Fishing for Forgotten Rivers: The History and Toxicology of Subsistence Fishing on the Potomac and Anacostia, Washington, D.C.

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Introduction

The Potomac and Anacostia Rivers have significant historical, cultural, and environmental importance for D.C. residents, and are the locus for myriad, often competing interests that seek to exploit both the use and exchange values of the watershed. For most of D.C.'s history the health of both rivers has been in a state of decline. One of the most troubling repercussions of this legacy of neglect and pollution is the increased health risk with which local residents, who rely on fish from the rivers to support their physical and social well being, must contend.

We have, however, reached a sea change in the management and administration of D.C. waters. While water quality and conservation efforts have dramatically improved the state of the watershed, significant work remains to be done to make the Potomac and Anacostia, in the words of the District Department of the Environment, both "fishable and swimmable". As government, conservationists, industry, and residents work together to create a better future for the capitol's rivers it will be of upmost importance to ensure that the aspirations and needs of D.C.'s urban fishermen, who have long been among the most vulnerable and least represented watershed stakeholders, are included in calculations for the future of the Potomac and Anacostia.

NB: All photos used in this document are the author's own, unless otherwise indicated.

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Thanks also to my family, American University, and the Honors Department for the opportunity to be here in the first place; and to Katie Alexander, my fair-weather research assistant who provided occasional, but nonetheless enjoyable company.

Abstract

The Potomac and Anacostia rivers have significant historical, cultural, and environmental importance for D.C. residents, and are the locus for myriad, often competing interests that seek to exploit both the use and exchange values of the watershed. This paper explores the historical, environmental, and political context for modern water resource management in the metropolitan area. The segments of the Potomac and Anacostia that fall within the District are particularly important for the local urban fishing population. Many of these fishers rely on the fish they catch from the Potomac and Anacostia as part of their livelihood portfolio. Unfortunately, a long history of environmental degradation has reduced water quality in both rivers, and consequently presented a health risk to urban fishers who consume fish caught in the polluted waters. Conservation and rehabilitation efforts in the decades since the Clean Water Act have dramatically improved the state of the watershed. However, significant work remains to be done in order to make the Potomac and Anacostia both "fishable and swimmable." As government, conservationists, industry, and residents work together to create a better future for the capitol's rivers it will be of upmost importance to ensure that the aspirations and needs of D.C.'s urban fishermen, who have long been among the most vulnerable and least represented watershed stakeholders, are included in calculations for the future of the Potomac and Anacostia.

Forgotten Rivers

> "The fourth river is called Patawomeke, 6 or 7 myles in breadth. It is navigable 140 myles, and fed as the rest with many sweet rivers and springs, which fall from the bordering hils. These hils many of them are planted, and yield no lesse plentie and varietie of fruit, then the river exceedeth with abundance of fish.[1]"
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> -John Smith, 1607

It is difficult today to imagine a time when the Potomac and Anacostia Rivers were not lined with refuse, used effectively as aquatic landfills; even more so to imagine that they could have once been used as abundant sources of food for a burgeoning city. Nonetheless, the social and environmental history of Washington, D.C. cannot be separated from the history of the Potomac and Anacostia.

One of the reasons for the district's early attractiveness to migrants was the existence of a substantial fishing industry, which brought with it the potential to find work catching, processing, distributing, and selling fish along the riverbanks. In the absence of any kind of gear or catch regulation, the Potomac and Anacostia fisheries yielded prodigious quantities of fish throughout the 1800s.[2] Bass, shad, sturgeon, herring, pike, perch, eel, crabs and oysters filled the tidal areas and provided both a source of protein and economic opportunity as far north as Great Falls, twelve miles above central Washington. During the early

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[1] Smith, John. *The generall historie of Virginia, New England & the Summer isles: together with the true travels, adventures and observations of*. Bedford, MA: Applewood Books, 20061907, pg 49

[2] Cummins, Jim. "A Compilation of Historical Perspectives on the Natural History and Abundance of American Shad and Other Herring in the Potomac River." www.potomacriver.org.

1800s, fishermen frequently reported catches in excess of 4,000 shad or 300,000 herring per seine haul.[3]

The development of the fisheries paralleled the district's population growth. While participation in the Potomac and Anacostia fisheries was widespread and brought residents from diverse backgrounds, slavery, the Civil War, and Emancipation generated significant demographic change in the region and the industry. Before the Civil War, Washington DC was a destination for a growing population of both free and enslaved African-Americans.[4] [5] After the end of the war, and throughout Reconstruction, the Potomac attracted southern, African-American migrants to supply labor for a quickly expanding fishing industry.[6] During the 1870s, population within the district grew by 75% and new neighborhoods began to develop, largely inhabited by black residents, along the waterfront between Georgetown, Alexandria and the Capital area, and on the banks of the Anacostia.[7]

This new residential population created even greater demand for fish from the Potomac and Anacostia, establishing an informal recreational fishery to rival

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[3] Cummins, Jim. "A Compilation of Historical Perspectives on the Natural History and Abundance of American Shad and Other Herring in the Potomac River." www.potomacriver.org., pg.5

[4] Cummins, Jim. "American Shad and African American Watermen; A Heritage Nearly Forgotten." www.potomacriver.org.

[5] Smithsonian Institution. "Washington, D.C. - History and Heritage | Washington DC | Smithsonian Magazine." History, Travel, Arts, Science, People, Places | Smithsonian Magazine. http://www.smithsonianmag.com/travel/destination- hunter/north-america/united-states/east/washington-dc/washingtondc-history- heritage.html (accessed December 4, 2012).

