

Risky Business: Subsistence fishing in Tyrrell County, North Carolina

By

Elizabeth Ann Brown-Pickren

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Directors of Dissertation: David Griffith, PhD & Alex Manda, PhD

Major Department: Coastal Resources Management

ABSTRACT:

Catching fish provides inexpensive protein to low income residents living near fish producing water bodies. Tyrrell County, North Carolina, is one of the most economically challenged counties in the state. Located in the Albemarle estuarine system of eastern North Carolina, Tyrrell County is home to an abundance of fish and shellfish but also has a fish consumption advisory for dioxins and mercury for which the levels of awareness of the risks associated with consuming the fish are unknown. The goal of this dissertation is to study the people of Tyrrell County who fish for subsistence with three objectives: (1) to evaluate the extent to which residents of Tyrrell County are aware of the risks associated with consuming fish in the Albemarle estuarine system, (2) compare the local ecological knowledge held by these anglers against corresponding scientific data, and (3) determine whether the subsistence waiver provided by the state is achieving the purpose of allowing low income anglers access to free fish. Data for this study were collected through semi-structured interviews of community leaders and surveys of Tyrrell County residents who eat recreationally-caught fish, either by catching it themselves or by receiving fish as gifts.

Results of the study indicate that 86% (N=36) of the respondents depend on catching fish or getting fish as gifts to help with their grocery bills, although several barriers exist to freely accessing fish for consumption. The results also reveal that survey respondents were not well informed about the Albemarle Sound fish consumption advisory for dioxins in carp and catfish. Most people surveyed were not informed about the statewide consumption for mercury, directed especially at women of child-bearing age, developing children, and people with compromised immune systems. Many of the survey respondents do not use the internet, which is a main source of updated fish consumption advisories. Finally, survey participants incorrectly assumed that fish consumption advisories would be posted at locations where contaminant risks are elevated. The local ecological knowledge held by the respondents did not correspond well with the data provided by other sources. Respondents were asked about changes in abundance and size of species then those responses compared to a fisheries biology population survey and there was little correlation. Responses about changes in water temperature and salinity did not agree within the survey, so when they were compared to USGS data there was correlation with about half the responses. Four factors were used to gauge whether the subsistence waiver is effective: participant awareness of the waiver; individual usage of the waiver; opinion of the waiver; and whether the data collected about subsistence waiver usage was sufficient for fishery management purposes. Less than half of the respondents were aware of the waiver, although most were eligible for it. Some chose to fish without a license rather than enroll in the social services required to be issued a waiver. No research has been conducted by fishery managers on the extent of usage of the subsistence waiver, leaving a data gap resulting in incomplete information used for management.

The effectiveness of the waiver is a social justice issue in three ways. Respondents indicated they learned of the new fishing regulations after implementation; that they had no input into the process; a form of procedural justice. Several respondents voiced frustration at limits placed on their catch under the new regulations; a form of distributive justice. Finally, those who rely on eating their catch are at disproportionate risk of consuming contaminants; a form of environmental justice. Because recreationally-caught fish is important to low income residents of Tyrrell County as a supplement to their grocery costs, and not all eligible residents have a subsistence waiver, one recommendation is to loosen the restrictions on obtaining the waiver and publicizing its availability. Better communication about contaminant risks in recreationally-caught fish is needed. Suggestions are to post information about contaminant risks at public meeting places (e.g., boat ramps, libraries, and social service offices) and print public service announcements in local newspapers.

RISKY BUSINESS: SUBSISTENCE FISHING IN TYRRELL COUNTY, NORTH
CAROLINA

A Dissertation

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East Carolina University

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Doctor of Philosophy
In Coastal Resources Management

by

Elizabeth Ann Brown-Pickren

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by
Elizabeth Ann Brown-Pickren

APPROVED BY:

CO-DIRECTOR OF
DISSERTATION: _____

Alex K. Manda, PhD

CO-DIRECTOR OF
DISSERTATION: _____

C. David Griffith, PhD

COMMITTEE MEMBER: _____

Bob Edwards, PhD

COMMITTEE MEMBER: _____

Anthony Overton, PhD

COMMITTEE MEMBER: _____

Hans Vogelsong, PhD

DIRECTOR OF COASTAL RESOURCES
MANAGEMENT PHD PROGRAM: _____

Siddhartha Mitra, PhD

DEAN OF THE
GRADUATE SCHOOL: _____

Paul J. Gemperline, PhD

DEDICATION

For Doctor Alex Kapolo Manda.

Without his endless reserve of kind persistent encouragement I would have never succeeded.

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Chapter 1: INTRODUCTION

Purpose and Motivation

It would be easy to drive through North Carolina (NC) to the beaches and not notice Tyrrell County, other than bemoaning the sudden drop of the speed limit from 70 to 35 mph as Highway 64 travels through the county seat of Columbia. With a goal of sand and waves, only a few stop, perceiving lower prices, to fill up their coolers and gas tanks before heading to the Outer Banks. But a slight detour on the way to the beach will show a complex landscape and small groups of people who have made their living off the land by farming (68% of jobs in the county are in agriculture), gardening at home, hunting, and fishing. Dominated by swamp, Tyrrell County has been limited in both development and population growth, resulting in the smallest population of North Carolina's 100 counties and the second highest unemployment rate (North Carolina Department of Commerce, 2018). Lack of employment creates free time and tight purse strings for Tyrrell County residents, which both lead to the pursuit of thrifty ways to help put food on the table. This study evaluates (a) how the residents of Tyrrell County perceive the importance of subsistence fishing to them, and (b) what barriers and risks are associated with subsistence fishing.



Figure 1. Location of Tyrrell County in North Carolina.

Tyrrell County is situated in a low lying coastal area in eastern North Carolina (Figure 1), bounded by the Albemarle Sound to the north and the Alligator River to the east (Figure 2). The county has an area of ~600 square miles including 390 square miles of land and 210 square miles of water and a highest elevation of 16 feet above sea level. The extensive rivers and swamp land suggest historic reliance on fish and shellfish for sustenance. The population of Tyrrell County is among the most economically challenged in the state (North Carolina Department of Commerce, 2016) with 25% of County residents living in poverty (U.S. Census, 2017). Like many largely rural populations, Tyrrell County residents depend on fishing, hunting, gardening, and collecting wild food for a good portion of their sustenance (Brown et al., 1998; Vaughan and Vitousek, 2013). Recreational fishing is a popular activity in Tyrrell County that usually provides residents with an affordable source of protein (TyrrellCounty.org, 2018). However, because self-caught fish may also be a source of contaminants, low income anglers might be at greater risk of consuming contaminants because subsistence fishers are likely to eat considerably more fish than the average person in the United States.

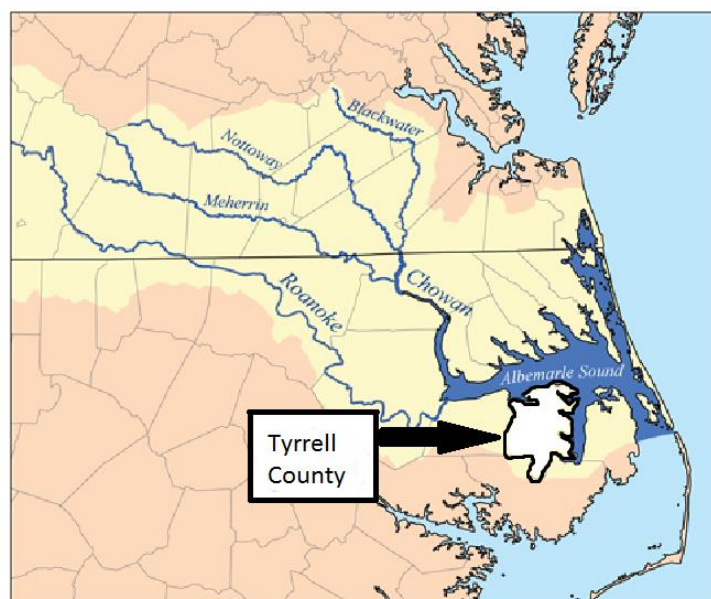


Figure 2. Location of Roanoke River and Albemarle Sound.

In the United States, each state has the authority to issue consumption advisories (which are state-wide or specific to water bodies), and manage fish and shellfish through catch limits, size limits, closed areas, and other measures (e.g. licensing). In North Carolina, such restrictions (e.g., bag and size limits on catch) are published in annual fishing regulations booklets by the NC Wildlife Resources Commission for inland fishing and by the NC Division of Marine Fisheries for coastal waters. The inland booklet contains a summarized version of all fish consumption advisories while the coastal booklet contains none. Although consumption advisories are in the public domain, anglers often (a) show little concern for contaminants in their catch (LePrevost et al., 2013; Imm et al., 2013), (b) have minimal knowledge of the effects of contaminants on human health (Maren and Stern, 2005; Surgan et al., 2008; Katner et al., 2011; Engelberth et al., 2013), and (c) possess misguided faith that the governing authorities post warnings at every water body that is at high risk for contaminants (Driscoll, 2010; Verbeke et al., 2004). These scenarios suggest a need for better collaboration between fishery management and public health agencies in publicizing catch regulations along with contaminant risks (Love et al., 2013; Scherer et al., 2004).

Research Questions and Objectives

The goal of this research is to better understand subsistence fishing in a rural coastal North Carolina county: the political context, the cultural and economic importance to anglers, the social networks that build local ecological knowledge, and the risk from contaminant consumption.

- Research Question 1.a: To what extent are recreational fishers in the Albemarle Sound aware of relevant public health advisories?

- Research Question 1.b: What beliefs do recreational fishers hold about methods to reduce and remove contaminants in fish and shellfish by cooking or cleaning methods?
- Research Question 1.c: What environmental cues do recreational fishers use to avoid contaminants?
 - Objectives for Research Questions 1.a-1.c:
 - Assess level of awareness of public health advisories
 - Determine angler methods of cooking or cleaning fish to eliminate contaminants
 - Identify perceived environmental factors that indicate presence of contaminants in water bodies
- Research Question 2: What changes over time do fishers identify in the size and abundance in their catch and what factors to they attribute these changes to?
 - Objectives for Research Question 2:
 - Establish length of local fishing experience
 - Record angler perceptions changes in size and abundance of catch species
 - Determine angler perceptions of changes in the local environment including storm activity, water temperature, construction, angler competition, and water pollution and establish perceived connections between species changes and these factors.
- Research Question 3: Is the NC Subsistence Waiver achieving the stated goal of allowing impoverished NC residents to fish for free?
 - Objectives for Research Question 3:
 - Establish type of fishing license each angler possesses
 - Determine angler familiarity with the various waivers provided in NC fishing license structure

- Ascertain angler opinion of the subsistence waiver
- Establish the level of research on catch by subsistence waiver recipients

Background

Fish and shellfish have been important food sources for the people of coastal North Carolina throughout history. Long before Europeans came to North America, Native people lived off the land, gathering nuts and plants, hunting, fishing, and collecting shellfish. The earliest residents lived in small nomadic bands during the Paleo-Indian period (before about 8000 BC). During the archaic period (8000-1000 BC) North Carolina coastal residents are thought to have established semi-permanent base camps and a series of smaller procurement camps to take advantage of seasonal resources. Not until the middle part of the Woodland Period (300 BC – AD 800) did limited agriculture began to emerge, mostly in the form of maize and squash (Schaefer, 2011). When the first Europeans settled the North Carolina coast they found Native Americans living in permanent settlements and hunting fishing and farming for sustenance. Thomas Harriot arrived in 1585 and described the many species taken by Native Americans and the weirs and spears used for harvest:

“The inhabitants vse to take then two maner of wayes, the one is by a kind of wear made of reedes which in that countrey are very strong. The other way which is more strange, is with poles made sharpe at one ende, by shooting them into the fish after the maner as Irishmen cast dartes; either as they are rowing in their boates or els as they are wading in the shallowes for the purpose.” (Harriot, 1588)

European settlers increased agricultural endeavors but also continued to hunt and fish, both through the small farmer providing family needs and the major seasonal harvests of river herring and shad throughout the plantation era of eastern North Carolina (Griffith, 1999; Taylor 1992). This study focuses on Tyrrell County, where fishing is still important to many residents, with 567 coastal recreational fishing licenses – almost 14% of the entire county population – issued in

2014 (NCDMF, 2015). This may not reflect the true number of people fishing, as between 7-10% of North Carolina anglers fish without a license (Responsive Management, 2011).

The state of North Carolina is generally divided into three regions: the mountains, the piedmont, and the coast. Coastal North Carolina is geologically divided into two regions, described in Pilkey et al. (1998) as the northern and southern provinces. These provinces have different geological foundations, resulting in longer barrier islands with fewer inlets and therefore less ocean influence in the north. Both provinces are relatively flat, with an average slope of 3 feet per mile in the south, while the northern province is even flatter, with an average slope of 0.2 feet per mile. Rivers meander through such flatness and marshes form with the retention of precipitation. Tyrrell County covers 600 square miles, one-third of which is water. The highest point in the county is about 17 feet above sea level, the lowest high point of any of North Carolina's 100 counties, and flooding is an ongoing issue. The range of sea level rise in the northern province is estimated to be up to 8.1 inches in the next 30 years (NC CRC Science Panel Draft, 2015) which will substantially affect Tyrrell County water bodies and, therefore, the fish which live in them and the people who live around them. In addition to rising sea level, temperatures are expected to rise between 5 and 6 degrees F by 2100 (DeWan et al., 2010) and change the biodiversity of the area.

Tyrrell County has the smallest population of all North Carolina's counties, with a 2016 estimate of 4,141 (U.S. Census Quickfacts, 2017), which represents a decline of 6% from 2010, as opposed to the overall North Carolina population increase of 4.3%. The average income of each person in Tyrrell County is \$16,658, considerably lower than the state average of \$25,284. An estimated 25% of county residents live below poverty (US Census, 2017), a much higher rate than the statewide rate 17.5%. Educational attainment in Tyrrell County is also considerably

lower than the rest of the state, with 71.5% of persons 25 or older holding a high school diploma (North Carolina average is 84.9%) and those holding a bachelor’s degree higher comprise 8.4% of residents (North Carolina average is 27.3%). Tyrrell County is assigned Tier 1 status by the North Carolina Department of Commerce (2017), which indicates it is among the 40 most distressed counties in the state, using household income, unemployment rate, property taxes, and population growth to calculate the Tier status (Figure 3).

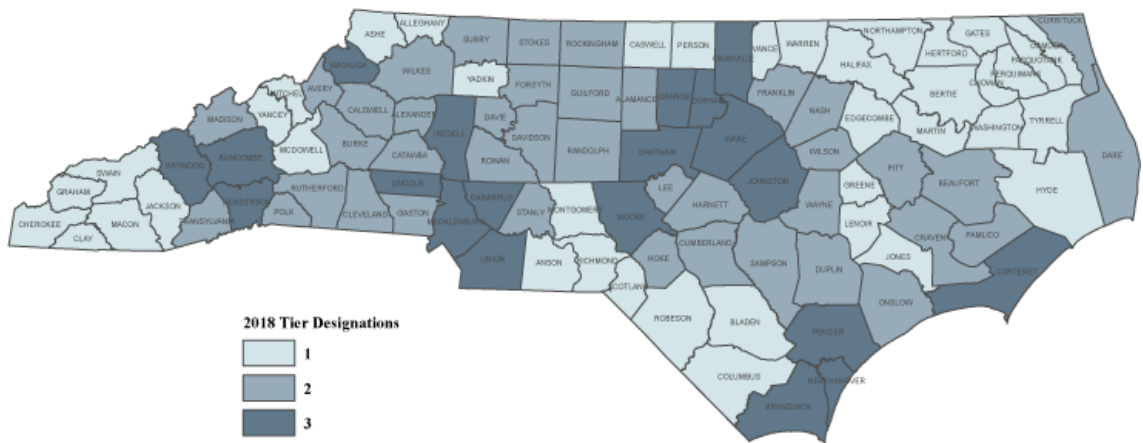


Figure 3. Economic well-being of North Carolina counties.

The importance of the health benefits and contaminant risks in self-caught fish is reflected in the large number of published studies on the topic. Extensive reviews of fish consumption practices found that the benefits of eating fish far outweigh the risks in general populations (FAO/WHO, 2011; Mozaffarian and Rimm, 2006; Nesheim and Yaktine, 2007; USFDA, 2009; Wang et al., 2006). Fish and shellfish supply healthful lean protein, vitamins A, B3, B6, B12, and D, calcium, iron, zinc and healthy omega oils (Sheeshka and Murkin, 2002). Leading specialists recommend eating fish at least twice a week (American Heart Association, 2015; Association of Reproductive Health Professionals, 2015). In the United States the average consumption of fish meals is considerably lower than the rest of the world.

While health practitioners encourage increased consumption of fish nationwide, there is also the risk of contaminants in certain species of fish, certain sizes of fish, and certain water bodies. Directing consumption advisories at the average American poses a problem. The ingestion rate used for the basis of consumption advisories is either the average American consumer or specific to pregnant women and developing children, while research has suggested that certain populations rely on self-caught fish and have considerably higher fish consumption rates (Burger, 2013). Rural residents often have poor access to healthful foods (Hardin-Fanning & Raynes, 2013) and fishing is often an important supplement to purchased groceries, especially in low income households.

Access to consumption advisories is another problem in North Carolina. While advisories are issued in the inland fishing regulations, there are none in coastal regulations. In order to find fish consumption advisories, the seeker must have access to a computer connected to the internet (also an expense) and follow the seven links from the Division of Marine Fisheries website to the actual Department of Epidemiology advisory. The only place for the public to access the internet for free in Tyrrell County is the public library, where six computers are available (J. Bugniazat, Personal Communication April 5, 2018) and the librarians are very accommodating to those with minimal or no computer skills.

Finally, consumption advisories are generally issued separately from information on the health benefits of eating fish, reducing overall consumption (Burger and Gochfield, 2009). Pieniak et al. (2010) surveyed residents of five European countries and found that despite of the overall belief that eating fish is healthful, consumers reduced their consumption after reading an

advisory that suggested reducing consumption of certain species, indicating a need for including descriptions of health benefits along with risk potential.

There are five possible sources of contamination in the Albemarle Sound: mercury and other metals, dioxins, agricultural waste, human waste, and personal and health care products (Burkholder et al., 2007; Deaton et al., 2010; Hackney et al., 1998; Powell et al., 2017). Other potential contaminants can emerge suddenly and although the NC Department of Environmental Quality responds as quickly as possible, before they are able to, the contaminants can reach consumer's drinking water and food sources. Two recent examples of emergent contaminants are coal ash waste and GenX.

In February 2014, a retention pond from a Duke Energy coal combustion plant near Eden, NC ruptured, releasing 39,000 tons of coal ash and 27 million gallons of untreated ash wastewater, containing arsenic, selenium, and copper. Of the 47,000 cubic yards of coal ash discharged into the Dan River, less than ten percent of the ash was recovered during clean-up efforts. In 2015 an advisory was issued by the DPE to not consume any fish or shellfish from the Dan River downstream in Rockingham and Caswell counties (North Carolina Division of Public Health, 2015), which is still in effect. The amount of unrecovered coal ash could indicate that the remainder may be further downstream, in the Roanoke River and Albemarle Sound. There are three other coal ash ponds upstream from Albemarle Sound, in Belews Creek, Roxboro, and Mayo (Southern Environmental Law Center, 2015), which may pose problems in the future.

Although taking place in a different watershed, recent news of the identification of an industrial chemical named GenX in the drinking water from the Cape Fear River has stirred fears of unknown pollutants in water bodies. The chemical is a non-stick pan coating produced by the Chemours company in Fayetteville and is not regulated in drinking water by either the North

Carolina Department of Environmental Quality or the U.S. Environmental Protection Agency. GenX is also not removed during typical drinking water treatment process, and as the investigation continues, the number of private wells contaminated with GenX and the possibility of airborne dispersal of the chemical increase (NCDEQ, 2018). Nearly a year after the GenX contamination came to light, the NC Legislature introduced two bills in May, 2018 (HB 972 and SB 724), that address the problem but, according to the NC Wildlife Federation, both proposals, “Miss the mark by confusing agency authorities, adding unnecessary processes and procedures, and continuing to underinvest in the men and women working on the frontlines to protect us all from chemical pollution (Hamilton, 2018).” Both bills were sent to committees on May 21, 2018, and neither has emerged.

