Beneath The Surface:
Urban Fishing and Environmental Justice

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Abstract

Urban fishing and shoreline fishing are popular year round activities that have received little attention in research and literature. We specifically looked at Monona Bay and Lake Wingra in Madison to examine the various factors that influence health risk fishing and consuming fish in these waters. While little data exists on definitive measures of known toxicants in the sediment and fish, the history of development around the lakes indicates many toxicants are present and have serious implications for the health of both aquatic ecosystems and anglers consuming fish from these lakes. Proper assessment of the extent of risk that anglers face are thus complicated by limited information.

From our preliminary research, we found a pattern of disproportionate risk among minority anglers within Madison and in other states due to variation in fish consumption, cultural and subsistence influences, and disproportionate awareness of risk tied to lack of access to risk communication materials. Through our own collected data of interviews, observations, and informal interviews our data also suggests a similar pattern of higher risk among minority members of the angling community.

Our findings illustrate the need for more toxicant testing of fish in Madison in addition to alternative means of current risk communication to more adequately assess risk exposure and close disparities of risk among community members.

This paper is accompanied by a documentary digitally archived at Minds@UW.

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I. Introduction

The angling community in Madison is made up of many culturally diverse populations. Broadly, anglers are exposed to certain biological or chemical risks by fishing in the Madison lakes. Through interviews, observations, and archival sources we intend to inquire the angling community in Madison on their perception or awareness of certain risks. This exploratory research project aims to determine which cultural groups make up the angling community in Madison, and address how bioaccumulated compounds may be affecting those cultural groups differently based on either cultural practices or behaviors. We specifically are look at two popular fishing areas in Madison: Lake Wingra and Monona Bay. We will delve into the developmental history and physical geography of these two areas to farther examine the biological and chemical risks to anglers. We then will look into how these risks are presented to the public through consumption advisories and fish advisory signs developed by the Wisconsin Department of Natural Resources and other environmental groups, and review their effectiveness of communicating those risks.

Our project will be looking into engaging environmental justice in the discussion of the risks that are exposed to the anglers. We define environmental justice as "equal access to enjoyment of environmental benefits and protections against environmental burdens regardless of race, income, gender, or ethnicity. Moreover, environmental justice necessitates due consideration and involvement of all people in control over decision-making about environmental resources and regulations. Through our research thus far, there is limited data on the health risks of urban fishing. We look at the history of environmental justice cases in urban settings to better understand what we know as environmental justice today. From a number of historical environmental justice cases, we can apply an analysis to the urban fishing issue in Madison.

The physical geography of Monona Bay and Lake Wingra is significant because it reminds us that human actions in one area have a unintended effects on people and environments elsewhere. Looking at the watersheds' historical development is necessary to not only understand the aquatic ecosystem we have today, but also how our current actions will affect it in the future. The history of Monona Bay and Lake Wingra are important in order to understand which toxins were introduced to the aquatic ecosystems, how they were introduced, and how they have historically been mismanaged or solved.

To understand the biological and chemical risks, we will research toxins in Lake Wingra and Monona Bay, as well as how these contaminants affect humans. This is crucial in order to understand how harmful these toxins can be when ingested. Lake Wingra and Monona Bay have organic and heavy metal toxins which have been historically or biologically introduced and whose levels have fluctuated with time. These pollutants and toxins are bio accumulated through the aquatic food chain and then are transferred to humans through ingestion of fish. We will look at arsenic, lead, mercury, PCBs, PAHs, and cyanobacteria, and how those toxins, when biologically accumulated, can affect different groups of people based on behavioral or cultural reasons.

Through other research on how risks affect urban fishing communities, we can infer that those risks also disproportionally affect those who rely on fish to feed themselves and their families. We will look at how different lifestyle behaviors and cultural influences play into the risks exposed to anglers, namely subsistence fishing and race. We also will consider overlap between these two factors, as they are likely to be correlated in some respect. This will help us identify the angling community in Madison, and help uncover who is most at risk. Within the community most at risk, we will then look at how cultural influences affect the perception of risk, and how cultural behaviors may lead to higher risks in some groups as opposed to others.

The way fish consumption advisories are communicated to the angling community is significant when there are multiple cultural and socioeconomic groups practicing angling. . It has been shown that the effectiveness of fish advisories is at not successful at communicating their message to the angling community (Flaherty et al. 2003: 502). Many anglers are not aware of the risks, do not fully understand the nature of the risks, or don't have proper access to information about the risks. We will also discuss possible solutions to ineffective fish advisories.

Through interviews with anglers, environmental advocates, and water quality experts, we aim to create a narrative documentary of the angling community in Madison and the environmental situation. The documentary will bring awareness to the complexity of this issue, and show that the risks of fishing and consuming the fish is a complicated, multi-layer issue with environmental justice components. Our project intends to contribute to the topic of environmental justice and bring awareness to the risks Madison's angling community is exposed to.

II. Research Question

Are there disproportionate risks fishing in Monona Bay and Lake Wingra for different segments of the angler community? Our project aims to investigate the varying degrees of risks associated with urban angling in these contaminated waters. Though seemingly straightforward, bound to this question mark is a complexity of interstitial topics, including the pollutant history of Monona Bay and Lake Wingra, the health risks associated with various toxins and toxicity levels, perceptions and cultural variation among anglers, in addition to reviewing the effectiveness of fish advisories minimizing and ending risk to the angler community.

Though much research has been conducted for oceanic marine water pollution and health risk, freshwater urban fishing is a neglected research interest in the United States. Studies examining freshwater fishing for subsistence and minority anglers are even fewer. (Pitchon and Karama 2012: 141). Despite limited data for specific toxin tests and human toxicant levels from fish consumption (Rogalus and Watzin 2008: 22, Ottinger 2011: 151, Ramachandran et al 2006: 1185), communicating known risks is paramount to preventing neurological and cancerous health problems among angler communities.

As an exploratory research project, we aim to deepen our understanding of urban fishing in Madison. In particular, we seek to identify (1) who fishes in Monona Bay and Lake Wingra (2) to what extent these individuals are at risk considering the plethora of factors such as the nature of certain toxicants, number and species consumed, in addition to angler profiler such as culture, gender, age and lastly (3) if these individuals are at risk, are they aware of their health risk? Altogether we hope to deepen our understanding of the types and degrees of risk fishing and consuming fish from Monona Bay and Lake Wingra, taking particular interest in whether certain members of the community are disproportionately at risk.

III. Literature Review

A. Environmental Justice

1. Environmental Justice History

Toxic fish consumption in Madison is a complicated, multi-faceted topic that can be approached from many angles, but incorporation of an environmental justice perspective provides a framework for a better understanding and analysis of this issue. The dictionary of Human Geography defines environmental justice as "The right of everyone to enjoy and benefit from a safe and healthy environment, regardless of race, class, gender or ethnicity" (Gregory et al. 2009: 201 - 202). This dictionary further breaks down the term into three components, namely 1) unequal exposure to hazards due to discriminatory policies or practices related to gender, class, race, or ethnicity, 2) differential access to and control over resources and decision making as individuals, or within corporations and institutions, and 3) cultural politics around key terms such as risk, waste, race and environmental health (Gregory et al. 2009: 201 – 202). However, environmental justice is not a simple concept, and this term has been defined in a variety of ways by different scholars and organizations. Given these variations, the best understanding of the term environmental justice is illustrated through exploration of the complex social, political, and academic history, of the Environmental Justice Movement – a movement that draws from a plethora of diverse voices and struggles to create the vision environmental justice as we know it today.

Luke Cole and Shelia Foster provide a comprehensive history of the Environmental Justice Movement in their book *From the Ground Up: Environmental Racism and the Rise of the Environmental Justice Movement*. In the first chapter, Cole and Foster identify and explore the five diverse strands that eventually came together in the Environmental Justice Movement, specifically civil rights, grassroots anti-toxics, academic, labor, and indigenous influences. According to Cole and Foster, the most significant of these strands is the Civil Rights Movement of the1950s, 1960s, and 1970s. Through this movement, African Americans and their allies gained experience fighting for social change, and gained empowerment through grassroots, political activism (Cole and Foster 2001: 20). Another contribution from the civil rights movement is the emergence of the recognition of the structural nature of racial oppression, and the ways in which structural injustice contribute to the disproportionate exposure of minority communities to environmental hazards (Cole and Foster 2001: 20). In 1987 the United Church of Christ produced a landmark report entitled *Toxic Wastes and Race in the United States*, which conclusively demonstrated this relationship between race and the disproportionate exposure to environmental hazards, and directed the attention of civil rights activists and the nation to this issue. This report was key in galvanizing the Environmental Justice Movement.

The second contributor to environmental justice was the grassroots and anti-toxic movement, for this movement once again demonstrated the crossover between social and environmental problems, leading to a shift in environmental activism. Cole and Foster cite Andrew Szaxz as noting how the anti-toxic movement brought to light how environmental conflicts, "'tended not to be about nature, per se, but about land use, social impact, [and] human health'" (Cole and Foster 2001: 22). Additionally, anti-toxic activists illuminated how the placement of toxic hazards was determined by an economic structure that necessitated pollution as part of its natural functioning. (Cole and Foster 2001: 22).

Academics have also made a contribution to the Environmental Justice Movement, headed by pioneers in the field like Robert Bullard. These academics are important in that they produced studies that once again confirmed the relationship between communities of color and exposure to environmental hazards, which reaffirmed Environmental Justice leader's recognition of the structural nature of environmental oppression (Cole and Foster 2001: 25). Bullard is an especially prominent figure in the Environmental Justice Movement, and has been instrumental is conceptualizing the terms 'environmental justice' and 'environmental racism.' Thinking about environmental racism as opposed to environmental justice is helpful because it place the movement with documented institutional oppression. As Bullard points out in his article "Anatomy of Environmental Racism and the Environmental Justice Movement:"

> The history of the United States has long been grounded in white racism. The nation was founded on the principles of 'free land' (stolen from Native Americans and Mexicans), 'free labor' (cruelly extracted from African slaves), and 'free men' (white men with property). From the outset, institutional racism shaped the economic, political, and ecological landscape, and buttressed the exploitation of both land and people (Bullard 1993: 16).

This institutional racism continues to play a critical role in environmental policies and decision-making today, and Bullard describes it as an up-hill battle convincing government officials and policymakers that racism exists in environmental policy and enforcement given the structural, and therefore often naturalized, character of this oppression (Bullard 1993: 17). What is extremely important to pull from Bullard's work on environmental racism is the idea that race and class interact, but are not interchangeable when it comes to environmental justice given that minority communities are exposed to higher levels of toxins even when other variables such as income, education, and occupational status are held constant (Bullard 1993: 21).

One caveat to Bullard's work, as discussed by Ellen Stroud in her article "Troubled Waters in Ecotopia: Environmental Racism in Portland, Oregon," is that it is important to stress that 'environmental racism' generally does not refer to specific racist acts or exclusions. As Stroud states, "the history of this correlation between severe pollution and minority communities is extremely complex. There is not a single racist culprit, nor any one policy or type of policy which can be blamed," rather the term is used to "designate the geographic and social result of the many interwoven policies and ideas which have created such a striking correlation. Some of the policies and ideas have involved conscious racism; many have not. However, their combined result is discriminatory" (Stroud 68). Stroud's words bring to the table the idea that issues of environmental justice generally cannot be pinned to the action of one institution or a certain group of officials, but must be understand within a broader societal context.

Moving beyond academia, Native American activism has also played an extremely important role in shaping the Environmental Justice Movement. Native American struggles are some of the earliest examples of environmental justice issues in this country, going back 500 years in fights for self-determination in land-use that began with the first encounters with Europeans (Cole and Foster 2001: 26). In his work Bullard cites the European colonists' attitude towards Native Americans as one of the root problems that led to a need for environmental justice today, and Cole and Foster name Native American activism in the 1960s and 1970s as "The precursor to today's organizing around environmental issues by Indians on and off the reservations, organizing that contributes one of the most vibrant and ever expanding tributaries to the movement" (Cole and Foster 2001: 26). Native Americans also contributed the idea of self-determination to the Environmental Justice Movement, giving rise to the Environmental Justice credo of "We speak for ourselves" (Cole and Foster 2001: 27).

The fifth contribution to the Environmental Justice Movement history stems from various strands of the labor movement. The farm-worker movement of the 1960s led by activist like Cesar Chavez is a particularly iconic case in the development of the early Environmental Justice Movement, and Cole and Foster cite this movement as the "first nationally known effort by people of color to address an environmental issue" (Cole and Foster 2001: 27).

Cole and Foster include an exploration of the traditional environmental movement in their history of the Environmental Justice Movement, although they do not include it as one of the main contributory strands, which may seem strange at a first glance. However, as these authors demonstrate, the traditional environmental movement has also contributed to the creation of many environmental justice problems, as environmental "lawyers helped write most of the environmental legislation on the books today…These laws created complex administrative processes that exclude most people who do not have training in the field and necessitate specific technical expertise" (Cole and Foster 2001: 29-30) Additionally, while some see the Environmental Justice movement as a new wave of environmental activism, as Cole and Foster eloquently put it, "we see the Environmental Justice Movement as separate from and as transcending the environmental movement – as a movement based on environmental issues but situated within the history of movement for social justice" (Cole and Foster 2001: 30-31). This distinction is important, for, as Bullard points out, the mainstream environmental movement failed to address the fact that "social inequality and imbalances of social power are at the heart of environmental degradation, resource depletion, pollution, and even overpopulation. The environmental crisis can simply not be solved effectively without social justice" (Bullard 1993: 23).

As demonstrated in the discussion above, the Environmental Justice Movement arose from a variety of influences from across the social, political and academic fields. However, it was not until 1991 that these strands were brought together at the First National People of Color Environmental Leadership Summit to create the Environmental Justice Movement we are familiar with today. During this summit, alliances, connections, and conceptual linkages were made between what were seen previously as different fights, leading to the birth of the Environmental Justice Movement, where attendees signaled to the world that 'I don't care to join the environmental movement, I belong to a movement already.'" (Cole and Foster 2001: 31). After this summit, it was clear that the Environmental Justice Movement was a force to be reckoned with at the national level – a movement that drew from a diverse history to give a new voice to environmental issues as conceptualized in the past.

An understanding of the history Environmental Justice Movement is critical for addressing environmental issues in Madison today. As demonstrated by various strands of the environmental justice movement, structural oppression is pervasive in our society, and plays an insidious role in putting minority and low-income communities more at risk from environmental hazards. Drawing from an understanding of the diverse voices and considerations within the Environmental Justice Movement, for our project we have composed our own working definition of environmental justice. Through our understanding, environmental justice means equal access to enjoyment of environmental benefits and protections against environmental burdens regardless of race, income, gender, or ethnicity. Moreover, environmental justice necessitates due consideration and involvement of all people in control over decision-making about environmental resources and regulations. Utilizing this definition, in our project we will explore unequal distribution of environmental burdens in our own Madison community within an environmental justice context.

2. Environmental Justice, Racism, and Fish Consumption

Since the beginning of the cohesive environmental justice movement, academics have been studying and discussing water pollution and fish consumption within an environmental justice context. Through their research, it is well documented that minority anglers are disproportionately at risk from consuming fish with unsafe levels of toxicity, and therefore are disproportionately experiencing the environmental burden of toxic levels in our nation's waterways. Two of the early studies that dealt with fish consumption and environmental justice appear in *Race and the Incidence of Environmental Hazards,* an anthology edited by leading environmental justice scholars Bunyan Bryant and Paul Mohai published in 1992. Patrick C. West examines toxic fish consumption in his article "Invitation to Poison? Detroit Minorities and Toxic Fish Consumption from the Detroit River," and although his findings are preliminary, this study exposes how water pollution regulations in Detroit do not adequately protect anglers consuming fish that live in those waters, especially minority anglers. According to West, Michigan's law "regulating point source municipal and industrial discharge of toxic contaminants into Michigan surface waters," Michigan's Rule 1057, "uses an average fish consumption assumption in its standards setting process and thus does not account for variation in levels of consumption by different sub-groups of the Michigan population" (West 1992: abstract). Based on these findings, West lays out the issue that dominates the discussion around fish consumption and environmental justice today, that minority anglers in general are consuming more fish caught from contaminated waterways, a phenomenon that is not accounted for in environmental protections and regulations.

West's original findings in Detroit are confirmed in the next article of anthology, "Minority Anglers and Toxic Fish Consumption: Evidence from a Statewide Survey of Michigan," which built on the findings from the West's original study by examining this issue within the whole state of Michigan. However, this study differed from West's original investigation in that West, and coauthors Fly, Larkin, and Marans, considered the consumption of sport caught fish within the context of total fish consumption. This consideration is important in that it gave a better understanding of the total levels of toxins that consumers of fish are exposed to through their fish consumption. This study definitively demonstrated that not only were most sport fishermen and their families consuming much more fish than accounted for in state regulations, but beyond that, minority anglers consumed significantly more fish than their white counterparts, and therefore were placed at significantly higher risk from toxins found in these fish. While Michigan's Rule 1057 assumed average fish consumption to be 6.5 grams/person/day and regulated accordingly, this study found that "average fish consumption for the winter-spring period for sport fishermen and members of their families who eat fish was 18.3 grams/person/day" (West et al. 1992: 103). However, while white anglers consumed an average of 17.9 grams/person/day, minority sport fishermen and their families consumed 21.7 grams/person/day. Through these findings it is clear that this is an environmental justice issue where certain communities are placed at disproportionate risk from government regulations.

Issues of environmental racism further complicate this case, as the study in "Minority Anglers and Toxic Fish Consumption: Evidence from a Statewide Survey of Michigan," demonstrated that it was not the lowest income members among minority communities who consumed the most fish, but rather minority anglers whose income ranged from $5,000 to $20,000 reported the highest amount of fish consumption (West et al. 1992: 97). This finding clearly places this issue within the realm of environmental racism, as class was not directly correlated with risk, and race rather than class was the highest indicator of risk. This article serves to demonstrate in which the way racial issues, beyond economic access to resources associated with class, are implicit in the issues of environmental justice related to fish consumption, and therefore environmental racism must be considered when confronting this issue.

While the two articles discussed above were written over two decades ago and are some of the earliest studies on issues of environmental justice and fish consumption, the issue has clearly not been resolved in the intervening years as demonstrated by a report put out by the National Environmental Justice Advisory Council (NEJAC) in 2002. The report, entitled "Fish Consumption and Environmental Justice," was compiled in response to a policy question posed by the EPA as to how they could improve aquatic ecosystems in the United States in order to better protect the health of people consuming fish and aquatic resources. The report seeks to understand why "those most affected by contaminated and depleted aquatic ecosystems are communities of color, low-income communities, American Indian tribes/Alaskan Native villages and their members, and other indigenous peoples" (NEJAC 2002: iii). According to the findings in the report, this is because these communities depend on and make use of these ecosystems more than the general population, and that "affected groups consume and use fish, aquatic plants, and wildlife in different cultural, traditional, religious, historical, economic, and legal contexts than the 'average American'" (NEJAC 2002: v – vi). Given these findings, the report highlights the fact that government agencies cannot rely on "conventional understandings of the 'health benefits' or 'economic benefits' of catching, harvesting, preparing, and eating fish, aquatic plants, and wildlife" when creating aquatic environmental policy around risk assessment, risk management, and risk communication in relation to aquatic resources, as these understandings “do not adequately capture the significant value these practices have in their lives and the life of their culture” of individuals from many communities (NEJAC 2002: iv – v). From these findings and from those of West and his coauthors in the early 1990s, it is clear that the root of the environmental justice problem in relation to fish consumption is that policymakers do not take into account the needs of minority and low-income communities when creating environmental policies involving aquatic resources, nor do they communicate the risks of eating fish from contaminated waterways effectively to anglers from these communities. The issue of risk communication will be taken up further in a later section on fish advisories, as these advisories are a key component of the environmental justice problems inherent in government policy related to fish consumption.