[6] Anderson, Harold. "Maryland Marine Notes: March-April 1998 Sidebar - Slavery, Freedom and the Chesapeake", pg. 5

[7] Morello, Carol, and Dan Keating. "D.C. population soars past 600,000 for the first time in years." *The Washington Post*, December 22, 2010.

the local commercial fishing industry. Expansion of the recreational fishery was particularly concentrated in African-American communities,

> *"go out to the Hunting Creek bridge any summer evening and you will see the 'coons' almost elbow to elbow its entire length, their bare feet swinging over the water and a myriad of lines dangling among what seem to be the reflection of trunks in the stream. There are sometimes almost as many women as men.*[8]*"*

Concerns[9] that fish populations were beginning to drop off due to overfishing spurred the district government to institute gear and seasonal restrictions on both recreational and industrial fishers in the 1880s and '90s.[10]

Such concerns were complemented by the apparent deterioration of water quality, particularly in the Anacostia, and the socio-economic decay of waterfront

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[8] *The Washington Post*, "Fishing with Nets in the Potomac." June 2, 1891. http://www.proquest.com/en-US/ (accessed December 3, 2012).Cultural differences in the fishing practices, apparent between white and black communities in the late 1800s and early 1900s, reflected ethnic rather than socio-economic characteristics. There was also diversity in practice within the communities, particularly between former slaves and other African-Americans. (Cheek, Charles D. , and Amy Friedlander. "Pottery and Pig's Feet: Space, Ethnicity, and Neighborhood in Washington, D.C., 1880-1940." *Historical Archaeology* 24, no. 1 (1990): 34-60.)

[9] Image from: Horydczak, T. c.1920. Fishing. Boys fishing in Chesapeake and Ohio (C&O) canal. Book Fishing. Boys fishing in Chesapeake and Ohio (C&O) canal. Library of Congress, City.

[10] Connelly, J. H.. "Fishing in the Potomac an article that will interest Washington anglers." *Washington Post*, February 27, 1888. http://www.proquest.com/en-US/

communities. After two centuries of erosion, riparian agricultural development, and deforestation, the Anacostia had succumb to sedimentation. Whereas the river had been 40-45 feet deep during the early 1800s, by 1875 it had shrunk to a mere 8 feet deep.[11] The first of many attempts at "urban renewal" also changed the waterfront landscape. The 1920s and '30s brought another influx of migrants to the district, creating demand for new housing and services.[12] Decline in waterfront communities, particularly in Southwest D.C., where poverty and squalor provided stark contrast to the sanitary monuments and government buildings adjacent, encouraged the replacement of homes and shops with office buildings and high-rise apartments.[13] Rezoning of waterfront property, the removal of African-American communities to Northeast and Southeast D.C., and deteriorating water quality began to sever the relationship between residents, and the Potomac and Anacostia rivers, a trend that would continue throughout the 20th century.

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11 Williams, Brett. "A River Runs Through Us." *American Anthropologist* 103, no. 2 (2001): 409-431, pg. 9

12 Anderson, Harold. "Maryland Marine Notes: March-April 1998 Sidebar - Slavery, Freedom and the Chesapeake."

13 Abrams, Amanda. "Southwest Waterfront: A Neighborhood Where A Change Is Gonna Come."

Waterfront development during the mid-20th century[14] included military institutions, industrial plants, waste and sewage processing plants, and the construction of dams to supply potable water to D.C. residents.[15] Pollution resulting in record fish kills, loss of habitat, and overfishing not only dramatically reduced the number of fish in the Potomac and Anacostia, but also shifted the species assemblage.[16] At the peak harvest in 1890, commercial landings of American shad from the Potomac amounted to 7 million pounds for the season.[17] By 1980, less than a century later, the shad fishery had collapsed in the Potomac and Anacostia forcing Maryland, D.C., and Virginia to close the fishery (1980, 1982, and 1993 respectively).[18]

Today there is no commercial fishing within D.C. limits, and recreational fishing is closely monitored. Maryland, Virginia, and the District government share responsibility for pollution, wastewater treatment,

[14] Image from: Horydczak, T. c.1920. Washington Monument. View of Washington Monument from across Tidal Basin, with fisherman. Book Washington Monument. View of Washington Monument from across Tidal Basin, with fisherman. Library of Congress, City.
[15] Williams, Brett. "A River Runs Through Us." *American Anthropologist* 103, no. 2 (2001): 409-431.
[16] Thompson, Jim. "Fish Passage Program History & Background." Fish Passage. www.dnr.state.md.us/fisheries/fishpassage/index.asp
[17] Id.
[18] Cummins, Jim. "A Compilation of Historical Perspectives on the Natural History and Abundance of American Shad and Other Herring in the Potomac River." www.potomacriver.org, pg. 6

public health as well as environmental protection. Regulation of the recreational and commercial fishing industries and a proliferation of environmental legislation, resulting in improved water quality, allowed fish stocks in the Potomac and Anacostia to recover somewhat. Nonetheless, water quality, fish and human health remain serious concerns for local environmental authorities. So long as there are fish in the rivers, D.C. residents will be there to catch them – interpreting D.C.'s fishing history in a modern context – and the importance of healthy waters will remain ever before us.