Mercury is the most significant fish and shellfish contaminant not only in Tyrrell County, but nationwide, because of known detrimental effects of mercury on the neurological systems of developing fetuses. The EPA and FDA have addressed mercury sources and consumption and the North Carolina Division of Public Health has issued a statewide advisory regarding consumption of fish known to contain mercury (North Carolina Division of Public Health, 2015). Mercury occurs naturally in the environment and is produced in industrial processes and burning. After deposition into water bodies, marine and aquatic organisms transform elemental mercury into methyl mercury, which is of concern to human health, then amplify mercury levels through bioaccumulation, resulting in fish and shellfish supplying the primary source of ingested mercury in humans (Driscoll et al., 2013). The extensive slow-moving swampland of Tyrrell County allows substantial opportunity for mercury accumulation.

Dioxin is the other contaminant noted in DPH fish consumption advisories in coastal North Carolina, specifically in the Roanoke River, Welch Creek, and Albemarle Sound. The

source of dioxins for these water bodies is identified as the Weyerhaeuser pulp mill in Plymouth, which discharged directly into the Roanoke River beginning in 1937 until 1956, when the discharge method was modified. The new method was to first hold the effluvia in treatment ponds, then the treated effluvia was discharged into Welch Creek. The 2,400-acre site is listed as “National Priorities List Caliber” by the Environmental Protection Agency, which is working with the property owners to clean up. Dioxins can cause reproductive and developmental problems and impair the immune system, and chronic exposure can result in cancer (Food and Agriculture/World Health Organization, 2014). Dioxins are absorbed and stored by fat tissue and are chemically stable in the body.

North Carolina is home to the second largest swine and turkey industries in the nation and the third largest producer of chickens, and all those animals produce millions of gallons of waste. Unlike human waste, which is carefully treated through sewer or septic systems, agricultural waste is channeled into lagoons then sprayed on crops as fertilizer. Evidence is mounting that more fertilizer is applied than can be taken in by crops, and nearby streams and lakes have been found to have elevated ammonia and nitrates through air dispersion (Harden, 2015) and fecal contamination from waste lagoons is seeping into nearby water bodies (Heaney et al., 2015).

Septic systems are the most common waste disposal on the sandy soils of rural coastal North Carolina (Pilkey, 1998). North Carolina’s twenty CAMA counties are largely rural except for population density along the coast. Almost 60% of homes distributed over the 11,419 square miles in the CAMA counties use septic systems (NC DHHS, 2015). Flooding is common throughout the region and a great deal of raw human waste that is released into groundwater migrates to streams and rivers, particularly when systems leak or fail due to their age. More than

66% of the 1,457 households in Tyrrell County use septic systems while 24% are on a sewer system. Nine percent of household waste systems are listed as ‘other’ types, presumably these are pit toilets, also known as outhouses. In addition to the coliforms that can be released, human drugs and pharmaceutical products can be released.

Pharmaceuticals and personal and health care products are an emerging area of concern in water supplies (U.S. Environmental Protection Agency Office of Water, 2008; DeWitt and Patisaul, 2018; Erickson, 2017). Wastewater treatment plants are designed to detect and treat known contaminants and do not include these prescription and non-prescription drugs, cleansers, detergents, fragrance products, and cosmetics. Del Rosario et al. (2014) studied effluent from septic systems in the coastal plain and found that domestic wastewater is not fully treated in these septic systems and the current setbacks between these systems and surface water bodies do not protect coastal streams.

The study site for this research was selected for three reasons. First, the only fish consumption advisory in coastal North Carolina other than mercury, which is statewide, is for dioxins in Welch Creek, the Roanoke River, and the Albemarle Sound, the northern border of Tyrrell County. Secondly, Tyrrell is one of the most economically challenged counties in North Carolina. Finally, the abundance of rivers and creeks and the Sound allow plentiful access to places to fish throughout the County, indicating probably heavy reliance on self-caught fish.

Theoretical Basis

Subsistence fishing can be viewed within the framework of social injustice, which can be distributive, procedural, or environmental. Social justice is the concept of a contract between and individual and society defined as early as 380 BC by Socrates: by accepting the benefits of society the individual must behave according to societal norms and accept societal burdens.

These societal norms and burdens are subjective, leading to subjectivity in defining social injustices. Rawls (1971) argued that social allocation rules should not harm the most disadvantaged in a society.

In natural resource management, distributive justice can be defined as the perceived fairness of resource distribution (Loomis and Ditton, 1993; Smith and McDonough, 2001). Fisheries resources are managed by governmental agencies. In the United States the federal and state governments manage fisheries for biological sustainability then divide the available optimal sustainable yield between the commercial and recreational sectors and, in Alaska and with regards to Native American treaties, allocations are made for subsistence users. In North Carolina, subsistence fishing is housed in the recreational fishing sector.

Much has been written about the conflicts over allocations in fishery management. In the United States, examples of allocation conflicts include those between commercial gear groups (Hanna and Smith, 1993), processor types (PFMC, 1986), recreational and commercial harvesters (Smith, C.L., 1980), different ethnic groups of commercial fishers (Maril, 1983), etc. Other than Native American treaties and Alaska, little has been discussed about allocations to subsistence uses.

Procedural justice is the perceived fairness of the decision-making process (Folger et al, 1983; Parkins and Mitchell, 2007). Without taking part in the decision-making process, natural resource users may object to the decisions. Research shows that participation in the decision-making process will lead to better acceptance of the decision, even when the outcome is not the desired one (Cohen, 1985; Lawrence, Daniels and Stankey, 1997). The issuance of fishing licenses and the management of fisheries through catch limits and size limits curtail the simple act of fishing locally. State agencies that manage fisheries typically have extensive public

comment periods before implementing major changes in license structures, but many stakeholders are oblivious of their ability to comment, lack the skill, means, or inclination to participate, or simply feel that their input would be ignored. Catch regulations are speedy responses to political will and scientific research and have little input from the public.

Environmental justice is the recognition of uneven distribution of both problems from pollution and the benefits of environmental protection throughout society (Bryant and Mohai, 1992), with low-income people and people of color more likely to suffer poor health and quality of life due to environmental degradation (Bullard and Johnson, 2000; Edwards, 1995; Taylor, 2014). Those who consume self-caught fish are at risk of consuming contaminants in their catch, with the only protection provided is from the state issued fish consumption advisories, which can be difficult to find or, when found, difficult to understand.

Protesting the siting of a chemical waste landfill in Warren County, North Carolina in 1982 is often offered as the beginning of the environmental justice movement, and it certainly is the first well-documented proactive protest. An earlier case in Triana, Alabama in 1978 was reactive in nature. A plant producing DDT upstream from Triana had been contaminating the Tennessee River, which Triana residents used to catch fish.

In studies of the effectiveness of fish consumption advisories, special attention has been paid to settings with urban pollution, but there are many rural areas also impacted by industrial waste. Albemarle Sound, Tyrrell County's fishing grounds, is one of these areas. Two facilities located upstream from Albemarle Sound on the lower Roanoke River, the Weyerhaeuser Paper Mill and the Georgia Pacific Sawmill, have been discharging wastes containing dioxins and other metals since 1937. Longitudinal testing for contaminants shows much improvement since the first consumption advisories were issued in 1990 but Tyrrell County residents have been eating

fish from the area for centuries. This research was conducted to assess the issues surrounding the consumption of fish from these waters.

Organization of Dissertation

This dissertation is intended to be three stand-alone articles that are ready for peer-reviewed journals, therefore some of the material will be repeated. The first chapter of this dissertation includes the problem statement, the three research questions that build the framework for the research, and the objectives used to address these questions. Next is an overview of the study area and background for the research topics. Finally, the theoretical basis for the work is introduced.

The second chapter gives additional background of the topics discussed, including an overview of subsistence fishing as a global issue and a local issue, the risk of contaminants for those who eat non-commercial fish, and the concept of local ecological knowledge (LEK) held by those who fish. The third chapter describes in detail the methods used to gather information. The fourth, fifth, and sixth chapters present the findings of the research in a format intended for publication in peer-reviewed journals, therefore some of the methodology and literature review will be repeated in those chapters.

The fourth chapter discusses the perceptions held by the respondents about contaminants in their catch by formulating three questions: To what extent are recreational fishers in the Albemarle Sound aware of relevant public health advisories? What beliefs do they hold about methods to reduce and remove contaminants in fish and shellfish by cooking or cleaning methods? What environmental cues do they use to avoid contaminants? Three objectives were used to answer these questions; first, to assess the level of awareness of fish consumption advisories, second, to determine if anglers used any methods to eliminate contaminants in their

catch (e.g. discarding skin, baking rather than frying), and third, to identify which environmental factors they believed would indicate the presence of contaminants in water where they fished.

The fifth chapter investigates the local ecological knowledge the anglers reported about fishing in Tyrrell County by assessing their perceptions of changes in size and abundance of their catch and discerning what they believed to cause these changes. Objectives to find this information included establishing each angler's length of local fishing experience, listing the changes they perceived in their catch and the area surrounding their fishing sites, then finding what they believed to cause these changes in the catch.

The sixth chapter identifies the types of social justice applicable to subsistence fishing and evaluates whether the subsistence waiver is effective in its purpose of helping poor North Carolina residents by allowing them to fish for free. Five objectives were used to address this question: first, to establish angler opinion of the subsistence waiver; second, to determine which type of fishing license each angler holds; third, to determine angler familiarity with the waivers provided in the new license structure; fourth, to assess the perceptions of contaminant risk in self caught fish; and, fifth, to document the research on subsistence usage by fishery managers.

The seventh chapter ties together the findings of the three articles, discuss the implications of the findings, and provide recommendations borne of these findings.

Chapter 2: SUBSISTENCE FISHING

The Right of Subsistence

Having enough to eat has long been recognized as a human right. As early as 5200 BP, King Menes of Egypt issued edicts which were designed to improve food production and distribution, along with guarding the rights of ruling families, improving education, and enhancing knowledge of the natural world through geometry and astronomy (Mark, 2016). All major religious doctrines include encouraging hospitality towards the disadvantaged.

Blessed is he who considers the poor; the Lord delivers him in the day of trouble.
Judaism and Christianity. Psalm 41.1

Charity--to be moved at the sight of the thirsty, the hungry, and the miserable and to offer relief to them out of pity--is the spring of virtue.
Jainism. Kundakunda, Pancastikaya 137

Relieve people in distress as speedily as you must release a fish from a dry rill. Deliver people from danger as quickly as you must free a sparrow from a tight noose. Be compassionate to orphans and relieve widows. Respect the old and help the poor.
Taoism. Tract of the Quiet Way

Be kind to parents, and the near kinsman, and to orphans, and to the needy, and to the neighbor who is of kin, and to the neighbor who is a stranger, and to the companion at your side, and to the traveler, and to slaves that your right hands own. Surely God loves not the proud and boastful such as are niggardly, and bid other men to be niggardly, and themselves conceal the bounty that God has given them.
Islam. Qur'an 4.36-37

One should give even from a scanty store to him who asks.
Buddhism. Dhammapada 224

Not having enough of anything can cause one to become a miser.
African Traditional Religions. Yoruba Proverb (Nigeria)

He who has two coats, let him share with him who has none; and he who has food, let him do likewise.
Christianity. Luke 3.11

See to it that whoever enters your house obtains something to eat, however little you may have. Such food will be a source of death to you if you withhold it.

Native American Religions. A Winnebago Father's Precepts

It was not until 1948 that the universal right for food was articulated, when the newly formed United Nations published the Declaration of Human Rights that set out fundamental human rights to be universally protected, in a common set of achievements for all people of all nations. Article 25, Section one stated: “Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control.”

At the Millennium Summit, in 2000, the UN General Assembly adopted the Millennium Declaration; the first of the eight goals is to eradicate extreme poverty and hunger. International leaders met again in 2005 and 2010 to reaffirm their commitment to achieving the set of goals by 2015. A report in 2013 found the goal of halving, between 1990 and 2015, the proportion of people who suffer from hunger was not being met: “While the proportion of undernourished people globally decreased from 23.2 per cent in 1990-1992 to 14.9 per cent in 2010-2012, this still leaves 870 million people—one in eight worldwide—going hungry” (United Nations, 2013).

In 2015 all 193 members of the UN adopted the Sustainable Development Agenda, which included Goal 2: “End hunger, achieve food security and improved nutrition and promote sustainable agriculture” by 2030. Many of the member countries have addressed the right to food. Nineteen countries have adopted a framework law, 56 countries include the right to food in their constitution, and another 51 countries have ratified international law. The United States, however, expresses no such right, other than the vague assurance of “life, liberty and the pursuit of happiness” set forth in the Declaration of Independence.

The United States has recently come under fire from the United Nations for the proposed tax reform program that, "...stakes out America's bid to become the most unequal society in the world, and will greatly increase the already high levels of wealth and income inequality between the richest 1% and the poorest 50% of Americans. The dramatic cuts in welfare, foreshadowed by the President and Speaker Ryan, and already beginning to be implemented by the administration, will essentially shred crucial dimensions of a safety net that is already full of holes (Alston, 2018)." The reaction from the Executive Branch of the United States to the "Report of the special rapporteur on extreme poverty and human rights on his mission to the United States of America" (United Nations General Assembly, 2018) was to withdraw from membership in the United Nations Human Rights Council (Harris, 2018).

Philosophers have argued the right of subsistence from various perspectives: based on biological needs, vital human interests are central for living a life with dignity (Jones, 2013), without adequate food, humans do not reach their capabilities (Sen, 1997), material goods are necessary for a decent life (Fabre, 2000), and meeting basic needs are essential to leading a satisfying and fulfilling lives (Macleod, 2013).

Psychology acknowledges the importance of meeting basic survival needs before being able to achieve any higher accomplishments of intellectual or spiritual growth; for example, Maslow's (1934) hierarchy of needs theory claims that each level must be achieved before moving to the next; without meeting the physiological needs of air, food and water, humans cannot advance.

Self-transcendence: Giving outside the self in altruism or spirituality

Self-actualization: Reaching full potential and recognizing that potential

Esteem: Respect from others, self-respect

Social Belonging: Friendships, intimacy, family

Safety: Personal security, financial security, health, insurance against accidents and illness

Physiological Needs: Air, water, food, sleep, clothing, shelter, sex

Although world religions, world leaders, and social scientists agree that food is a basic human right, the world is rife with impoverishment and hunger abounds. The United Nations estimates that globally, one in nine people, about 870 million, do not have enough food to eat to live a healthy active life. In the United States, the USDA estimated that 41.2 million people, 12% of the population, lived in food-insecure households in 2016, defined as a lack of consistent access to enough food for an active, healthy life.

Food insecurity is not a new idea. In 1798 Malthus published the first edition of “An Essay on the Principle of Population” which argued that because it is natural for society to reproduce, human population increases exponentially; however, food supply can only increase arithmetically, therefore, food being vital to human survival, population growth would lead to starvation. The theme was updated and a predicted starvation scenario in the 1970s by Erlich in “The Population Bomb,” a prediction which not come to pass. Bosrup (1973) theorized that as population rises “agricultural intensification” takes place, in which land is used more efficiently and increases production (Figure 4). This combination has led to agricultural production surpassing population growth since the early 1990s.

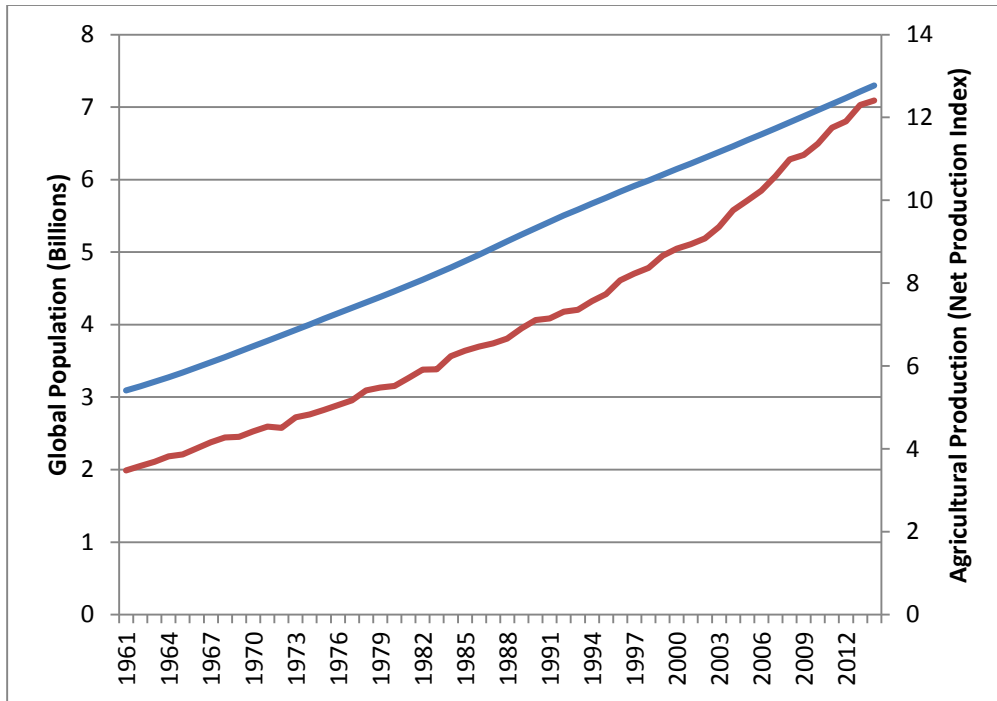


Figure 4. Increase in agricultural production and population 1961-2014 (FAOSTAT, 2017).

Additionally, humans have slowed down on reproduction (Figure 5) after a peak of 2.1% growth in 1961 (FAOSTAT, 2017) and the rate of growth is predicted to continue to decline (Figure 6) (UN Population Division, 2015).

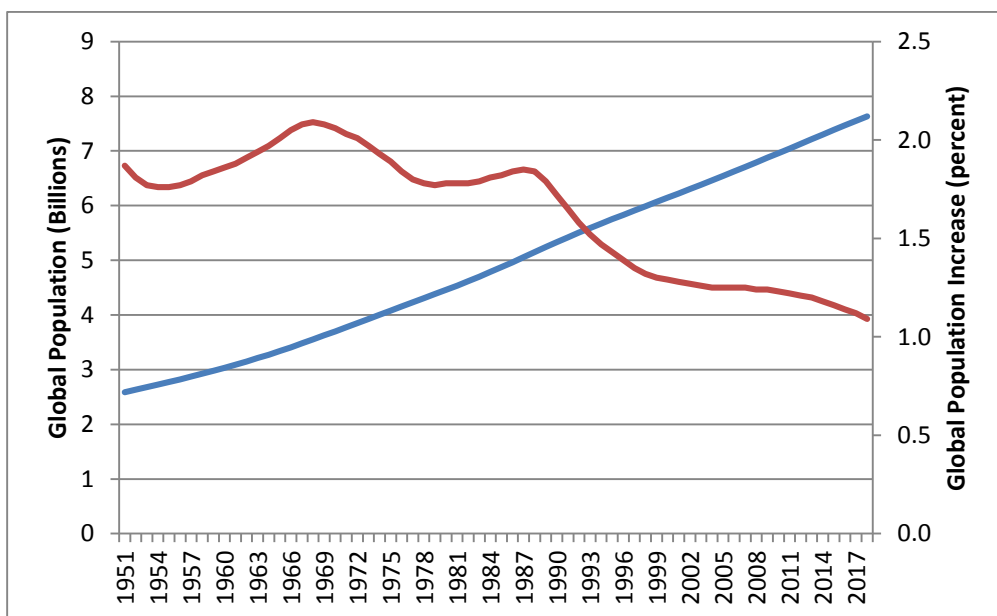


Figure 5. Global population and population increase rates 1951-2017 (FAOSTAT, 2017).