The Midwest Environmental Justice Organization has been working on issues of locally caught fish in Madison since 2006, and constitutes the main source of information on fishing and environmental justice in this city. Their exploration of this issue in Madison, as well as their struggles in trying to change government policy to protect low-income and minority anglers, illustrates how unequal toxic exposure from fish consumption is clearly an important, and largely unaddressed, environmental justice issue in Madison today. MEJO worked with communities of color and low-income communities in Madison for several years to learn how cultural practices of Madison angling communities impacts the ways these communities catch and prepare fish, in order to understand the issues of toxins in locally-caught fish. As in most studies from around the country, MEJO found that in Madison "knowledge and communication gaps related to fish consumption risks are created and ignored by the same institutions that have power and responsibility for addressing them" (Powell et al. 2011:3) namely governmental and public health institutions. The issues of environmental justice and toxic fish consumption in Madison will be explored more in depth in following sections, however, relevant to this discussion is the fact that "MEJO's research and organizing work have found that understanding and communicating risks to minority and poor subsistence anglers who fish from local lakes have not been priorities for government agencies and academics in Madison, despite the numerous political and scientific resources in the community" (Powell et al. 2011). From MEJO's findings, it is clear that the same issues around public policy and fish consumption that shape environmental justice discussions around the nation are present in Madison as well.

3. Environmental Justice and Historic Land Use Change in Cities

While the trends discussed above illuminate the current problems with government regulations and fish advisories, it is important to understand this environmental justice issue within the larger context of land use change, social structure, and historic policy in Madison. By situating the current issues and struggles surrounding aquatic water systems and resources within historical trends and the history of a place, one can come to a much better understanding of how minority and low-income communities have been structurally distanced from decision making about and rights to water ecosystems, both in Madison and around the country. Two examples of taking a historical approach to understanding the condition of marginalized communities and water resources can be found in the articles "City of the Changers: Indigenous People and the Transformation of Seattle's Watersheds" and "Oyster Growers and Oyster Pirates in San Francisco Bay." Both pieces demonstrate how the creation of two cities, Seattle and San Francisco respectively -- and more broadly, environmental ideologies and policies in the nineteenth and twentieth century -- and the pursuant transformation of waterways in these areas resulted in devastating changes for and increased marginalization of the communities that depended on these waterways for subsistence.

In “City of Changers,” Coll Thrush demonstrates how settlement of the present-day Seattle area resulted in the creation of “a city of ‘second nature,’” borrowing the term from William Cronon, to describe, “the mix of ecology and artifice that typified the American ideal of progress throughout the nineteenth and twentieth centuries” (Thrush 2006: 91). Throughout the piece, Thrush demonstrates how the indigenous fishing community was pushed to the margins of the landscape through traditional American colonial tactics, dramatically changing the relationship between indigenous people in the area and waterways. As Thrush states, “As the city's planners straightened rivers, lowered lakes, filled tidelands, and built canals, they reoriented not just landscapes but lives, remaking not only indigenous places but indigenous people, indigenous memories, and even the term indigenous itself” (Thrush 2006: 95). According to Thrush, “Indian people struggled to survive among these changes”(Thrush 2006: 95) and he details how skilled fishermen starved to death, demonstrating how indigenous communities were not only displaced, but changes in the landscape made it impossible for them to pursue their traditional forms of subsistence. As Thrush puts it, this history demonstrates how, “Along the lakes, rivers, and shores of Seattle, environmental inequality was literally built into the city's new watersheds, and its legacies resonate down to the present day” (Thrush 2006: 95). Some of these legacies in Seattle include “PCB counts in poor neighborhoods, in signs in immigrant languages like Lao and Spanish warning of contaminated fish, and in deep, seemingly intransigent cultural divides over who should pay for the next attempt to make things better in the city” (Thrush 2006: 92). Through his argument, Thrush demonstrates how “urban development schemes, typically perceived as bringing new order and solving ecological and social “problems” such as flooding and squatters’ camps, often had the result of exacerbating social divisions, placing the greatest burdens upon the most vulnerable, unleashing new ecological challenges, and creating new kinds of disorder” (Thrush 2006: 92).

Through his examination of “Oyster Growers and Oyster Pirates in San Francisco Bay,” Matthew Booker demonstrates the how same type of landscape changes that marginalized indigenous communities in Seattle came to bear on working class and low-income communities in San Francisco through transformations in the city’s oyster industry. As Booker puts it, "Everywhere in the industrializing nineteenth-century world, poor people lost access to traditional common lands and the products they had gathered there” (Booker 2006: 66). According to Booker, in nineteenth and twentieth century San Francisco these ‘common lands and products’ were typified in oysters, as "Shellfish were some of the most accessible and valuable of all tidal resources…Once a key element in Native economies of the region, clams and oysters became a reliable source of free protein for working-class and poor urban dwellers” (Booker 2006: 67). In addition to being a high-quality, inexpensive food for working and lower-income communities, oysters in San Francisco also supported a multimillion-dollar industry from the 1870s to the 1910s. However, this industry quickly declined after the 1910s as during this time the San Francisco bay “received enormous quantities of biological wastes, including untreated organic effluent from slaughterhouses, tanneries, and city sewers” (Booker 2006: 81). However, as Booker points out, “the problem with sewage is not that it is toxic to oysters but rather that it carries diseases that can harm those who eat them" (Booker 2006: 81). Concerns over pollution and subsequent food poisoning, and increased state regulation reduced the number of people “seeking wild food,” and changed “the public's attitude toward foraging" (Booker 2006: 85), with the result that "What had once been a food on everyone's plate was now seen as a marginal and dangerous food for marginal people" (Booker 2006: 86). Rather than attempting to decrease the amount of pollution going into the Bay and its effect on oysters, however, as Booker details, "residents around San Francisco Bay slowly came to accept that they could not eat out of the bay" (Booker 2006: 87), and by the middle of the 1900s it came to "seem natural that San Francisco Bay would be a refuge for birds but not for people" (Booker 2006: 87). This woeful tale of the San Franciscan oysters perfectly demonstrates the ways in which changes in land use (e.g. viewing the Bay as an appropriate site for dumping pollution rather than as a productive aquatic resource) resulted in changing attitudes towards waterways as public resources that needed to be protected, with the result that lower-income communities that made use of these resources were experiencing increasing risk from use of these contaminated resources while others in the city simply chose to abandon these old food sources.

While the stories detailed above describe west coast cities, Seattle and San Francisco's histories share clear parallels with Madison's in that these cities that were developed in the nineteenth and twentieth century near water resources, which eventually led to a degradation of aquatic ecosystems and a related marginalization of communities that depended on these aquatic ecosystems. While Madison may not have ever had a booming oyster industry, it is easy to draw connections between oysters and fish as common resources that are utilized for subsistence mostly by low-income and other marginalized communities. Just as changing perceptions about proper use of the San Francisco Bay waterways impacted the contamination of oysters as a food resource, exploration of Madison's history in relation to its own waterways may shed light how fish resources in our own community came to be so polluted and ignored in public, environmental policy. As demonstrated in these environmental histories of both Seattle and San Francisco, in order to fully understand the environmental justice issues embedded in landscapes and communities today one must look back into the history of a region that shaped environmental resources and landscapes. Such a historical, geographical analysis clearly demonstrates the link between urban development, landscape change, and toxic fish consumption as an environmental justice issue, and provides a template for a broad analysis of this issue in Madison today.

4. Summary

Application of the term 'environmental justice' provides a framework for understanding and locating issues of social inequality and structural oppression within an environmental context. As demonstrated in the case studies above, there is a documented history of environmental injustice around issues of aquatic ecosystems and aquatic resources. Indigenous and working class communities have borne the brunt of the environmental burden of changes in landscape and land use, and at the same time have lost out on the benefits of 'progress' of urban areas. However, this environmental injustice in relation to aquatic ecosystems and urban areas is certainly not a thing of the past, and through the work of organizations like MEJO it is clear that environmental injustices are still embedded in issues like risk from toxic fish consumption today. By applying an environmental justice framework to our research question exploring the experience of risk from fish consumption by various segments of the Madison angling community, we will be better able to understand this issue within the broader context of structures of oppression.

B. Historical and Physical Geography of Monona Bay and Wingra

1. An overview of Monona Bay and Lake Wingra Physical Geography

Lake Wingra and Lake Monona are part of the Yahara River Watershed. A watershed is an area of land that drains surface water into a larger body of water, like a lake. Lake Wingra is upstream of Lake Monona, meaning water form Wingra flows into Monona. The Yahara River watershed is over 300 square miles and includes the Yahara chain of lakes, Lake Mendota, Monona, Wingra, Waukesha, and Kegonsa (Martin 1965: 21). The Yahara River flows through each of the lakes, with the exception of Lake Wingra. The Yahara River watershed can be further separated into smaller areas of land, called sub watersheds (Figure 1). The watersheds are then managed and considered at local and large geographic scales. It is also important to distinguish that these sub watersheds, while separated by humanly perceived boundaries, they still are physically connected and nutrients, sediment, and contaminants flow through them freely.

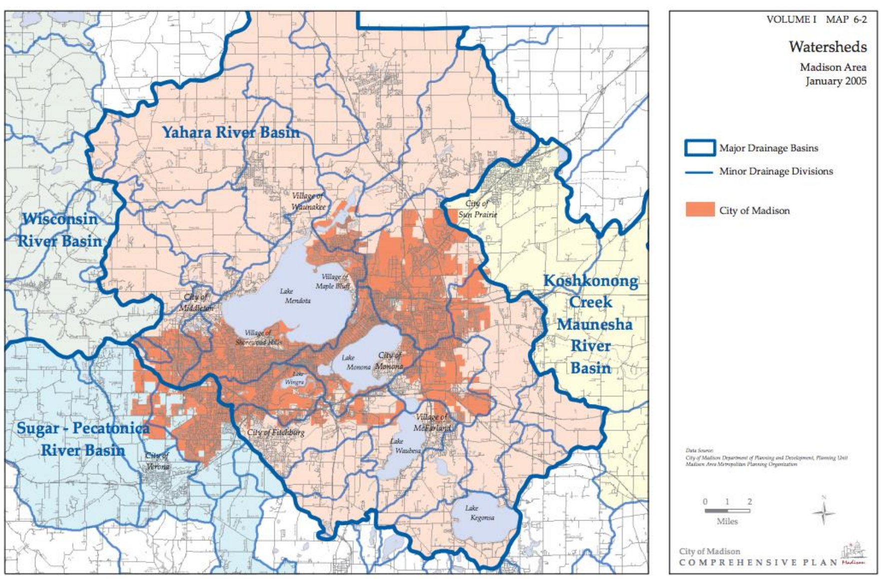

Figure 1: Yahara River Basin Watershed and Sub Watersheds
Source: City of Madison Comprehensive Plan, Vol. 1-6, Map 6-2.

Within the Yahara River Basin Watershed, Lake Wingra is a part of the Lake Wingra sub watershed, while Lake Monona belongs to the Lake Monona sub watershed. The history of both sub watershed's development, contaminants, and management will be discussed in this section.

2. Lake Wingra Pollutant History and Geography

The Lake Wingra watershed stretches from the Odana Lakes on the west to Lake Wingra on the east, and encloses roughly 8 square miles and 33,000 residents (Lake Wingra: A Vision for the Future 2009: 9). The actual lake is approximately 336 acres and 14 feet deep (WDNR Wingra).

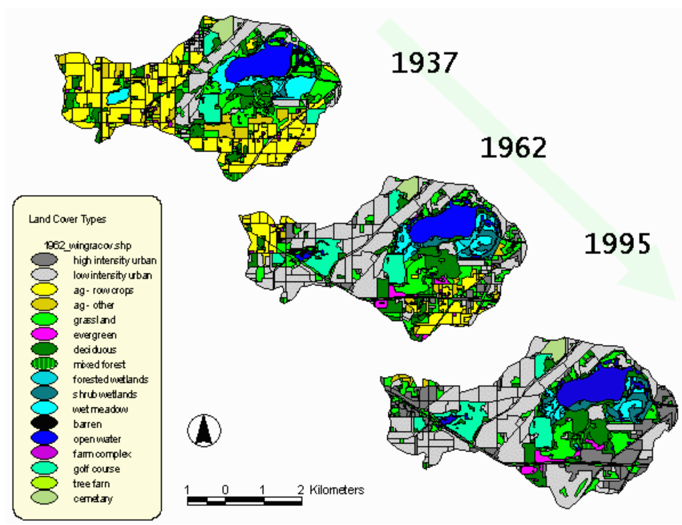

Figure B: Lake Wingra watershed land use change
Source: Wegener Figure 5

The Lake Wingra watershed is unique in that its land use coverage underwent a major transformation in a very short amount of time (Wegener). As illustrated by Figure B, as late as the 1930's a majority of the land within the watershed was used for agricultural practices. By the mid 90's, most of the land was transformed into urban area. Thus, within 60 years the watershed has been exposed to a wide range of ecological, biological, and chemical stresses which all shape the watershed we know today.

Previous to the watershed becoming developed, Lake Wingra drained into the Gardner Marsh at the southeastern end of the lake. The two became isolated through the process of dredging in the early 1900's. The Gardner Marsh was important to lake Wingra's aquatic health. In general, wetlands are important to watersheds for a number of reasons. They are vital habitat to many aquatic and terrestrial organisms as well as contribute to a high biodiversity within an ecosystem. They also serve to improve water quality by filtering out significant amounts of nutrients, specifically phosphorus, from an aquatic system (Walbridge and Struthers 1993). In Lake Monona's case, the preservation of the Gardner Marsh could have helped combat the issues it's historically had with excess nutrients.

The dredging in Lake Wingra altered the landscape notably. In 1919, it created what is now known as Vilas Park (Lake Wingra: A Vision for the Future 2009: 9). Dredging is the process of removing sediment from the bottom of a body of water. There are many purposes for dredging. It can help create easier transportation routes, or to replenish eroded sand on a beach. It has a significant impact on the environment (Yell 1995: 1). An ecosystem can be completely disrupted through dredging. Fish can lose their spawning habitat, aquatic vegetation can be killed, and it can even reintroduce heavy metals and PCBs that had been settled in the sediment back into the ecosystem. The dredging in Wingra was so disruptive, that in 1917 when the lake was being dredged for a development project, the lake's water level fell 3 feet. It upset residents so much that the development company had to build the dam on the eastern side of the lake to control water flow. The dam also controls water flow into Wingra creek, which then flows into Lake Monona.

As the watershed urbanized, so did the contaminants that were in Lake Wingra. Not only was phosphorus input high from agriculture runoff, but other toxins were present too. Mercury could be found at certain concentrations. Lead commonly enters a body of water through storm water runoff, and due to Lake Wingra's urbanized watershed and its proximity to Lake Monona, which has known concentrations of lead, we can infer that Lake Wingra also has historically and is currently present in Wingra. However, the UW Arboretum, built in 1934, is has likely had a significant impact on reducing runoff of pollutants into the lake, as it has prevented any building along a wide stretch of Wingra's shoreline. Overall, the research done on Madison lakes lead concentrations and other pollutants is rather sparse.

3. Lake Monona Watershed Geography and History

The Lake Monona watershed is roughly 40 square miles (Water Trail Guide 2007: 24) with a depth of 74 feet and is approximately 3300 acres (WDNR Monona 2013). Unlike Lake Wingra watershed, Lake Monona's watershed urbanized quickly due to its proximity to the capital. There are a few parks along the shoreline of the lake, but it is otherwise completely urbanely developed.

Lake Monona is naturally a highly eutrophic lake. Eutrophication is the natural process of a body of water accumulating nutrients (Lathrop 2007: 345). Highly eutrophic lakes tend to produce more aquatic plants and algae. Elements that play key roles in the eutrophication of a lake include nitrogen and phosphorus, which enter a lake through biological processes like the nitrogen cycle, or through groundwater runoff. The city of Madison hasn't had the cleanest track record when it comes to managing the quality of its lakes. The algae blooms that Lake Mendota and Lake Monona produce are a well-known event to Madison residents, and has been for well over a century, and can be partially attributed to the city's historical actions.

As David Mollenhoff's *Madison: A History of the Formative Years* explains, the rise of indoor plumbing became introduced to individual homes and the residents of Madison were built a sewage plant in 1888 to accommodate their needs. The sewage plant dumped its waste into Lake Monona, increasing the amount of nutrients in the lake, which in turn encouraged foul-smelling algae and unaesthetic vegetative growth. In 1898, a water treatment plant was built to try and curb the nutrient input into the lake.

As Madison's population grew, the land coverage of the watershed and around Lake Monona changed. Dredging also played a role in Lake Monona's history. In 1906, Brittingham park was built through the process of dredging, filling in an old marsh with sand (Mollenhoff: 316). Similar to Lake Wingra and Gardner's Marsh, this marsh could have significantly helped to naturally filter and dilute urban runoff and pollutants. Throughout the 40s, 50s, and 60s, the whole shoreline of Monona transformed into an urban landscape. The changing landscape brought different pollutants. In John Nolen Drive was built across Lake Monona to accommodate transportation needs, however this has allowed many toxicants and trash to easily enter the lake without any chance of being naturally filtered or diluted. The throughout the late 1940's and the early part of the 1960's Monona was treated with arsenic to kill rooted aquatic plants (Nelson Institute 2007:34). Also with the changing landscape came a change in perception of the lakes and how they could be managed. The 1970's were accompanied by a new approach to Lake Monona's nutrient input problems. A report by the Dane County Advisory Council for Lake Quality Improvement in 1975 intended to target the sources of pollutants. Its findings pointed to the primary culprits of phosphorus in Lake Monona watershed were urban and rural runoffs. As mentioned in Lake Wingra's section, storm water runoff also contributed to traces of lead being found in Lake Monona (Nelson Institute 2007:3). With the urbanization of Wisconsin came industrialization as well. Mercury enters the ecosystem primarily by emission from coal plants. The airborne mercury is then biologically cycled through the atmosphere and makes it into waterways, such as the Yahara River Watershed.

PCBS are introduced into the environment and accumulate in sediments. PCBs are chemically stable compounds, which means they take time to break down and easily build up over time. They were produced in the United States from the 1930s- 1977 for electrical appliances. (EPA 2013). PCBs were not of concern to Madison until the 1980s, when a couple of fish caught and test by the DNR had high concentrated levels of PCBs that raised concern (Nelson Institute 2007:37).

4. Lake Wingra and Lake Monona Today

Recently, there have been many different efforts to help monitor and manage the lakes. There was a big push during the 1980s when environmental conservation was becoming an important public issue, for Madison residents to help clean up the lake on their own time, and that their contributions as an individual were valuable. There are also a number of citizen based monitoring projects, where citizens and scientists collaborate data about sediment, water quality, and even flora and fauna observations.