Toxins

The Potomac and Anacostia rivers have a history of environmental and water quality monitoring that surpasses that of the majority of American watersheds. This is in part due to the fact that both rivers are uniquely positioned to be under the jurisdiction of an array of local governments, state governments, and federal agencies responsible for natural resource management in the District of Columbia. It is also due to the multiplicity of NGOs and academic institutions located in the area that continuously produce their own independent status reports on the health of the rivers.

One of the longest running efforts in water quality monitoring is the USGS National Water-Quality Assessment Program (NWQAP), which has collected contaminant data with relative consistency since 1987.[1] In the 1992 NWQAP report on the Potomac River Basin found that Chlordane, dichlor-diphenyl-trichloroethane (DDT), and polychlorinated biphenyls (PCBs) were the most widespread contaminants to be found in biological tissues.[2] Today, PCBs, Chlordane, as well as other classes of contaminants such as polycyclic aromatic hydrocarbons (PAHs), coliform bacteria, and heavy metals are ubiquitous in the Potomac and Anacostia rivers. These contaminants are known to be harmful to human health, and are particularly dangerous in that many tend to bioaccumulate in fatty tissues.[3] Also of interest are pollutants associated with urban and

[1] U.S. Geological Survey. The National Water-Quality Assessment (NAWQA) Program. 2013. Accessed: January 12, 2013. http://md.water.usgs.gov/nawqa/podl/podlhome.htm.
[2] Zappia, H. 1992. Chlordane, DDT, PCB's, and Other Selected Organic Compounds in Asiatic Clams and Yellow Bullhead in the Potomac River Basin, 1992. Water-Resources Investigations Report.
[3] Wenning, R. J., Martello, L., Prusak-Daniel, A. 2011. Dioxins, PCBs, and PBDEs in Aquatic Organisms. Pages 103-169 *in* Beyer, W. N., and Meador, J.P. editor. Environmental Contaminants in

agricultural non-point runoff, or contaminants of emerging concern (CECs). There is research linking such contaminants (pharmaceuticals, hormones, and antibiotics) to problems in animal health (reproductive and morphogenetic mutation and behavioral alteration among others)[4] [5], but there is less research determining the effect of ambient concentrations of CECs on human health.

Contaminant concentrations from certified monitoring programs are used to inform regulatory, policy, and planning authorities with domain over the Potomac and Anacostia. In order to satisfy the requirements of the Clean Water Act, the District Department of the Environment (DDOE) uses monitoring data to report on whether or not urban waters exceed the Total Maximum Daily Load (TMDL) for a set of prescribed contaminants. Water, sediment, and tissue contaminant concentrations are also used to produce Remedial Investigation and Feasibility Studies (RI/FS) for the 8 Superfund sites located inside the District of Columbia.

Local and state governments use monitoring data to help inform waterfront development, identify potentially responsible parties for cleanup costs, and establishment of fishing and swimming advisories. In D.C., due to excessively high concentrations of toxic material in the water, sediment, and biological tissue a fishing advisory has been in effect since 1989. The DDOE advises fishermen against any consumption of catfish, carp and eel taken from the Potomac and Anacostia, and advises only limited consumption of

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Biota: Interpreting Tissue Concentrations. 2nd ed. CRC Press, Boca Raton, FL.

[4] Vicki S. Blazer, A. E. P., Jill A. Jenkins, Luke R. Iwanowicz, Steven Minkkinen, Rassa O. Draugelis-Dale, James H. Uphoff. 2013. Reproductive health of yellow perch Perca flavescens in selected tributaries of the Chesapeake Bay. Science of the Total Environment (447):198-209.

[5] Blazer, V. S. 2011. Fisheries Currents: Understanding Fish Mortalities in the Potomac Drainage. Fisheries 36(1):40.

largemouth bass and sunfish.[6] For all species catch and release, rather than consumption, is encouraged.

Fishing advisories are the prerogative of state authorities, not federal agencies. The Food and Drug Administration (FDA) is responsible for regulating and monitoring seafood traded commercially, but does not have jurisdiction over recreational, subsistence, and sport fishing. One role that the federal government does play is in the Environmental Protection Agency's (EPA) establishment of toxin-specific screening values (SVs). Screening values are published for an array of commonly occurring contaminants and are meant to serve as warning values, not as no consumption levels. When sampling and analysis shows concentrations in excess of EPA screening values then the particular contaminant becomes a "contaminant of concern."[7]

Risk-based SVs are generally calculated using a model similar to that expressed in Equations 1 and 2, where E_m represents the *effective* dose of contaminant, C_m is the concentration of contaminant in the edible portion of the fish, CR is the daily consumption rate, X_m is a measure of human absorption of the contaminant, and BW is the mean body weight of the population of interest.

$$E_m = (C_m \times CR \times X_m)/BW \qquad \textbf{Equation 1}^{8}$$

The SV also depends upon the toxicological potency of the contaminant, which corresponds to the dose-response variable (P_m).[9]

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[6] District Department of the Environment. Fishing in the District. Accessed: 11 November 2012. http://ddoe.dc.gov/service/fishing-district.
[7] Pinkney, A. E. 2009. Analysis of Contaminant Concentrations in Fish Tissue Collected from the Waters of the District of Columbia, Annapolis, MD. (13).
[8] U. S. EPA 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Washington, D.C. (148).
[9] Id.