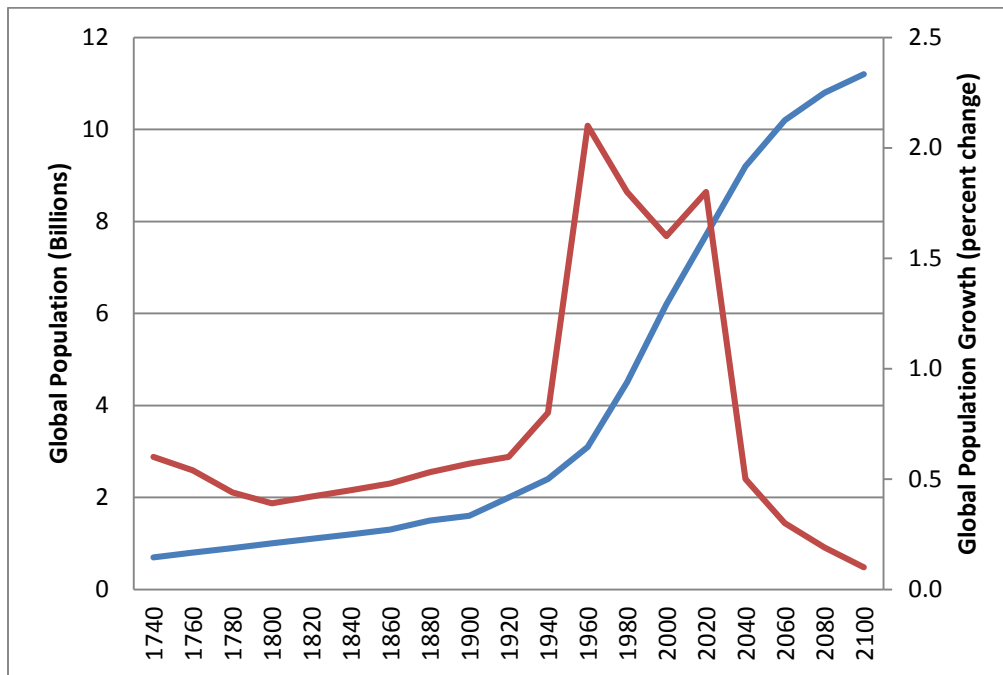


Figure 6. Predicted growth of world population 1750-2100 (UN Population Division, 2015).

Thanks to agricultural improvements, there is an abundance of food worldwide. The “green revolution” is the name for the implementation of irrigation, pesticides, synthetic fertilizers, and improved crop varieties in developing countries, which has been responsible for doubling cereal (rice, maize, wheat) production from 1961 to 1985. Yet the food is not distributed to those who need it, as described in “Poverty and Famines: An Essay on Entitlement and Deprivation” (Sen, 1981), which argued that famines were not caused by the lack of food supplies, but the societal, economic, and political distribution of available food. While the improvement of food production is highly lauded, the increased industrialization of agriculture has also led to displacement from land and jobs (Utting, 2015).

Access to agricultural products is one facet of food security. The other facet is access to subsistence foods; those which are gathered locally. As woodland is transformed to cropland, habitat for game and foraged plants is reduced. As waterfronts are gentrified and land is

privatized, access to fishing is limited. Threats of pollution in water bodies decreases the safety of the fish catch. Increasingly restrictive regulations reduce access to hunting and fishing.

Twenty-one states in the United States guarantee the right to fish and hunt through the state constitution (Table 1), although license fees and bag limits still apply (National Conference of State Legislatures, 2017). In 2016, North Carolina, along with eight other states (Colorado, Iowa, Maine, Michigan, Missouri, New Jersey, New York, and West Virginia) considered legislation on the constitutional issue, but did not pass. More recently, Senate Bill 677, which protects the right to hunt, fish, and harvest wildlife, passed both the North Carolina Senate and House of Representatives, and will be voted on as a Constitutional amendment in the November, 2018 election (North Carolina General Assembly, 2018). The amendment would change nothing and is seen as an effort by Republicans to encourage voter turnout (Rierson, 2018).

State	Year of Adoption
Alabama	1996
Arkansas	2010
Georgia	2006
Idaho	2012
Indiana	2016
Kansas	2016
Kentucky	2012
Louisiana	2004
Mississippi	2014
Minnesota	1998
Montana	2004
Nebraska	2012
North Dakota	2000
Oklahoma	2008
South Carolina	2010
Tennessee	2010
Texas	2015
Vermont	1777
Virginia	2000
Wisconsin	2003
Wyoming	2012

Table 1. States with the right of fishing and hunting written into the constitution.

There is no differentiation between management of sport and subsistence hunting and fishing (Figure 7) for all residents other than in Alaska, where subsistence hunting is managed separately from sport hunting, and subsistence fishing is managed separately from commercial and recreational fishing (Figure 7.b); both subsistence uses are given priority above the other uses. Other states (e.g. Washington, Wisconsin, Minnesota) are bound by historic Native American treaties to include provisions for subsistence fishing. States without these treaties either treat subsistence fishing no differently than recreational fishing or provide some form of subsistence permit intended to help the impoverished (Figure 7.c).

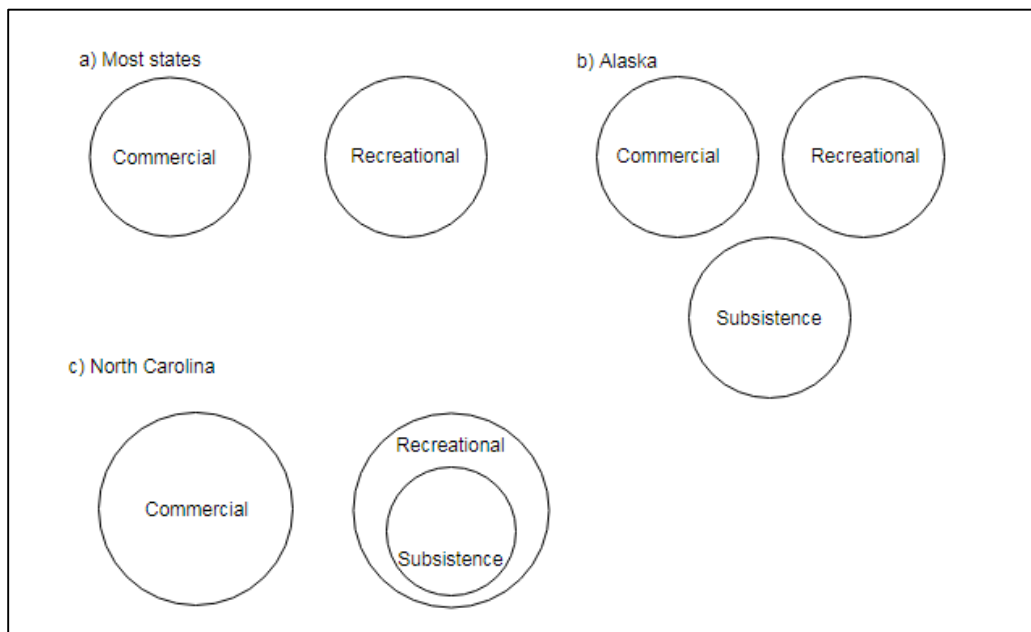


Figure 7. Fishery Management in a) most U.S. States, b) Alaska, and c) North Carolina.

North Carolina recognized the importance of access to fishing by economically challenged residents when it restructured the recreational fishing regulations in 2007 by including the “Unified Subsistence Inland/Coastal Recreational Fishing License Waiver” (subsistence waiver). The subsistence waiver is free for North Carolina residents who receive Medicaid, Food Stamps

(SNAP), or Work First Family Assistance and is issued through each county department of social services.

Defining Subsistence

Subsistence fishing is considered either a subset of recreational fishing or is managed entirely separately from commercial and recreational fishing, depending on who is managing the resource. The phrase “subsistence fishing” is difficult to define (Clark et al., 2002) and can have several meanings. Schumann and Macinko (2007) reviewed academic literature on subsistence and found four distinct meanings: 1) a level of existence that doesn’t exceed a survival level; 2) an economy that doesn’t include monetary exchange; 3) institutions that accord special social meanings to sharing and exchanges; and 4) activities that don’t have a strictly material motivation. A global definition is provided by the United Nations Food and Agriculture Organization (FAO), “A fishery where the fish caught are consumed directly by the families of the fishers rather than being bought by middle-men and sold at the next larger market (FAO, 1999).” In the United States, the EPA defines subsistence fishers as those, “...who rely on non-commercially caught fish and shellfish as a major source of protein in their diets (EPA, 2000).” The commonly used definition of subsistence fishing in the social sciences is “Local, non-commercial fisheries, oriented not primarily for recreation but for the procurement of fish for consumptions of the fishers, their families and community” (Berkes, 1990). For the purposes of this thesis, subsistence fishing is fishing for food by low-income anglers, not the recreational angler who occasionally keeps enough for a meal, or the commercial crew member who brings non-target species home for the supper table, or higher-income anglers who keep their catch for consumption.

Subsistence catch is said to be vastly underestimated (McClanahan, Allison and Cinner, 2015) because fishery economics are largely based on catch reporting and focused on markets, which generally exempts subsistence catch (Béné et al. 2007; Bartley et al. 2015). Not knowing the quantity of catch degrades the decision-making process for fishery managers and leaves fish consumers at risk of consuming contaminants (Mariën and Stern, 2005).

Importance of Fishing

Fishing is important for employment, recreation and sustenance. Employment in marine fisheries generates an estimated 203 ± 34 million full-time equivalent jobs globally (Teh and Sumaila, 2013) when including both artisanal (small scale) and industrial (large scale) fisheries. In 2015, commercial and recreational fisheries in the United States generated 1.6 million jobs throughout the national economy (NOAA, 2016).

Recreational fishing is popular in the United States, with over 10% of the population regularly participating in 2011, the last year the national survey of fishing and hunting was published (U.S. Department of the Interior, 2012). More than 33 million Americans fish regularly, with varying levels of catch retention, from only catch-and-release to depending heavily on bringing fish and shellfish home to supplement the grocery bill. In North Carolina, more than 1.3 million residents fished in 2011, which is more than 13% of all 9.7 million residents in that year (U.S. Department of the Interior, 2012; US Census, 2016).

Globally, fish is often the most accessible source of protein (Berkes, 1990), providing an estimated 17% of all animal protein and more than 70% in some nations (FAO, 2014). Fish is widely known to be a good source of a variety of health benefits including lean protein (FAO/WHO, 2011; Mozaffarian and Rimm, 2006; Nesheim and Yaktine, 2007; U.S. Food and Drug Administration, 2009; Wang et al., 2006) and several micronutrients of increasingly

recognized importance (Golden et al., 2016; Sheeshka and Murkin, 2002). However, fish can absorb contaminants from water they live in and their food.

Contaminant Risks in Fish

In the U.S. commercial fish are subject to inspection either during importation or when landed in a licensed seafood production plant. Self-caught fish, however, undergo no scrutiny and there is evidence that many groups consume quantities of fish and shellfish much greater than the average U.S. citizen, reported to be 14.9 pounds per capita in 2016 (National Marine Fishery Service, 2017). The first nationwide study representing the population of the United States (Stackelberg et al., 2017) showed that 7.5% of the entire population should be considered “high-frequency fish consumers, with an average of 30 g/day or 10.95 kg/yr. This is considerably higher than the EPA default fish and shellfish consumption rate of 6.4 kg/yr (EPA, 2000). Other studies on individual populations have also shown much higher consumption rates: 19.3 kg/yr by recreational anglers in Washington State (May and Burger, 1996); 14 kg/yr by minority anglers in Indiana (Williams et al., 2000); 19 kg/yr by Asians in New Jersey (Burger, 2002); 25.6 kg/yr by black men in South Carolina (Burger and Gochfield, 2002); 13.9 kg/yr by Pacific Islanders in San Francisco (Moya, 2004); 16.7 kg/yr by Native Hawaiians (Loke, 2012); and 40 kg/yr by Alaska Natives (Nobmann et al., 1992). The greater the consumption rate leads to a greater the risk of consuming contaminants.

Anglers often have minimal knowledge of the effects of contaminants on health (Maren and Stern, 2005; Surgan et al., 2008; Katner et al., 2011; Engelberth et al., 2013), little concern for contaminants in their catch (LePrevost et al., 2013; Imm et al., 2013), and a misguided faith that the government will post warnings at every water body at risk for contaminants (Driscoll et al., 2012; Verbeke et al., 2005).

North Carolina, like the rest of the United States, is under a fish consumption advisory for mercury, with special attention to women of childbearing age because of the damage to developing neurological systems. Some mercury may be reduced by gutting and skinning the fish, but effectiveness at contaminant reduction varies widely among species (Foran et al., 2005; Shen et al., 2016). Mercury levels cannot be reduced in fish through cooking (Burger et al., 2003). Studies have shown that mercury loads may increase during cooking (Perugini et al., 2016; Ouédraogo and Amyot, 2011; Maulvault et al., 2011) because the loss of moisture concentrates the mercury during the cooking process. Other than removing the skin and guts before cooking, mercury risk may be reduced by combining fish with several other foods. Tomato products (Gagne et al., 2013), coffee and green tea (Ouédraogo and Amyot, 2011), and tropical fruit (Passos et al., 2007) have been shown to reduce mercury bioavailability during digestion by attaching mercury to the fiber in the fruit or the antioxidants and expediting excretion (Gagne et al., 2013).

The only other fish consumption advisory for coastal North Carolina is in Albemarle Sound for dioxins, from nearly a century of pulp production upstream (Clark, 2004). Dioxins can cause reproductive and developmental problems, damage the immune system, interfere with hormones and cause cancer (WHO, 2014). Dioxin contamination can be reduced by certain cooking methods that remove the belly flap, skin, and lateral line, as dioxin is stored in lipids (Zabik and Zabik, 1999).

Policy Considerations

Each of the states in the U.S. imposes fishing regulations specific to state water bodies and specific stocks, but most states have no separate subsistence fishing rules. Hawaii and Alaska carefully manage subsistence fishing separately from commercial and recreational; it is

no coincidence that these are the states with strong voices from their indigenous populations. Other states (e.g. Washington, Wisconsin, Minnesota) are bound by historic Native American treaties to include provisions for subsistence fishing. States without these treaties either treat subsistence fishing no differently than recreational fishing or provide some form of subsistence permit.

North Carolina is one of the states that addresses subsistence fishing. Beginning in 2007, all North Carolina residents over age 16 were required to have a license to fish, whereas before that date no license was needed to fish in salt water or to fish in the resident's home county, as long as natural bait was used. The importance of access to fishing for economically challenged residents was recognized during the restructuring and acknowledged by including the "Unified Subsistence Inland/Coastal Recreational Fishing License Waiver" (subsistence waiver). The subsistence waiver is free for North Carolina residents who receive Medicaid, Food Stamps (SNAP), or Work First Family Assistance and is issued through each county department of social services. The number of waivers issued steadily increased from its inception in 2007 to 2015, then began declining in 2016 (Figure 8) (Linehan, 2017). More than a third of the waivers were issued in the twenty coastal counties.

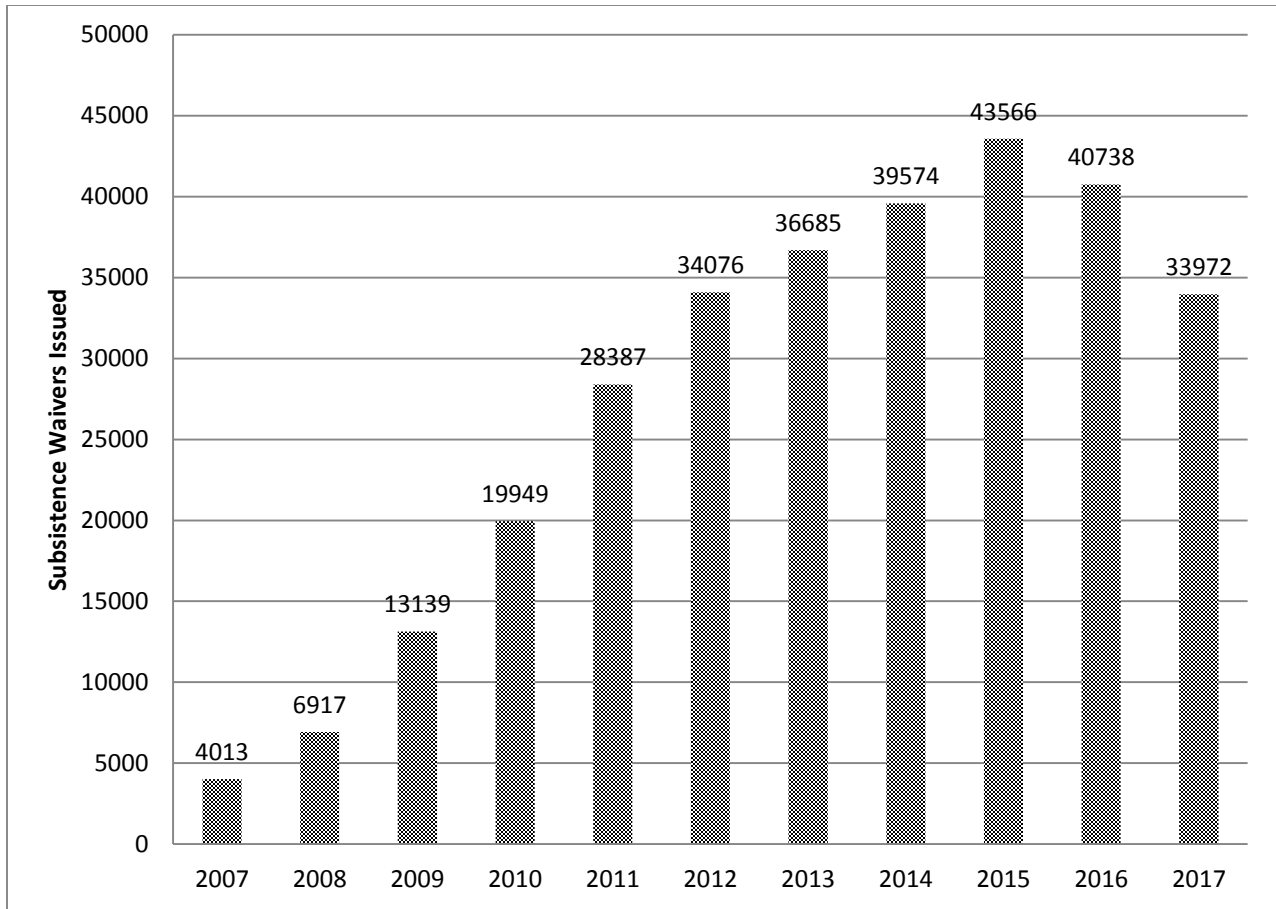


Figure 8. North Carolina subsistence waivers issued 2007-2017.

In North Carolina, fishing licenses for salt water fishing are distributed through the Division of Marine Fisheries in the North Carolina Department of Environmental Quality, while licenses for fresh water are distributed through the North Carolina Wildlife Resources Commission. The Subsistence Waiver is distributed through each county’s Division of Social Services (Figure 9). The method of distribution of subsistence waivers through social services departments rather than through fishery management agencies has caused a gap in collecting catch data, which is conducted by surveys sent to license holders (C. Wilson, personal communication, May 24, 2016).