The city has also tried treating Monona with copper sulfate to kill algae, however this seems like a short-term solution because it is only addressing the problem and not addressing the cause. In 2007, there was a large citywide project implemented by the City of Madison and Madison Gas & Electric to help alter the quality of runoff into Lake Wingra. Madison Gas & Electric filters roughly 60 million gallons a year of pond water from the Lake Wingra watershed and returns it underground near the Odana golf course, in effort to decrease the nutrients in the groundwater (Lake Wingra: A Vision for the Future 2009: 9). Even with the efforts, there is today still an input of 3300 lbs. a year of phosphorus runoff into Lake Wingra. Along with phosphorus, PCBs, mercury, and other contaminants can be found in differing levels today in both Lake Wingra and Lake Monona, which will be discussed in the next section.

5. Summary

Lake Wingra and Monona Lake are part of a large watershed basin know as The Yahara River Watershed. The Watershed is broken up into smaller, sub watersheds; the Lake Wingra watershed and The Monona Watershed. These watersheds were historically developed differently but had many similar biological and human stressors on them that degraded water quality over time, and accumulated toxins and contaminants in the lakes. There was little awareness of these problems with the exception of the nuisance algae bloom problem that can historically be linked to sewage dumping. There are a handful of programs aimed to improve water quality in the Madison lakes and combat toxin issues, however the lakes' location in an urbanized setting make improvements challenging.

C. Pollutants

Within Lake Monona and Lake Wingra exist a plethora of both organic and heavy metal toxins, with varying degrees of testing and known risk associated with fish consumption in relation to toxin levels. The most commonly explored and mentioned in various fish advisories include PCBs, mercury and methylmercury. However, given Lake Wingra and Lake Monona toxicity assessments, cyanobacteria (blue-green algae), heavy metal including arsenic, lead, in addition to organic compounds such as polycyclic aromatic hydrocarbons (PAHs) are present in these waters. Through various sources, we attempt to discern the point sources and concentration of these toxins, the health effects on humans, and the current levels of each toxin in Monona Bay and Wingra.

1. Heavy Metals: Arsenic, Lead, and Mercury and Methylmercury

ai. Arsenic

Arsenic also known as Sodium arsenate ($NaSO_2$) is primarily exposed to humans through emissions and waste water from ore mining and processing industry, dye manufactures, tanneries, thermal power plants, industrial and domestic waste water, natural run off, in addition to certain insecticides, herbicides, and pesticides. Arsenic is a commonly known human carcinogen and can cause some types of cancer including lung, liver, skin, and bladder cancer (Shah et al. 2009: 520-521).

Though arsenic generally accumulates in water body sediments, fish can assimilate arsenic through ingestion of arsenic suspended in the water, arsenic contaminated food sources, exchange of dissolved arsenic across gills and membrane surfaces, in addition to adsorption in fish tissues. Similar to the cases of mercury and PCBs, the uptake of arsenic depends on various factors including fish species, size, and age. (Shah et al. 2009:522). A study that evaluated 10 species of fish in a Pakistan freshwater body, found that certain fish species had higher accumulation in fish muscles that could potentially be harmful to humans when consumed. The study further concluded avoiding the consumption of inner organs and gills where arsenic was more directly concentrated should be advised when preparing fish with high arsenic levels, particularly in light of traditional cooking processes that may result in higher consumption arsenic contaminated gills and inner organs (Shah et al. 2009: 523-524).

aii. Arsenic in Monona Bay and Lake Wingra

Re-examining Monona Bay's history reveals the common use of arsenic in the late 1950s as a means to kill rooted aquatic plants but was discontinued in 1964 due to concerns of cumulative toxic effect in the environment. Altogether a hefty total of 36,000 pounds of sodium arsenate were applied in Monona Bay between 1947 and 1964 (Nelson Institute 2006: 33). In examining the effects of arsenic history on the bay, a 2006 study conducted by the Nelson's Institute that analyzed various toxins using three core samples from three test sites in Monona Bay revealed arsenic surface values were lowest near the Brittingham Park but highest in the middle of the bay, the reverse of most storm water pollutants. The study speculated that this disparity in concentration was likely due to lack of suspended solids that dilute arsenic as seen in storm water outfall. The 2006 study concluded that arsenic where higher than WDNR standards in Monona Bay, and were thus of particular concern (Nelson Institute 2006: 31-33). In the 1940's arsenic was also used as a means of exterminating rats from the city in the Shorewood Hills neighborhood (see figure C). Arsenic was scattered throughout a city dump near University Avenue.

Figure C
1948 - Scattering Rat Posion in Shorewood City Dump: WHi 54022

bi. Lead

Sources of lead are primarily concentrated in its heavy application since the 1980s, most notably leaded gasoline. Though leaded gasoline has been phased out by the government, anthropogenic sources of lead are generally found in peeling or chipped leaded paint, contaminated soils, vehicle wear, batteries, and residual leaded gasoline (Nelson Institute 2007: 32). John Nolen Drive, the street that was built over Lake Monona, allows for lead to easily enter the lake and bay through runoff form vehicles.

Lead is often viewed as a leading environmental health problem to children and pregnant women due to the vulnerability to the developing brain. At high levels, lead can result in numerous poisoning symptoms whereas at lower doses, lead has subtle effects on neurological functions including impaired memory functions and attention span (Nelson Institute 2007: 33). Surprisingly from our research, no literature was found in examining lead concentration in fish and its effects on human health.

bii. Lead in Monona Bay and Lake Wingra

The 2006 Nelson Institute study on lead concluded that of all 16 samples taken from the silt layer in Monona Bay, led was above WNDR standards of 130mg/kg. The study concluded that lead contamination from storm water runoff was likely the largest contribution rather than in-bay application from leaded paints or gasoline (Nelson Institute 2007:33).

ci. Mercury and Methlymercury

Though mercury is a naturally occurring element in the Earth’s crust produced through the weather of rock and volcanic eruptions, when unearthed and released into an environment, in certain concentrations and forms, mercury can become a human health concern. In the United States, mercury is utilized in the production of relay switches, measurement devices, and dental amalgams (silver tooth fillings), though it is additionally utilized in the extraction of sedimentary gold, chloralkali production as well as fluorescent and neon lights. Coal-fired power plants are a large contributor of mercury through atmospheric releases, as coal also contains traces of mercury (Knobeloch et al. 2007: 205).

When mercury enters wetlands and water is methylated by aquatic microorganisms and becomes Methylmercury (MeHg), a more toxic form of mercury to humans. Human exposure to MeHg is generally through the consumption of contaminated fish and seafood, bioaccumulated in the aquatic food chain. Thus high concentrations of MeHg in generally found in large, predatory fish at the top of the food chainlike shark, swordfish, and king mackerel (Knobeloch et al. 2007:206-207).

Exposure to MeHg, unlike lipophilic contaminates such as PCBs cannot be reduced through selective cooking methods (Flaherty et al. 2003: 503) as MeHg accumulates to fish muscle tissue, binding to protein (Turyk et al. 2012: 12). Mercury levels in fish can vary greatly size, age, and species of fish, though large predatory fish generally have higher levels than other species of fish. (Choose Wisely-2012 2012: 4-5). Moreover, because the blood compartment half-life of MeHg in the human body is 60 days, if an individual exceeds the rate of excretion, MeHg can accumulate in the body and pose risk to damage the central nervous system, cardiovascular system, and kidneys. The process of excreting MeHg accumulated in the body is approximately 16 weeks without further MeHg inputs (Flaherty et al. 2003: 503). While most clinical laboratories report blood mercury levels below the range of 5 μg/L as normal, there is no established normal range for methlymercury. (Knobeloch et al. 2007:209).

As a neurotoxic, the health consequences of methlymercury consist of potential irreversible damage to both children and adults (Flaherty et al. 2003: 410). Methylmercury at low-level prenatal exposure can interfere with growth and migration in neurons, causing permanent brain damage and long-term effects on intelligence and coordination. Post-natal exposure to MeHg can cause overt clinical symptoms including blurred vision, mental confusion, peripheral neuropathies, slurred speech, hearing impairment, and parenthesis. In men hair mercury levels that exceed 2 μg/g resulted in men twice as likely to suffer heart attack compare to men with lower mercury levels over a seven year study period (Nelson Institute 2007: 36). Though the underlying effect is unknown, there is evidence that cardiovascular system is incredibly sensitive to MeHg (Knobeloch et al. 2007: 207-210).

cii. Mercury and Methlymercury in Lake Monona and Lake Wingra

According to Marshall in 1988, total peak mercury levels Lake Monona sediment roughly coincided with peak average sewage discharge into Yahara Lakes, where highest levels were found to be 1.1mg/kg. A more resent testing of Monona Bay in 2006 however, found lower mercury levels in sediment cores of 0.5 mg/kg. The decrease of mercury level concentrations in 2006 compared to 1987 suggests a positive potential of lower mercury bioaccumulations in fish and thus lower mercury risks (Nelson Institute 2007:33).

However the results of sediment testing do not adequately reflect the contamination levels in fish, or the effects mercury concentration on human health. In 2001-2002, ice anglers on Monona Bay were interviewed and assessed of their mercury intake based on their consumption patterns. Of the surveyed white male population, 95% of the anglers were not at risk of mercury toxicity due to lower trophic level fish consumption. The study further emphasized that the consumption of lower trophic level fish was not due awareness of mercury advisory, as 40% of the anglers who consumed fish from Monona Bay were unaware of fish contamination. Through modeling and reported fish consumption by anglers, family members particularly women and children also avoided exceeding the mercury toxicity threshold, though it was noted that the accuracy of remembering family consumption was questionable. It was additionally noted that the results of modeled mercury levels was representative of seasonal differences and specifically an ice angling culture, rather than an adequate reflection of annual methlymercury levels. Specifically, it was postulated that ice anglers consumes fewer and smaller trophic level fish than potentially spring or summer anglers as seen in exceed mercury levels for those who consumed sports fish (Flaherty et al. 2003: 501-504).

In contrast, mercury exposure analyzed through fish consumption in 2004-2005 survey of Wisconsin residents revealed higher concentrations of mercury in men than in women. Levels were significantly correlated with monthly fish consumption estimate, where of 2031 volunteers, 29% of the men and 13% women had levels that exceeded the mercury guideline of 1ppm. Furthermore, those who consumed sport-caught fish had hair mercury levels that averaged 1.5 times higher than those who ate only commercial fish (Knobeloch et al. 2007: 208-210).

2. Organic Compounds: PCBs and PAHs

ai. Polychlorinated biphenyls

Polychlorinated biphenyls are a group of toxic and highly persistent organic compounds that consist of 209 related chemicals that differ in the number and position of chlorine atoms on the two coupled biphenyl rings $(C_6H_5)_2$. In the 1970s, prior to being phased out of most commercial uses, PCBs were utilized heavily in capacitors, paints, pesticides, sealants, plastics, and flame retardants Nelson Institute 2007:38-40). However, as PCBs take time to break down in the environment PCBs continue to be a persistent problem (Choose Wisely-2012 2012: 16).

Exposure to PCBs is possible through food consumption, as seen in Italy, where PCB 126 was found in meat, fish, and vegetables. Concentrations of polychlorinated biphenyls in fish have declined in recent years though PCB intake continues to largely be contributed by fish. These compounds have low water solubility, especially in seawater, but can be absorbed and concentrated in the fatty tissue of fish (Chang et al. 2012: 284-286). As with mercury, contamination levels varied depending on fish species, though it is speculated that sediment concentration may explain variation in pollutant levels among species. For example, organisms living close to the sediment are exposed to PCBs through direct respiration and indigestion of sediment. It is speculated that these species thus have higher contaminates than do pelagic organisms (Schantz et al. 2001: 605-606). Yet, Chang et. al study argues that fish consumption preference has a lesser effect on PCB levels compared to the number of fish meals per year. Turyk et al would further argue higher concentrations of PCBs are found fish that are fatty, older, and carnivorous (Chang et al. 2012: 287). The DNR "Wise 2012" document further speculates that based on these factors, fatty fish such as carp and catfish may contain higher levels of PCBs (Choose Wisely- 2012 2012: 17).

Dioxin-like compounds such as these, have a complex range of toxicological properties that can potentially cause liver damage, birth defects, immunotoxicity, and cancers (Storelli et al. 2003: 491). An association between utero PCB exposure and impaired childhood intellectual functioning in addition to potential risk of neuropsychological impairment from elevated PCB exposure in adults has been found. For both children and older adults, certain aspects of verbal memory and learning are primarily targets for PCB-related impairments. It is possible that even greater exposure to PCBs and other contaminants would result in additional impairments (Chang et al. 2012: 287-288). In contrast, Turyk et al argues that PCBs as a neurotoxicant are more susceptible to impairment as a developing brain than an adult and the result of higher PCB levels are due to older age groups due to higher exposures during the peak of PCB production and use (Turyk et al. 2012: 17).

aii. PCBs in Monona Bay and Lake Wingra

Testing for PCBs in Lake Monona became a priority in the late 1980s after the DNR determined that two carp contained elevated PCB concentrations of 1.1 and 1.7ppm. Though the values did not exceed the health standard of 2.0ppm at the time, they were high enough to cause alarm (Nelson Institute 2007:31).In 2001, the WDNR Lower Rock River water Quality Management Plan stated that "Fish monitoring for PCBs and mercury through WDNR fish consumption advisory program will continue indefinitely" due to high polychlorinated biphenyl and mercury levels in other sediment sample tests (Powell, Xiong, and Powell 2009:2). A 2006 sediment core study found that PCB contamination was widespread, but that in at all three core sites, deeper sediment indicated higher PCB levels than the surface PCB levels, indicating a decrease in the past fifty years. Surface concentration of all three sample cores in 2006 were also below levels of concern, supporting the trend that contamination of PCBs has declined Nelson Institute 2007:35).However, as MEJO pointed out, a very small number of fish, 487 over a 32 year period, have been tested in Dane county waters. Though the sample numbers are low, there is reason for concern the levels of PCBs in Madison lake sediments and fish are within range that are of concern. Madison fish tested ranged from 0.05 to 0.46ppm PCBs while some fish had higher levels. To avoid non-cancer endpoints including immune, reproductive, neurological problems, the EPA recommends people should consume no more than half a fish per month within 0.19 to 0.39 ppm PCB and no fish over 0.39. To avoid cancer endpoints, the EPA recommends people eat no fish that contain over 0.097ppm PCBs and only half a fish per month in a 0.048 to 0.096 ppm range. Avoiding a cancer endpoint is thus not possible as al Madison tested fish were above EPA cancer endpoint recommendations of 0.05 to 0.46 or higher ppm (Ottiger 2011: 170-173).

bi. Polycyclic aromatic hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons or PAHs are formed due incomplete combustion of carbon-containing fuel. This can occur from coal, vegetation, wood, diesel and tar. In urban settings this generally includes coal, tar, crude oil, creosote, roofing tar, driveway sealant, and certain pesticides. Generally, PAHs is considered one of the most commonly detected toxic organic compound in urban runoff Nelson Institute 2007:36).

Fish can accumulate soluble petroleum hydrocarbons rapidly. As displayed by Thomas and Rice in 1982, a fish placed in a crude-oil contaminated water will take up dissolved hydrocarbon usually by diffusion though the gills due to their lipid richness and directly exposure. However, tests involving PAHs and fish have been primarily tested in marine waters rather than freshwater. In general, however, freshwater fishes are hyperosmotic and experience an inflow of water compared to marine fish. In other words, freshwater fish uptake soluble compounds more frequently than their marine fish counterparts. A study conducted by Ramachandran et al in 2004 comparing the effect of oil spills in coastal areas and estuaries found exposure to PAHs will be up to 60-fold greater in water of low salinity compared to water of full salinity (Ramachandran et al. 2006: 1185-1189).

PAHs represent one of the largest class of known carcinogens Nelson Institute 2007:36). The effects of PAHs are of particular concern to fetal brain and nervous system development. Prenatal exposure to PAHs has previously been associated with multiple adverse effects of 3 years development delay in addition to reduced IQ at age 5. Other factors including anxiety and depression have significant associations between prenatal exposure to PAHs and indicators of Anxious/Depressed and Attention Deficient in children. Prenatal exposure is associated thus with impaired cognitive development, influencing ability to learn but in addition may have anxiety, depression and attention problems. Though PAHs is generally attributed to cancers through dietary sources such as food or fish, there are not many studies that have determined the exact influences of PAHs contaminated fish consumption and human health risk (Dhanaanjayan and Muralidharan 2012: 1-3). As with all toxins, PAHs levels of contaminated varied significantly for fish species, age, and sex of the fish. Though Dhanaanjayan study stated that exceeding cancer risk guideline may only be caused by a lifetime consumption of fish, the study recognized various place-based environmental that may result in different PAHs levels in fish and humans through fish consumption (Dhanaanjayan and Muralidharan 2012: 6).

bii. Polycyclic Aromatic Hydrocarbon (PAHs) Monona Bay and Lake Wingra

Though Monona Bay has not experienced the extent of a large scale oil spill, it has experienced exposure to PAHs point source pollutions. In 2006, the Charter street power plant was a potential source of contamination as open piles of coal exposed to rain, resulted in water ladened with coal sediment. This mixture was often observed running off of the plant site, reaching the bay via storm sewers. In the last ten years two unknown petroleum spills have also occurred, in addition to an aquatic plant harvester spill of hydraulic fluid into bay. Accidental leaks of oil and gasoline from motor boats are also likely to play a role in the bay (Nelson Institute 2007:37-38), as well as track and road repair near the bay.

The 2006 Nelson Institute report on Monona Bay stated that sediment data indicated that levels of polycyclic aromatic hydrocarbons (PAHs) exceeded “midpoint concentration” and “probable effect concentrations” (Powell, Xiong, and Powell 2009: 3). All other common contaminates tested in the 2006 sample cores, resulted in lower concentrations at surface sediments and higher in the older, deeper sediments with the exception of PAHs. PAHs had only one of the three cores, sample B near Brittingham Park in Monona Bay, outfall exceed WDNR standards. However, within that core sample, sediments exceeded individual levels for acenaphthene, benzo(a)anthracene, benzo(a)pyrene, dibenz(a,h)anthracene, fluoranthene, chrysene, phenanthrene, and pyrene, where the first five compounds are considered to be human carcinogens (Nelson Institute 2007:38, 147). It is thus of huge concern to the angling community the uptake of PAHs levels in fish though PAHs has yet to be tested in Madison.

3. Other: Cyanobacteria

ai. Cyanobacteria (Blue-green Algae)

Cyanobacteria are a common component of the phytoplankton of lakes that are influenced by nutrient availability and water temperature (Rogalus and Watzin 2008: 225). Cyanobacteria (blue green algae) is often considered a smelly and mild irritant, certain strains such as Anabaena, Aphanizomenon, Microcystic and Planktothrix can produce lethal hepatoxins such as mycrocystin and neurotoxins including anatoxin-a, ana-toxina(s), and saxitoxin (Repavich et al. 1990: 225).