$$SV_m = (P_m \times BW)/CR \qquad \textbf{Equation 2}^{10}$$

Some sub-populations are more sensitive to contaminant exposure than others. For example, due to higher rates of fish consumption by subsistence fishing groups, and increased sensitivity by pregnant or nursing women, and children, SVs will be adjusted to reflect an adequate level of protection. In order to determine the most appropriate advisory for each sub-population, SVs are calculated using varying values of toxicological potency and human absorption. The D.C. government regularly funds projects that attempt to determine contaminant concentrations in the edible portions of fish in order to understand how much of a given contaminant the urban fishing population is being exposed to. Such research has shown that trace inorganic pollutants as well as carcinogenic organic compounds (PCBs, PAHs, DDTs, and Chlordane) exceed EPA SVs in the tissues of many species of fish.[11] [12] [13] [14] This is particularly true for bottom feeding species of fish that have greater interface with the sediment substrate, where many of the contaminants of concern preferentially settle out of the water column.[15]

[10] U. S. EPA 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Washington, D.C. (148).
[11] Zappia, H. 1992. Chlordane, DDT, PCB's, and Other Selected Organic Compounds in Asiatic Clams and Yellow Bullhead in the Potomac River Basin, 1992.
[12] MacAvoy, S. E., Ewers, E.C., Bushaw-Newton, K.L. 2009. Nutrients, oxygen dynamics, stable isotopes and fatty acid concentrations of a freshwater tidal system, Washington, D.C. Journal of Environmental Monitoring.
[13] Pinkney, A. E., Harshbarger, J.C., May, E.B., Melancon, M.J. 2000. Tumor Prevalence and Biomarkers of Exposure in Brown Bullheads (Ameiurus Nebulosus) from the Tidal Potomac River, U.S.A. Watershed. Environmental Toxicology and Chemistry 20(6):1196-1205.
[14] Pinkney, A.E., (2003), (2011).
[15] Newman, M. C. 2013. Bioaccumulation. Quantitative Ecotoxicology. 2nd ed. CRC Press, Boca Raton, FL.

Table 1 2009 fish tissue (wet weight) contaminant concentrations for taken from up and downstream Potomac and Anacostia (all sample concentrations are median values). EPA screening values are for recreational fishermen

River	Species	PCB - total (ppm)*	EPA SV (ppm)**	PAH - total (ppm)*	EPA SV (ppm)**	Methylmercury (ppm)*	EPA SV (ppm)**	DDT - total (ppm)*	EPA SV (ppm)**	Chlordane (ppm)*	EPA SV (ppm)**
Potomac	*American Eel*	2.28	0.02	0.06	0.01	0.20	0.40	0.29	.117 (carcinogenic), 2.0 (noncarcinogenic)	0.16	0.11
	Blue Catfish	0.05		0.06		0.27		0.15		0.11	
	Carp	0.67		0.23		0.08		0.11		0.12	
	Channel Catfish	0.03		0.07		0.07		0.07		0.05	
	Largemouth Bass	0.23		0.02		0.21		0.03		0.13	
	Sunfish	0.01		0.01		0.12		0.01		0.00	
Anacostia	*American Eel*	1.30		0.12		0.08		0.27		0.52	
	Blue Catfish	0.62		0.04		0.09		0.11		0.12	
	Carp	0.94		0.18		0.06		0.13		0.22	
	Channel Catfish	0.89		0.11		0.12		0.11		0.14	
	Largemouth Bass	0.35		0.03		0.21		0.04		0.04	
	Sunfish	0.09		0.03		0.05		0.01		0.01	

* data taken from Pinkney, A. E. 2009. Analysis of Contaminant Concentrations in Fish Tissue Collected from the Waters of the District of Columbia, Annapolis, MD., ** data taken from EPA, U. S. 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. 1. 3. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Washington, D.C.

Table 1 shows a summary of the findings of a 2007 DDOE investigation of contaminant concentrations in fish tissues from the Potomac and Anacostia.[16] Samples were taken from the Potomac south of Chain Bridge, and on the Anacostia south of Benning Bridge Road. In all samples for all species, total PCB concentrations exceed EPA SVs for recreational fishermen. Chlordane, total DDT, and PAH concentrations also consistently exceeded cautionary levels. Compared to earlier sampling from 2000, concentrations of PCBs and Chlordane increased in eel, carp, and largemouth bass, but decreased for both channel catfish and sunfish.[17]

While tissue concentrations of some species of contaminant have decreased, many others remain well above the corresponding EPA screening values for recreational fishers. Similarly, while the effect of some contaminants on human health is well established (PCBs and other dioxin-like compounds, methylmercury, Chlordane, etc.)[18], it is not as well known how newly observed contaminants accumulate in fish tissue, transfer to human tissue when consumed, and interact cumulatively with other contaminants known to be endocrine disrupters.[19] Some of the characteristics that differentiate CECs from classic COCs include: lack of a typical toxicological dose-response curve, presence of feedback

[16] Pinkney, A. E. 2009. Analysis of Contaminant Concentrations in Fish Tissue Collected from the Waters of the District of Columbia, Annapolis, MD.
[17] Id.
[18] Foster, G. D., and Cui, V. 2008. PAHs and PCBs deposited in surficial sediments along a rural to urban transcect in a Mid-Atlantic coastal river basin (USA). Journal of Environmental Science and Health 42(12):1333-1345.
[19] Vicki S. Blazer, A. E. P., Jill A. Jenkins, Luke R. Iwanowicz, Steven Minkkinen, Rassa O. Draugelis-Dale, James H. Uphoff. 2013. Reproductive health of yellow perch Perca flavescens in selected tributaries of the Chesapeake Bay. Science of the Total Environment (447):198-209.

mechanisms, difference between short and long-term health effects, variation in multiple exposure rates, and additive/synergistic impacts on biological systems.[20]

Further research is necessary on the presence and impacts of CECs as well as more comprehensive and regular monitoring of contaminant concentrations in fish tissues. There are very few freshwater toxicology studies that have been running long enough with a sufficient sample size to correlate land use and development practices with contaminant concentrations in biological tissues.[21] More such studies, with regional focus, are necessary in order to gain a comprehensive understanding of how humans influence and are in turn impacted by the presence of toxic contaminants in the environment.