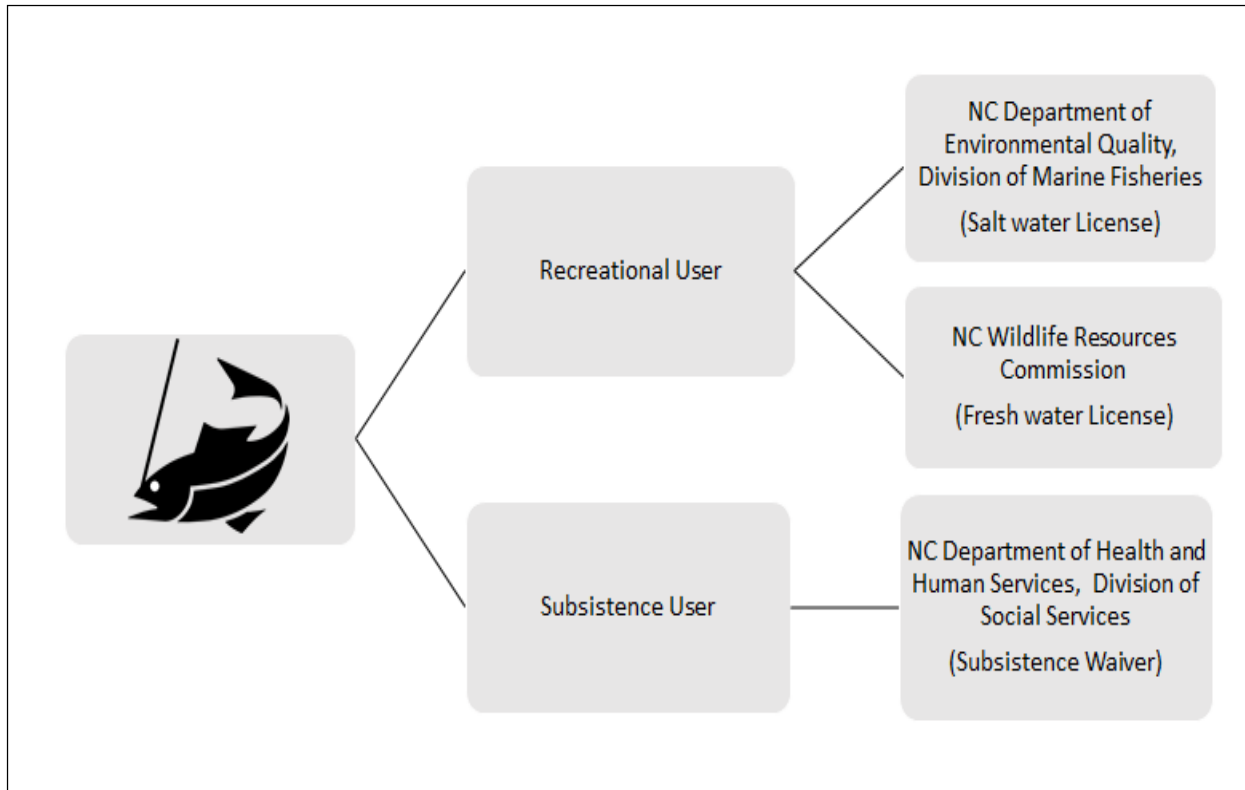


Figure 9. Departments responsible for fishing license distribution in North Carolina.

There also may be fewer subsistence waivers issued than is warranted by the financial situation of individuals; studies have shown that as many as two-thirds of Americans do not participate in assistance programs for which they are eligible (Blank and Ruggles, 1996; Stuber and Schlesinger, 2006), due to either lack of information about the programs or because of the stigma attached to enrolling in assistance programs.

Although the first year of the new fishing license structure targeted educating the public rather than writing tickets, the new regulations also introduces the potential of steep fines for fishing without a license; an estimated 7-10% of recreational fishers nationwide fish without a license (Responsive Management, 2011). The number of unlicensed fishers in North Carolina is unknown.

Chapter 3: RESEARCH METHODS

Research Design

The interviews and surveys that provided the data for this research were all face-to-face during trips to Tyrrell County, in line with Bernard's (2005) recommendations in his seminal work on anthropological research methods. Travel for face-to-face interviews is costlier in time and expense than other techniques (e.g. on-line surveys, telephone interviews), but the ability to explain any unclear questions and reach lower income residents, who are less likely to answer mail surveys or requests for phone interviews, made this technique appropriate (Alreck and Settle 1985, Bernard 2005, Holbrook et al. 2003, Szolnoki and Hoffmann 2013). The number of proposed community leader interviews and resident surveys was dictated by practicality of the availability of the researcher's time and available travel funds. The proposal for the study and the survey instruments were submitted to the East Carolina University Institutional Review Board, which approved the study September 16, 2015 (Appendix A). Data were collected in Tyrrell County in the fall of 2015 and the spring of 2016.

Participants

Community Leader Interviews

Semi-structured interviews were conducted with key community leaders, including social service providers, local law enforcement, county commissioners, fishery managers, librarians, business owners and other public figures, with a focus on those who have lived in Tyrrell County many years. The interview questions covered topics such as the need for county residents to fish, changes in the aquatic habitat, and the sources of contaminants in fish. The community leaders were asked to identify known anglers (snowball sampling) and angling locations. Fifteen interviews were conducted. A majority of the interview participants were male (60%). Sixty-

seven percent of the participants were Caucasian, 26% African-American, 7% Asian. No information was collected on age, educational attainment, or marital status.

County Resident Surveys

The resident survey included the topics covered in the community leader interviews as well as questions about sharing self-caught fish, methods of contaminant removal and avoidance, observations of changes in catch composition over time, the impact of fishing on the family grocery bill, and demographic information including education level and income. Participants in the county resident surveys were recruited through two methods. First, an ad was placed in the Scuppernong Reminder, the local weekly newspaper, inviting Tyrrell County residents who fished or received fish as gifts to meet at the Tyrrell County Library. The second method of survey participant selection was to intercept walk-in customers at the Scuppernong Quick Stop, a convenience store located in the center of the City of Columbia. Permission was obtained from the owner to post a flyer and set up chairs in their parking lot to administer the survey. Two other methods to recruit participants met with failure. The first was visiting rural convenience stores in the Alligator and Gum Neck communities to intercept customers. The second failed attempt was to contact church leaders. A short presentation about the project was made at the monthly meeting of the Tyrrell County Ministerial Association on February 2, 2016. Association members expressed interest in participating, but follow up contacts proved unsuccessful. At the outset of each survey the participants were told the purpose of the research, asked if they ate either fish they caught themselves or ate fish they received as a gift, advised that the study was voluntary, their information would remain confidential, and they would each be given a \$10 gift card from the local grocery store upon completion of the survey.

A total of fifty surveys were completed. Survey participants ranged in age from 23 to 81, with a mean age of 55. A slight majority of the survey participants were female (52%), and the majority of the participants were African-American (68%). The most common marital status was single (46%), 24% were divorced, 14% were currently married, 10% widowed, 6% separated. The most common employment category was unemployed (36%), with 28% working full time, 14% retired, 12% working part time, and 10% on disability.

Instruments

The instrument used for the community leader interview (Appendix B) was a series of open-ended questions designed to identify the participant's length of experience in the community, familiarity with fishing and fishing regulations, changes in the aquatic habitat, and knowledge of contaminants in locally caught fish.

The instrument used for the county resident survey (Appendix C) was a series of 85 questions using a combination of short answer, scale opinion, multiple choice, yes/no, and open-ended formats. Three sources informed the survey questions. The first source was the answers to the community leader interviews. The second source was a study conducted for the North Carolina Division of Marine Fisheries (Crosson, 2010); questions on user conflict and issues of concern related to fishing were taken from this study. The third source was unpublished surveys of recreational fishers in North Carolina, South Carolina and Georgia (Brown-Pickren, 2012) and of recreational fishers in coastal North Carolina (Brown-Pickren, 2014); questions on purposes of fishing, importance of fishing, contaminant awareness, and environmental changes were taken from those surveys.

Limitations

There are several limitations to this study. Only those who catch their own fish for consumption or receive recreationally-caught fish as gifts were invited to participate, therefore the results are not representative of the entire population of Tyrrell County. The selection of participants for the survey was limited to within the city of Columbia. Attempts were made to conduct surveys in the rural communities but were unsuccessful. According to the 2010 Census, about one-fourth of the county's residents live in Columbia. Although Hispanics comprise 7% of the population of the county, none participated in the survey, when a representational sample would have been 3 or 4 Hispanics.

Chapter 4: PERCEPTION OF CONTAMINANTS IN SELF-CAUGHT FISH IN A RURAL COASTAL COMMUNITY

Abstract

Recreational fishing is popular and fish is a good source of a variety of health benefits, yet self-caught fish may be a source of contaminants such as mercury and dioxins. The purpose of this study was to evaluate the perceptions of contaminants in self-caught fish in a small rural community by asking three questions: To what extent are recreational fishers in the Albemarle Sound aware of relevant public health advisories? What beliefs do they hold about methods to reduce and remove contaminants in fish and shellfish by cooking or cleaning methods? What environmental cues do they use to avoid contaminants? Three objectives were used to answer these questions; first, to assess the level of awareness of fish consumption advisories, second, to determine if anglers used any methods to eliminate contaminants in their catch, and third, to identify which environmental factors they believed would indicate the presence of contaminants in water where they fished. A questionnaire was developed and administered to residents of a rural county in eastern North Carolina who ate fish they either caught themselves or received as gifts. Results showed (1) reliance on fishing to supplement the grocery bill, (2) lack of awareness of fish consumption advisories, (3) misinformation about the sources of contaminants in fish, and (4) mistaken beliefs in ways to avoid contaminants. Anglers who rely on fish they catch to are likely to eat considerably more fish than the average American and are therefore at greater risk for ingesting contaminants.

Introduction

Globally, fish is often the most accessible source of protein (Berkes, 1990), providing an estimated 17% of all animal protein and more than 70% in some nations (Food and Agriculture

Organization, 2014). Fish is widely known to be a good source of a variety of health benefits including lean protein (Food and Agriculture/World Health Organization, 2014; Mozaffarian and Rimm, 2006; Nesheim and Yaktine, 2007; U.S. Food and Drug Administration, 2009; Wang et al., 2006) and several micronutrients of increasingly recognized importance (Golden et al., 2016; Sheeshka and Murkin, 2002). Recreational fishing is popular in the United States, with over 10% of the population regularly participating in 2011, the last year the national survey of fishing and hunting was published (U.S. Department of the Interior, 2012). More than 33 million Americans fish regularly, with varying levels of catch retention, from only catch-and-release to depending heavily on bringing fish and shellfish home to supplement the grocery bill.

In North Carolina more than 1.3 million residents fished in 2011, which is more than 13% of all 9.7 million residents in that year (U.S. Department of the Interior, 2012; US Census, 2016). Residents of coastal areas consume more fish and shellfish than inland residents (Mahaffey, Clickner, and Jeffries, 2009) and lower income anglers eat more of their catch than higher income (Burger, 2009). Although fishing is an important activity in North Carolina, some waterways are contaminated. Unfortunately, anglers often have minimal knowledge of the effects of contaminants on health (Marien and Stern, 2005; Surgan et al., 2008; Katner et al., 2011; Engelberth et al., 2013), little concern for contaminants in their catch (LePrevost et al., 2013; Imm et al., 2013), and a misguided faith that the government will post warnings at every water body at risk for contaminants (Driscoll, 2012; Verbeke et al., 2005), suggesting a need for collaboration between fishery management agencies and public health agencies in publicizing catch regulations along with contaminant risks (Love et al., 2013; Scherer et al., 2008).

Mercury and dioxins are the two contaminants of concern for coastal North Carolina listed in the NC Department of Epidemiology fish consumption advisories. Mercury is an important fish contaminant throughout the United States because of known detrimental effects of mercury on the neurological systems of developing fetuses. The U.S. Environmental Protection Agency and U.S. Food and Drug Administrations have addressed mercury sources and consumption, with special focus on women of child-bearing age and young children. The North Carolina Division of Public Health has issued a statewide advisory regarding consumption of fish known to contain mercury (North Carolina Division of Public Health, 2017). Mercury occurs naturally in the environment and is produced in industrial processes and burning. After deposition into water bodies, marine and aquatic organisms transform elemental mercury into methyl mercury, which is of concern to human health, then amplify mercury levels through bioaccumulation, resulting in fish and shellfish supplying the primary source of ingested mercury in humans (Driscoll et al., 2013). The extensive slow-moving swampland of eastern North Carolina allows substantial opportunity for mercury accumulation.

Dioxin is the other contaminant of concern for coastal North Carolina in the Division of Public Health fish consumption advisories, specifically in the Roanoke River, Welch Creek, and western Albemarle Sound. The source of dioxins for these water bodies is the discharge from the pulp industry into the Roanoke River and Welch Creek (Clark, 2004). Dioxins can cause reproductive and developmental problems, impair the immune system and chronic exposure can result in cancer (World Health Organization, 2004). Dioxins are absorbed and stored by fat tissue and are chemically stable in the body.

Each state manages fish and shellfish through catch limits, size limits and closed areas. Anglers are expected to know about bag and size limits on their catch and in North Carolina

these restrictions are published in annual fishing regulations booklets by the Wildlife Resources Commission for inland fishing and by the Division of Marine Fisheries for coastal waters. The freshwater booklet contains a summarized version of all fish consumption advisories while the coastal booklet contains none.

While commercial fish are subject to inspection either during importation or when landed in a licensed seafood production plant, recreationally-caught fish undergo no scrutiny. There is evidence that certain minority groups consume quantities of fish and shellfish much greater than average consumer (Gochfield and Burger, 2011) as calculated by the United States Environmental Protection Agency, which has uses a default fish and shellfish consumption rate of 6.4 kg/yr for the purpose of establishing levels of contaminant consumption (U.S. Environmental Protection Agency, 2000), while the annual per capita seafood consumption rate is around 6.8 kg (NOAA, 2017). However, studies on individual populations have shown much higher consumption rates: 19.3 kg/yr by recreational anglers in Washington (May and Burger, 1996); 14 kg/yr by minority anglers in Indiana (Williams et al., 2000); 19 kg/yr by Asians in New Jersey (Burger, 2002); 25.6 kg/yr by black men in South Carolina (Burger and Gochfield, 2002); 13.9 kg/yr by Pacific Islanders in San Francisco 13.9 kg/yr (Moya, 2004); 16.7 kg/yr by Native Hawaiians (Loke, 2012); and 40 kg/yr by Alaska Natives (Nobmann et al., 1992). The greater the consumption rate the greater the potential risk of consuming contaminants.

The goal of this study was to assess residents' perception of the risk of contaminants when eating recreationally-caught fish and shellfish in a coastal county in North Carolina. The goal was explored by addressing the following research questions: 1) How important is catching fish or receiving fish as gifts to rural coastal residents? 2) To what extent are coastal residents concerned about contaminants in their catch? 3) What do they believe to be the sources of

contaminants? 4) What beliefs do they hold about methods to reduce and remove contaminants in fish and shellfish by cooking or cleaning methods? 5) Are coastal residents aware of relevant public health advisories?

Study Region

The study was conducted in Tyrrell County, which is located in eastern North Carolina, USA (Figure 10). Tyrrell County has a population of 4,073, the lowest county population in the state. The county lies at an elevation of between sea level and 4m and is characterized by low lying land with many rivers, streams, swamps, and the Albemarle Sound, offering County residents many fishing opportunities. In addition to the statewide fish consumption advisory for mercury, Albemarle Sound holds the only additional advisory in coastal North Carolina, for dioxins from nearly a decade of pulp production upstream (Clark, 2004). Thus, Tyrrell County is well suited for this study. Tyrrell County is one of the most economically challenged counties in the state; the county is designated “Tier 1” based on high unemployment rates, low incomes, low population growth, and a small tax base (North Carolina Department of Commerce, 2016). More than one in four residents, or 27%, are considered poor (U.S. Census, 2016). The two largest industries in Tyrrell County, White Cap Linen and Captain Charlie’s Seafood, are staffed almost exclusively by Hispanics with H-2B visa, other than administrative staff (Selby, Dixon and Hapke, 2001; Efland, 2011; Garrity-Blake and Nash, 2012; Kros and Rowe, 2013).



Figure 10. Location of Tyrrell County in North Carolina.

Methods

Two instruments were used for this study. Sixteen open-ended questions were asked to community leaders regarding their knowledge of recreational fishing in Tyrrell County. The answers to these questions were used to develop an 85-question questionnaire which cover fishing habits, perceptions of fishing regulations, familiarity with fish consumption advisories, and awareness of contaminants found in fish. The questions were a mix of dichotomous, open-ended, and scale. Surveys were administered to Tyrrell County residents (N=50), both those who eat self-caught fish and those who receive recreationally-caught fish as gifts. All participants were assured of the confidentiality of their responses. A description of the study and the survey were submitted to the East Carolina University Institutional Review Board and was approved September 16, 2015.

Survey participants were recruited using two methods. First, an announcement was placed in the regional weekly newspaper, inviting Tyrrell County residents to meet at the library at specified times. Second, after permission was obtained, a flyer was posted in a local convenience store and the interviewer conducted surveys on folding chairs in the parking lot. All potential survey respondents were asked if they were residents of Tyrrell County, asked if they

ate recreationally-caught fish (either that they caught themselves or were given by a recreational fisher), assured of the confidentiality of their answers, and told they would receive a ten-dollar grocery store gift card upon completion of the survey. Respondents who did not participate in fishing were administered an abbreviated survey, which is included in the results below. The interviews and surveys were completed during nine trips to Tyrrell County between October, 2015 and April, 2016.

Study Limitations

There are two notable limitations to this research, both of which restrict the possibility of generalizing these results to the broader community. First, the sample size is small, only 2% of the population of Tyrrell County residents. Second, the method of participant selection was not randomized, but designed to include low income county residents. Although not suitable for quantitative statistical analysis, the information is useful because of the correlation in these purposive samples.

Results and Discussion

The fifteen community leaders were, mostly, longtime residents of the county, with a median residency of 33 years. Almost half of those interviewed fished, but only one person was worried about contaminants in fish. Only three community leaders said they were aware of the fish consumption advisories for the local area, about the same as the survey respondents, indicating a need for better distribution for information on contaminant risks.

Respondents were asked how important fishing was to their family grocery bill, with four choices from “not at all important” to “vitally important.” More than three quarters (77%) of those who caught fish for themselves responded that fish was important to feeding themselves and their families. Of those who did not fish but regularly received fish (30% of those

interviewed) as gifts, 67% said receiving fish was important. On the question about whether respondents were concerned about consuming contaminants in fish they caught or were given as gifts, 48% responded that they were concerned and 52% weren't. When the respondents were asked about their perceptions of the sources and types of contaminants, the results indicate that the majority of the contaminants were agricultural runoff (39%) and trash or litter (29%) (Table 2.). These results reveal that although half of the respondents were concerned about contaminants, fewer than 15% of respondents correctly identified the major contaminants in the water bodies.

<i>Where do you think contaminants originate?</i>	Percentage
Farm runoff, crop fertilizer	39
Trash, litter	29
Pollution	8
Industrial pollution	8
Mercury	12
Dioxin	0
Sewage	4

Table 2. Sources of contaminants perceived by survey respondents.

When respondents were asked if they knew of methods to either clean or cook fish that would reduce or remove contaminants, 80% of those who fished said they didn't know of any methods to do so. Those who said they knew ways to cook fish to reduce contaminants mentioned boiling and deep frying, neither of which reduces contaminants in fish. Although the effectiveness of removing contaminants by cooking and cleaning techniques varies widely among species (Foran et al., 2005; Shen et al., 2016), dioxin contamination can be reduced by certain cooking methods that remove the belly flap, skin, and lateral line, as dioxin is stored in lipids (Zabik and Zabik, 1999). No respondents mentioned these valid methods of reducing dioxin levels by cleaning or cooking fish.

Mercury levels cannot be reduced in fish through cooking (Burger et al., 2003). Studies have shown that mercury loads actually increase during cooking (Perugini et al., 2016; Ouédraogo and Amyot, 2011; Maulvault et al., 2011) because the loss of moisture concentrates the mercury during the cooking process. No respondents mentioned combining fish with other foodstuffs to reduce mercury risk, although tomato products (Gagne et al., 2013), coffee and green tea (Ouédraogo and Amyot, 2011), and tropical fruit (Passos et al., 2007) have been shown to reduce mercury bioavailability during digestion. Thus, respondents' ideas about using cooking methods to reduce mercury in fish are misplaced.