Cyanotoxins may accumulate through different routes in fish, but it was found that toxic cyanobacteria were found in higher concentrations in predatory and omnivorous fish than in species such as silver carp that feed directly on phytoplankton and thus toxic cyanobacteria. Concentrations in fish are unpredictable and there appears no clear relationship between feeding and toxic concentration in fish tissue, though higher concentrations of toxic mycrocystin in particular, was found in a fish’s gut and liver. Lower concentrations of cyanotoxins were found in the lower kidneys and gonads and even lower concentrations in the fish tissue. As with many toxins, there is an emphasis of bioaccumulation of cyanobacterial toxins in fish, though the extent of bioaccumulation dependent on the species, age, and length of exposure . In general, the World Health Organization (WHO) advises that people who choose to eat fish taken from blue-green algae blooms consume a fish in moderation and avoid eating the fish organs, taking care not to cut into organs when filleting fish (Rogalus and Watzin 2008: 510-514).

aii. Cyanobacteria Monona Bay and Lake Wingra

In 1996 and 1986, Lake Monona was tested and found free of toxic cyanobacteria. However, in 2004 and 2005, DNR testing of Wisconsin statewide sample tests revealed blue-green algae presence in the west and south-central regions that included Anabaena, Aphanizomenon, Microcystis, and Planktothrix at a concentration that was “a moderate risk to human health”. Mycrocystin, a hepatoxin was most commonly detected and at the highest concentrations. However, as stated previously due to the limited data on fish concentrations of cyanobacteria, it is uncertain to what extent cyanobacteria in Lake Monona and Lake Wingra pose risk to anglers and to those who consume local fish. Previous alerts concerning toxic blue-green algae thus did not include advisories for the consumption of fish exposed to cyanobacteria.

bi.2, 4-diclorophenoxy acetic acid (2, 4-D)

2,4-diclorophenoxy acetic acid or 2, 4-D has been used as an herbicide in Monona Bay due to its significant effect on Eurasian water milfoil an exotic plant found in the Yahara lakes. As an herbicide however, it has undoubtedly affected other non-targeted plants and organisms due to the spread of herbicides once in the water (Maria Powell, 2013). Dane County has supported populations of this invasive plant since the 1960s, found throughout the Yahara Chain of lakes, often associated with the decrease of biodiversity, decreased aesthetic value, and impeded recreational use (Office of Lakes and Watersheds 2011). Though 2, 4-D is a legal herbicide registered by the U.S. EPA its safety is somewhat questionable, with its ban use on lawns and gardens in Sweden, Denmark, Norway, Kuwait, and Canadian provinces in Quebec and Ontario (response to 2 4-D experience). 2, 4-D is a component of Agent Orange with various forms of dioxins that accompany it (Maria Powell, 2013). Several recent studies have shown that this herbicide can cause lymphantic cancer in exposed humans. Moreover, several forms of dioxin have been identified in 2, 4-D, which can cause cancer, birth defects, reproductive effects, and liver damage. In humans, minor exposures have been known to cause peripheral neuropathy (that is loss of feeling extreme emotions) where depression, lethargy, and coma have been documented in both humans and animals (Beyond Pesticides 2013). Moreover, 2, 4-D in some forms are highly toxic to fish, raising question on further human health risk from consuming contaminated fish. Though there is variability that 2, 4-D is biomagnified in fish, 2, 4-D are often found in fish tissues emphasizing problems of potential cancerous health effects given that dioxins are extremely toxic (Maria Powell, 2013). Moreover, the doxins that accompany 2, 4-D may additionally bioaccumulation in fish and thus pose cancerous risk to those consuming 2, 2-D contaminated fish.

bii. 2, 4-D in Monona Bay and Lake Wingra

According to the army Corps of Engineers, about 750 pounds of Navigate with 2,4-D were applied to two plots in 2008, 2009, and 2010 for a total of 1,500 pounds per year for three years in Monona Bay near Turville Park (Maria Powell 2013, Office of Lakes and Watersheds 2011). It is likely that due to these applications, a considerable amount is resting in the sediment. 2, 4-D may persist for several months (Beyond Pesticides).

4. Summary (Toxins)

Toxicity accumulation in humans varies significantly depending on various factors including environment, age, gender, species, and how often fish are consumed and depending on the toxin, what parts of the fish are consumed. Specific recommendations to avoid increased contaminant levels included avoiding the consumption of fish fat for PCBs, in addition to avoiding internal organs and gills (head) for arsenic, cyanobacteria, and potentially PAHs. For all other toxins, accumulation is either unknown or dispersed throughout the fish as in the case of methlymercury and likely 2, 4-D. It is especially important to lower how much fish is consumed and avoid large predatory fish.

The health impacts of each toxin varies significantly depending on the individual's initial health, age, sex, and level of exposure including other environmental pollutant exposures. Studies on toxins that are related to certain types of cancer include PCBs, PAHs, and Arsenic. Studies on toxins related to neurological damage include low doses of lead, methlymercury, PCBs, PAHs, and cyanobacteria. Other health risks or the extent of these risks vary depending on the toxin. However, few studies examine the consumption of contaminated freshwater fish.

D. Assessment of Risk by Toxin

The extent of determining what is risky and what is safe, is often political and controversial given the very nature that risk is influenced by a variety of factors. Some factor examples include toxin levels in fish affect human health when consumed (including frequency of consumption, meal size, toxin type, and species of fish), behavior (sources of information, cultural influences, personal preference), individual profile (susceptibility, age, gender), attitudes (risk aversion, environmental concerns), and accessibility to advisory and resources for consumption information (language, lower education, targeted populations). To fully assess the risk of consuming fish from Monona Bay and Lake Wingra it is important to break this information down in multiple parts including assessment of individual toxic risk, minority risk, in addition to angler perception.

1. Heavy Metals: Arsenic, Lead and Methylmercury and Mercury

a. Arsenic

Very little literature was found that examined the links between consumption of freshwater arsenic contaminated fish and human health. Considering the trend that prenatal exposure and children are more vulnerable due to a developing processes of the body, it generally advisable, as in many cases with all of the toxins, pregnant women, nurturing women and children under 15 should reduce their consumption of fish to prevent arsenic exposure and thus certain types of cancer (see Arsenic).

In the case of Monona Bay, it was found that arsenic values were on average higher than WDNR standards but did not explain subsequent consequences of consuming arsenic contaminated fish (Nelson Institute 2007:49). As it appears arsenic concentrates primarily in the inner organs and gills, excessive consumption of these fish parts may result in higher arsenic levels and thus higher risk of lung, liver, skin, and bladder cancer.

b. Lead

Literature on the consumption of freshwater lead contaminated fish and consequences on human health were even fewer than arsenic. Surprisingly from our research, no concentration of lead through freshwater fish consumption was found.

However, in the 2006 core sediments of Monona Bay, lead was higher than WDNR standards (Nelson Institute 2007:34). As there is little understanding of the methods that fish accumulate lead in addition to consequences of lead exposure through freshwater fish, it is important to consider the small doses of lead that can lead to neurological damage and be particularly cautious in limiting fish consumption for pregnant women, nursing women, and children under 15.

c. Methlymercury and Mercury

Though in general mercury levels are on the decline globally, this trend varies greatly spatially and is highly dependent on various factors including water bodies, size and age of fish, in addition to the average consumption of specific fish species. For example, in a 2007 study by Rasmussen, although mercury was on the decline in the northern Wisconsin lakes by 0.5% a year from 1982-2005, fish mercury levels in lakes in the southern part of Wisconsin increased by 0.8 per year during 1982-2005 (Powell, Xiong, and Powell 2009: 1).

Altogether, though there is an indication of declining mercury levels, particularly in Monona Bay core sediments, it is important to reduce exposure to populations most at risk for mercury exposure. In general, as with many toxins, methlymercury concentrations can have severe neurological damage on prenatal and influence post natal development putting women and children. However, as Knobeloch Assessment of methlymercury exposure in Wisconsin shows, an overlooked segment of the population may include men, and especially those who eat sport-caught fish. Moreover, mercury levels were highest among hair donors who had less than

12 years of formal education, reflecting most likely, subsistence fishermen and families who consume more fish. Knobeloch assessed that this finding was additionally associated with higher income families eating larger, predatory marine fish or participating in sports fishing as a recreational activity (Knobeloch et al. 2007: 208-210).

The complexities of mercury risk is further compounded by potential differentiation of seasonal fishing culture and thus specific fish consumption, as seen in mercury levels in Flaherty's ice angler study. Similar problems regarding limited data include risk minority populations for methylmercury testing, revealed in both the 2001-2001 ice angler survey, where a predominately 95% of its population was Caucasian males and the methlymercury 2004-2005 fish consumption study where the surveyed population of 2031 volunteers had only 0.8% Black, 0.6% Hispanic, 1.0% Asian, and 0.1% Native American (Flaherty et al. 2003: 502-504).

Based on the Wisconsin DNR inland water fish advisory "Choose Wisely 2012", there are specific guidelines for various genders and age groups to avoid excessive mercury levels. It states specifically that women of childbearing years, nurturing mothers, and all children under the age of 15 to consume bluegill, crappies, yellow perch, sunfish, bullheads and inland trout one meal per week. Moreover the consumption of walleye, pike, base, catfish and all other species to one meal a month and muskies avoided entirely. In contrast women beyond childbearing years and men were recommended to only limit walleye, pike, bass, catfish, and all other species one meal a week in addition to muskies one meal per month (Choose Wisely-2012 2012: 9-10).

2. Organic Compounds: PCBs and PAHs

a. Polychlorinated Biphenyls (PCBs)

In contrast, where mercury accumulates in the fish muscle tissue, PCBs concentrate primarily in the fat of the fish. The 2012 DNR "Choose Wisely- 2012, A health guide for eating fish in Wisconsin" suggest reduction of PCB intake from fish is possible through select cooking, primarily through proper trimming, skinning, of the fish fat including the method of cooking such as broiling, grilling or baking the fish are examples of reducing fish fat and thus reducing PCB intake. Others include body weight ratio to fish meal, for example a body weight of 150lbs would consume ½ lbs of fish, while a body weight of 75 lbs would consume ¼ lbs of fish (Choose Wisely-2012 2012, 16).

Health risk of PCBs differs considerably based on location and amount of fish consumed (Chang et al. 2012: 285). For example, the decline in the Great Lakes PCB levels in fish may be generally due to a combination of a decline in PCB levels in overall in the diet and ban of many chemicals in the 1970s and 1980s, however Great Lakes sport-caught fish consumers in 2004-2005 were higher than a 2003-2004 representative sample of the U.S. population (Turyk et al. 11). In general, licensed sport fishermen, pregnant women, and excessive consumption of fish such as Native peoples who fished for cultural reasons and subsistence anglers are particularly at risk groups to PCBs (Chang et al. 2012: 287).

In regards to Monona Bay and Lake Wingra specifically, few fish and PCBs tests have been implemented that better quantify how at risk fishing in Monona Bay and Lake Wingra are of concern. Though the 2006 sediment core tests showed an overall temporal reduction in PBCs (Nelson Institute 2007:49), MEJO emphasized that all PCB fish tests conducted from Madison lakes were above EPA recommendations for cancer endpoints, and some PCB fish tests within the range of "non-cancer endpoints" or neurological, reproductive, and immunity problems. The sample size of fish tested for PCBs in Madison lakes is relatively low, 478 fish in a 32 year period, and thus not representative to conclude PCBs as a definitive risk(Ottigar 2011: 149-153). However, given the fact that this small sample size is within the bounds of cancer endpoints and many within the range of noncancerous endpoint, it is important to function on the precautionary principle of following DNR fish advisory and recommendations to limit PCB intake through the number and type of fish consumed, taking care to prepare it as described above, to minimize PCBs intake. The “Choose Wisely 2012” DNR document makes the same recommendations for limiting both PCB and mercury intake. However, for both Monona Bay and Lake Wingra, the document specifically states that avoiding PCB levels include limiting consumption of carp of all sizes to no more than one meal per month (Choose Wisely-2012 2012: 4-5).

The “Choose Wisely 2012” document further states that using the methods developed by the U.S. Environmental Protection Agency (also known as the EPA), if 10,000 people ate PCB-contaminated fish over their lifetime while following the DNR fish advisory, no more than one additional cancer case would be expected (Choose Wisely-2012 2012: 16). However, this statement functions on the assumption that individuals would know and follow DNR fish advisory guidelines carefully which will be explored later in the literature review.

b. Polycyclic Aromatic Hydrocarbons (PAHs)

Though PAHs is also a known toxic carcinogen we did not come across studies comparing its effect to specific traits such as age, gender, or ethnicity. PAHs levels vary on environmental factors of place, fish species, fish age, fish gender, and the amount of fish consumption making it especially difficult to determine specifically for Monona Bay and Lake Wingra to what extent PAHs exposure through fish consumption is a concern.

The 2006 sediment study of three core samples in Monona Bay revealed PAHs to be higher than WDNR standards. Moreover within those core samples, five known individual carcinogens were additionally above WDNR standards (Nelson Institute 2006: 49). Though there were not polycyclic aromatic hydrocarbon tests in fish caught from Monona Bay or Lake Wingra, this finding is particularly concerning, given that PAHs levels may be higher in freshwater fish than marine fish due to freshwater fish biological susceptibility.

In general, it appears that PAHs may function like methylmercury in that, accumulation is generally throughout the entire fish, rather than concentrated in certain organs or fat (Ramachandran et al 2006: 1182-1183). Moreover, as PAHs is likely to be biomagnified throughout the food chain like many toxins, it is best to limit consumption of larger carnivorous fish but additionally limit overall fish consumption in general. As with many toxins, it is additionally important for women of childbearing age, children under 15 and nurturing women to take extra precautions as children and fetal development is particularly vulnerable to PAHs exposure (Perea et al 2012: 922-926).

3. Other:

a. Cyanobacteria

Though cyanotoxins can pose serious health issues through drinking and recreational use of a contaminated body of water, little literature exists concerning the effects that cyanobacteria concentrations have on fish and seafood. With no direct human health risk analysis of cyanobacteria toxins, much speculation is derived from animal studies which include lethal poisonings, and in the case of mycrocystin potentially increase the growth rate of existing tumors. In the case of Monona Bay and Lake Wingra no sufficient evidence exists to make speculations on whether or not fish are contaminated with toxin strains of cyanobacteria. However, given the history of blue-green algae persistence on many of Madison’s lakes since 1988, until further studies come to exist, it is likely best to avoid fishing in areas that have had cyanobacteria alerts and excessive consumption of large fish due to the likelihood of bioaccumulation of cyanotoxins (Rogalus and Watzin 2008: 506).

b. 2, 4-diclorophenoxy acetic acid (2, 4-D)

Though scientific consensus of whether 2, 4-D bioaccumulates in fish remains uncertain, it is clear that the 2, -4 D concentrations are often in fish tissue and accompanying dioxins in 2, 4-D do bioaccumulate. Effects of 2, 4-D on humans are known to range from neurological to cancerous health risks in very small doses, and are further known to have high toxicity when accumulated in fish. (Beyond Pesticides 2013). Due to 2, 4-D concentration in fish tissue and inability to avoid toxicant accumulation as seen with avoiding PCB in fish fat, there should undoubtedly be more studies done on 2, 4-D in Monona Bay especially, given the history of structural application and unknown residential application in controlling exotic and non-invasive plants.

4. Pollutant Risk Summary

In almost all cases bioaccumulation is a factor of higher risk of toxins, and avoiding large carnivorous fish is likely the best means of addressing toxin with some or no information regarding its concentration levels in Monona Bay and Lake Wingra. Moreover a common cautioned emphasis on toxic exposure is especially addressed towards children and pregnant women or nurturing women reduce their consumption of fish this most regardless of the toxin due to the vulnerability of children and baby development.

The largest problem in determining pollutant risk summary is the lack of toxicants done in Monona Bay and Lake Wingra, despite the historical and current influx of pollutants from industry, residential, and urban sources alike. Moreover, though there are several toxicants that we explored above ***this does not cover all toxicants that are present in Monona Bay or Lake Wingra and there are likely many more toxicants in the sediments and thus fish. Moreover there are large gaps in understanding how these toxicants accumulate in fish or their effects on human health through contaminated fish consumption***. Without further testing on the toxicants present in both the sediment and fish in these waters, the assessment given above may only be a scratch of what lies beneath the surface.

However, it is important to acknowledge that despite a very small number of toxin tests on fish have been conducted in Monona Bay and to a lesser extent Lake Wingra, there is a necessity to operate on the precautionary principle when consuming fish and choosing to consume certain species. Aside from the obvious conclusions of bioaccumulation for all toxins and avoiding large, older predatory fish, avoiding excessive health risk may result in a far fewer number of fish consumed on a weekly or monthly basis. This is particularly problematic for those who rely on fish for subsistence or cultural means which will be explored in the next section.

E. Other Risk Assessment Factors

1. Subsistence Fishing

Based on the trends on various other cities comparing subsistence fishing, race, and cultural differences, there are likely disproportionate risks for certain individuals fishing in the Madison lakes.

Subsistence fishing in particular reveals the potential increased health risk associated with a far greater number of fish consumed than those who recreationally fish. For example, a study conducted on fishing of the Calumet waters of Chicago, IL found that, of the 97 anglers who gave definitive responses about whether or not they fish for consumption in Calumet, 68 (70.1%) stated they fish at least occasionally for consumption and 44 (45.4%) said they usually do.

However, it is likely that race and subsistence fishing also overlap considerably. Another survey conducted as a part of an environmental justice study of the Detroit River found that 73% of low-income people of color took fish home in contrast to 56% of high-income people of color and 35% of low-income Caucasians (Kalkirtz, Martinez, and Teague 2008: 66). Similarly, a Newark Bay study found only 51% of white fisherman ate their catch while 60% of Hispanics, 76% of Asians, and 78% of African Americans ate theirs (Burger 2002: 130). In the same study, a portion of the Savannah River in South Carolina and Georgia, it was found that African Americans consume more fish than whites with at least 25% of African Americans interviewed exceeding the "Hazard Index" (Burger et al. 1999: 433-436).

Furthermore, the Calumet study similarly found racial disparities in elevated fish consumption. 93% of Blacks, 78% of Latinos, and 57% of whites reported at least occasionally fishing for consumption and while 68% of Blacks and 50% of Latinos stated they usually fished for consumption compared to only 20% of their Whites counterparts (Westphal, et al. 2008: 51). Additionally, report done on consumption of contaminated fish in the San Francisco bay found that Latinos consumed three times as much fish from the Bay as whites and African Americans twice as much (PEHAB 1999: 4). A survey done by MEJO in Madison reported that 60% of the sampled group said they regularly eat fish. More specifically, 73% of nonwhites said they regularly eat fish while only 29% of whites said the same (MEJO 2009: 5).

Based on these studies, it is evident that urban fishing minorities and low-income minorities are more likely to eat their catch from local waters. According to an EPA study from

2002, consumption of contaminated fish "it is an especially pressing concern for many communities of color, low-income communities, tribes, and other indigenous peoples, whose members may consume fish, aquatic plants, and wildlife in greater quantities than does the general population (NEJA 34-36). Though each study area is geographically unique with varying types of angler and racial population, the concept behind the studies in San Francisco and Calumet is relevant to Madison because they all have subsistence anglers. This trend of racial differences and amount of consumed fish affects the communities of color in Madison who catch and consume fish more often than whites.

2. Cultural Variation

Cultural variation is a key component when evaluating risk from fish consumption. It should be considered more carefully when warning communities about risks of consuming contaminated fish, because preparation could be more important than size, species or frequency in some cases.