[20] Vickey Blazer, U.S. Geological Survey. personal communication, 7 March 2013.
[21] Alfred Pinkney, U.S. Fish & Wildlife Service, personal communication, 7 March 2013.

Subsistence

As America's urban areas continue to grow, so to do the challenges associated with sustaining a healthy urban public and environment. Over the past decade, urban areas in the U.S. have expanded to accommodate an additional 27 million people representing a three percent growth rate.[1] Washington D.C. is no exception to this trend, where the resident population for Washington, Alexandria and Arlington, VA has grown 16.4% since 2000.[2] Much of this growth is driven by increased economic opportunity and urban development and redevelopment projects, which in turn impact local environmental considerations.

Last year American Rivers labeled the Potomac River America's most endangered waterway due to persistent sources of urban and agricultural pollution, as well as the threat of regulatory rollbacks.[3] While the report's findings are relatively subjective, they do highlight the fact that despite significant progress in the wake of regulatory regimes like the Clean Water Act, Washington D.C.'s urban waters are not yet clean. At risk is both human and environmental health, particularly in contexts where the two are most intimately connected.

Fishing in urban areas has become increasingly popular as local metropolitan governments encourage the use of public space and as demographic changes bring

[1] U. S. Census Bureau. 2010 Census Urban and Rural Classification and Urban Area Criteria.
[2] Wilson, P. M. a. S. 2011. Population Distribution and Change: 2000 to 2010Population Distribution and Change: 2000 to 2010, Washington, D.C.
[3] American Rivers. 2012. America's Most Endangered Rivers 2012America's Most Endangered Rivers 2012, Washington, D.C.

fishing cultures and traditions into American cities.[4] [5] [6] [7] [8] Growing interest in urban fishing has brought questions of water quality, health, and pollution to the forefront of city planning considerations, conservation, and environmental remediation efforts. With regard to the public health dimension of fishing, authorities have been tasked with ensuring citizens are protected from potentially harmful concentrations of toxic contaminants in fish catch intended for consumption. So far, rhetoric to this effect is typically broken into discussions of risk reduction (i.e. reducing observable contaminant concentrations in water, sediment, and fish tissues) and discussions of risk avoidance (i.e. discouraging people, or "risk bearers" from eating contaminated fish). Both address human exposure to contaminants, but do so by employing different assumptions about the nature of risk. While risk reduction prioritizes the sources of pollution, risk avoidance measures attempt to dissociate risk bearers from sources of contamination by changing their behaviors. However, risk avoidance measures, such as fish advisories, education programs, etc., make the assumption that such behaviors are changeable. In fact, as will be explored in the sections to follow, for

[4] Shilling, F., A. W., Lippert, L., and Lubell, M. 2010. Contaminated fish consumption in California's Central Valley Delta. Environmental Research.
[5] MacDonald, J. 2011. Fishing's Great in New York…City? Book Fishing's Great in New York…City? , City.
[6] Heatwole, C., West, N. 1985. Shorefront Fishing in New York City. Geographical Review 75(3):245-264.
[7] Kalkirtz, V., Martinez, M., and Teague, A. 2008. Environmental Justice and Fish Consumption Advisories on the Detroit River Area of Concern. Book Environmental Justice and Fish Consumption Advisories on the Detroit River Area of Concern. University of Michigan, City.
[8] Balsman, D. M., Shoup, D. E. 2008. Opportunities for Urban Fishing: Developing Urban Fishing Programs to Recruit and Retain Urban Anglers. American Fisheries Society Symposium 67:31-40.

many urban anglers, demand for locally sourced, fresh fish is highly inflexible, regardless of risk avoidance efforts undertaken by local authorities.

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Subsistence fishing is institutionally recognized most frequently at the federal level and through relations with tribal authorities. Established in 1993, the National Environmental Justice Advisory Committee (NEJAC) informs and advises the EPA on issues related to environmental justice, and is one of the few federal agency entities that engages with subsistence livelihoods and environmental health. Part of the body's role is to, "Improve the environment or public health in communities disproportionately burdened by environmental harms and risks."[9] While NEJAC's reports on environmental justice concerns apply generally, most of their focus in recent years has been on subsistence in Native American and Inupiat communities. However, they do acknowledge that there is in general a relationship between communities dependent on fishing for subsistence, and minority or economically disenfranchised groups:

> *"[C]ommunities of color, low-income communities, tribes, and other indigenous peoples depend on healthy aquatic ecosystems and the fish, aquatic plants, and wildlife that these ecosystems support… These resources are consumed and used to meet nutritional and economic needs. For some groups, they are also consumed or used for cultural, traditional, or religious purposes. For members of these groups, the conventional understandings of the "health benefits" or "economic benefits" of catching, harvesting, preparing, and eating*

[9] U.S. EPA. National Environmental Justice Advisory Council Charter, 2012. NEJAC, EPA. 2012. Washington, D.C. http://www.epa.gov/environmentaljustice/resources/publications/nejac/nejac-charter-2012.pdf.