Participants were asked if they knew about the fish consumption advisories for the places they go fishing. Almost 70% of participants who fished were unaware of the local fish consumption advisories. Those who indicated they were familiar with the advisories were asked to describe the fish or chemicals involved. Only three respondents mentioned mercury, one mentioned catfish and nobody mentioned dioxins.

Fish consumption advisories were first issued for all species of fish in western Albemarle Sound in 1991 based on findings of exceedance of the state tolerance level for dioxin of 3 PPT (Clark, 2003). In 2001 the advisory was removed from all species other than carp, which is generally not a species targeted for consumption, and catfish, which is highly desirable to many anglers. The current advisory recommends no consumption of these two species by women of childbearing age and children, while all others are recommended to eat no more than one meal of these species per month.

One encouraging aspect to this topic was discussion with a social worker, which revealed that all prenatal care includes a discussion with the mother about the risks of mercury and offers advice on quantity and types of seafood to eat and to avoid. However, there may be an

overreaction to this advice, leading to eliminating a good source of protein and nutrients. As one respondent expressed, “When I had my baby the doctor told me all kinds of fish could hurt the baby so I just quit eating any fish at all.”

Because the Department of Public Health website is one of the few places to find the list of fish consumption advisories, respondents were asked if they used the internet. More than half (58%) of respondents said they never used the internet. Those who use the internet to find information were asked if they had ever looked up the North Carolina fishing regulations on the internet and about half (52%) said yes, they had looked up fishing regulations. Each of the internet users were asked if they had ever looked up the North Carolina fish consumption advisories on the internet and most (76%), had not visited the fish consumption advisory page on the North Carolina Department of Public Health website.

Conclusion

Eating self-caught fish or receiving fish as gifts is very important to these rural coastal residents. Although the respondents were somewhat concerned about contaminants in the fish they consume, they had little information about the sources of the contaminants and were misinformed about methods to reduce and remove contaminants by cooking or cleaning methods. The respondents were largely unaware of the relevant fish consumption advisories and many did not use the internet, one of the few sources of the advisories. The continued consumption of potentially contaminated fish, whether because of necessity or unawareness of the risk, or a combination of the two, creates a health risk, of concern to public health officials. The people who need to eat their own catch because of financial constraints are the very people who are the least informed about the risks of contamination in their catch.

These findings lead to a recommendation of making the information about risk of eating fish more widely available. This might be accomplished by posting the consumption advisories at boat ramps and in public spaces, such as libraries and post offices, for those who do not use the internet to find. Publishing the information in appropriate languages additional to English would be useful and including simple graphics of risky fish and of portion sizes would aide in understanding.

Chapter 5: ANGLER LOCAL ECOLOGICAL KNOWLEDGE ABOUT CHANGES IN FISH ABUNDANCE AND SIZE AND PERCEIVED CAUSES OF THESE CHANGES IN A RURAL COMMUNITY

Abstract

Resource users often amass local ecological knowledge about the resource. Anglers who fish in the same spot over time have knowledge of the fluctuations of types and sizes of species they target and environmental conditions where they fish. The purpose of this study was to assess angler perceptions of changes in size and abundance of their catch and discern what they believed to cause these changes. Objectives to find this information included establishing each angler's length of local fishing experience, listing the changes they perceived in their catch and the area surrounding their fishing sites, then finding what they believed to cause these changes in the catch. A surveys of anglers in Tyrrell County, North Carolina (N=50) revealed perceived longitudinal changes of the size and quantity of fish they caught, but these perceptions did not align with other species abundance studies in the area. These anglers attributed these changes to a combination of increased angling competition, increased pollution, and expanded built environment, but did not perceive changes in water temperature, changes in salinity, or increased storm activity to be the cause. Although other research has found good correlation between formal scientific research and local ecological knowledge, this was not the case in this study.

Introduction

Managers of natural resources have come to respect the knowledge of the users of those resources, who may have local knowledge handed down through generations (traditional ecological knowledge) or may have learned through their activities (local ecological knowledge: LEK) (Berkes, 2015; Berkes et al., 2000). Scientific reports increasingly include LEK, both in

tandem with research results, and by itself when it is the only information available for fishery management in the absence of scientific studies (Murray et al., 2006; Beaudreau & Levin, 2014). Studies have produced good association between LEK and scientific research; for example, Silvano and Valbo-Jørgensen (2008) found agreement of river habitat and fish habits during a Brazilian comparison of LEK and scientific inquiry. Other LEK has informed studies on fish migration (Huntington et al., 2004), reproduction (Aswani and Hamilton, 2004), and trophic relationships (Silvano and Begossi, 2002). In the United States, the National Marine Fisheries Service responded to the expanded respect for LEK by planning to increase the presence of social scientists in staff expansions (Hanna et al., 2009).

This study assessed the knowledge of anglers about six aspects of the environment surrounding their fishing locations; the factors included were the built environment, pollution, competition from other anglers, and three proxies for climate change: frequency of storms, changes in water temperature, and changes in salinity. Climate change is not the same as weather, and cannot always be seen at the local level. Recent longitudinal studies in the United States showed that short term weather fluctuations had little influence on the perception of climate change (Deryugina, 2013; Egan & Mullin, 2012; Hamilton & Stampone, 2013), although another study showed that anomalous weather over 3-12 months would influence beliefs about climate change (Donner & McDaniels, 2013).

The study site was Tyrrell County, which is a low-lying county in eastern North Carolina (Figure 11), USA, bordered by the Alligator River to the east and Albemarle Sound to the north. The county has a total area of 594 square miles (1,540 km²), of which 389 square miles (1,010 km²) is land and 205 square miles (530 km²), or about 35%, is water, including creeks and swamp. This access to water bodies allows Tyrrell County residents extensive opportunities to

catch fish and almost 12% of the residents hold the Coastal Recreational Fishing License (CRFL) (NCDMF, 2017).



Figure 11. Location of Tyrrell County in North Carolina.

The question for this study was, what changes do anglers perceive in the size and abundance of their catch and what environmental factors do anglers perceive as contributing to these changes? Three objectives were developed to answer these questions: establish the anglers' length of local fishing experience, list their perceived changes in catch composition, find their perceived changes in the environment where they fish, and discover what they believe caused the perceived changes in their catch.

Methods

Community leaders (elected officials, librarians, church leaders) were interviewed about subsistence fishing in the County. From their responses a questionnaire was developed using open ended, dichotomous, and scaled questions and the topics included changes in the local fishing spots: size and abundance of species caught in that location, water temperature, salinity, increase or decrease of storm activity, pollution, and development. All respondents were asked how long they had been fishing in the area and how much of their catch they released, kept for themselves, or gave away to family or community members. The survey was administered to Tyrrell County residents (N=50), both those who fish and those who receive fish as gifts. The

responses of those who fished (70% of respondents) are used in this paper. The survey was approved by the East Carolina University Institutional Review Board.

Survey participants were recruited using two methods. First, an announcement was placed in the regional weekly newspaper, inviting Tyrrell County residents to meet at the library at specified times. Second, after permission was obtained, a flyer was posted in a local convenience store and the interviewer conducted surveys on folding chairs in the parking lot. All potential survey respondents were asked if they were residents of Tyrrell County, asked if they ate recreationally-caught fish (either that they caught themselves or were given by a recreational fisher), assured of the confidentiality of their answers, and offered a grocery store gift card for completing a survey. The surveys were completed during nine trips to Tyrrell County between October, 2015 and April, 2016. The small sample size and purposive sampling methods limit the usefulness in generalizing these results to larger populations.

Results and Discussion

Demographics

The respondents were almost evenly divided between men (48%) and women (52%) which is similar to the composition of both Tyrrell County (46/54) and North Carolina (49/51). A higher portion of African-Americans responded to the survey (68%) than reside in Tyrrell County (37%) or North Carolina (22%). Respondent ages ranged from 21 to 84, with a mean age of 51 years old. Just over half (56%) of respondents had an educational attainment of high school or less, which is considerably lower than the adults in Tyrrell County (71%) and North Carolina (85%). Although 40% of the respondents hold either part time or full time jobs, 70% of respondents earned less than \$30,000/year, with none of the respondents earning more than \$50,000/year. The high rates of low income and African-American respondents is likely due to

the recruitment method and suggests that the respondents are not a representative sample of either the county or the state.

Fishing Habits

Almost 70% of respondents fished three or four seasons out of the year and almost 60% fished at least weekly, showing that fishing was a common pastime, whether for recreation or sustenance. Most (86%) fished from the bank and 91% used a hook and line to fish. Only 9% had fewer than 10 years of experience fishing, while 68% had more than 30 years of experience. When asked who taught them to fish, most people (89%) replied that they had learned to fish from older relatives, including parents, grandparents, aunts and uncles. In addition to putting food on the table, fishing serves as a cultural bond both allowing families to spend time together and passing information and tradition down from older relatives.

Fish Species Changes

Each of the respondents who fished was asked if there were types of fish that they catch in the present that they rarely caught in the past in the region. About one-fourth answered in the affirmative and named bass, catfish, flounder, gar, bowfin, mud diggers, and “invasives.” They were then asked if there were types of fish they used to catch frequently that they rarely catch now and 37% said yes and named croakers (N=6), spot (N=5), herring (N=2), rockfish (N=2), bass, red drum, sturgeon, trout and white perch as examples of species declining in presence. This lack of correspondence of answers may be due to the wide range of expertise held by respondents; some fished several times a week and targeted certain species, while others fished for leisure and socializing. The purpose of the sampling method was to find respondents who caught or ate recreationally-caught fish, not to seek out the anglers with the most expertise, which would have elicited better LEK.

The responses do not align with findings of an analysis of a 41-year data set of fish sampling in the Albemarle Sound (Gillum, 2014), shown in Table 3. Two gear types, seine and trawl, were used for sampling with differing results.

Fish	This Survey	Gillum- Seine	Gillum –Trawl
Striped bass (rock)	Increased	No change	Increased
Gar	Increased	Decreased	
Spot	Decreased	No change	Increased
Croaker	Decreased		Increased
White perch	Decreased	No change	Decrease

Table 3. Comparison of the perceived increases and decreases of fish species in this survey with an analysis of long term data of species abundance change in Albemarle Sound (Gillum, 2014).

Several factors could account for the differences between this survey and the analysis. Most of the respondents in this survey fished off of the bank, while the sampling in the Gillum study was conducted using gear deployed away from the bank. The respondents were also targeting particular species for consumption, rather than the seine and trawl surveys, which collected all available species for enumeration. The survey asked for perceptions of species changes as opposed to the actual count of the seine and trawl surveys.

Environmental Changes

Respondents were asked about changes in the environment during their fishing experiences in the area, and given the three choices of “more”, “neither”, or “less.” Those who did not have enough information to answer the question were included in the “neither” column. Table 4 shows that the overwhelming answer was the respondent not seeing changes in these categories, with the exception of the category of development, which more than half the respondents said had increased. Pollution was said to have stayed the same by almost half of the respondents, while 40% said it had increased.

<i>What changes have you seen in this area over the time you have fished here?</i>	More	Neither	Less
Pollution	14	17	4
Development	20	14	1
People fishing	15	15	5
Warmer water	8	23	4
Number of storms	13	18	4
Salinity	7	26	2

Table 4. Changes in the Environment around fishing areas perceived by survey respondents.

Apart from nature preserves and unusable land, development generally increases over time, but Tyrrell County’s development is much slower than the rest of the state. The County population declined 6.0% between 2010 and 2016, resulting in the issuance of only one building permit in 2016 (US Census Quickfacts, 2017). Although new buildings are few, new roads and new pavement on old roads may have influenced those who thought development in the area had increased.

The NOAA Storm Events Data Base (<https://www.ncdc.noaa.gov/stormevents>) was used to compile a chart (Figure 12) to show that storm events have increased in Tyrrell County in the past 40 years. Weather events included were thunderstorm wind, hail, tornado, hurricane, waterspout, tropical storm, winter storm, and storm surge. The slope of 0.1031 indicates an increase in the number of storms, in agreement with 37% of respondents. Just over half (52%) of the respondents indicated that they believed the number of storms in the area had neither increased nor decreased, while 11% stated that the number of storms had decreased.

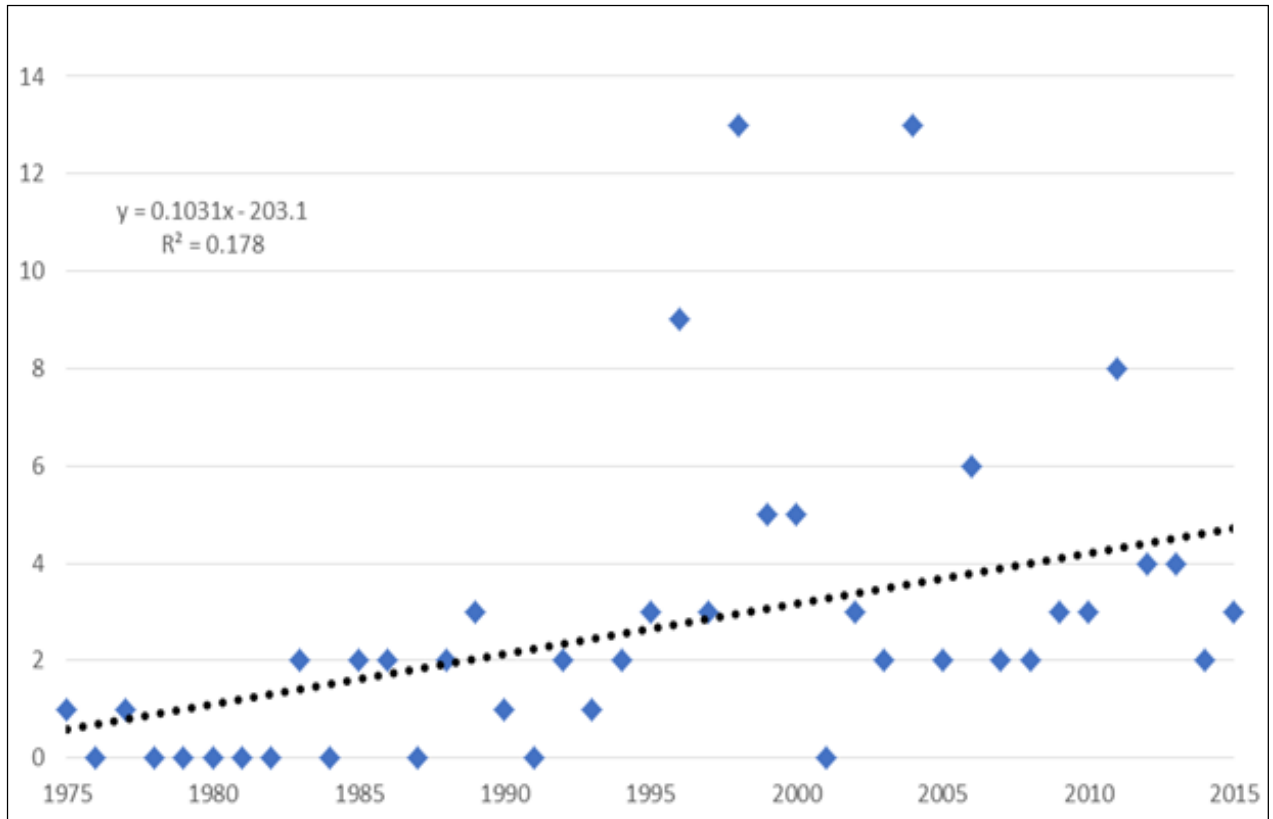


Figure 12. Combined storm events in Tyrrell County, North Carolina 1975-2015.

About two-thirds (65%) of respondents thought the water in their fishing spots had neither warmed nor cooled in their years of experience. Historical data from a U.S. Geological Survey monitoring station upstream from the mouth of Albemarle Sound in the Roanoke River at Westover (USGS 0208114150) (<https://waterdata.usgs.gov>) (Figure 13) revealed that the water temperature has not changed at this station significantly (Slope = 0.0001) in the past twenty years of available data which agrees with the perceptions of the survey respondents.

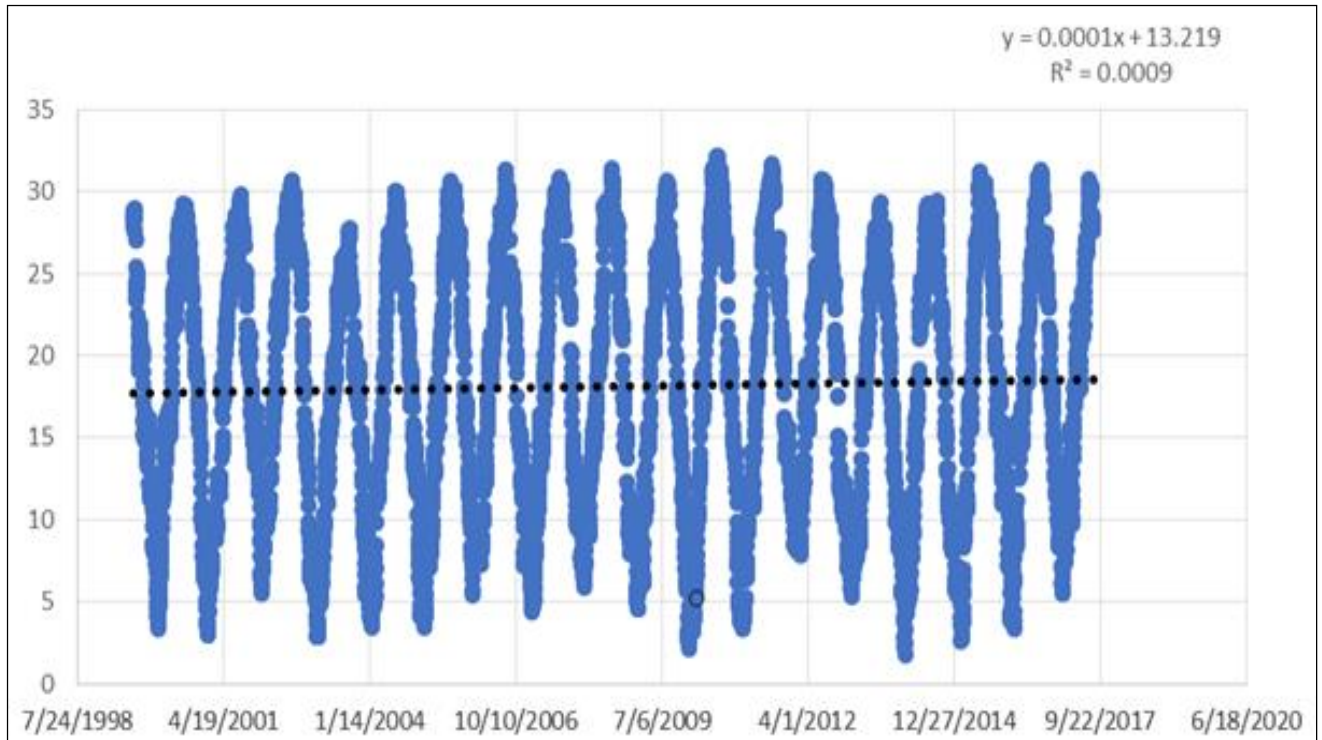


Figure 13. Water temperature in the Roanoke River at Westover, 1999-2017.

The salinity at this station has had dramatic fluctuations over the 13 years of available data (Figure 14), but these are likely wind-driven mixing events, and not permanent changes. Most of the respondents (74%) indicated that they felt unqualified to respond to whether the water was more saline, although 20% thought the salinity had increased, which does not correspond with the slight decrease in salinity measured over this period.