Hmong first came to Wisconsin in 1975 and 1976 as a part of the government's refugee dispersal plan. They settled in Appleton, Eau Claire, Green Bay, La Crosee, Manitowoc, Milwaukee, Oshkosh, and Sheboygan. The population expanded from about 2,000 to another 5,000 in 1978. Since 1985, there has been an annual increase of 350 families (2,000) individuals (Fass 1991: 15).

a. Hmong

There is a clear Hmong presence in Madison and fishing is a popular activity among Hmong communities. A study done on fishing consumption and activity found that, among the local Hmong population in Green Bay, more than half the interviewed households participated in fishing (Hutchinson and Kraft 1994: 473). The same study found that over half of the interviewed households consume fish caught in local waters and a quarter of the households consumed fish at least once a week. Eating fish is part of Hmong culture and information on how to prepare fish is traditionally passed down from parents to children (Eshenaur, McCann, Berglund 2009: 8). In an outreach project done on the fishing and fish consumption in the Great Lakes, it was reported that crappie, sunfish, bass, and catfish were the most popular local species for consumption (Eshenaur, McCann, Berglund 2009: 7).

Preparations in Hmong fish recipes consist of leaving the fish whole such as Ntses Ki—oven broiled fish (hmongfood.info 2010) and Barramundi with Banana Flower (ediblyasian.info 2011). As explored in the pollutant section, certain parts of the fish, namely the head, fat, and internal organs are more at risk for specific contaminates, though other contaminates rest within the fish itself. As a result, as it is a common characteristic of Hmong recipes to consume the entire fish, it is possible that Hmong anglers, unaware of fish advisories or pollutant accumulations, may be more at risk for PCBs, cyanobacteria, and arsenic contamination more so than anglers who avoid cooking these parts of the fish.

Hmong Food 2010


Rob and Stephanie Levy 2010

Some studies recommend that low-income people who rely on fish they catch to supplement their diet should focus on fish preparation techniques rather than on meal size and consumption frequency (Burger et al. 1999: 437; Bienenfeld, Golden, and Garden. 2003: 354). Thus it is important for outreach efforts, such as the project done on the Great Lakes, to effectively communicate the risk for preventable accumulation of certain toxins.

b. African American

African Americans generally tend to follow a similar cultural tradition of fishing to Hmong anglers. Beehler et. al conducted a study in 2001 in which African American participants explained how they learned to fish from their parents and that techniques and methods had been passed down for generations (Beehler 2001: 291).

Preparation of fish in African American communities is also likely to have traditional Southern or cultural ties. An article done on an adult male angler in 2012 found that Trey Mackey, an African American man drove up from Chicago to fish on Monona Bay for a dinner of blue gill. Mackey said he grew up in the South where his family fished regularly because it was inexpensive and fresh food. Another interview participant explained that he would not eat black bass when he “cooked them like bunnies” but an older man showed him how to clean them a particular way so as to remove a brown lateral line out of the fillet. He claimed that if you do not do this, the fish will taste oily (Beehler 2001: 292).

c. Latino

Latino anglers have their own reasons and methods of fishing and fish consumption as well. Another study on Latino anglers of the Great Lakes near Buffalo done by Beehler, McGuinness, and Vena in 2003 found that most of the anglers fished more for leisure than anything else (Beehler, McGuinness, and Vena 2003: 104). However, the fish they did keep and consume was cleaned and typically breaded and fried or marinated.

Additionally, the broth created from boiling the head was believed to be good for those who were ill or recovering from illness or surgery (Beehler, McGuinness, and Vena 2003: 109-110). It is likely that these individuals are unaware of the possible higher accumulations of arsenic, cyanobacteria, and potentially PAHs in this part of the fish, thus putting them more at risk from consumption.

3. Perception

Additionally, perception plays a large role in risk from consumption of caught fish. The perception of the angler consists of their opinion of particular species of fish, their beliefs relating to particular areas, and their knowledge and beliefs about contaminants. There are general perceptions of risk but also demographic variation on the perception of fish consumption, pollution, and risk due most likely a lack of resources and accessibility to fish advisories. In general perceptions of fishing and risk further tie into the likelihood of risk. The specific factors affecting these perceptions include: misunderstanding of what kinds of toxins accumulate and how they do, the definition of a safe fish, and sensory cues as signs of pollution.

The Beehler et al. study from 2001 done on sources of knowledge and perceptions of risk among African-American anglers on the great lakes discovered a cultural model of pollution in lakes and fish: the anglers' representation of pollution consisted of junk or debris in the water that is visually unappealing, a clear sign of contamination. Based on the interviews, the anglers felt they were able to judge if a fish was safe for eating by appearance or smell (Beehler 2001: 293).

In addition, a study done on the Calumet waters of Chicago also found that when asked about pollution, participants indicated that they expected to be able to detect and identify pollutants in the water or fish with their senses (Westphal et. al 2008: 52). Older participants in the interviews from the Beehler et al. 2003 had similar sentiments: garbage and debris could be seen but they had not heard of nor did they believe that the water was contaminated and therefore did not believe there was anything wrong with consuming the caught fish (Beehler 2003: 108). However, younger, and thus possibly more environmentally aware participants in the same study believed the water quality was poor and perceived the risk from consumption to be high; therefore they practiced catch and release (Beehler 2003: 109). This exemplifies the importance of perception and understanding of the severity of risk from consuming contaminated fish.

Another survey of predominantly African American and Hispanic anglers fishing in waters around New York City (for which advisories exist) found that 83% of anglers sampled believed the water in which they fished was safe and 63% believed the fish was safe to eat (Burger, Staine, and Gochfeld 1993: 99). The authors of the research concluded that anglers were exceeding recommended consumption levels with a self-reported average of two to three fish meals per week. Research done on ice fisherman of Monona Bay found that, of the sampled anglers, 40% who consumed fish from the Bay were unaware of contamination of fish in the lake (Flaherty, Sass, and Stiles 501: 2003).

Additionally, anglers came from a 107-mile radius and traveled an average of 40 miles to fish at Monona Bay (Flaherty, Sass, and Stiles 2003:505). It should be noted that Flaherty found methylmercury levels were low in anglers who ice fished but stated that it was predominately Caucasian males and did not adequately reflect other demographics (Flaherty, Sass, and Stiles 200:3501-502). The study did not predict whether specific groups of ice anglers were more likely at risk of toxicity because the sample consisted mostly of adult, white males but does note that subsistence fishing increases risk of mercury contamination.

4. Summary

Though there are few, previous studies have shown how minorities and low-income individuals are more at risk from consumption because of their attitudes, perceptions, and cultural ties to fishing and fish consumption. In a diversifying city such as Madison, where urban subsistence fishing is evident, these factors can put certain demographics more at risk than others. It should also be noted that minority and low-income individuals are also less likely to be aware of these risks because efforts to warn anglers fail to reach low-income and minority populations (Tyson 2012).

F. Communicating Risk: Fish Advisories

Given that anglers are clearly at risk of health hazards through fish consumption, the next question whether this risk is being communicated effectively to the angling community so that people can make informed decisions about their fish consumption. The main way that government and public health agencies communicate information about exposure to toxins through fish consumption is via fish advisories. In Wisconsin, fish advisories are created based on factors of water quality, public health, and opinions of fishery experts, and are intended to inform the public about how much fish is safe to consume in a lifetime based on contaminants found in fish and how these contaminants affect human health (Fish Advisory PDF WI). However, there are many problems associated with fish advisories as they are produced today, and various studies have documented the ways in which these advisories fail to effectively communicate information about fish consumption to the public. Controversy around the efficacy of fish advisories involves many considerations, including whether advisory information is being equally communicated to all communities within the angling population, bringing the question of fish advisories into the environmental justice realm.

1. Effectiveness of Current Fish Advisories

The very nature of fish advisories have been argued to be confusing in sending mixed messages about the concerns and benefits of consuming fish. From a public health perspective, fish are a very health source of protein, and provide omega-3 fatty acids that are generally accepted as a means to reduce cholesterol levels, heart disease, stroke, pre-term delivery, and likelihood of hostility in young adults (Burger 2006: 275). With a scientific debate of direct health risks and benefits of consuming fish, determining whether or not to eat fish is likely to confuse consumers (Knobeloch 2007:206). Thus, the responsibility of communicating risk should not discourage fish consumption but rather increase positive benefits from fish consumption while reducing the risk from contaminants.

Burger's assessment of self-caught fish and anglers is that in many cases people are aware of fish advisories but ignore or underrate these advisories given that the risks are voluntary and familiar (Burger 2006: 277). Indeed, in Knobeloch's predictors of methylmercury, anglers with elevated mercury levels were in possession of a Wisconsin fishing license and were familiar with the Wisconsin sport fish consumption advisory (Knobeloch 2007:208). In Flaharty's survey, 60% of Madison anglers claimed to know of contaminants but only 1% stated they fished less frequently in Madison lakes because of this knowledge and only 6% stated they consumed less fish from Madison lakes as a result (Flaherty 2003:503). As these two studies demonstrate, even if fish advisories are helping to inform anglers about risks associated with fish consumption, these advisories are not achieving the broader goal of changing fish consumption behavior and subsequent toxic exposure, rendering them largely ineffective.

The reliance on government agencies in creating fish advisories is often discussed as one of the main problems in the efficacy of advisories. (Burger 2006: 283-285, Ottinger 2011: 175-178). Monitoring fish for toxin accumulation is a very expensive and time consuming task that is often charged to state and local agencies under federal law. As a result, a majority of fish and aquatic systems in the United States are not monitored for synthetic toxins, and generally only one or two contaminants are assessed (Ottinger 2011:151). Burger stresses that though expensive, it is necessary that research on fish species, consumption, and toxicity levels be conducted correctly, and that the complex information be made straightforward and accessible to the public (Burger 2006: 284) Without the funds or priority in examining the contamination levels within fish and waterways, fish advisories as they stand today are thus only partial reflections of a much greater picture of toxin assessment.

In particular, Burger argues that, given the inefficacy of fish advisories, the responsibility of protecting the public from toxic exposure should fall on governments in reducing contaminants in aquatic systems, rather than on individuals in changing their fish consumption behavior. The idea is that government protections and regulations should focus on reducing, cleaning up, and preventing contaminants in aquatic systems, which would render fish advisories unnecessary. This concept is appealing when considering the ineffectiveness of and low compliance with fish advisories today. Though there are some cases in which certain people and populations changed their attitudes about fish consumption based on fish advisories, such as pregnant women and Hispanic fishermen in Brazil (Burger 2006: 277) these cases are rare, and in general a change in fish consumption behavior based on advisories has not been much observed. Given these considerations, reducing the input of contaminants into aquatic systems is the ultimate solution to reducing contaminant levels in fish and thus protecting public health through reduced risk exposure.

2. Fish Advisories and Environmental Justice

This issue of communicating risk through fish advisories is especially critical and multi-faceted when considered within an environmental justice context. A large portion of the literature that addresses environmental justice and fish consumption focuses on the failure of government agencies and other public health organizations to adequately communicate the risks of consuming fish from contaminated waterways to the communities that are most at risk from toxic fish consumption. One factor contributing to this lack of communication is that agencies generally use a form of bland, generic 'government-speak,' or "passive voice, third-person narratives, and bland description" (Chess, Burger, and Hughes McDermott 2005: 272) in fish advisories that fails to "target audiences, consider cultural and linguistic factors, and develop clear messages" (Chess, Burger, and Hughes McDermott 2005: 272) in communicating with members of the minority angler communities. Additionally, fish advisories are usually disseminated through avenues such as press releases, signs, websites, and publications given to anglers when they obtain a fishing license (Chess, Burger, and Hughes McDermott: 269), all of which are unlikely to adequately reach minority and low-income anglers.

The heart of the environmental justice struggle in relation to fish advisories goes beyond culturally appropriate language and dissemination techniques however. As discussed in the previous sections of this paper, minority and low-income communities generally depend on fish and aquatic resources in different and greater ways than the general population. Given both economic and cultural considerations, this means that for individuals within these communities there are no real alternatives to consuming fish. This clearly situates the use of fish advisories and risk communication in general as a valid policy for protecting anglers against toxins as an environmental justice issue, as for minority anglers and their families the choice to avoid consuming fish may simply not be an option, and therefore these individuals disproportionately bear the environmental burden of toxic water pollution.

Given these environmental justice considerations it is clear once again that fish advisories must be only a part of the large picture of cleaning up and protecting aquatic ecosystems. This assertion is supported in the environmental justice literature on the topic, where it is stressed that fish advisories should be a "temporary, stop-gap measure" (West et al. 1992: 112) and a "short-term, temporary strategy" (NEJAC 2002: 6) used only until toxic pollutants are cleaned up and new protections set in place. These recommendations demonstrate that fish advisories must be considered only as part of an integrated program to protect minority and low-income anglers against the dangers and risks associated with fish consumption.

3. Fish Advisories in Madison

The case of MEJO, or the Midwest Environmental Justice Organization, and their experience working on fish advisories in Madison illustrates many of the problems outlined above with fish advisories. MEJO began working on issues of locally caught fish in Madison in 2006. In 2008, this organization released on publication entitled "State of Shoreline fishing in Dane County: A Report on Fishing, Fish Consumption, and Public Health Advisories," that focused on the issue of the widespread lack of knowledge amongst minority anglers in Madison about fish advisories, and included recommendations for the Department of Public Health for the City of Madison and Dane County to better communicate potential risk associated with fish consumption to these communities. Just as is the case discussed in broader trends around the country, MEJO found that in Madison there existed a lack of research and knowledge about both contaminant data on Madison lakes and fish, as well as the health impacts of fish consumption on low-income and minority citizens within the community. Additionally, their findings demonstrated that there existed "very little data about fish consumption habits among Dane County shoreline anglers"(Powell, Xiong, and Powell 2009: 2), and that "minority and lower-income groups are often not reached via government risk communication strategies and not engaged in public policy discussions and decisions about these issues" (Powell, Xiong, and Powell 2009: 2). Therefore, MEJO's recommendation centered on the fact that fish consumption advisory information had to be better disseminated, particularly amongst "low-income and minority communities, through permanent, laminated metal signs at popular publicly-accessible shoreline fishing locations, in Hmong, Spanish and English" (MEJO 2008: 2). Through MEJO's efforts, by May 2009 twenty-two fish advisory signs had been placed in shoreline fishing hot-spots around Madison.

However, even after all of the efforts on MEJO's part, the efficacy of the Madison fish advisories can still be called into question. As demonstrated by the data gathered by MEJO in 2009 and compiled in their report "Evaluation of Fish Consumption Advisory Signs on Dane County Shorelines (Pilot Project)," there remained "many substantial race-based disparities in awareness about fish advisories, fish consumption, and in information environments" (Powell, Xiong, and Powell 2009: 7). For example, 73.6% of nonwhite anglers still reported regular fish consumption as opposed to 29.1% of white anglers, and while 60% of nonwhite anglers received their fish advisory information from the fish advisory signs compared with 38.5% of white anglers, only 46.2% of nonwhite anglers had read the fish advisory signs as opposed to 69.1% of white anglers. MEJO's analysis of these findings reveals many of the same problems that have been explored with fish advisories in a larger context, and MEJO cites both language and cultural issues such as "trust in authority, comfort with written information, and overall differences in information environments of whites compared to non-whites" (Powell, Xiong, and Powell 2009: 8) as some many of the main problems that limit the efficacy of the Madison fish advisories. While MEJO does not call for broader policy based action to address the larger issue of reducing levels of toxins in Madison fish and lakes in these reports, it is clear from their findings that fish advisories in Madison continue to be problematic and largely ineffective in protecting at-risk communities from the hazards of fish consumption.

4. Summary

While fish advisories have been shown to be problematic, ineffective, and environmental unjust in Madison and across the country, they still play an undeniably important role in protecting communities from the hazards of toxic fish consumption, and therefore strategies must be developed to improve these advisories. This is due to the fact that even if policymakers instated groundbreaking policies on reduction of contaminants in water systems today, entirely ridding a system of contaminants takes time. In the Everglades of Florida, reduction in mercury inputs resulted in a decline in fish tissue over a period of eight years though other contaminants and initial contaminant levels will influence the reduction process significantly (Burger 2006: 276). Though the argument is true that cleaning the lakes should be the utmost priority and ultimate solution, it is necessary to improve on fish advisories until the contaminated water bodies of Monona Bay and Lake Wingra are clean.

G. Methodologies

1. Purpose in Chosen Methodologies

Urban fishing and freshwater urban fishing in particular, are complex topics that vary significantly over geographic studies due to inextricable ties to the very foundation of the issue, the physical and anthropological interactions upon a space. Integrating the few place specific compiled studies and statistics on Monona Bay and Lake Wingra with the research of pollution history, environmental justice, risk assessment, toxin accumulation and health risk, and variation among angler perception and cultural influences is akin to examining ones backyard through the splotchy glass window.

Given the few studies focused on Madison and the specificity of risk and urban fishing to a particular geographic space, addressing our research question “Are there disproportionate risks fishing in Monona Bay and Lake Wingra for different segments of the angler community?” requires an open, exploratory research approach. A collection of interviews with key individuals, namely anglers but including government DNR officials, environmental justice advocates such as MEJO, and water quality experts will allow our research to be exploratory. Interviews will also allow more flexibility in building and understanding those most at risk rather than limiting our research to our conceptions of risk and pollution on the lives and experience of anglers based off surveys. Most importantly, through the process of interviews we can more heavily expand on certain aspects of our research including cultural influences, the effectiveness and place-specific obstacles of fish advisories in Madison, and better understand if and how certain individuals are more at risk through interviews.

Though the limitations of primary research are plentiful given a shortchange of money and thus time as undergraduates, it is of particular interest to pursue both formal and informal interviews. Those we will formally interview will be given a list of questions prior to the interview in order for them to best prepare their answers. Formal interviews will also be recorded and used in our documentary. As many of us are outside of many of the angling community circles separated by language, culture, knowledge, and overall trust, we acknowledge the potential of not having in-depth interviews, particularly among subsistence and minority anglers. Through formal interviews the goal is to be given space to access more detail and clarification as a person-to-person interaction. Informal interviews will happen conversationally as we speak with anglers in public, and may be recorded and used in our documentary if the angler agrees to it. As a complimentary factor, informal interviews will bring a breadth to our subject and more concrete glimpses into the harder to reach individuals in Monona Bay and Lake Wingra.

Our goal is to present our subsequent breadth observations and interviews in a documentary form. A documentary will visually bring the faces and voices of the community to the forefront represented as a people rather than disconnected statistics or hidden individual experiences behind numbers. Certain aspects of numerical statistical research is certainly necessary and applicable, however given the half-empty glasses of toxin and broad data representing anglers, it is important to understand the issue from the ground up: through the anglers themselves.

The angler interview questions will be of particular interest given their role in addressing our research question. In particular, asking profile questions such as, “How often do you eat the fish you catch, what parts of the fish do you catch” will give a general idea of toxin risk without making the individual feel directly confronted. Addressing compounding variables of increasing risk, namely awareness of advisories and posted physical fish advisories will further provide insight into general observations in which advisories are effective or ineffective in communicating toxin risk through specific fish consumption behaviors. Other open ended, personal questions including “Have you noticed any changes to the lakes, are you concerned for pollution in these areas, and in what ways could the city improve your fishing experience” will provide a more exploratory means of gathering information specific to Madison or particular demographics.

2. Logistical Considerations

The bulk of our primary data will be gathered through video recorded interviews with anglers, fish and lake experts, and officials from the public sector that are either involved with or are knowledgeable about the topic of fish consumption in Madison.

These video recorded interviews will help us understand the perceptions of risks and concerns among anglers about the lakes and the fish in them while also allowing us to compare and contrast these perceptions and beliefs with those of experts and officials. The interviews will be semi-structured, meaning they will consist of a unique set of questions designed for accurate responses from different groups (anglers, officials, experts). The interviews will be conversational and informal in tone to allow for an open response in the participants' own words (Longhurst 2010: 105).