> *fish, aquatic plants, and wildlife do not adequately capture the significant value these practices have in their lives and the life of their culture. The harms caused by degradation of aquatic habitats and depletion of fisheries, moreover, do not only affect the present generation. They take their toll on future generations and on the transfer of knowledge from one generation to the next (e.g., ecological knowledge, customs and traditions surrounding harvest, preparation and consumption of aquatic resources)."* - NEJAC, *Fish Consumption and Environmental Justice* (2001), (v).

Such statements have been supported quantitatively for a variety of groups, predominantly comprised of people of color[10], low-income groups[11], and Native communities.[12] Individuals and communities that rely on non-commercial fish catch as a source of protein also tend to be socially and economically vulnerable and thus bear a disproportionate burden when fishing is no longer an option. The EPA, and a handful of state and local authorities have recognized the need for alternative parameters of risk exposure for such groups, as they have been shown to consume greater quantities of fish, more frequently, and over longer periods of time than do non-subsistence, recreational fishers.

[10] Fraser Shilling, A. W., Lucas Lippert, and Mark Lubell. 2010. Contaminated fish consumption in California's Central Valley Delta. Environmental Research.
[11] Id.
[12] Harris, S. G., and B.L. Harper. 1997. A Native American exposure scenario. Risk Analysis 17(6):789-795.

Table 2 2009 fish tissue (wet weight) contaminant concentrations for taken from up and downstream Potomac and Anacostia (all sample concentrations are median values). EPA screening values are for subsistence fishermen

Species	PCB - total (ppm)*	EPA SV (ppm)**	PAH - total (ppm)*	EPA SV (ppm)**	Methylmercury (ppm)*	EPA SV (ppm)**	DDT - total (ppm)*	EPA SV (ppm)**	Chlordane (ppm)*	EPA SV (ppm)**
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Carp	0.67		0.23		0.08		0.11		0.12	
Channel Catfish	0.03		0.07		0.07		0.07		0.05	
Largemouth Bass	0.23		0.02		0.21		0.03	1.44E-02	0.13	
Sunfish	0.01	2.45E-03	0.01	6.73E-04	0.12	4.90E-02	0.01	(carcinogenic), .245 (noncarcinogenic)	0.00	1.40E-02
American Eel	1.30		0.12		0.08		0.27		0.52	
Blue Catfish	0.62		0.04		0.09		0.11		0.12	
Carp	0.94		0.18		0.06		0.13		0.22	
Channel Catfish	0.89		0.11		0.12		0.11		0.14	
Largemouth Bass	0.35		0.03		0.21		0.04		0.04	
Sunfish	0.09		0.03		0.05		0.01		0.01	

* data taken from Pinkney, A. E. 2009. Analysis of Contaminant Concentrations in Fish Tissue Collected from the Waters of the District of Columbia, Annapolis, MD., ** data taken from EPA, U. S. 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. 1. 3. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Washington, D.C.

EPA SVs for subsistence fishermen reflect different levels of consumption, and consequently, different levels of vulnerability to contaminants. Subsistence fishing SVs assume a rate of consumption of around 140g/day – ten times that estimated for the recreational fishing SVs (Table 1).[13] With the exception sunfish, tissue contaminant concentrations in both rivers, for all species in the 2007 DDOE study were well above the EPA SV for subsistence fishers.

While there are significant, important differences among subsistence communities – the challenges faced by Alaskan Native communities are certainly different than those faced by urban minority and low-income communities – the line between subsistence and non-subsistence can be too firmly established. In November 2012, The Anacostia Watershed Society (AWS) released a report on subsistence fishing along the banks of the Anacostia. The first of its kind for the D.C. region, the report utilized qualitative interview data to estimate the size, composition, and rates of fish consumption of the local urban fishing community. The AWS's findings paralleled those of similar investigations in other metropolitan areas (Detroit, New York City, and southern California in particular, see Appendix B).

The AWS report highlighted three crucial discoveries about the Anacostia urban fishing community.[14] First, the fishing community (based on self-identification survey statistics) is comprised of more than two-thirds African-Americans, almost

[13] U. S. EPA. 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. 1. 3. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Washington, D.C.
[14] Anacostia Watershed Society. 2012. Addressing the Risk: Understanding and Changing Anglers' Attitudes to Consuming Anacostia River Fish, Washington, D.C.

one-fifth Hispanic, and the remained Asian and White. Moreover, 62% of fishers had no more than a high school education, and one-quarter never completed high school. Two-thirds of fishers reported that they fish the river at least once a week, weather permitting, and more than half reported fishing more now than they have in the past few years.

Second, almost one-quarter of fishers reported having never heard of the potentially damaging effects of toxic contaminants in fish tissues. Of those who had heard, only 21% had seen a fishing advisory sign, poster, or information accompanying a fishing license. Instead of getting knowledge from authorities, fishers are more likely to use their own personalized methods of determining whether or not a fish is good to eat (e.g., testing the firmness of the skin, clarity of eyes, color of the blood, etc.).

> "*Using the most conservative assessment, based on 5.7% consumption of Anacostia River fish, a minimum of 17,200 community residents may be consuming contaminated fish. This is based on 2010 Census data showing a lower watershed population of approximately 303,000.*"
>
> – *Addressing the Risk (2012)*

Finally, urban fishers on the Anacostia described a strong desire to share catch with neighbors, friends, family, or whoever else might ask. According to the report, one in five fishers "eat or share everything they catch." 46% of all fishers interviewed report sharing their catch with people outside their immediate families. Moreover, much of the catch appears to be shared with groups that, by EPA standards, would be considered high-risk (children, pregnant/nursing mothers). 12% of fishers report sharing their catch with children, wives, or girlfriends.