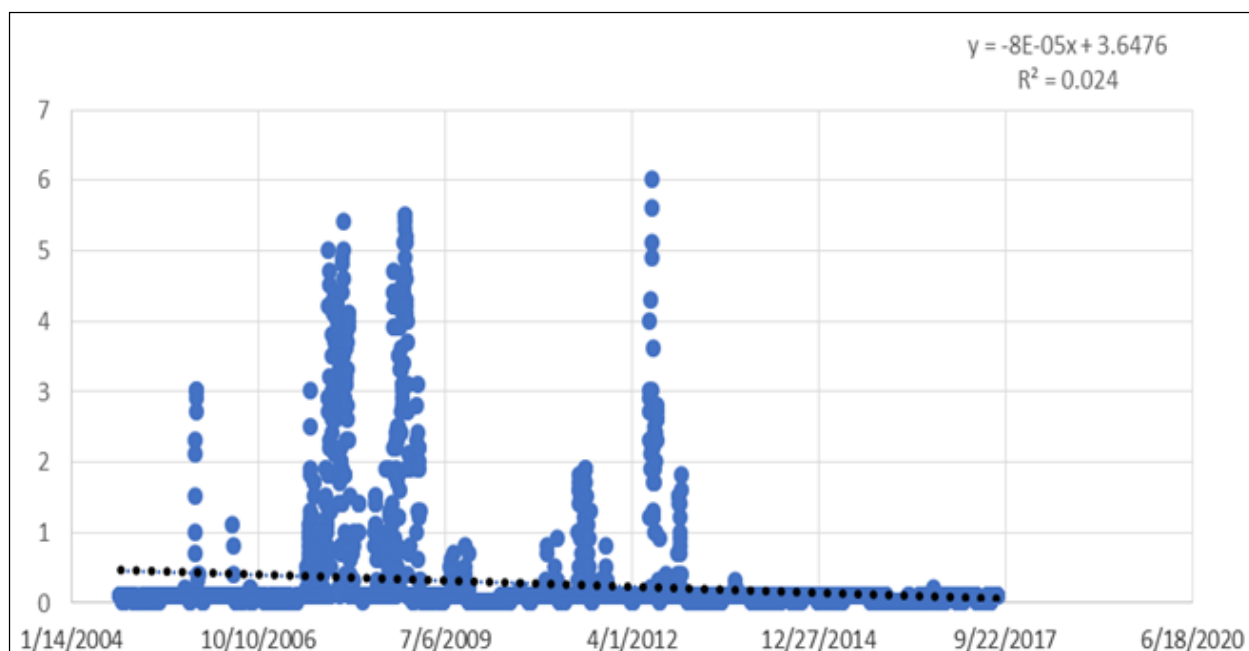


Figure 14. Salinity in the Roanoke River at Westover, 2004-2017 using bottom mean salinity.

Conclusion

This study succeeded in finding survey respondents with lengthy experience fishing in the area, but did not differentiate between these experts and occasional anglers. The respondents had perceived changes in size and abundance of catch species over time, but these changes did not align with other population surveys in the area. This may be due to the difference in fishing from the bank for target catch versus trawling and seining away from the bank for all species. Respondents had also perceived changes over time of environmental factors but these did not align well with the long-term data on number of storms, water temperature and salinity. This study did not find correlation between the respondents' local ecological knowledge and scientific studies in the area. Berkes (2004) found that local ecological knowledge may be different from scientific knowledge because the local users have learned to impart the knowledge strategically and politically for territorial claims, but the more likely reason for the lack of correspondence in this study was the method of participant selection. Previous successful local ecological knowledge studies (those that found agreement between LEK and scientific studies) carefully

selected participants for their community-validated expertise in fishing (Aswani and Hamilton, 2004), then using the snowball selection technique (Silvano and Valbo-Jørgensen, 2008), or consulted with elders of the community (Huntington et al., 2004), or developed specific criteria such as a minimum of 25 years of residency in the community combined with a minimum age of 40 years. Without purposively selecting participants who are considered experts in the subject area, the local ecological knowledge gathered will be marginal at best.

Chapter 6: THE EFFECTIVENESS OF NORTH CAROLINA'S SUBSISTENCE FISHING WAIVER: A SOCIAL JUSTICE ISSUE

Abstract

Subsistence fishing is important to many lower income residents of the United States but is increasingly difficult to achieve and can put these residents at risk of consuming contaminated fish. New fishing regulations were implemented in North Carolina in 2007 creating three types of social justice issues. As land is privatized and gentrified and as regulatory restrictions on fishing increase, people dependent on subsistence fish find less access to fishing sites, creating a distributive justice problem. Having little or no input into the creation of new regulations and land use decisions creates the frustration of procedural justice. Fishing in waters known to harbor contaminants creates the risk of consuming these contaminants and the necessity of catching fish to feed the family along with a lack of access to information on contaminants is an environmental justice problem. The new regulations included the "subsistence waiver" for the purpose of helping impoverished North Carolina residents by allowing them to fish for free. Is the waiver program successful? Four objectives were employed to address this question: determine angler familiarity with the waiver; determine which type of fishing license each angler holds; establish angler opinion of the subsistence waiver; and document the research on subsistence usage by the North Carolina Division of Marine Fisheries (NCDMF).

A survey of residents in of one of the most impoverished coastal counties in North Carolina showed that 1) people there relied on catching fish to feed themselves and their families and 2) only half of respondents were familiar with the waiver, 3) a large portion of respondents fished without a license, 4) local access to fishing grounds is being lost, 5) respondents were largely unaware of the contaminant risks in their catch, 6) the NCDMF has no information about

the subsistence catch, and 7) many of these anglers did not use the internet, which is a major source of the fish consumption advisories published by the North Carolina Department of Epidemiology. Two recommendations arise from this study. First, a revision of the distribution of subsistence waivers is needed, in order to better reach those who need them, and, second, better communication of contaminant risks in self caught fish is needed in order to safeguard the public.

Introduction

Many residents of the United States enjoy recreational fishing with varying levels of dependence on keeping the catch to eat, from sportsman who only practice “catch and release” to those who rely on bringing home fish to help defray the grocery bill, defined as “subsistence fisher.” Up until 2006, North Carolina residents were free to fish in salt water or in fresh water in their resident county with natural bait with no need of a fishing license. In 2007 new fishing regulations were enacted that required a license for all fishing in the state other than in private ponds and children under 16 years old. The restructured regulations recognized the importance of subsistence fishing by including the “Unified Subsistence Inland/Coastal Recreational Fishing License Waiver” (subsistence waiver), and the number of these waivers steadily increased from 4,013 in 2007 to 43,566 in 2015, then began to decline (Linehan, 2017), with more than a third of those distributed in the twenty coastal counties. The subsistence waiver is free for North Carolina residents who receive Medicaid, Food Stamps (SNAP), or Work First Family Assistance, and is issued through the North Carolina Division of Social Services office in each county. This method of distribution through social services rather than through fishery management agencies has resulted in three outcomes: an increased risk of consuming

contaminants, the possibility of fines from wildlife enforcement officers for fishing without a license, and incomplete catch information for management.

Subsistence fishing can be viewed within the framework of social injustice, which can be distributive, procedural, and environmental. Social justice is the concept of a contract between and individual and society; by accepting the benefits of society the individual must behave according to societal norms and accept societal burdens. These societal norms and burdens are subjective, leading to subjectivity in defining social injustices.

In natural resource management, distributive justice can be defined as the perceived fairness of resource distribution (Loomis and Ditton, 1993). Fisheries resources are allocated by governmental agencies. In the United States the federal and state governments manage fisheries for biological sustainability then divide the available surplus yield between the commercial and recreational sectors and, in some cases, allocations are made for subsistence users. Other than Native American treaties and Alaska, few allocations have been made to subsistence uses.

Procedural justice is the perceived fairness of the decision-making process (Folger et al, 1983). Without taking part in the decision-making process, natural resource users may object to the decisions. Research shows that participation in the decision-making process will lead to better acceptance of the decision, even when the outcome is not the desired one (Tyler and Griffin, 1991). The issuance of fishing licenses and the management of fisheries through catch limits and size limits curtail the simple act of fishing locally. State agencies that manage fisheries typically have extensive public comment periods before implementing major changes in license structures, but many stakeholders are unaware of their ability to comment, lack the skill to participate, or simply feel that their input would be ignored.

Environmental justice is the recognition of uneven distribution of both problems from pollution and the benefits of environmental protection throughout society (Bryant and Mohai, 1992), with low-income people and people of color more likely to suffer poor health and quality of life due to environmental degradation (Edwards, 1995). Those who consume self-caught fish are at risk of consuming contaminants in their catch, and the only protection against these contaminants is through state issued fish consumption advisories, which can be difficult to find or, when found, difficult to understand.

Study Region

Tyrrell County is situated in a low lying coastal area bounded by the Albemarle Sound to the north and the Alligator River to the east (Figure 15). The county has an area of ~600 square miles including 390 square miles of land and 210 square miles of water. The extensive rivers and swamp land suggest historic reliance on fish and shellfish for sustenance. The population of Tyrrell County is among the most economically challenged in the state (North Carolina Department of Commerce, 2016) with 25% of County residents living in poverty (U.S. Census, 2017). Like many largely rural populations, Tyrrell County residents depend on fishing, hunting, gardening, and collecting wild food for a good portion of their sustenance (Brown et al., 1998; Vaughan and Vitousek, 2013).



Figure 15. Location of Tyrrell County in North Carolina.

Albemarle Sound has been under a North Carolina Public Health Department fish consumption advisory since 2001 because of the presence of dioxins from the pulp industry on the Roanoke River (Clark, 2004), as well as a statewide advisory for mercury (North Carolina Department of Public Health, 2017). Residents of Tyrrell County who eat the fish they catch are at risk for consuming these contaminants.

The purpose of this research was to evaluate whether the “subsistence waiver” is effective in its purpose of helping poor North Carolina residents by allowing them to fish for free. Five objectives were used to address this question: first, to establish the opinions of anglers and community leaders on the subsistence waiver; second, to determine which type of fishing license each angler holds; third, to determine angler and community leaders familiarity with the waivers provided in the new license structure; fourth, to assess the perceptions of contaminant risk in self caught fish; and, fifth, to document the research on subsistence usage by the North Carolina Division of Marine Fisheries.

Methods

Community leaders (N=15), including elected officials, librarians, social service workers, business owners, and enforcement personnel were interviewed about the state of fishing in Tyrrell County. The responses were used to develop a questionnaire to collect information from Tyrrell County residents (N=50), both those who fish and those who receive fish as gifts. Survey participants were recruited using two methods. First, an announcement was placed in the regional weekly newspaper inviting Tyrrell County residents to meet at the library at specified times. Second, after permission was obtained, a flyer was posted in a local convenience store and the interviewer conducted surveys on folding chairs in the parking lot. All potential survey

respondents were asked if they were residents of Tyrrell County, asked if they ate recreationally-caught fish, and offered a \$10 grocery store gift card upon completion of the survey as an incentive. All participants were assured of the confidentiality of their responses. The interviews and surveys were completed during nine trips to Tyrrell County between October 2015 and April, 2016. The small sample size and the purposive selection method of respondents limits the study's usefulness in generalizing to a wider population. However, the resulting information is useful in the intended purpose of discovering the opinions and practices of this group.

Results and Discussion

The semi-structured interviews with community leaders indicated the necessity of fishing to some of Tyrrell County's residents. The fifteen interviewees were, mostly, longtime residents of the county, with a median residency of 33 years. One-third of those interviewed thought catching fish was "highly important" to county residents, especially given the dismal outlook for employment, which two-thirds of the interviewees described as "bad." The lengthy residency and leader position implies valid knowledge of the situation for county residents. About half of those interviewed were "very familiar" with fishing regulations, with one-quarter "somewhat familiar" and one-quarter "not at all familiar." About half of the respondents were familiar with the various fishing license waivers available, showing a need for more publicity for the availability of the waivers.

To evaluate whether the subsistence waiver is effective, the fifty survey respondents were asked what type of fishing license they held. Offering an incentive of a grocery store gift card and interviewing people who were frequenting the convenience store resulted in skewed demographics. The respondents were 68% African American, as compared to Tyrrell County

residents who are 36% African American. The level of educational attainment of the sample population was 54% high school graduate, as compared to 71% for all of Tyrrell County.

Of the 50 survey respondents, 35 (70%) participated in fishing, a considerably higher rate than the North Carolina rate of recreational fishing, which was 13.5% in 2011 (U.S. Department of Interior, 2012). Respondents were asked how often they kept fish to eat and how important these fish were to supplement their grocery bills. Almost all (91%) of those who fish responded that they fish to eat, indicating that the ability to fish is crucial for the protein intake of rural residents. Of those who received recreationally-caught fish as gifts, 67% said it was an important part of their cost of groceries.

All respondents to the survey were asked what type of fishing license they held. About 30% of respondents did not fish for themselves. Of those that fished, 44% held one of the various fishing licenses, 10% held a subsistence waiver, and 16% did not have a fishing license. The fine for state residents fishing without a valid fishing license is around \$200, depending on court costs; a steep fine for a person who can't afford a fishing license. As many as two-thirds of Americans do not participate in assistance programs for which they are eligible (Blank and Ruggles, 1996; Stuber and Schlesinger, 2006) either through lack of knowledge about the programs or because of the stigma attached to enrollment in such programs. One older male respondent said, "He'd be damned if he'd go on welfare just to catch a fish." In order to protect residents from fines for fishing without a license, the method of distribution of the subsistence waiver could be changed; for example, the waiver might be available through the Division of Social Services without enrolling in the other aid programs. Or the waiver might be distributed by another entity based on an income level with evidence from individual tax returns.

When asked how they first heard about the new fishing regulations (Table 5), the largest number (28%) had received their information from enforcement agents and from the Division of Social Services (23%). Seventeen percent had heard about the regulations on the news and 9% were told by a bait store. Notably, nobody had received this information from the Internet. This question elicited some frustration from respondents. Three different respondents offered some version of the opinion that the fish ought to be free to people who need it; the government shouldn't have the right to charge to use what belongs to the public. This belies the concept of fishery management that the purpose of a fishing license is to assess how many people are fishing, rather than profiting the government.

<i>How did you learn about the new fishing regulations?</i>	N	Percentage
Enforcement agents	10	28
Division of Social Services	8	23
News	6	17
Bait seller	3	9
Moved here after new regulations	1	3
Don't remember	7	20
Internet	0	0

Table 5. Source of new regulation information.

When asked if they were aware of the subsistence waiver, 48% said they knew about it. Those who hadn't heard of it were given a brief description of the waiver. The immediately following question was whether they thought the waiver was a good idea and 100% of the respondents said yes, but several people said that it wasn't as good as the pre-2007 fishing regulations, which allowed fishing in one's home county without a license.

Since the implementation of the new fishing regulations in 2007, the number of subsistence waivers steadily increased, reaching a maximum in 2015 (Figure 16) (Linehan, 2017).

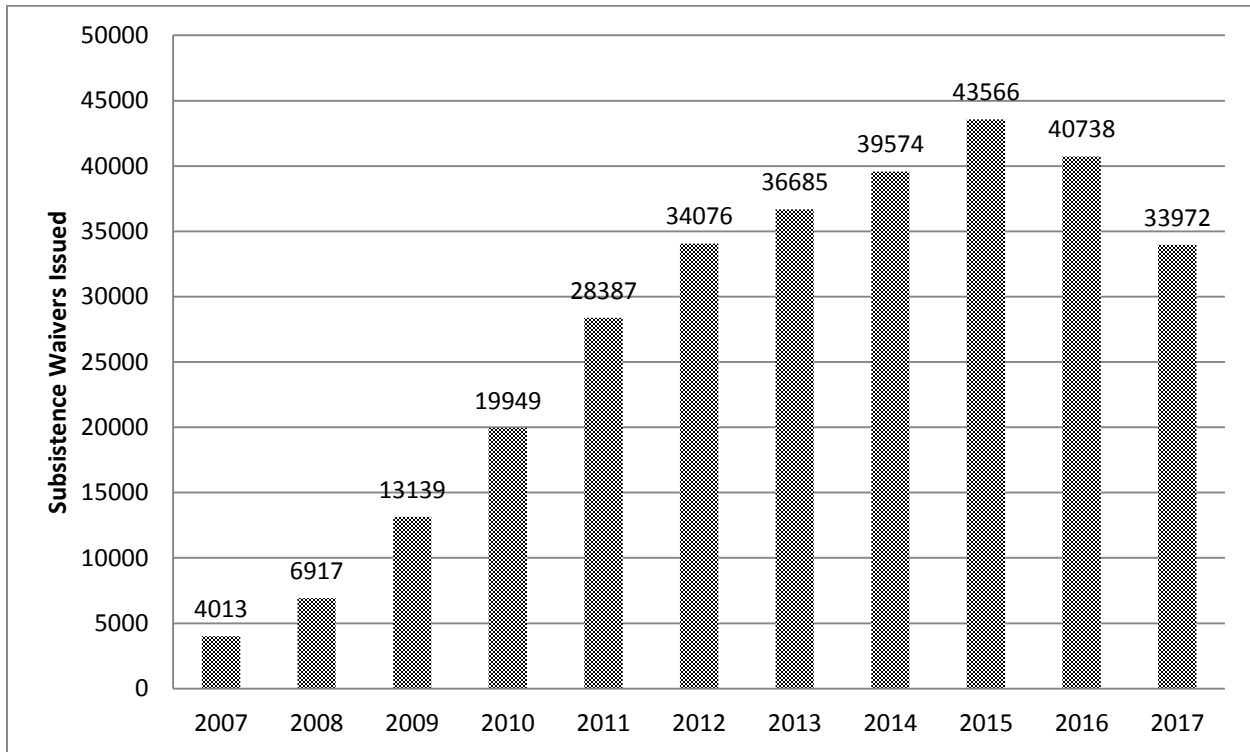


Figure 16. North Carolina subsistence waivers issued 2007-2017.

The disconnect between those who have a subsistence waiver and those who are eligible may be suggested by the U.S. Census figure of 28.3% of county residents living in poverty (2016 estimate) while 3.4% of residents have received the waiver. In North Carolina those under the age of 16 need no license to fish. If every one of the 18.8% of county residents estimated to be under the age of 18 (U.S. Census estimate) were living in poverty, the number of subsistence waivers would be 9.5% of the population if one was issued to every person eligible; this conservative estimate shows that another 6.1% county residents are eligible for the subsistence waiver than are receiving one.

Respondents were asked about factors that affected their fishing behavior (Table 6). The imposition of regulations was the highest ranked issue affecting fishing behavior, with size and quantity restrictions ranking number five. Losing fishing sites ranked seventh, but almost all older respondents cited this concern. Frustration with increasingly complex regulations acts as a barrier to accessing a good source of protein for the impoverished who need it the most.

<i>How important do you consider each of these issues about fishing to you personally?</i>	Not at all important	Not very important	Neutral	Somewhat Important	Extremely important	Ranking
Keeping up with rules	0	1	0	7	27	1
Water quality / pollution	4	2	0	7	22	2
Weather	3	4	1	14	13	3
Finding enough time in my life to fish	7	7	5	5	11	4
Bag or size limits	10	5	0	8	12	5
Overfishing / too few fish	14	4	1	9	7	6
Losing fishing sites	15	3	0	9	8	7
Fuel prices	16	3	1	7	8	8
Access issues (lack of boat ramps, parking, etc.)	17	4	2	9	3	9
Competition with other fishers / crowding	21	3	1	9	0	10
Competition with commercial fishermen	27	4	0	3	1	11

Table 6. Factors affecting fishing behavior.

When asked if they were concerned about contaminants in the fish they ate, the responses were about evenly split with 48% saying they were concerned and 52% saying they weren't. Almost 70% of the residents surveyed were unaware of the contaminant risks in the recreationally-caught fish from the area. When asked what type of contaminants they believed to be present in Albemarle Sound, nobody mentioned dioxins and only three people interviewed mentioned mercury. Many survey participants assumed that there would be warnings posted any place there is a risk, but that is not the case. The only sources for fish consumption advisories are in the print copies of the inland fishing regulation booklet and on the internet; 58% of respondents never used the internet and of those who did, only 10% had looked up local fish consumption advisories. North Carolina has fewer people who own home computers and use the internet

compared to other states (File and Ryan, 2014). Also, internet usage is considerably lower in rural communities than urban communities (Carlson and Goss, 2016). Thus, a better method of disseminating information about contaminant risks in fish is needed.