Pictures, informal interviews, and observations will additionally be used as primary sources to collect information related to the research question such as perceptions and consumption levels among shoreline anglers at Monona Bay and Lake Wingra.

Through participant-observation, we will approach anglers while fishing with an informal tone to talk to them about the research project, the methods involved, and whether or not they would like to participate in any way. The researcher(s) will have a photographic camera, a video camera, an audio recorder, or a notebook to take notes during informal interviews to recall and synthesize afterword (Laurier 2010: 121).

However, these informal interviews will remain anonymous with the camera either facing downward or away from the participants' face and avoiding/silencing the use of the participants' personal information. The hope is that the anglers we talk to will 'open doors' to speaking with other anglers creating a 'snowball effect' to increase the chances of successful formal and informal interviews (Longhurst 2010: 109). It is also important to note that we are interacting with people who are part of cultures likely very different from ours. While they live in the same region as we do, it is necessary to be aware of the feelings of other people in order to prevent offensive behavior (Smith 2010: 158). In particular, we must be careful with our word choice when talking with anglers about our research and also make sure we have their approval before any kind of filming or photography takes place.

Additionally, we will use primary sources to examine the historical time period and the history of pollution in Lake Monona and Lake Wingra. This information will give us a broader understanding of the problem of pollution in the while also giving a history of lake use by the community (i.e.: recreation, consumption, sewage).

We will also make use of secondary sources to further the understanding of the complexities involved with pollution in the lakes and other aspects of the study including: perceptions of risk, cultural variation, environmental justice, and history of land-use change in Madison relative to the Yahara Lakes. These secondary sources will primarily consist of previous surveys related to our topic and peer-reviewed studies, including interviews with anglers throughout the country.

As researchers, there is an ethical responsibility to protect the rights of individuals and communities involved with or affected by our research (Hay 2010: 36). This means keeping informal interviews confidential and allowing participants to completely withdraw any information from the interviews, both formal and informal. It is our goal to remain objective throughout the research project, meaning representation all key players involved without bias and respect our voluntary participants.

H. Results

The purpose of our project was exploratory means, and the main focus of our project was to be more oriented towards depth of individual interviews rather than survey data. However, a combination of in depth interviews, informal observations, and informal interviews provided insight into better understanding the three parts of our research question (1) who fishes the shorelines of Monona Bay and Lake Wingra (2) to what extent these individuals are at risk considering the plethora of factors such as the nature of certain toxicants, number and species consumed, in addition to angler profile such as culture, gender, age and lastly (3) if these individuals are at risk, are they aware of their health risk?

Formal interviews included Maria Powell an environmental toxicologist and President of the Midwest Organization of Environmental Justice (MEJO), Candy Shrank a Wisconsin Department of Natural Resources (DNR) toxicologist, Kou Xiong a DNR Hmong outreach coordinator, and three Lake Wingra anglers Jeff, Nate, and Patrick.

1. Who fishes in Monona Bay and Lake Wingra?

Our informal interviews and observations suggest a wide range of diversity including age and ethnic variety, and gender of those who fish the shorelines of these waters. Angler I2 was visually impaired angler who had been fishing his whole life. A group of preteens were noted to be fishing alone in an informal observation on October 10th. There were a handful of accounts of African American anglers observed fishing at both Lake Wingra and at Monona Bay. There also were a group of anglers of Asian descent observed in September. A large portion of our anglers were retired, and of ages typically ranging from late 40’s all the way up to 73 years of age. We found that many of the anglers at Lake Wingra tended to be from the Madison area and often had been fishing the area for most of their lives. Roughly half the anglers informally interviewed at both Lake Wingra or at Monona Bay would mention fishing with their significant other, family, or children as a pass time.

Of the informal interviews on Monona Bay and Monona Terrace, 7 were African American or black folk who came from Milwaukee to fish in Madison, suggesting that a certain amount of anglers at Monona Bay are traveling there specifically to fish and are not local residents. Anglers G, H and angler groups A, B and D had all traveled from Milwaukee, however only angler D1 mentioned actually consuming the fish caught as a means of diet supplementation. Anglers C, E, F, I2, L, M and angler groups J and N were all from the Madison area originally or had been living in Madison for an extended period of time.

As informal interviews could range from 10 to 40 minutes, in order to answer the question of who shoreline fishes at Monona Bay and Lake Wingra, we collected observations regarding rough estimations of age, gender, ethnicity and any other substantial information. However, it should be noted that judging a person's age, gender, and ethnicity involves huge error given the bias of the observer in addition to how the person identifies that may not be discernable by a mere glance. For example, if Angler H had been observed rather than informally interviewed, it is highly likely he would have been categorized as black or African American rather than Jamaican. Similarly, Angler I2 said he was blind during an informal interview, but this would unlikely be determined by observation alone given the circumstances that he was wearing glasses and sitting in a lawn chair fishing (See Appendix B). For this reason, our observations are useful as an exploratory means in understanding the diversity of anglers, however they are by no means representative of Madison's angling community.

From our observations additionally provide insight into gender, age, and racial diversity. The gender demographic was primarily male though often women were present in groups with men, only one group of all women were observed. Women were also observed with other children and other families not fishing while other surrounding males were.

The age of observed anglers also varied immensely, where young children to white haired, older individuals were seen fishing at Monona Bay and Wingra. Though we attempted to categorize rough ages, in general, ages 40 years and older were observed fishing more frequently than other ages. From our data, young adolescents to about 25 years of age groups totaled 6 times, and thus not as frequently as those observed in their late 30s and up. There were only a handful of occasions where children were observed fishing on their own.

As stated previously, determining an angler's race through observation alone is fairly difficult and somewhat misleading. From our broad racial categories, our observations were predominantly African American or black. Caucasian groups were second highest observed and the broad "Asians" category observed 5 times with one informal interview. There were no observations made for Latino and Latina anglers (See Appendix C).

From the formal interviews, Maria Powell and Kou Xiong stated that Hmong frequently fish from the Madison lakes (Maria, 2013). In general, Kou Xiong stated, "We have a Hmong population of 57-58,000 here in Wisconsin. I've found out that there are approximately 16,000 fishing and hunting here in Wisconsin" (Kou, 2013). Maria also mentioned Latino and African American or black folk also fish in Monona Bay and Lake Wingra. Of the African American and black demographic, this broad group fishing in these areas tended to be primarily from Milwaukee (Maria, 2013). Neither were able to provide population estimates for each of the racial groups who fish in Monona Bay or Wingra. However, it is clear based on the collected data from observations, informal interviews, and formal interview, a wide variety of people within and outside of Madison fish in these waters.

2. To what extent are these individuals at risk?

Risk is difficult to discern based on our research as it involves a complexity of lacking information, different health risks for different toxins, and variability of species consumption, what parts of the fish, and how many. We attempted to identify risk by asking anglers questions concerning the species, means of preparing, and how fish was consumed in addition to awareness of toxicants in the waters and fish (See Appendix A).

Given the complex variability of toxins and limited data, we relied primarily on our research generally many toxicants are influenced by bioaccumulation, meaning that large, fatty older fish accumulate more toxins. This was used as a broad means to determine risk among the informally interviewed anglers. Other factors of risk based on our research to determine risk included greater consumption of fish over a weekly basis, in addition to the consumption of fish organs, fish fat, or gills (head) for PCBs, cyanotoxins, arsenic, potentially PAH.

Overall, many anglers preferred to catch and consume bluegill, crappies, and other smaller pan fish indicating the potential for lower toxicant accumulation and thus lower health risk. However, it was not always included in the interviewed how many fish were eaten on a weekly, or monthly basis. As stated previously, teasing out the extent of health risk is very difficult, particularly for species beyond the general rule of thumb of avoiding larger, fattier, carnivorous fish. The 2012 *Fish Wisely* guide produced by the DNR for example, states that consumption of bluegill and other small pan fish for men and women beyond pregnancy years are unrestricted, implying little to no risk consuming these smaller fish in large quantities. However, in contrast, Maria Powell emphasized the principle of bioaccumulation can be magnified in human behavior of consumption of fish as well. Thus, consuming multiple small fish on a daily or weekly basis can increase toxicant accumulation and thus human health risk associated with the various toxins (Maria, 2013) This contrasting information poses more serious questions as to the necessity in further researching the toxicant accumulation in Dane County fish in order to establish guideline beyond speculation and general bioaccumulation principles.

A total of 5 of our 18 informally interviewed anglers, Angler A, Angler B1, Angler D, Angler H, and Angler O ate fish other than bluegill. It was either explicitly stated by the angler or referenced to what they had caught that day for consumption means. However, in these interviews it was not clear if these men were exceeding DNR recommended standards of eating these species beyond DNR standard, which states limiting walleye and catfish to once a week to avoid PCBs and mercury (Choose Wisely-2012 2012: 9-10). From our informal interviews, based on our data it was much more difficult to discern if they were at risk based on their dietary consumption.

Many anglers, Angler A, B, D, J, L all stated that they fried their fish, which involved often, the removal of the inside organs but consumption of the head. Other variations included Angler T who stated that he occasionally made soup from the fish (See Appendix B). Again, this does not imply increased risk, but does indicate that variation fish preparation and specific parts of the fish consumed, there is potential risk from consuming the head and thus gills (See C. and D. of Literature Review).

In examining risk awareness, without awareness of government posted advisories or awareness of information concerning the risks associated with excess fish consumption, certain individuals may unknowingly exceed WDNR standards for fish consumption and be put at greater risk. As discussing pollution was a perceived uncomfortable question, we attempted to discern awareness and pollution through multiple questions of pollution awareness, awareness of physically posted advisories, and where they got their information (See Appendix A).

From informally interviewed individuals who were Caucasian Angler E, Angler F, Angler I, stated they did not eat any of the fish, primarily from observed fish advisories posted

(Angler E) or concern for pollutants and lake cleanliness from other sources (Angler F and I). All 3 anglers also expressed extreme shock or disgust when asked if they ate fish from these lakes, emphasizing the importance to them, to avoid consuming fish based on the lake's conditions. Angler C and O both stated they ate lower level trophic fish. However, Angler O stated he received his information from the DNR website and Angler C stated he "did not play on the internet", he did not know about the toxicants in the fish and lake (See Appendix B). Overall, 4 out of 6 informally interviewed Caucasians had seen fish advisories and knew of toxicant presence in the water. Moreover, about 3 avoided eating self-caught fish from these waters altogether basing their behavior on the observed fish advisories or other resources affiliated with the DNR.

In contrast, informally interviewed anglers who were African American or black often did not see fish advisories or have any knowledge of toxicants in Monona Bay or Lake Wingra. A toal of 6 out of the 10 African American or black anglers Angler A, B, C, D, H, R stated that they neither saw the fish advisories and did not know that there were toxins within the water. Angler D interestingly, did know of fish advisories when receiving his fishing license, but could not recall its details nor had associated its content to toxicants in the lakes. Furthermore, 4 anglers, Angler G, S, U, K who were African American or black had heard of fish advisories or seen the physically posted advisories, where anglers K and G mentioned specific acknowledgement of mercury in the fish.

The 2 remaining anglers Angler H who was Jamaican and Angler T who was broadly categorized as Asian, both stated they were not aware of the posted fish advisories. Angler H further stated he did not know of any pollutants in the water and was not concerned fishing from Monona Bay (See Appendix B).

Given that our sample size is incredibly small, it is difficult to assert total risk, particularly from fish consumption given lacking details of how often fish were consumed but moreover the accuracy of assessing risk given the limited data of toxicant nature and accumulation in fish (See C. of Literature Review) in examining collecting informal interview information on risk awareness, though the sample still remains small, what the data potentially suggests is of importance. Of the broad groups of Caucasian and African American/black, only 1 of the Caucasian group stated he was not aware of either pollutants or fish advisories posted for Lake Wingra and Lake Monona, in contrast to 6 out of 10 African American/black anglers. The total number for unawareness of advisories and pollutants in the water regardless of race or individual identifiers totaled 9 of the 18, or about half of the informally interviewed anglers. This raises some concern, that despite being a small sample size, anglers are not aware of pollutants or fish consumption advisories, potentially putting them more at risk than the other 9 anglers who are aware of fish advisories.

Determining the why for the discrepancy that half of informally interviewed anglers did not have either pollutant and fish consumption awareness can't be assessed based on our data alone. From our research, we speculate a variety of causes including lack of accessibility to DNR resources such as the internet, mistrust of their organization, few signs posted where anglers heavily fish, and language barriers (though perhaps more for Latino and Hmong, Vietnamese, Cantonese, and others).

Of the anglers we formally interviewed, we found that there was a wide range of contact with physical fish advisory signs. All of our formally interviewed anglers were older, Caucasian males from the Madison area. One of formal interviewees had actually seen the fish advisory signs, while another formal interviewee knew of the signs but preferred to reference the DNR's

Fishing Regulations to the signs. The third formal interviewee had never seen the signs but knew of the DNR's resources and guidelines relating to fish consumption. All of them were aware of the PCB and mercury contaminants. All 3 formal interviewees additionally mentioned sources of toxicant pollution broadly as urban runoff and phosphorus. One of the formal interviewees gave specific information concerning the risks of eating the gills of the fish. Though it is possible this knowledge was known prior to the interview, it is possible that this anglers answers were somewhat influenced by our extensive research in our literature review.

Moreover, all 3 formally interviewed anglers received consumption guidelines through the Department of Natural Resources when obtaining their hunting or fishing license. They also mentioned retrieving consumption information through other online sources or from press releases.

Kou Xiong said certain parts of the fish that are high in PCBs are consumed by Hmong due to traditional recipes and dishes prepared. A difficulty the Hmong people may encounter with fish advisories is reflected especially with elders whom do not know how to read English, making it difficult to reach out and communicate possible risks to them. Kou also stated that, "In my generation, we don't have the education in English. So, the DNR provides the brochure that is all in English and the older generation cannot understand it, but the younger generation can now understand English." (Kou, 2013). Furthermore, when talking about older Hmong who do not read English, he states that, "especially the fishermen and the women cooking the fish so the brochures are not very effective for the family." (Kou, 2013). He mentioned that this is slowly changing with the growing Hmong youth who can also read English in general he stated that very little has changed in Hmong fishing and fish consumption habits (Kou, 2013).

Kou said this lack of awareness of risk within the Hmong community may stem from the fact that in their "homeland" Hmong people could fish and eat fish out of the waters without the risk of being exposed to the toxins. This assumption that the fish are safe to eat is carried over here to the Madison lakes, which puts these individuals more at risk than those who have access to toxicant and advisory information.

Maria Powell additionally mentions the discrepancy between the assumptions made about consumption by the government and the actual amount of fish consumed. "Government folks have told me they know people eat fish but they don't eat much of it or they only can catch the smaller fish from the shore. Both of those things are simply not correct," (Maria, 2013). The general assumption by the government, not just the DNR, is that few people eat the large fish, which have a higher risk of bioaccumulation of toxins. This is highlighted in our interview with Candy, " What we do know is that people don't eat a lot of fish and so they probably don't need to change their consumption habits after looking at the advisories," (Candy, 2013). This shows that the disconnect between what government agencies perceive as typical angler behavior and actual angler behavior poses a threat to the angling community, who are consuming more fish than what is thought of them.

According to Maria Powell, the biggest barrier with communicating these risks comes in to play with those who do not have access to the internet, do not own a car, can't read English, or are not aware of resources available that would communicate these risks to minority communities. Kou additionally stated that for the Hmong communities, pamphlets and information available in the Hmong language were available in offices, but there is little outreach to the Hmong community. He suggested that a more direct connection in helping the Hmong community become more aware of health risks would be more effective (Kou, 2013).

Minority anglers were especially difficult to formally interview because many had traveled from other parts of the state and could not set aside time for interviews. There also was a language barrier problem that prevented us from effectively communicate and interview certain groups within the minority community to effectively gain an insight into their perspectives on the lakes and fishing in these waters.

Maria Powell further assessed that those at risk were anglers who subsistence fished. Subsistence angling put those more at risk in the Madison community. Even if consuming smaller pan fish, often accumulated numbers could result in high risk for toxicant concentrations. However, these individuals also faced complications of needing to feed themselves or their larger families. Lower income, especially among recently immigrated Hmong, meant reliance on fish for consumption and thus higher risk of toxicant information (Maria, 2013). As Kou had stated, Maria also emphasized that language barriers and lack of government reaching out to these individuals specifically put them more at risk because they were not aware of this information or risk. (Kou, 2013 and Maria, 2013)

During our formal interview with Candy, a toxicologist within the DNR, she presented the viewpoint that there are very few people who consume the fish they catch out of the Madison Lakes. She states that, "[angler's risk] Awareness is high but effectiveness will vary by person. Most people don't eat a lot of fish, don't need to change their consumption habits." (Candy, 2013). This contradicts our findings from our informal interviews, because we talked to a number of anglers who were fishing for the purpose of consumption and who were consuming many fish in one setting or multiple times throughout a short time span. This reinforces the complications of this issue as a whole, because those in the position to make consumption guidelines are not recognizing certain behaviors of anglers in the Madison.

3. If these individuals are at risk, are they aware of health risk?

Awareness of health risk ties closely into awareness of the fish advisories. However, in examining this question more closely, whether anglers understood significance of fish advisories on human health can't be easily determined from our data alone either. Given that we did not make this specific distinction in our informal interview questions, we rely primarily on our analysis of the informal interview.

As stated previously, about half of the informally interviewed anglers were aware of the fish advisories. However, this does not further bridge the gap of associated health risks to them as anglers. Some of the anglers Anglers E, Angler G, Angler I who mentioned awareness of fish advisories or other fish advisory resources specifically mentioned the importance of avoiding fish consumption for women and children, but not their demographic as men (See Appendix B).

Moreover, as we had done considerable research into the actual health effects of the toxins, from our informal interviews, none of the anglers mentioned what the specific health effects were. Though pollution by itself is a big enough deterrent for its nomenclature association with health risk, the lack of understanding the implications of health risk may additionally contribute as a factor in decreasing health risk. This idea however, is complicated from a political and limited information standpoint. The limited data on fish toxicant accumulation and toxicants in the sediment in Monona Bay and Lake Wingra can neither truly support nor deny the extent to which these toxins are of risk. Given that fish advisories are based primarily on assumptions and precautionary principle of risk rather than toxicant tests for Dane County, it is misleading to post specific neurological and cancerous health risks associated with fish consumption. However, that does not mean that these health risks are non-existent. Many toxins have yet to be tested in these waters, but have a likely, strong presence given the history and sources of toxin input into these waters. Maria Powell stated that many toxins that are yet to be tested, such as PAH, 2,-4D, many of Dane County's lakes may potentially put all anglers at more risk than is perceived by government because the information they function upon, has a limited scope for Dane County's lakes specifically (Maria, 2013).

Many of our formal interviews showed that anglers recognized risks for children and pregnant women for consuming fish, but none of them could articulate any specific health effects. These same anglers mentioned receiving consumption information from DNR guidelines, which do not address health effects associated with consumption of toxicants. Two of the anglers could speak for mercury advisories but not to risks. Nathan said, "I don't think I've seen any health advisories besides mercury warning for the Madison Lakes," (Nate, 2013). Patrick also stated, "The only thing I can think of as far as Madison is the small pan fish, and the amount of mercury in the fish and warning people not to eat too much because of the mercury content," (Patrick, 2013). Although some anglers may be aware of consumption guidelines, that does not necessarily mean they are aware of the actual health risks consumption poses.