"This is our spot. It's where we bring our families. And we give that [fish away], it's food to people, and someone or another will eat it." - Fishermen near the Washington Canal, November 2012.[15]

Little research currently exists outside the AWS report to quantify urban fishing on the Potomac and Anacostia. Nonetheless, the report's findings do offer a useful glimpse of just how dependent waterfront communities are on locally sourced fish.[16] [17] Whether fishermen are eating the fish themselves or sharing with others it is clear that consumption of Potomac and Anacostia river fish likely exceeds that assumed by EPA SVs for recreational fishers (14 g/d).

"We typically give a good amount to a few of our neighbors, and there's always a couple of girls asking for [fish], they just love it." – Fishermen at Haines Point, November, 2012.

[15] Unless otherwise noted, quotes are taken from a series of semi-structured interviews conducted along the Potomac and Anacostia between November 2012 and April 2013.
[16] Paul Connor, Deputy Director, Environmental Protection Administration, personal communication, 4 April 2013.
[17] Alfred Pinkney, U.S. Fish & Wildlife Service, personal communication, 7 March 2013.

Therefore, the amount by which contaminant concentrations in fish tissues exceed acceptable levels of risk based on consumption rates is likely undervalued. If the difference between observed and acceptable risk is indeed undervalued, then despite the gains made by regulatory frameworks like the Clean Water Act, the task of environmental rehabilitation looms larger than previously thought.

Another significant finding of the AWS report is the ineffectiveness of fishing advisories in communicating risk to fishers and their communities. This is particularly the case for fishers who speak English as a second language, or not at all. 53% of Spanish-speaking fishers had never heard or understood that it was dangerous to eat river fish from the Anacostia.[18] Furthermore, of all fishers 51% said that knowledge of the fact that Anacostia river fish could be harmful to one's health would not affect their decision to consume or share their catch.[19]

This aspect, that is, a refusal to discontinue consuming locally caught fish, is indicative of the fact that fishing and sharing of catch are integral to the social,

[18] Anacostia Watershed Society. 2012. Addressing the Risk: Understanding and Changing Anglers' Attitudes to Consuming Anacostia River Fish, Washington, D.C. (8).
[19] Anacostia Watershed Society. 2012. Addressing the Risk: Understanding and Changing Anglers' Attitudes to Consuming Anacostia River Fish, Washington, D.C. (12).

cultural, and economic fabric of waterfront communities in D.C. – particularly those with a long fishing tradition, as is the case in much of the district. The perpetual need for cheap, nutritious food means that there is always someone who will eat whatever is caught. So long as there is such a need, it seems, D.C.'s urban fishermen will seek to supply for it, while simultaneously enjoying recreation and developing social connections.

Not only do fishing advisories fail to communicate risk to the populations that are in most need of protection, they also fail to do so in a way that is sensitive to the unique needs and vulnerabilities of urban subsistence fishers. The counter argument that urban fishers have viable alternatives does not, and cannot, account for the historical, social, economic benefits of subsistence fishing. To proscribe local fish consumption occasions an unacceptable loss for urban fishers *as well as their communities* that rely, at least in part, on the nutritional, cultural, and social benefits of subsistence provisioning. A new balance of risk reduction and avoidance is necessary in order to ensure that urban fishers are afforded the protection they need.

> *"Furthermore, because risk avoidance strategies place this responsibility on those who are exposed to environmental contaminants, they will necessarily impose a greater burden on communities of color, low-income communities,*

tribes, and other indigenous peoples. As has been amply demonstrated, it is members of these groups who are among the most exposed." - NEJAC

Alternative means of communicating risk are being explored by local non-profit groups, such as AWS's Watershed Steward Academy, in which local residents are trained in freshwater policy, science, and advocacy to act as leaders in their communities.[20] However, education can only go so far. According to DDOE's *2032 Plan*, the day when the Anacostia and Potomac rivers are both "fishable and swimmable" is still decades off.[21] In the meantime it is necessary to refocus and redouble resources towards risk reduction strategies.

"Subsistence fishers are part of the whole system. They need protecting just as much as the river itself; anything that depletes the river or makes its use more difficult hurts them directly." - Fly Fishermen at Fletcher's Boathouse, 6 February 2013

In this regard, the NEJAC has recommended that crucial to ensuring long-term protection of subsistence fishing populations is to require that authorities take subsistence use into consideration when issuing permits and planning for development.[22] Formalizing the consideration and participation of subsistence fishers creates an avenue for community advocacy that does not currently exist. Formalized recognition in existing regulatory frameworks is accompanied by stakeholder engagement, financial and technical assistance, and reduced recourse to

[20] Anacostia Watershed Society. Watershed Stewards Academy. 2013. Accessed: 4 April 2013. http://www.anacostiaws.org/programs/education/watershed-stewards-academy.
[21] Hawkins, G. S. 2008. Anacostia 2032: Plan for a Fishable and Swimmable Anacostia, Washington, D.C.
[22] U.S. EPA. National Environmental Justice Advisory Council Charter, 2012. NEJAC, EPA. 2012. Washington, D.C..

"falling back on institutional controls", that is, proscribing the consumption of fish without consultation.

Navy Yard, SE Washington D.C., CERCLA Superfund site since 1997.