In addition to scant information being received about potential contamination in the catch, the subsistence waiver is not effective for fishery management. In North Carolina, managers rely on mail-in surveys to anglers to gather data used for stock assessments manage the fisheries. The names of the subsistence waiver recipients are kept confidential therefore their catch information is not included in these important surveys (Mumford, 2016). No state agency has collected information about the type and amount of fish caught by holders of subsistence waivers (C. Wilson, personal communication, May 24, 2016), leading to incomplete information used for stock assessments and fishery management. The rate of consumption of catch is also unknown, leading to unknown rates of exposure to contaminated fish.

Conclusions

The subsistence waiver is not successfully achieving its goal of helping poor North Carolina residents and the new fishing regulations can be framed as several types of social justice issues. All respondents thought it was a good idea to have the waiver in place, but many expressed annoyance that the regulations had changed to needing a fishing license at all, showing a preference for the pre-2007 regulations, when fishing in the home county was unregulated. Fishery managers also expressed concern over the lack of data stemming from the issuance of the waiver through each county's Division of Social Services rather than through the Wildlife Resources Commission and the Division of Marine Fisheries.

About half the respondents knew about the waiver and after the others had heard a description of the waiver, all thought it was a good idea. However, several respondents voiced frustration about having the new regulations imposed on them without having a chance to engage in the decision-making procedure; an example of procedural injustice.

Almost three times as many Tyrrell County residents are eligible to receive the waiver than hold them and one-fifth of respondents fished without a license, risking costly citations. Respondents cited reasons for fishing without a license as either in avoidance of the stigma of enrolling in social welfare programs, lack of cash, or in protest of perceived unfair restrictions on access to a public resource.

Respondents gave several reasons for perceived unequal distribution of the fishery resource, an example of distributive injustice. Licenses limiting who can fish is one type of barrier to access; catch regulations are another. Imposing limits on quantity and size of the catch limits access, but also the perception that the constantly changing regulations are too complicated to understand acts as a deterrent. A final barrier to accessing fish is the gradual loss of access to fishing sites through land privatization.

People who are most dependent on fish run a disproportionate risk of consuming contaminants. An additional issue is the lack of available information about the risks associated with eating self-caught fish. Fish consumption advisories are available on line but more than half of respondents never use the internet, and few who do have visited the website. The problem of consuming contaminants disproportionately burdening poor people is an example of environmental injustice.

Recommendations

Eligibility for the subsistence waiver should be expanded beyond those enrolled in state aid programs. One idea is to allow issuance of the waiver by county social service divisions based on the same sort of information as enrolling in SNAP and Work First but without enrolling in those programs. Another idea is to allow enforcement officers to accept tax documents that show low income.

A more drastic method would be to manage subsistence fishing separately from recreational fishing altogether. An example of successful separate subsistence fishing management is the state of Alaska, where rural residents fish for free but are required to record all subsistence fish taken, which helps give the managers the information needed for stock assessments.

An educational campaign should be undertaken that would post signs in several languages containing consumption advisories at boat ramps, known fishing spots, and public venues including libraries, post offices, and municipal buildings. Another group to target would be school age children. A work plan for a school project is attached as Appendix G.

Chapter 7: SUMMARY AND CONCLUDING REMARKS

It is risky business to be poor in the United States today. As the middle class disappears and the numbers of impoverished swell, poor people do what they can to make ends meet. Living in an area of bountiful fish, the poor people of Tyrrell County do what makes good sense; they catch fish to feed a good protein source to themselves and their family for little or no cost. This dissertation is intended to reveal the risks associated with catching one's own meal and offer ways to minimize those risks.

Key Findings of Research and Recommendation

- People depend on catching fish or getting fish as gifts to help with their grocery bills.
- Several barriers exist to freely accessing fish for consumption.
- None of the respondents had accurate information about the Albemarle Sound fish consumption advisory for dioxins in carp and catfish.
- Most people surveyed were not informed about the statewide consumption for mercury, directed especially at women of child-bearing age and developing children.
- Many lower-income residents do not use the internet, which is the primary source of updated fish consumption advisories.
- Survey participants incorrectly assumed that fish consumption advisories would be posted at locations with contaminant risks.

In order to help poor people in North Carolina feed themselves more safely, subsistence fishing should be managed separately from commercial and recreational fishing for three reasons.

Firstly, low income anglers would have better access to the fishing resource through an expanded subsistence waiver program that would not be channeled through the stigma-laden social services

program. Secondly, consumers of self-caught fish would be better protected from contaminant risks because the acknowledgement of a higher consumption rate would influence advisories and catch allotments. Finally, fishery managers would have better information to use to manage fish populations, as discussed in chapter six.

Contaminants

The first question this research asked was how aware the fishers are of the contaminant risk associated with self-caught fish. Both the community leaders interviewed, and the county residents surveyed revealed limited knowledge of the sources of contamination, methods of mitigating contamination, and awareness of fish consumption advisories, although there was some concern about contaminants. Many survey participants assumed that there would be warnings posted any place there is a risk, but that is not the case. The low level of awareness of fish consumption advisories aligns with other studies; in the U.S. the awareness ranges from 8-23% (Johnston et al., 2016). The only sources for fish consumption advisories are in the print copies of the inland fishing regulation booklet and online, and yet many Tyrrell County residents do not use the internet. North Carolina has fewer people who own home computers and use the internet compared to other states (File and Ryan, 2014). Also, internet usage is considerably lower in rural communities than urban communities (Carlson and Goss, 2016). Thus, relying on the internet to disseminate information about contaminant risks may not be an effective method.

The other positive trend is the decreasing amount of dioxin contamination in the area. Early testing for dioxins resulted in an advisory to avoid eating any fish from western Albemarle Sound in 1991. In 2001 the advisory was revised to apply only to catfish and carp. While carp is not a commonly targeted species, catfish is. According to one respondent, “I’m always happy

when I get a mess of catfish; my wife loves them fried up. I been eating them for fifty years and I ain't dead yet.”

Better dispersal of information about contaminant risks in fish in Albemarle Sound is essential. The lack of internet usage among survey participants suggests that instead of relying on the internet, signs should be posted in public areas, including libraries, Division of Social Service offices, and, especially, at boat ramps. The Department of Public Health fish consumption advisories are published in the inland fishing regulations and should also be included in the saltwater fishing regulations.

The catch regulations and consumption advisories should be produced by an inter-agency collaboration. One example of this is the set of publications about fish consumption in the state of Georgia, produced by the Georgia Department of Natural Resources, and the Georgia Division of Public Health (GADNR, 2008). Another example of an effective consumption advisory campaign is a combined effort from the Upper Neuse Waterkeeper and the University of North Carolina Superfund Research Program staff, who posted signs in several languages at Lake Crabtree in Wake County, which included easily understood graphics of types of fish to be avoided and appropriate serving sizes (Clabby, 2016).

Local Ecological Knowledge

The second research question was intended to gauge the level of knowledge each angler had about the fish they targeted and the surrounding environment. The results showed little association between scientific studies of fish species changes and changes perceived by respondents. There was also little association angler survey responses and published data on changes in salinity, water temperature, and number of storms. The tenuous local ecological

knowledge is attributable to the sampling procedures, which were intended to target low income county residents, not expert anglers.

Effectiveness of the Subsistence Waiver

When asked their opinions of the new fishing regulations, most of both groups – community leaders and county residents - responded negatively. While some acknowledged the need for new boat ramps and management, most thought fishing should be free near their homes, as it was previous to the 2007 changes. While a change to fishing regulations is unlikely to make it through the general assembly in Raleigh, small changes to help poor residents should take place.

When the new fishing license structure was implemented, the need for poor people to have access to fish was acknowledged by including the subsistence waiver. The waiver was overwhelmingly thought to be a good idea by both community leaders and survey respondents, yet the program has several flaws.

The first problem is that the waiver is only available to people who are enrolled in welfare programs, and many people who are eligible for these programs do not participate, due to the stigma attached to the program or being unaware of their eligibility or some other reason. The disconnect between those who have a subsistence waiver and those who are eligible may be suggested by the U.S. Census figure of 28.3% of county residents living in poverty (2015 estimate) while only 3.4% of residents have received the waiver. If every one of the 18.8% of county residents estimated to be under the age of 18 were living in poverty, the number of subsistence waivers would be 9.5% of the population if one was issued to every person eligible. Although the cost of a fishing license in North Carolina is lower than most states, many people are unable to afford it as evidenced by 23% of the survey respondents who fish but do so with no

license. Broadening the eligibility of those who receive subsistence waivers beyond those enrolled in assistance programs would help the most economically challenged North Carolina residents.

The second problem is that because the waivers are issued through each county's Division of Social Services, fishery managers do not include waiver holders in the surveys they use to gather recreational fishing usage information, upon which management decisions are made. While the number of subsistence is only a small percentage of North Carolina anglers, subsistence users tend to keep more of the catch than recreational anglers and having this information would be useful to fishery management.

Access and Importance

This project revealed that residents of Tyrrell County depend substantially on catching fish or getting fish as gifts to help with their grocery costs, yet several barriers exist which limit Tyrrell County residents' access to the fish in their rivers, streams, and the Albemarle Sound. Although waterfront construction of high end homes is not as rampant in Tyrrell County as much of the rest of the North Carolina coastline, several people mentioned no longer being able to fish in ponds where they used to fish because the property owners had fenced them out or posted "no trespassing" signs. Also mentioned repeatedly was the stagnant water in the local ditches, which were said to previously be moving water and good places to catch fish. Recent strong storms have also washed out previously productive streams or eroded away the access roads to these points.

In addition to feeding the family, fishing is also an important social event. Most people were taught to fish by older relatives and still go fishing with relatives. Two-thirds of fishers said they enjoy fishing because it lets them spend time with family or friends.

Limitations

There are several limitations to this study. The selection of participants for the survey was limited to within the city of Columbia. Attempts were made to conduct surveys in the rural convenience stores in the Gum Neck and Alligator communities but were unsuccessful. According to the 2010 Census, about one-fourth of the county's residents live in Columbia. Although Hispanics comprise 7% of the population of the county, none participated in the 333 survey, when a representational sample would have been 3 or 4 Hispanics.

Future Directions

This small survey showed that the people who catch and eat local fish are largely unaware of contaminants. The same survey with a larger group of respondents randomly sampled might provide statistical significance. One additional study might be to assess the effectiveness of the seafood consumption advisories by taking a random sample of Tyrrell County residents, assessing their knowledge of the consumption advisories, providing information about contaminant risk, then reassessing their knowledge. Another similar study might be to ask residents if they had changed their behavior after learning about the advisories or, in the case of pregnant women, if they had changed their consumption patterns after receiving prenatal care.

Consumption of self-caught fish as a social justice issue might be more thoroughly studied. The environmental justice aspect might be better refined through a comparison of income levels, ethnicity, and awareness of consumption advisories on a larger scale. Research on

the angler perceptions of fishing regulations would provide information on both distributive and procedural justice.

Information gleaned from this study could be used by health officials, officers, fishery managers, and extension agents to educate the public about the risks and benefits from eating self-caught fish. Fishery managers are recommended to make this information more widely accessible by signage at boat ramps and other known fishing sites, and by inclusion with fishing regulations.

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APPENDIX A: INSTITUTIONAL REVIEW BOARD APPROVAL LETTER



EAST CAROLINA UNIVERSITY

University & Medical Center Institutional Review Board Office

4N-70 Brody Medical Sciences Building· Mail Stop 682

[600 Moye Boulevard · Greenville, NC 27834](http://www.ecu.edu/irb)

Office 252-744-2914 · Fax 252-744-2284 · www.ecu.edu/irb

Notification of Initial Approval: Expedited

From: Social/Behavioral IRB
To: [Elizabeth Brown-Pickren](mailto:Elizabeth.Brown-Pickren@ecu.edu)
CC: [Alex Manda](mailto:Alex.Manda@ecu.edu)
Date: 9/16/2015
Re: [UMCIRB 15-001438](#)
Risky Business: Consumption of Self-Caught Fish in Tyrrell County, North Carolina

I am pleased to inform you that your Expedited Application was approved. Approval of the study and any consent form(s) is for the period of 9/16/2015 to 9/15/2016. The research study is eligible for review under expedited category # 6, 7. The Chairperson (or designee) deemed this study no more than minimal risk.

Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The Investigator must adhere to all reporting requirements for this study.

Approved consent documents with the IRB approval date stamped on the document should be used to consent participants (consent documents with the IRB approval date stamp are found under the Documents tab in the study workspace).

The approval includes the following items:

Name	Description
InterviewQs08-23.doc	Interview/Focus Group Scripts/Questions
Revised Consent Form	Additional Items
Risky Business Consent Form	Consent Forms
Risky Business: Consumption of Self-Caught Fish in Tyrrell County, North Carolina	Study Protocol or Grant Application
Survey08-23.doc	Surveys and Questionnaires

APPENDIX B: DATA COLLECTION INSTRUMENT FOR COUNTY LEADERS

Interview questions for Tyrrell County leaders, including church leaders, social service workers, county law enforcement, county commissioners, business leaders, fishery managers, state water quality personnel, regional environmental groups, and regional economic development organizations.

1. How long have you lived in Tyrrell County?
2. What proportion of county residents do you think fish regularly to feed themselves and their family?
3. What is the employment situation in the county?
4. How familiar are you with fishing regulations?
5. Do you know of the various fishing waivers?
6. Specifically the subsistence waiver?
7. What is your personal opinion of the fishing regulations?
8. What do you think the general opinion about fishing regulations is held by county residents?
9. Do you fish?
10. What do you do with the catch? (keep and eat, give to friends/neighbors, release)
11. Are you worried about contaminants in your catch?
12. Which contaminants?
13. What do you do about contaminants?
14. Are you familiar with the fish consumption advisories?
15. What changes have you seen in the rivers and Sound in the time you've lived here?
16. How do you think the county will be affected by sea level rise?

APPENDIX C: DATA COLLECTION INSTRUMENT FOR COUNTY RESIDENTS

Risky Business: Consumption of Self-caught fish in Tyrrell County, North Carolina Coastal Resources Management Program, East Carolina University Interview Guide

We are interested in learning about the experiences of the people who fish recreationally in Tyrrell County. Your participation in this study is voluntary. You are free to end the interview at any time and to refuse to answer any question you do not want to answer. We would like to record the interview for accuracy, but any names or other identifiers will be removed from the transcripts we produce from the recordings. The information you provide will be kept confidential. While we will be using an interview guide, we encourage you to speak about any issues you believe are relevant to your experience as a Tyrrell County resident who fishes or has family members who fish. For your participation, you will be given a \$10.00 Food Lion gift card.

Section I for fishers

4. How often do you go fishing? Daily, weekly, monthly, yearly 1. Date _____
5. Months fished (circle all) J F M A M J J A S O N D All 2. Time _____
6. What gear do you use and what do you target? 3. Location _____
- Hook and line for finfish
 - Clams ___ Rakes or ___ Other method _____
 - Crabs ___ Pots or ___ Other method _____
 - Cast net
 - Gig for flounder
 - Dive
7. Where do you fish?
- Bank
 - Pier
 - Boat
- ___ Own ___ Rent ___ Friend owns
- If owns boat, how big is it and where is it kept?
8. Do you ever fish in another state? No ___ Yes ___ (which state?) _____
9. How long have you been fishing? (in years) _____
10. Who taught you how to fish?
___ Parent ___ Grandparent ___ Other relative ___ Friend ___ Self ___ Other _____
11. Who do you ask about fishing now?
___ Parent ___ Grandparent ___ Other relative ___ Friend ___ Self ___ Other _____
12. Are you concerned with contaminants in the fish you catch? Yes No Sometimes
13. Where do you think the contaminants come from? _____
14. Do you cook or clean the fish any way to reduce contaminants? Yes No
If 'yes' please explain _____
15. Can you tell if there are contaminants in fish by looking at the water? Yes No
If 'yes' please explain _____
16. Where do you get information about contaminants in fish? _____

17. Are you aware of the consumption advisories for this spot? Yes No

18. Do you use the internet to find information? Yes No

19. Where do you use the internet? Home Library Other _____

20. Have you looked up fishing regulations on the internet? Yes No

21. Have you looked up fish consumption advisories on the internet? Yes No

22. In the last year have you had any conflicts while fishing? If yes, please explain:

- With other recreational fishers
- With commercial fishers
- Federal officers (like the Coast Guard)
- State officers (like Marine Patrol)
- Other

How important do you consider each of these issues about fishing to you personally?

	Not at all important	Not very important	Neutral	Somewhat Important	Extremely important
23. Keeping up with rules					
24. Finding enough time in my life to fish					
25. Weather					
26. Bag or size limits					
27. Water quality / pollution					
28. Competition with other fishers / crowding					
29. Competition with commercial fishermen					
30. Overfishing / too few fish					
31. Fuel prices					
32. Losing fishing sites					
33. Access issues (lack of boat ramps, parking, etc.)					
34. Other					

35. Are there fish you rarely catch here now that you used to catch frequently? Yes No

36. What type(s)?

37. Are there fish that you catch now that you almost never caught in the past? Yes No

38. What type(s)?

39. Have you noticed any change in size of fish over the years? Yes No

40. What type(s)?

What changes have you seen in this area over the time you have fished here?

41. Pollution ___ More ___ Neither more or less ___ Less

42. Development ___ More ___ Neither more or less ___ Less

43. People fishing here ___ More ___ Neither more or less ___ Less

44. Warmer water ___ More ___ Neither more or less ___ Less

45. More storms ___ More ___ Neither more or less ___ Less

46. Salinity changes ___ More ___ Neither more or less ___ Less

47. What other changes have you seen in this fishing spot?

48. Why do you fish? (Select all that apply)

- It's fun or relaxing
- To help feed my family
- To spend time with family/friends
- Some other reason (describe)

49. How often do you keep fish to eat?

- all legal fish I catch
- only certain species
- sometimes
- only catch/release

50. Do you keep fish for your household or share the catch?

51. Whom do you share it with? (Family, neighbors, church, other)

52. How often do you give fish away? never occasionally frequently everything

53. How important is catching fish to your family grocery bill?

not at all slightly important somewhat important very important vital

54. What other activities do you participate in besides fishing?

Garden Hunt Collect wild plants Sell crafts Have yard sales Other

55. What type of fishing license do you have?

56. When and how did you find out about the new fishing regulations?

57. Have you heard of the various types of the fishing license waivers? Yes No

58. If 'yes': Do you know anybody who uses one? Yes No

59. Do you think the waiver system is a good idea or a bad idea and why? Good Bad

Why?

Section 2 for non-fishers

60. How often does somebody give you fish?

61. Are you worried about contaminants in local fish?

62. What types of contaminants?

63. Do you have ways to clean or cook the fish to reduce contaminants?

64. How important is receiving gift fish to your family grocery bill?

not at all slightly important somewhat important very important vital

65. What other activities do you participate in?

Garden Hunt Collect wild plants Sell crafts Have yard sales Other

Section 3 for everybody

66. Does this area flood often? Yes No

67. Has flooding increased recently? Yes No

68. Why do you think flooding has increased?

69. How far do you live from here (either ___ miles or ___ minutes to drive)

70. (If home is nearby) What will you do if the flooding gets worse?