Maria mentioned that with her experience through MEJO, many anglers were not aware of risk exposed through consumption. "The anglers themselves aren't always aware and that has to do with structural inequalities in the first place: lack of awareness, lack of resources, lack of time to sit at meetings and learn about fish toxins." (Maria, 2013). This suggests that though minorities are more at risk for toxicity exposure from fish consumption, generally these health risks are not known by the greater angling community.

Again, our interview with Candy farther showed a disconnect between the government and public communities when it came to awareness of risk. Candy stated that, " The awareness is high. The effectiveness, of course, is going to vary by person, depending on what people actually do," (Candy, 2013). Suggesting that it is generally believed that the angling community is aware of these risks, but how they perceive and choose to act based on that awareness (i.e. in regards to consumption) is the individual's choice.

4. Other Results

When asked how the city could improve their angling experience, many informal interviews didn't talk about cleaning up the lakes. Instead, they suggested a more logistical process of access to the lakes, private property, and other immediate angling associations. Concerns of anglers may be reflective of lack of information of toxic pollution and health risk, but also immediate concerns about the fishing experience. Anglers C1 and F1 both mentioned that access to lakes was an issue for them because the land around the lakes was increasingly becoming privately owned. Angler I1 though more trash cans placed in strategic places of high angling traffic would reduce litter around the lakes. Angler E1 didn't like the dam at Lake Wingra and felt it has negatively affected fishing at the lake since it's addition.

The formally interviewed anglers had little to say about cleaning up the lakes in regards to toxins. One stated that it was a given thing that people had to live with. There was also a sense that overall, there was a certain level of trust for the government provided resources addressing toxins. Our interview with MEJO's Maria Powell suggests that this sense of trust may not be the case for some minority groups.

We found that there was certain misinformation about the present toxins and how to identify these toxins from both minority and Caucasian anglers. Many anglers based the level of toxins on the "cleanliness" of the lake by visible factors like liter around the lake or algal blooms. Angler I1, a Caucasian female explained that she could identify toxicity or pollution based on physical factors such as trash and clarity or darkness of the water. Angler B1, an African American male state the methylmercury could be concentrated and visibly seen in "little balls," in the fish, and toxins were visible in a fish's arteries. He also stated that toxins were concentrated in a fish's skin, and so consumption of toxins could be avoided by not consuming those areas. Similarly, Angler K, another African American male said toxins like mercury could be removed by means of a salt bath. These perceptions on pollution and methylmercury however, are not accurate. Some further spoke in general in determining fish consumption based on whether the fish visibly appeared healthy. Though this is true for avoiding the health risks that come with consuming rotten or dead fish, this is not telling of actual toxicant accumulation.

We mapped the locations of informally interviewed anglers and some observed anglers at Lake Wingra and Monona Bay. In this map we attempted to spatially examine the factors of whether or not the angler had seen posted fish advisories, where popular fishing spots were, and the fish advisories for both areas (Appendix D) .We found that there were only 2 fish advisory signs for all of Lake Wingra and 3 for Monona Bay. Though it is a relatively smaller set, the striking difference of the two maps is that Monona Bay has several "No, did not see posted sign" in contrast to Lake Wingra which consists of either "yes, saw posted sign" or no data. We speculate a reason for a difference in signs reaching anglers at Lake Wingra than Monona Bay may be due to the limitation of where anglers can fish. At Lake Wingra, due to the fishing restrictions at the Arboretum, only 2 miles of shoreline are available in contrast to a much more expansive and of Monona Bay. Moreover, tracking down signs for Monona Bay may be harder as these signs are obscured landscape of parks, parking lots, and railroad tracks in contrast to a relatively flat and clear shoreline of Lake Wingra. This may also explain why on the Monona Bay map, even though some anglers were relatively close to the sign spatially, when informally interviewed, stated that they had not seen the signs. However, this spatial analysis is only reflective of our limited collected data set.

5. Other Result Considerations

For formal interviews, it was difficult to reach individuals who were related to the sciences who could speak to the toxins present in the lakes as well as the geographic and biological history of the lakes. One professor commented, "I don't do these types of interviews." It is possibly that the project of environmental justice was a deterrent topic that scientists and water quality representatives were uncomfortable representing, given direct association of an interview and a politically controversial topic. It was also very common for a contact to pass us on to "other" parties. Typically these kinds of interactions were accompanied with the phrase of "not having enough expertise or knowledge [for the topic]". This persistent reply may have been elicited by communication problems on our end on the difference between our project's goals and the intended purpose of the interview. There is also a possibility that uneasiness of underlying film crew agenda that the contacted individual felt would misuse their image and words. We also perceived there was an issue with having a visible video camera during informal interviews. There is a possibility that we may have received different answers to our questions without the camera due to apprehension or because of certain individuals overfishing with the intent to resell the fish in other cities.

We faced many different issues that made it difficult for us to reach anglers for formal interviews. The fishing season was rapidly coming to the end at the beginning of our project, so starting this project earlier on would have allowed us more time to reach a greater number of anglers. Moreover, of the interviews we did successfully complete, they took a significant amount of the participant's time, however the longer interactions allowed for more of a relationship to be built between the interviewees and us.

For our informal interviews, the four of us went out to Monona Bay and Lake Wingra at various times throughout the day to informally ask anglers the questions written in appendix A. Anglers A-I were primarily in the morning at Monona Bay, though there is an exception of one in the afternoon at Monona and two Lake Wingra interviews. Reaching demographics may have been more effective and vary results of who eats larger predatory fish, if interviewing at late night or early morning.

Furthermore, our general angler observations may not be completely reliable because our primary focus when going out to the lakes was to informally interview anglers. This focus may have caused general observations to be overlooked.

I. Future Research

From our literature review, it is clear that many barriers in assessing risk stem from the "likelihood" of risk based on several factors due to the lack of data concerning fish toxicity levels as well as various toxicity levels in humans and especially minorities. The studies that we found during our research for Madison were only a handful, many that were limited to sediment testing, one season, or almost exclusive testing on white anglers. In order to breach the cyclical problems of uncertainty in determining who is more at risk, it is important for further research to be conducted in testing the fish for Dane County specifically and minority communities. In considering the wide variability and exposure that toxins negatively affect human health and development, no tests for certain toxins such as PAH and 2,4-D should be expanded upon in addition to small-sample studies of concern such as MEJO's PCB study. It is of utmost importance to begin testing toxicity in fish and minorities from self-caught fish, despite time and cost for the government.

There are sensitivities that must be considered for cultural perceptions on toxicity testing but these barriers can be overcome if the importance of such tests is adequately communicated. In the case of the Hmong community for example, it is inappropriate to give away one's hair, a sacred part of one's soul and identity. However, MEJO in working with the Hmong community, were able to establish a relationship of trust and assurance for what the hair was used for explicitly, and then after the test that the hair was returned to its owner.

Though our own data revealed potential insights, given the various constraints of time, lack of credibility, and lack of funding, this research can be radically be expanded on. Given the timing of our project starting in September and ending in December, our group caught the tail-end of summer fishing and ended too early to examine ice fishing. It is important to consider the seasonal differences in risk and demographic changes, as certain types of fishing tend to attract different demographics and influence the types of fish caught and consumed. To more comprehensively answer our research question "Who fishes at Monona Bay and Lake Wingra" it is important to consider the seasonal pulses and thus demographic variation that occurs with different fishing seasons.

Moreover, it is important to establish relationships with various communities, organizations, and people early on. Though our group anticipated challenges in trust and willingness to informally and formally interview from the angler community, we did not anticipate reluctance of other topic-specific experts. From our research experience, finding individuals within the Madison community willing to speak and represent their perspectives on this issue in addition to establishing meaningful and trusting relationships among minority communities takes time. Though we were successful in our informal interviews and a fairly good number of varied formal interview representatives, to further understand Madison geographic lakes and angling community requires the time to provide space and support in hearing these stories openly. Some examples include the Latino and African American Communities, but moreover Native People such as the Harry Whitehorse family who have stayed in Madison since the 1830s (Maria, 2013).

Future research considerations for informal interviews are many. Given the restrictions of four undergraduate students with set schedules, we were unable to cover many different hours of the day and thus adequately reflect different demographics that prefer to fish during different parts of the day. For example, Anglers A-I were primarily Monona Bay in the morning and reflected generally, a large African American or black groups of male anglers from Milwaukee rather than Madison. However, informal observations done in the middle of the afternoon tended to involve older, white males (See Appendix C). To more adequately asses who fishes at Monona Bay in addition to different fish that are caught at different hours, it is important for future research to investigate various hours of the day including early morning and late night. Moreover, there were few perspectives of angler women, though there were five angler women in particular that spoke in the informal interviews (See Appendix B). As informal interviews additionally take time, though more females were observed fishing than represented in our informal interviews, given the time constraint it was not possible to talk to them all. Moreover, taking the time out of an angler's day for an informal interview was time consuming. Interactions varied considerably and in some cases, certain information could not be collected given the spontaneity of the interview and time constraint of the angler.

In addition to cultural perspective, it is important to consider potential differences in perceptions, and types of concerns that women may hold. In regards to communication, even for informal interviews at times, a very strong language barrier was present. From our experiences, this was primarily from anglers of Southeast Asian descent, though this is not limited to this particular demographic. Given the limited fluency in certain languages that our group could speak, this added an extra complexity in reaching certain members of the angling community.

A final consideration for informal interviews is the presence of a video camera. Though in some cases anglers thought it amusing when individuals of our groups asked to film them fishing, it is possible for anglers fishing and re-selling their caught fish, the presence of a camera potentially meant legal trouble and may have influenced immediate distrust.

All in all future research should consider pushing for toxicity test on fish and humans, and especially minority communities in Madison and Dane County Area, longer research time frames to encompass all fishing seasons in Madison, a more thorough and reflective time schedule of informal interviews including early morning and night, and more time in order to connect to various communities and establish trust in interviewing and thus hearing angler voices from the Madison community. Though all of these are challenged by obstacles such as time and money, it is important to consider these factors to better determine and assess the research question of who or what communities are more at risk fishing in Monona Bay and Lake Wingra.

J. Conclusion

As demonstrated in the above analysis of the research, it is clear that of fishing communities, anglers from minority communities are the most likely to consume amounts of fish exceeding recommendations putting these anglers at higher risk of experiencing health problems associated with these toxins. While not much comprehensive data exists on toxins in the Madison lakes and their effects on the Madison fishing community, a survey of the available information from across the country and knowledge of the history of the Yahara watershed indicates that many toxins are present in these lakes that have serious implications for the health of both aquatic ecosystems and people consuming fish from these ecosystems. Drawing from these conclusions, it is clear that communities of color are at disproportionate risk for exposure to toxins in fish and therefore experience an unequal burden of toxic pollution of water systems, making this an environmental justice issue.

Besides information compiled by MEJO, there is a great dearth of information in Madison on many topics related to fish consumption. The research produced by MEJO's initial studies in Madison are laudable in that they uncovered and brought public attention to this environmental justice issue within our own community. However, while these studies were a great first step in establishing the disproportionate exposure to toxins through fish consumption that minority anglers experience here in Madison, they serve largely to demonstrated the great need for further investigation into this issue. Much more research needs to be collected on the pollutants and toxins present in the Madison lakes that are hazardous to the angling community through increased sediment testing, fish testing, and testing of exposure to toxin levels via fish consumption. In addition to these studies, however, MEJO's work mostly served to demonstrate the need for exploration of the environmental justice aspects of this issue within Madison, by bringing to the surface the story of communities that are placed most at risk from the hazards of toxins in Madison's lakes and fish.

Through our research project, we hope to address the lack of information in relation to the above-mentioned topic, by exploring who is fishing in Monona Bay and Lake Wingra and how these communities are placed at risk by lack of effective communication and government policy in relation to fish consumption. In a larger academic context, our project will contribute to the growing literature on environmental justice, environmental policy, and risk communication through a place-based case study of fish consumption in Madison. By weaving narratives of anglers, environmental justice advocates, academics, and government officials with both primary and secondary historical and current data about fish consumption in Madison, we will examine various facets of the complicated, multi-layered issue of fishing for subsistence in the Madison lakes, and hopefully shed light on a largely invisible environmental justice issue within our own Madison community.

VI. Appendix A: Angler Interview Questions and Statement

We deeply appreciate your participation in our senior Geography project. The purpose of this interview is to understand the perspectives of people who fish in the Madison lakes and also public officials who may have health and environmental concerns about fishing in these areas. Our research and these interviews will be presented in a 8-15 minute film documentary.

Safeguarding your personal identity is important to us. We will not use your name or other personal identifiers without your written consent.

This interview is voluntary. You may withdraw at any time or choose not to answer any questions. If you wish, you may review the footage of your interview before we use it in the documentary. If you do not approve, we will NOT use it in the documentary.

Please feel free at any time during the interview to ask the interviewer questions regarding our research. If at any time you wish to see progress on our research please contact us at matsumotoher@wisc.edu.

You are welcome to attend our final product presentation on the UW-campus in 180 Science Hall on Thursday, December 12, 2013. Class presentations start at 4:00pm. After our project is finished it will also be digitally archived on the Minds@UW website. Please contact us if you would like a copy of the final project.

Sincerely,

Makie Matsumoto-Hervol
Ellie Shand
Mitchell Johnson
Jessica Duma

Angler Profile

1. Who first introduced you to fishing? (example parent, other family member, friend, no one (yourself)

2. Where do you like to fish in Madison?

3. How many times have you gone fishing there (ie Lake Wingra or Monona Bay) in the past month?

4. Do you fish throughout the year?

5. What is your favorite season for fishing?

6. What are your reasons for fishing? (Are there more strong reasons over others?)

Angler Consumption

1. Do you typically eat the fish that you catch?

2. What are your favorite fish to eat from the Madison Lakes? What are your least favorite fish to each from the lakes?

3. How often do you eat the fish you catch?

4. What parts of the fish do you eat? What is your favorite recipe?

5. Do you share your catch with friends or family?

Angler Perception and Knowledge of Risk

1. Have you noticed any chances in the lakes since you first started fishing there?

2. Do you have concern for lake pollution in these areas? What are your concerns?

3. Do you have concern for algae in these areas? What are your concerns?

4. Are you concerned about lake access? What are your concerns?

Advisories

1. Have you ever heard or seen any health warnings about eating fish from the Madison lakes? If yes, do you remember what the warning said?

2. Do you remember where you saw or heard this warning?

3. Do you have any concerns about eating the fish you catch?

4. In what ways could the city improve your fishing experience?

Secondary Questions:

1. Where do you primarily fish in Madison and why?

2. Do you prefer to fish alone or with a group?

3. Are you a local to Madison?

4. Do you primarily shoreline fish or fish from a boat?

5. How long have you been fishing in the area?

6. What type of bait do you like to use?

Appendix B: Informal Interview Data Angler A-N

Angler ID	A1, A2, A3	B1, B2	C1	D1, D2, D3	E1
Location	Near Porter Boathouse, right next to tracks where rowing club and equipment is stored	John Noland Drive next to South Bedford. Next to Monona Bay. Has one fishing	On train tracks crossing lake Court and O'Sheridan Street	Near Porter Boathouse, right next to tracks where rowing club and equipment is stored	Arboretum Drive and North Wingra Drive Right next to bridge that follows Arboretum Drive on the left
Date **Time**	Sept. 26th 2013 8:40AM	October 1st 2013	October 10th 2013 8:30AM	October 7th 2013	October 13th 2013 7:10AM
Sex	All Male	Males	Male	D1 Male D2 Female D3 Female	Male
Ethnicity	All African American/black	African American/black	Caucasian/ white	African American/black family	Caucasian/ white
Age	All 50-60 years	Both 40-50 years	72 years	D1 20-30 years D2 20-30 years D3 40-50 years	28 years
Changes to the lake?		Did not have any specific descriptions	Lack of change. Believes dredging ineffective both Monona Bay and Wingra. Dredging as a means of cleaning pollution and toxin but does not think it did any significant changes	Fishing in Madison recently.	Used to swim in Lake Wingra when young, Deep enough to climb up 20 foot tree and jump into water. But lots of ear infections from the lake, speculates maybe from pollution. Installation of fish advisories as a big change and reflection of pollution in the lake. Described lakes as cleaner (perhaps blue green algae) because also stated mercury as a

					problem. Can tell by the clarity. Carp used to be especially bad but believes numbers have been lowered.
What species caught and how are they prepared?	Blue gill, crappie, catfish. Skin the fish, "clean the inside" likely gutting and then deep fry fish	B1 stated primarily croppies, blue gill, walleye. Any self-caught fish. Primarily deep fry them. Eats fish every day and self-caught fish also.	Eats anything that is self-caught but primarily blue gill, crappies, and pan fish. Ice fishing tends to eat more, consumption of fish may be high. 150 bluegills caught and split between two of them. With daughter another time 53 bluegills caught.	Primarily blue gill, croppies, other small pan fish. Indication of eating larger fish potentially if they could catch one. Primarily fry and take off skin to gut them.	Does not consume any self-caught fish, but also said never did. "NO!" very strong answer
Species not consumed?		B1 will NOT eat carp or skin of the fish.	Will not eat catfish or other "garbage fish", likely bottom feeders.	Avoid catfish consumption.	See above
Share catch with others?		B1 shares fish with local church. Family together consume fish.	Eats fish every Friday with wife, mostly self-caught but also not self-caught		Catches bass, northern pike, and other large fish primarily
What species do they like to catch (regardless consumption)		All that they eat.			
Aware of physical posted fish advisories?	No, did not appear to have any awareness or information.	No not at all. Gave a direct look at interviewee and asked "do you know of any toxins in these waters".	Not aware of any pollution or fish advisories.	None. Did not see any for Monona Bay.	Yes. Specifically mentioned mercury advisories, the one posted on the stop sign down on Vilas Drive towards Fish Hatchery Road Decided not to eat fish based on mercury warnings. Gave specific details about types of fish, extra precautions for age, pregnant women, and limitations of fish to eat on a weekly

					basis.
Where did they get information?		The angler did not know of any pollution or risk associated in these waters.	"Doesn't play on the internet". Did not specify	Angler D1 male brief recollection of Milwaukee advisory for fish when received license. Described as a pamphlet but did not recall specific details or toxins.	Signs primarily.
Reasons for fishing?	Angler A3 Retired and likes to fish	Likes fishing for recreational reasons. Potentially also as a means of providing food for himself, though not explicitly mentioned.	Fishing appears as a means of food though not mentioned specifically	D1 son of D3 and D2 wife fish recreationally and for fun. Likes catching fish. D2 "it's fun" D1 "relaxing".	Primarily appears to be recreational; "serenity from work".
How old fishing for?	Angler A3 Started fishing 20 years ago but took a break in between. Recently came back to fishing	Been fishing in Madison since he was 20 years old	Fishing since he was very young 6 years old.		Fishing since he was 8 years old.
Who taught how to fish?	Angler 3 self-taught how to fish	Uncle taught him and introduced him to this specific spot in Madison when he was in college.	Self-taught.	D3, learned to fish from mother and father.	Dad
How long fishing in Madison? Monona Bay, Wingra specifically?	All three would come up together at night and fish weekly in Madison	Frequently fishes around the Yahara Lakes. Come up at least 1-2 a week to Madison.	Fishes in Monona frequently, prefers train tracks. Older so unconcerned with fines or danger. Fishing for a long time in these areas as well, 30+ years. Used to swim in Monona and jump from trees into water		Fishing at least 20 years or more based on info, only fishes Lake Wingra
How can the city improve their experience?			Specifically mentioned accessibility to lakes due to lake property becoming more private than public		Doesn't like the addition of the dam, thinks it takes away from fishing experience of fish coming down to certain parts of the Lake Wingra. "Fishing used to be really good before they put that in".

