persistent bio-accumulative toxic chemicals:
There are no persistent bio-accumulative toxic chemicals being released by TRI sites or that are the cause of impaired waterbodies within 10 kilometers of Wolf Trap NP. However, an active fish consumption advisory in Maryland for mercury indicates that this pollutant may be present. Eisler (2000) has described the hazards of these contaminants to wildlife.

J. Critical areas and sensitive species:
There were no critical areas or sensitive species reported for Wolf Trap NP.

K. Additional priority contaminant monitoring/research:
The Wolf Trap NP was not found to have current sources for contamination within 10 kilometers of its boundary in this study. Upon discovery of a contaminated site, samples from terrestrial vertebrates should be collected to determine the level of exposure.

Appendix E. Principal contaminants for which critical concentrations and diagnostic guidelines are available for wild terrestrial vertebrates

Contaminants	Toxicological Effect	Critical Concentration or Diagnostic Guideline
Organochlorine Pesticides		
Chlordecone (Kepone)	Neurotoxin, endocrine disruptor and other effects	Median lethal concentration 115 ppm in pheasants; chicken egg hatchability adversely affected at 120 µg/g ww eggs effected; significant estrogenic effects in quail oviduct at dietary concentraiton of 10 ppm. (World Health Organization, 1984; Wiemeyer, 1996).
p,p'-DDE	Eggshell thinning in raptors and fish-eating birds by inhibiting calcium-ATPase in shellgland in oviduct	Concentration in eggs associated with eggshell thinning (≥10%) varies greatly among species of raptorial and fish-eating birds ranging from 1 to 10 µg/g ww eggs. (Blus, 1996).
Dicofol	Eggshell thinning and reproductive effects	Eggshell thinning in sensitive species at dietary concentrations of 3 ppm and egg concentrations of 2.5 µg/g ww in eggs. (Clark et al., 1990; Wiemeyer, 1996).
Dieldrin	Neurotoxin	Brain concentrations associated with lethality in birds and mammals is 4 to 10 µg/g ww. (Blus et al., 1996; Peakall, 1996).
Endrin	Neurotoxin	Brain concentrations associated with lethality in birds is >0.8 µg/g ww. (Blus et al., 1996).
Heptachlor epoxide	Neurotoxin	Brain concentrations associated with lethality in birds is >8 µg/g ww. Reproductive effects for sensitive species of birds (American kestrel) is 1.5 µg/g ww in eggs (Blus et al., 1996; Wiemeyer, 1996).
Hexachlorobenzene	Neurotoxin	Severe exposure in adults (not diagnostic of death) > 85 µg/g ww in liver, >465 µg/g ww in liver. (Wiemeyer, 1996).
Hexachlorocyclohexane	Neurotoxin	Severe exposure is >4.2 µg/g ww in liver. (Wiemeyer, 1996).
Mirex	Neurotoxin	Greater than 177 µg/g ww in brain is associated with lethality. (Wiemeyer, 1996).
Oxychlordane	Neurotoxin	Significant exposure is 5 µg/g ww in brain. (Wiemeyer, 1996).

Appendix E. Principal contaminants for which critical concentrations and diagnostic guidelines are available for wild terrestrial vertebrates

Contaminants	Toxicological Effect	Critical Concentration or Diagnostic Guideline
Organophosphorus and Carbamate Pesticides	Inhibition of acetylcholinesterase	Inhibition of brain acetylcholinesterase activity by 20% is considered diagnostic of sublethal poisoning, and dead birds with >50% reduction in activity is diagnostic of anticholinesterase poisoning. (Hill and Fleming, 1982).
Polychlorinated biphenyls		
Total aroclors	Impaired growth, embryotoxic effects, wasting syndrome, edema, cytochrome P450 induction, porphyria, immunotoxicity, often involving the arylhydrocarbon receptor.	Lethality associated with about 300 µg/g ww in brain. Concentration threshold associated with embryo toxicity, depressed growth, porphyria and cytochrome P450 induction varies greatly among species, but as low as 1 µg/g ww. (Hoffman et al., 1996; Rice et al. 2003).
Coplanar PCB congeners, Dioxins, Dibenzofurans	Impaired growth, embryotoxic effects, wasting syndrome, edema, cytochrome P450 induction, porphyria, immunotoxicity, often involving the arylhydrocarbon receptor.	Effects in some species occuring at < 100 pg TEQs/g ww. (Hoffman et al., 1996; Rice et al. 2003).
Petroleum hydrocarbons	Impaired thermoregulation, reproduction, endocrine function, osmoregulation; hematological disorders	As little as 1 to 20 µl on an eggshell can be highly embryo toxic in sensitive species of birds; effects in adult variable depending on route of exposure. Aromatic fractions generally more toxic than aliphatic fractions (Jessup and Leighton, 1996; Albers, 2003).