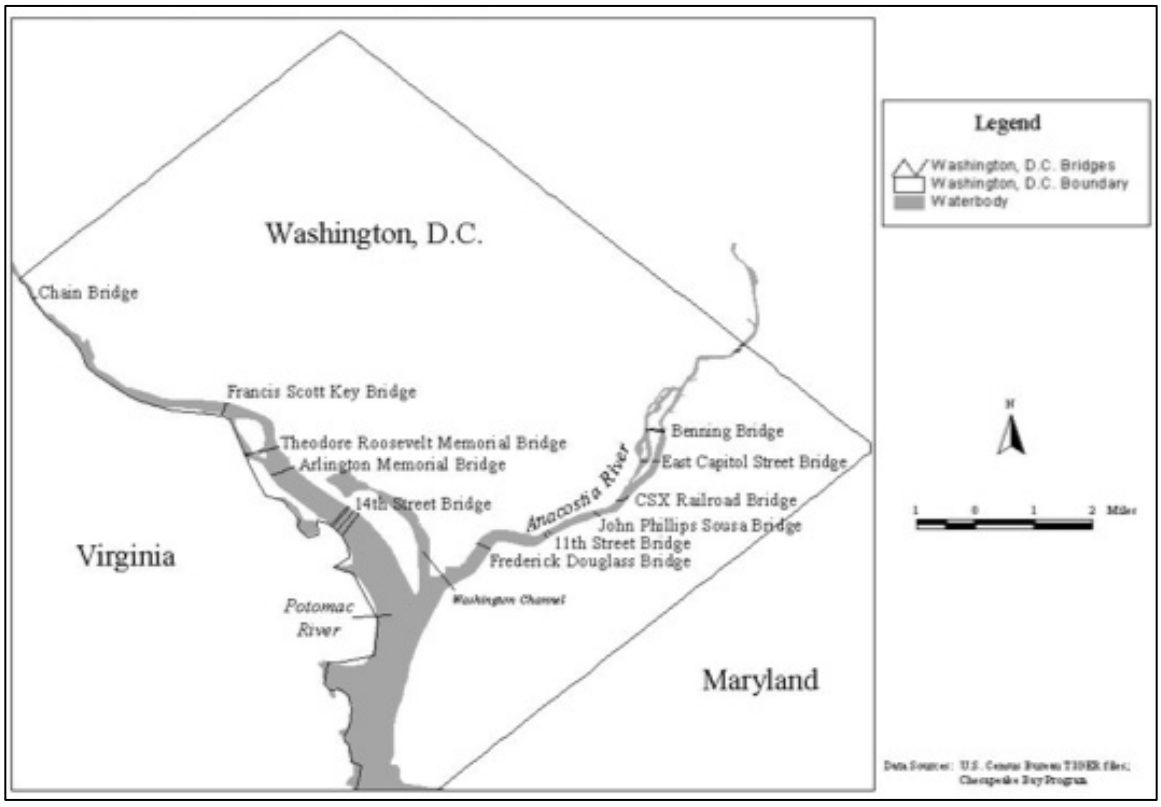
Also crucial to the future of the Potomac, Anacostia, and the people who fish them is a reevaluation of the leading sources of pollution to Chesapeake Bay tributaries. Non-point source pollution is leading source of water quality impairment across in U.S., including the Potomac and Anacostia.[23] In fact, no less that three-fourths of all TMDLs address water quality problems due to non-point sources.[24] Moreover, it is becoming increasingly costly to continue focusing regulatory efforts on point-source polluters.[25] [26] By continuously searching polluters that can reduce the most for the least cost, and continuously raising the bar on "pollution diets" like the Clean Water Act's TMDL framework, it is possible to leverage limited funding for environmental protection to its fullest extent.

Rebalancing risk reduction and risk avoidance while leveraging funds for the greatest environmental and human benefit will better support the needs and

[23] U. S. EPA. 2011. A National Evaluation of the Clean Water Act Section 319 Program.
[24] Id.
[25] George Hawkins, General Manager Blue Plains WWTP, personal communication, April 2013.
[26] Hawkins, G. S. 2013. A Cleaner Water Act. Democracy (27). http://www.democracyjournal.org/27/a-cleaner-water-act.php?page=all.

vulnerabilities of D.C. urban fishing population. The current binary of subsistence and recreational fishers in the district hides the fact that many urban and suburban residents are dependent on environmental quality for their health and well being in a way that cannot be easily, or acceptably, substituted. Instead, it is necessary to adjust our understanding of "subsistence" in modern urban populations to reflect the fact that the humans are inextricably linked to the environment, and that for those living in relative poverty, with few options, this link is stronger than ever.

Appendix A



Map borrowed from: Pinkney, A. E. 2009. Analysis of Contaminant Concentrations in Fish Tissue Collected from the Waters of the District of Columbia, Annapolis, MD.

Appendix B

Ethnicity	*N**	mean (g/d) local fish intake*	95th percentile (g/d) local fish intake*
African-American	32	31.2	**242.3**
Southeast Asian	152	32.3	129.4
Asian/Pacific Islander	38	23.8	**148.3**
Hispanic	45	25.8	**155.9**
Native American	6	6.5	ND
White	57	23.6	138.9
All Anglers	373	27.4	126.6

Data adapted from: Fraser Shilling, A. W., Lucas Lippert, and Mark Lubell. 2010. Contaminated fish consumption in California's Central Valley Delta. Environmental Research. Bolded values represent those that exceed EPA estimates for average daily consumption by subsistence fishers.