Lives in Madison?	No, all from Milwaukee	No, both from Milwaukee	Yes, lived in Madison entire life.	No, from Milwaukee	Yes.
Other notes and reactions	Likes to keep the fish in water for freshness to take back to Milwaukee	Described pollution and toxic research when asked. Told me that "methymercury is concentrated in little balls" in the fish that he can see visibly. Also avoids dark veins of fish. However, methlymercury cannot be seen, potential misconception that toxin pollution is visible. Angler B2 did not say a word.	Primarily fishes alone but will occasionally go with friends. Avid angler, but primarily shoreline angler. When gets access to a boat from time to time fishes from a boat.	No comment about pollution of the lakes when brought up what project was about. Angler D3 from Louisiana. Father and mother both avid anglers and frequently fished from a boat. Does not have a boat now, but likes shoreline fishing. Potential tradition/familial southern influence of catching fish and eating fish in family. All three took a angling class and certified licenses D1, D2, and D3 recently fishing together in Madison since 2 months ago since receiving fishing license.	Never ate fish from these lakes to begin with. Very apprehensive explaining reasons for not consuming fish at first. Avoided the question of why won't consume fish. Took some time before comfortable in saying that it is the pollution specifically. However, once explained, clear he had very strongly about toxin pollutions, namely mercury.

Angler ID	F1	G1	H1	I1, I2, I3
Location	Monona Bay before Brittingham Beach, closer to John Nolan Drive and North Shore Drive. Can immediately see railroad tracks on left less than 8 feet away	By Monona Terrace wall, not on fishing platform	By Monona Terrace wall, not on fishing platform	Monona Bay before Brittingham Beach, closer to John Nolen Drive and North Shore Drive
Date **Time**	October 20th, 2013	October 27th, 2013 8:10AM	October 27th, 2013 8:30AM	October 29th, 2013 1:30PM
Sex	Male	Male	Male	I1 Female I2 Male I3 Female
Ethnicity	Caucasian/white	African American/black	Jamaican	Caucasian/white
Age	30-40 years	40-50 years	30-40 years	I1 30-40 years I2 40-50years I3 30-40 years
Changes to the lake?	Lakes as cleaner and better from aesthetic an visual perspectives. Described Monona Bay as having a lot of dead trees that were pulled out and replaced. Believes that Lake Wingra changes are poor, namely retention pond problems	None, recently fishing in Madison as of 2 years ago	None in particular other than fewer fish “fishing is worse”. Previous years believed there were more fish in the lakes	I1 Thought that the lakes were cleaner somewhat compared to past years, but also believed that there were still aesthetic and pollution improvements such as a lake weed puller via boats. I2 thought that construction had been slower and thus thought that pollution had lessened over the years. I1 thought that Wingra was cleaner because it was clearer than Monona Bay. Doesn’t swim in Monona Bay for that reason.
What species caught in these lakes for consumption and how are they	Does not eat fish except for when ice angling, will consume some blue gill.	Primarily catches pan fish croppies in particular but also blue gill. Did not mention larger fish.	Will eat anything he catches, but primarily catches pan fish such as bluegill.	When prepare fish in general like to fry them, fillet them but DO NOT eat fish from these lakes.

prepared?	Deep fries them.	Bakes his fish, not fries them. Working on fillet technique, prefers to bake them after gutting the fish	Primarily fries fish.	
Species not consumed?	Big “NO” with open eyes when asked if consumes muskies or other large fish.	Won’t eat catfish.	No, will eat anything he catches.	I1 specifically said “NO” for all fish from Monona Bay wide eyes did not eat any fish from these lakes because of concern for pollution and toxins. “These lakes are DISGUSTING”
What species do they like to catch (regardless consumption)	Primarily likes to catch muskie and other large fish			I1 and I2 catch anything from croppies, bluegill, walleye I2 specifically likes to catch muskies
Aware of physical posted fish advisories?	Yes. Indicated fish advisory location for Wingra, though not necessarily for Monona Bay.	Never seen or heard any advisories for Madison. Never seen any posted physically in the areas that he fishes	Has never seen any warnings or caution posted for fish or algae anywhere for Madison.	I1 seen fish advisories physically posted around the lakes for mercury. I2 has vision impairment I3 no comment
Where did they get information?	Specific toxin information for Lake Wingra and Monona Bay comes from internet resources. Frequently checks DNR websites or other Wingra/Monona Bay websites for information.	Heard of fish advisories from Milwaukee concerning mercury levels that are important to avoid for pregnant women and certain amounts of fish. Recently received fishing license.		I2 heard of the advisories for pregnant women and children, limiting number to consume for health purposes. Specifically mentioned run off from construction and being “too close to the city” I1 specifically heard from a friend that Monona Bay “had things dumped in the lake by the UW” but specify any specific event or source of

				pollution. Relied primarily on visual sight. Litter was visible in the water, "green foam" likely blue-green algae.
Reasons for fishing?	Likes to fish recreationally, primarily to catch muskie Interested when saw someone catch a muskie in particular, he "was hooked"	Retired so picked up fishing as a hobby after the military. Describes fishing as relaxing.	Primarily fishes to relax	I1 fishes as a hobby I2 Was in the military until blinded, started fishing again when I1 encouraged him to pick it up again. Have been doing it ever since.
How old fishing for?		2 years ago.	Fished in Jamaica as a young boy, around 8 or so maybe 6.	I1 Fishing since she was 8 years old. I2 Fishing since he was 10 or 8 years old.
Who taught how to fish?	Began fishing by teaching himself while unemployed at the time with his wife in France.	No one in family fishes, self taught		
How long fishing in Monona Bay, Wingra or Madison area?	3-4 years	Comes up to Madison in those two years.	Comes up at least once a week in the summer and spring to fish in Madison.	I1 recent I2 all his life
How can the city improve their experience?	City could limit catch of blue-gills and other pan fish to allow fish to grow a certain size. Better shoreline accessibility including launch areas. Described this for Monona in particular as there is a huge jump from private to public properties that prevent shoreline fishing. Fix the Wingra			I1 had many suggestions. One was a trash receptacle placed where people like to fish to minimize litter. Another was a cigarette butt tray, as a smoker herself, to prevent butts from littering the lake or fishing area. Important for the city to control and reduce public sources of pollution

	retention ponds. Believes they are outdated and do not adequately address overflooding or urban run off.			including fertilizers, run off, etc. Felt that more boat launches, and specifically a boat rental service to provide to people who did not have boats to have a chance to fish from motor boats. Thought that fish license price could be lower
Lives in Madison?	Yes. 3-4 years in Madison but from Iowa	No, Milwaukee.	No, from Milwaukee 5-6 years.	I2 lived in Madison entire life I1 and I3 unknown
Other notes and reactions	Mentioned urban city run off, chemicals, mercury frequently as sources of pollution Is beginning a shoreline angling community for those who do not have access to boats or likes to shoreline fish. Mentioned female anglers for muskie fishing in particular. Muskie culture can apparently be “muskie or nothing” fishing mentality Fishes with family, though wife doesn’t fish as much. Kids also fish.	Primarily shoreline fishes, but will buy a boat soon, very excited.	Is not concerned about fish consumption or fishing in these waters. Different fishing experience in Jamaica than in Madison, used to spear fish easier than shoreline fishing he says. Water is different, salt and clearer Primarily fishes in the summertime as favorite season.	I2 specifically cited sources of pollution and toxin concern such as fertilizers, pesticides, and urban run off, but this seemed to refer mostly to blue-green algae and to some extent toxin pollution. I1 been fishing for only five years or so in Madison I2 fishing all his life in Madison. Both prefer to fish up North for fish consumption. I1 and I2 both sounded well versed in knowing about the pollution from both advisories as well as relying primarily on their own perception and logic. Consideration for I2 as a blind individual and fishing, very

				unique reason for fishing. Were both aware of DNR resources and local fish hatchery for restocking fish

Angler ID	J1, J2, J3	K1	L 1	M1
Location	Monona Bay at point that sticks farthest out into the bay in Brittingham Park	Lake Wingra, on piers right by dam	Lake Wingra down towards the bridge for the Arboretum	Lake Wingra Dam
Date **Time**	10 October 5:30 pm	3 November Noon	3 November 12:30 pm	October 30th 2013
Sex	J1 Female, J2 Male, J3 Male	Male	Male	Male
Ethnicity	African American / Black	African American / Black	White / Caucasian	Caucasian/white
Age	J2 and J3 about 50 - 60, J1 seemed younger about 40-50	40 – 50 years old	30 – 40 years old	50-60 years
Changes to the lake?		Increased weeds	More litter and trash in lakes	Noticed more algae blooms
What species caught and how are they prepared?	Mostly pan fish – deep fry them	Said soaks fish in a salt bath before eating to get rid of mercury		Panfish & catfish, deep fried
Species not consumed?			Larger game fish like muskie (said the flesh was 'mushy')	
What species do they like to catch (regardless consumption)		Bass, muskie, bluegill	Whatever can get	Largemouth bass & small mouth bass
Aware of physical posted fish advisories?		Yes		Yes
Where did they get information?		Did not say specifically, but was aware of mercury in fish from these lakes		DNR website
Reasons for fishing?	Were taking fish home to eat, but were having fun and relaxing as well	For consumption	For sport	Fishing takes his mind off of things.
How old fishing for?				Since a kid
Who taught how to fish?				Doesn't know for sure, always remembers fishing with his family as a kid

How long fishing in Monona Bay, Wingra or Madison area?				Last 10 years on and off
How can the city improve their experience?			Put out more trash cans for litter	
Lives in Madison?	Yes		Yes	Yes, but not originally from here
How long fishing these areas?				Last 10 years on and off
Other notes and reactions	J1 had caught about 6 pan fish within less than a half hour – was taking them all home to cook. She threw back a rather small fish and J2 and J3 made fun of her, saying "Big enough to hook big enough to cook"	When asked about pollution said that the Madison lakes were in good condition compared to other lakes in the state. He hadn't seen any "bad fish" from lakes here like he had in other places.		

Angler ID	N1, N2, N3			
Location	Lake Wingra dam			
Date **Time**	September 17th 2013 1:30 pm			
Sex	N1 female N2 male N3 male			
Ethnicity	N1 Caucasian/white N2 African American/Black N3 African American/Black			
Age	Mid 20s			
Changes to the lake?	Not sure			
What species caught and how are they prepared?	Blue gill			
Species not consumed?				
What species do they like to catch (regardless consumption)				
Aware of physical posted fish advisories?				
Where did they get information?				
Reasons for fishing?	Fun to do with friends, food			
How old fishing for?	N2/N3 said started around middle school, N1 didn't comment			
Who taught how to fish?	Parents. Typically a family event			

How long fishing in Monona Bay, Wingra or Madison area?				
How can the city improve their experience?				
Lives in Madison?	yes			
How long fishing these areas?	Since childhood			
Other notes and reactions	My observations: N1 using smaller bluegills she caught for bait, N2 & N3 used nightcrawlers. No bucket to keep the fish			

Appendix C: Informal Observations

Date &Time	Location	Notes
Unknown September notes	Brittingham Park	Family (Asian descent) gathering by picnic table near Brittingham park (Lake Monona). Women and children sitting at table while men (16-25 years, 4-5 of them) were all fishing.
Sept. 27th 10:00 AM	Monona Terrace	About 5 to 10 anglers along the wall and one seated in a lawn chair to the east a bit on grass All anglers along wall appeared to be African American / black, but there were two Caucasian / white anglers out in a boat just beyond the wall
		Two teenage anglers – one perhaps a few years older than the other Both male and appeared to both be African American / black
Sept. 29th 8:00AM	Brittingham Park	Two anglers, not sure if Hmong or Latino had hoods. One female and one male.
October 4th 6:00 PM	Monona Terrace	About 30 anglers along the wall. All African American / black except for two Caucasian / white anglers. Mostly men, although there were three to four women present – all women were seated / not actively engaged in fishing Anglers appeared to range in age from 20s to 60s, most anglers had a bucket to presumably hold their catch. Many anglers had multiple poles set up along the wall
October 8th 5:00 PM	Monona Bay Brittingham Park	Sunny, warm day – many anglers all along shoreline, perhaps thirty in all Interviewed 3 anglers (J1, J2, and J3) About 20 African American / black anglers, 10 anglers of Asian background, 1 Caucasian / white angler. African American / black anglers looked to be older (40s to 60s), while the white angler looked to be in his twenties and the anglers of Asian background looked to be in their late teens to twenties Almost all anglers were male except one female About half of the anglers were fishing in smalls groups of two to three and about half were fishing alone Many of the anglers had lawn chairs set up and buckets (that looked to be for holding caught fish)
October 10th Noon, midday	Lake Wingra (near dam)	Group of four to five preteen anglers – no parent supervision – all boys Appeared to be of Asian background
October 12th	Monona Terrace	Monona Terrace wall—15-20 generally older (age 40-60), some younger (age 16-25) black folk fishing, primarily male, 3-4 female. 3 older white males (40-65) also fishing and 2 middle-aged men of Asian descent fishing (age 30-45).
October 15th 5:00 PM	Brittingham Park	Male angler around 50 to 60 years old Quite foggy day – was the only angler seen that day Declined interview, appeared to be African American / black.

October 19th	Brittingham boat house	Shores by brittingham boathouse—2 groups of black folk fishing in different spots, likely families (cousins, uncles, fathers). One group with one middle aged woman.
October 26th	Monona Bay	Area by train tracks, bike path—2 white males fishing individually on piers in area. Group of 3 black males fishing individually but appeared to know each other, along shore of Monona bay past tracks.
October 20th 8:30AM	Lake Wingra	One older white male fishing briefly but then biked away. One blonde haired younger 20-23 male fishing from a distance, did not have time to interview.
October 27th 9:15AM	Monona Bay	Monona Bay on railroad tracks an African American/black male and female fishing from Milwaukee. Brief convo. Another white male fishing on middle far towards center of lake on the railroad tracks. Too far away to interview.
October 27th 11:50AM	Lake Wingra	Lake Wingra next to dam, two Asian males fishing. One had a much longer black pole while another had a normal fishing pole. Both could have been Hmong, but neither wanted to talk. Likely to be a language barrier that prevented interview based in body language and only a handful of words spoken. One male angler mid-40s with 8-10year old son both fishing seen Lake Wingra on platform right next to dam.
October 29th 10:00 AM	Monona Bay	One 50-60 year old white male seen on the railroad tracks fishing. Too far away to talk to.
November 4th 2:15 PM	Monona Bay	One male angler, across small rowing house in Monona Bay's small triangle. Had a bucket and fishing right next to John Noland Way.

Appendix D: Angler Observation Maps

Map of Anglers Lake Monona
Makie Matsumoto-Hervol

Map of Anglers at Lake Wingra
Makie Matsumoto-Hervol

Appendix E: Documentary Script

This may be a documentary. But it's also a story. Like many stories, some voices could not be heard. But that doesn't mean they don't exist…

Beneath the Surface: Urban Fishing and environmental Justice

Madison's lakes have been an advertised hotspot for swimming, boating, and fishing as early as the 1870s. From the balmy summer months to the ice of winter, fishing is a visible and vibrant aspect of the Madison community.

Monona Bay and Lake Wingra are widely popular among shoreline anglers. Both lakes are a part of the Yahara River Basin, a 360 square mile watershed that was largely sculpted by glacial ice and outwash some 10,000 years ago. By some measures, Monona Bay and the Lake Wingra have very similar physical and chemical properties due to their proximity to one another and related environmental history. But each lake is also unique, shaped in part by human hands and environmental influences.

Dredging in Lake Wingra during the 1900s disrupted fish habitat and caused the lake's water level to fall significantly. Gardner Marsh, an important part of Wingra's ecosystem and water quality, was physically separated through the process of dredging. Since the 1930's Lake Wingra's surrounding area shifted from an agricultural landscape to an urbanized city. While the Arboretum helps protect Lake Wingra today, the separation of Gardner Marsh increased susceptibility to runoff from Madison's rapid development.

To the north west of Wingra, Monona Bay sits glistening at the heart of the city and downtown area. Lake Monona's waters were once clean enough to support a thriving ice export industry and health spa in the turn of the 19h century. The expansion of Madison's capitol and residential area of urbanizing busy-body cars, industry, and people however, left Monona Bay and the greater Lake Monona vulnerable to human impact. From the 1880s until the New Deal, raw sewage from the city was dumped in Lake Monona and Monona Bay.

Other known recorded instances include two petroleum spills, hydraulic fluid, and runoff from the 2006 Charter Street power plant.

Both lakes likely natural eutrophic state contribute to the growth of blue green algae, a phenomenon that has captured Madison's attention since 1847. Excess nutrients from residential and commercial fertilizers have exacerbated blue-green algae growth, manifesting as a visible symbol of human impact. However less visible to the naked eye, are the toxins that lie beneath the surface.

Few tests have been conducted for both Lake Wingra and Monona Bay for toxicants in the fish and water, likely limited by cost and political controversy. Though the toxicants in Lake Wingra remain largely unknown, Monona Bay has more known toxicants.

The sources of these toxins are derived from historical and current influx of industrial, residential, and urban discharge.

Asserting how much and which identified toxins in sediment accumulate in fish is complicated. Toxin presence in fish depends on the age, sex, size, and species of the fish. In addition each toxin concentrates in a fish differently.

Each toxin has its own negative influence on human health. In general, mercury, PCBs, and small doses of lead influence neurological damage while arsenic, PAH, and low concentrations of PCBs can cause various types of cancers.

In general, women of childbearing age, children, and those with pre-existing health complications are more readily affected than others. Age, sex, type of fish, the parts of the fish, and how much of a particular species consumed, all factor into toxic exposure.

Individual angler behavior, risk perception, and profile further complicate human health risk and toxicity exposure.

Fishing and fish consumption also have underlying cultural, traditional, or subsistence significance that further influence risk.

Self-caught fish consumption has been shown to vary by race. In 2009, the Midwest Environmental Justice Organization found that in Madison, 73% of interviewed minority anglers ate the fish they caught in contrast to only 29% of white anglers.

Human health risk associated with fish consumption is communicated in several ways, primarily through the DNR.

Despite the variety of communication means, these outlets are limited to those who have access to certain resources or abilities.

Across the country studies have shown that fish advisories, press releases, and fish licensing information is less likely to reach minority and low-income anglers. For Madison, the Midwest Environmental Justice Organization found that 73% of white anglers claimed to have seen fish advisory information compared to only 39% non-white anglers.

A living time capsule of our past, the lakes are a reflection of our values that continue to shape the present and future. At the heart of the problem, toxicants in the lakes and fish, though invisible to the naked eye, is an issue that is intertwined in Madison’s community. Though communicating risk is a part of the solution, overall minimizing health risk disparities depends on reducing toxicant sources in our lakes. In particular, those with power must incorporate the unheard voices of all shoreline anglers and work towards eliminating the dangers posed by toxins.

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