Demographics

71. Year of birth _____

72. Ethnicity ___ Hispanic / Latino
 ___ White / Caucasian
 ___ Black / African-American
 ___ Asian / Pacific Islander
 ___ Native American

73. Marital status ___ Currently married
 ___ Divorced
 ___ Widowed
 ___ Never married
 ___ Separated

74. Education ___ Less than high school diploma
 ___ High school diploma
 ___ Some college or technical school
 ___ College diploma
 ___ Graduate work
 ___ Graduate degree

Income

75. Do you work? Yes No (if yes) Full time or part time? (if part time) How many hours?

76. How far do you have to drive to go to work?

77. How do you get there? ___ own car ___ public transportation ___ share rides ___ other

78. How much do you make?

Yearly	Monthly	Weekly	Hourly	Piece
<\$15,000	<\$1,200	\$290	\$7.25	
\$15,001-\$30,000	\$1,601-\$2,001	\$400	\$10.00	
\$30,001-\$50,000	\$2,001-\$4,000	\$600	\$15.00	
\$50,001-\$75,000	\$4,001-\$7,000	\$800		
\$75,001-\$100,000	\$7,001-\$9,000	\$1000		
>\$100,001	>\$9,001	>\$1200		

79. Do you receive benefits at your job? Yes No

80. What type(s)? ___ Medical insurance ___ Disability ___ Life Insurance ___ Retirement

Household size:

81. How many people live in your household?

82. ___ Working adults

83. ___ Unemployed adults

84. ___ Children

85. How many people do you financially support that don't live in your household? _____

Thank you for your time. Please sign the sheet to acknowledge that you received a Food Lion card.

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 Gender, Race, Age, Marital Status, Education Level, Employment, Income

Tyrrell County Community Leader Interviews

Table C1. Community leader length of residency in Tyrrell County

Tyrrell County	Min	Max	Median
Residency Years	0	68	33

Table C2. Community leader perception of fishing importance to residents

<i>How important is catching fish to County residents?</i>	Not at all important	Slightly important	Somewhat important	Highly important
	4	3	2	5

Table C3. Community leader perception of County employment

Bad	A few jobs available	Getting Better
10	2	3

Table C4. Community leader familiarity with fishing regulations

<i>How familiar are you with local fishing regulations?</i>	N	Percentage
Very	7	46
Somewhat	4	27
Not at all	4	27

Table C5. Community leader familiarity with fishing license waivers

<i>Do you know about the free waivers for fishing licenses?</i>	N	Percentage
Yes	7	49
No	8	51

Table C6. Community leader opinion of fishing regulations

Opinion of fishing regulations	N	Percentage
--------------------------------	---	------------

Positive	10	66
Negative	5	33

Table C7. Community leader fishing activity

<i>Do you go fishing?</i>	N	Percentage
Yes	6	40
No	9	60

Table C8. Community leader contaminant risk perception

<i>Are you worried about contaminants in fish?</i>	N	Percentage
Yes	1	7
No	14	93

Table C9. Community leader familiarity with fish consumption advisories

<i>Are you aware of the fish consumption advisories for this area?</i>	N	Percentage
Yes	3	20
No	12	80

Table C10. Community leader perceived changes in water bodies

	No changes	More flooding	Poor drainage	More saline	More pollution
Times mentioned	1	5	2	1	5

Table C11. Community leader predicted effects of sea level rise on County

	No changes	More flooding	Relocation needed	Poor will suffer
Times mentioned	1	7	3	4

Tyrrell County Resident Surveys

Tables S1-3. Interview dates, times, locations

Dates	Number of Surveys	Locations
19-Feb	1	Private home
20-Feb	6	Library
25-Feb	5	Library
5-Mar	6	Quick Stop Parking Lot
20-Mar	17	Quick Stop Parking Lot
29-Mar	15	Quick Stop Parking Lot

Table S4. Frequency of fishing activity

<i>How often do you go fishing?</i>	N	Percentage All	Percentage of Fishers
Daily	1	2	3
A few times a week	10	20	29
Weekly	9	18	26
A few times a month	4	8	11
Monthly	7	14	20
A few times a year	4	8	11
Don't fish	15	30	

Table S5. Seasonality of fishing activity

<i>Which seasons do you go fishing?</i>	N	Percentage All	Percentage of Fishers
All Months	9	18	26
Spring	1	2	3
Summer	8	16	23
Fall	3	6	8
Spring Summer and Fall	14	28	40

Table S6. Fishing gear preference

<i>What type of gear do you use?</i>	N	Percentage All	Percentage of Fishers	Percentage Crosson
Hook and Line	32	64	91	100
Crab pots	1	2	3	18
Cast net for bait	1	2	3	25
Gig for flounder	1	2	3	-
Rakes for clams	0	0	0	18
Dive	0	0	0	6
Don't fish	15	30		

Table S7. Fishing location preference

<i>Where do you fish?</i>	N	Percentage All	Percentage of Fishers
Bank	13	60	37
Pier	4	8	11
Boat	1	2	3
Bank and Pier	13	26	37
Bank and Boat	2	4	6
Bank, Pier and boat	2	4	6
Don't fish	15	30	

Table S8. Fishing outside of North Carolina

<i>Do you ever fish in another state?</i>	N	Percentage
Yes	13	26
No	27	56
Don't fish	15	30

Table S9. Years of fishing experience

<i>How long have you been fishing?</i>	N	Percentage	Percentage of Fishers
Fewer than 10 years	3	6	9
10-19 years	7	14	20
20-29 years	1	2	3
30-39 years	6	12	17
40-49 years	7	14	20
50-59 years	7	14	20
More than 60 years	4	8	11
Don't fish	15	30	

Tables S10-11. Fishing instruction

<i>Who taught you how to fish?</i>	N	%	% fishers	<i>Who do you ask about fishing now?</i>	N	%	% fishers
Parent	16	32	46		1	2	3
Grandparent	5	10	14		1	2	3
Other relative	10	20	29		10	20	28
Friend	4	8	11		21	42	60
Bait store emp.	0	0	0		2	4	6
Don't fish	15	30			15	30	

Table S12. Concern about contaminants

<i>Are you concerned about contaminants in the fish you catch?</i>	N	Percentage
Yes	24	48
No	26	52

Table S13. Perceived contaminant sources

<i>Where do you think contaminants originate?</i>	N	Percentage
Farm runoff, crop fertilizer	9	39

Trash, litter	7	29
Pollution	2	8
Industrial pollution	2	8
Mercury	3	12
Dioxin	0	0
Sewage	1	4
Total	24	

Table S14. Perceived contaminant reduction techniques

<i>Can you clean or cook a fish to reduce contaminants?</i>	N	Percentage
Yes	6	12
No	29	58
Don't fish	15	30

Table S15. Perceived contaminants in water

<i>Can you tell if there are contaminants in fish by looking at the water?</i>	N	Percentage
Yes	12	24
No	23	46
Don't fish	15	30

Table S16. Contaminant information sources

<i>Where do you get information about contaminants in fish?</i>	N	Percentage of All	Percentage of Fishers
The news	8	16	23
Enforcement officers	8	16	23
Friends / relatives / word of mouth	9	18	26
Internet	4	8	11
Self / general knowledge	6	12	17
Don't fish	15	30	

Table S17. Awareness of fish consumption advisories

<i>Are you aware of the fish consumption advisories for this area?</i>	N	Percentage of All	Percentage of Fishers
Yes	11	22	31
No	24	48	69
Don't fish	15	30	

Table S18. Internet usage

<i>Do you use the internet to find information?</i>	N	Percentage
Yes	21	42
No	29	58

Table S19. Location of internet use

<i>Where do you use the internet?</i>	N	Percentage
---------------------------------------	---	------------

Don't use the internet	29	58
Home	9	18
Library	7	14
Home and phone	2	4
Home and library	3	6

Table S20. Internet source of fishing regulations

<i>Have you ever looked up fishing regulations on the internet?</i>	N	Percentage
Yes	11	52
No	10	48

Table S21. Internet source of fish consumption advisories

<i>Have you ever looked up fish consumption advisories on the internet?</i>	N	Percentage
Yes	5	24
No	16	76

Table S22. Conflicts while fishing

<i>Have you had any conflicts while fishing?</i>	N	Percentage	Percentage Crosson
With federal enforcement officers	0		1
With state enforcement officers	0		3
With commercial fishers	0		11
With other recreational fishers	0		9
Other (With a Ski-Doo operator)	1		0

Tables S22-34. Factors affecting fishing behavior

<i>How important do you consider each of these issues about fishing to you personally?</i>	Not at all important	Not very important	Neutral	Somewhat Important	Extremely important	Ranking, this survey	Ranking, Crosson survey
Keeping up with rules	0	1	0	7	27	1	2
Water quality / pollution	4	2	0	7	22	2	1
Weather	3	4	1	14	13	3	6
Finding enough time in my life to fish	7	7	5	5	11	4	4
Bag or size limits	10	5	0	8	12	5	8
Overfishing / too few fish	14	4	1	9	7	6	5
Losing fishing sites	15	3	0	9	8	7	9
Fuel prices	16	3	1	7	8	8	3
Access issues (lack of boat ramps, parking, etc.)	17	4	2	9	3	9	7
Competition with other fishers / crowding	21	3	1	9	0	10	-
Competition with commercial fishermen	27	4	0	3	1	11	10

Table S35-38. Perceived changes in fish stocks

<i>Are there types of fish here you catch now that you rarely caught in the past?</i>	N	%	<i>Are there types of fish here you used to catch frequently but rarely catch now?</i>	N	%
Yes	9	26		13	37
No	26	74		22	62
Species named: bass, catfish, flounder, gar, bowfin, mud diggers, invasives			Species named: croakers (6), spot (5), herring (2), rockfish (2), bass, red drum, sturgeon, trout, white perch		

Table S39. Perceived changes in fish size

<i>Have you noticed any change in size of fish over the years</i>	N	Percentage of All	Percentage of Fishers
Yes – fish are smaller	20	40	57
Yes – fish are larger	0	0	0
No	15	30	43
Don't fish	15	30	

Tables S40-47. Changes in ecosystem

<i>What changes have you seen in this area over the time you have fished here?</i>	More	Neither	Less
Pollution	13	17	4
Development	19	14	1
People fishing	14	15	5
Warmer water	7	23	4
Number of storms	12	18	4
Salinity	6	26	2

Table S48. Reasons for fishing

<i>Why do you fish?</i>	N	Percentage of All*	Percentage of Fishers*
It's fun or relaxing.	33	66	94
To help feed my family.	23	46	66
To spend time with family or friends.	27	54	77
Other reason			
To spend time alone.	1	2	3
Don't fish	15	30	

*More than one answer was permitted so the total is more than 100%.

Table S49. Catch retention

<i>How often do you keep fish to eat?</i>	N	Percentage of All*	Percentage of Fishers*
All legal fish I catch.	20	40	57
Only certain species.	7	14	20
Sometimes I keep fish to eat.	5	10	14
I only catch and release.	3	6	9
Don't fish	15	30	

Table S50. Sharing the catch

<i>Do you keep the fish for your household or share the catch?</i>	N	Percentage of All	Percentage of Fishers
Share	29	58	82
Don't share	3	6	9
Only catch and release	3	6	9
Don't fish	15	30	

Table S51. Shared fish recipients

<i>Whom do you share your catch with?</i>	N	Percentage of All	Percentage of Fishers
Family	15	30	43
Neighbors	2	4	6
Church	4	8	11
Family / neighbors	7	14	20
Family / friends	1	2	3
Neighbors / friends	1	2	3
Elderly	2	4	6
Only catch and release	3	6	8
Don't fish	15	30	

Table S52. Frequency of sharing fish

<i>How often do you give fish away?</i>	N	Percentage of All	Percentage of Fishers
Never	2	4	6
Occasionally	20	40	57
Frequently	9	18	26
Everything	1	2	3
Only catch and release	3	6	8
Don't fish	15	30	

Table S53. Importance of catching fish

<i>How important is catching fish to your family grocery bill?</i>	N	Percentage of All	Percentage of Fishers
Not at all important	7	14	20
Slightly important	9	18	26
Somewhat important	7	14	20
Very important	11	22	31
Vital	1	2	6
Don't fish	15	30	

Table S54. Other sustenance activities

<i>What other activities besides fishing do you do?</i>	N	Percentage*
Garden	15	30
Hunt	10	20

Collect wild plants	6	12
Sell handmade crafts	0	0
Hold yard sales	5	10
None of these	27	54
Other (play guitar)	1	2

*More than one activity was allowed so not equal to 100%.

Table S55. Type of fishing license

<i>What type of fishing license do you have?</i>	N	Percentage of All	Percentage of Fishers
Unified Inland/Coastal Recreational Fishing	8	16	23
Inland Recreational Fishing	6	12	17
Unified Sportsman/Coastal Recreational Fishing	1	2	3
Lifetime Sportsman	1	2	3
Unified Subsistence Inland/Coastal Recreational Fishing License Waiver	5	10	14
Senior Coastal Recreational Fishing	4	8	11
Pier	2	4	6
No license	8	16	23
Don't fish	15	30	

Table S56. Source of new regulation information

<i>How did you learn about the new fishing regulations?</i>	N	Percentage
Enforcement agents	10	28
Division of Social Services	8	23
News	6	17
Bait seller	3	9
Moved here after new regulations	1	3
Don't remember	7	20
Internet	0	0

Table S57. Awareness of subsistence waiver

<i>Have you heard of the subsistence waiver?</i>	N	Percentage
Yes	17	48
No	18	52

Table S58. Familiarity with subsistence waiver user

<i>Do you know anybody who uses the subsistence waiver?</i>	N	Percentage
Yes	17	48
No	18	52

Table S59. Opinion of subsistence waiver

<i>Do you think the "subsistence waiver" is a good or bad idea?</i>	N	Percentage
Good	35	100
Bad	0	0

Table S60. Frequency of gift fish

<i>How often do you receive fish as a gift from somebody who caught it?</i>	N	Percentage	Percentage of non-fishers
Two times/week	2	4	13
Every week	1	2	7
Two or three times/month	4	8	26
One or two times/month	7	14	47
Less than once/month	1	2	7
Catch my own fish	35	70	

Table S61. Concern about contaminants in gift fish

<i>Are you worried about contaminants in fish you receive as gifts?</i>	N	Percentage
Yes	5	33
No	10	67

Table S62. Types of contaminants of concern

<i>What type of contaminants are you worried about?</i>	N	Percentage
Don't know	3	60
E-coli	1	20
Getting sick	1	20

Table S63. Methods to reduce contaminants

<i>Do you have ways to clean or cook the fish to reduce contaminants?</i>	N	Percentage
No	13	87
Yes	2	13
Deep fry		
Cook in boiling water		

Table S64. Importance of gift fish to grocery bill

<i>How important is receiving gift fish to your family grocery bill?</i>	N	Percentage	Percentage of non-fishers
Not at all important	5	10	33
Slightly important	6	12	40
Somewhat important	3	6	20
Very important	1	2	7
Catch my own fish	35	70	

Table S66-67. Perceived flooding

<i>Does this area flood often?</i>	N	%	<i>Has flooding increased recently?</i>	N	%
Yes	40	80		22	44
No	10	20		28	56

Table S68. Sample characteristics

Gender	N	%	% Tyrrell County	% North Carolina
Male	24	48	46.2	48.7
Female	26	52	53.8	51.3

Race	N	%	% Tyrrell County	% North Carolina
Black / African American	34	68	36.5	22.1
White / Caucasian	16	32	58.4	71.2

Age	N	%
21-30	3	6
31-40	4	8
41-50	6	12
51-60	17	34
61-70	15	30
71 and older	5	10
Mean = 51 years		

Marital Status	N	%
Currently Married	7	14
Divorced	10	20
Widowed	5	10
Never Married	23	46
Separated	5	10

Highest Level of Education	N	%	% Tyrrell County	% North Carolina
11 th Grade or Less	11	22		
High School Graduate	17	34	70.6	85.4
Some College / Technical Training	13	26		
College Graduate	7	14	8.0	27.8
Graduate Work	2	4		

Employment Status	N	%
Full Time Employment	14	28
Part Time Employment	6	12
Unemployed	18	36
Disabled	5	10
Retired	7	14

Household Income	N	%
Less than \$15,000	6	10
\$15,000 - \$30,000	12	60
\$30,001 - \$50,000	2	10
More than \$50,000	0	0
Total	20	

APPENDIX E: FLYER DEVELOPED FOR DISTRIBUTION TO TYRRELL COUNTY

RESIDENTS

Eating Local Fish

If you eat fish you catch yourself or fish somebody gives you as a gift there are a few things you should know.

- Fish is a great source of good lean protein.
- There are contaminant risks in some fish.

Albemarle Sound Consumption Advisories

Dioxins

Catfish and carp from these waters may contain low levels of dioxins. Women of childbearing age and children should not eat any catfish or carp from this area until further notice. All other persons should eat no more than one meal per month of catfish and carp from this area. Swimming, boating, and other recreational activities present no known significant health risks and are not affected by this advisory.

Mercury

Women of Childbearing Age (15-44 years), Pregnant Women, Nursing Women, and Children under 15: Do not eat fish high in mercury, including largemouth bass caught in the state. Eat up to two meals per week of fish low in mercury. A meal is 6 ounces of uncooked fish for adults, or 2 ounces of uncooked fish for children under 15.

All Other Individuals: Eat no more than one meal per week of fish high in mercury, including largemouth bass caught in the state. Eat up to four meals per week of fish low in mercury. A meal is 6 ounces of uncooked fish for adults, or 2 ounces of uncooked fish for children under 15.

Catching Local Fish

- Get a license – they are not expensive and the fine for fishing without a license is steep.
- To reduce certain contaminants remove fat and cook so fat drips away: broil, bake or grill and do not use the drippings.

Further information:

- Updated consumption advisories can be found on the internet:
<http://epi.publichealth.nc.gov/oeefish/advisories.html>
- Project results: Contact Liz Brown-Pickren at 252-737-4371 or e-mail
brownpickrene09@students.ecu.edu

This study was funded by North Carolina Sea Grant and the Albemarle Pamlico National Estuary Partnership.

APPENDIX F: DETAILED INFORMATION ON CONTAMINANT RISKS IN SELF- CAUGHT FISH IN TYRELL COUNTY

Retrieved from <http://epi.publichealth.nc.gov/oeefish/advisories.html>

Site-Specific Advisories by Body of Water

- **Albemarle Sound**

Affected Counties: Bertie, Camden, Chowan, Currituck, Pasquotank, Perquimans, Tyrrell, and Washington

Site: Albemarle Sound from Bull Bay to Harvey Point; West to the mouth of the Roanoke River and to the mouth of the Chowan River to the U.S. Highway 17 Bridge

Pollutant: Dioxins

Date Issued: October 2001

Advisory: Catfish and carp from these waters may contain low levels of dioxins. Women of childbearing age and children should not eat any catfish or carp from this area until further notice. All other persons should eat no more than one meal per month of catfish and carp from this area. Swimming, boating, and other recreational activities present no known significant health risks and are not affected by this advisory.

Statewide Advisories

Pollutant: Mercury

Date Issued/Updated: April 2, 2008

Advisory:

Women of Childbearing Age (15-44 years), Pregnant Women, Nursing Women, and Children under 15:

Do not eat fish high in mercury, including largemouth bass caught in the state. Eat up to two meals per week of fish low in mercury. A meal is 6 ounces of uncooked fish for adults, or 2 ounces of uncooked fish for children under 15.

All Other Individuals:

Eat no more than one meal per week of fish high in mercury, including largemouth bass caught in the state. Eat up to four meals per week of fish low in mercury. A meal is 6 ounces of uncooked fish for adults, or 2 ounces of uncooked fish for children under 15.

Affected Fish: Fish high in mercury

Additional information on mercury in fish is provided at http://epi.publichealth.nc.gov/oeefish/mercury/in_fish.html

A list of fish considered high in mercury and low in mercury is provided at <http://epi.publichealth.nc.gov/oeefish/mercury/safefish.html>

The Department of Epidemiology has developed a flyer explaining the mercury risks:

What fish are safe to eat?

From the North Carolina Division of Public Health

Most fish are good to eat and good for you - high in protein and other nutrients, and low in fat. But some kinds of fish contain high amounts of mercury, which can cause health problems in people, especially children. To help you make the healthiest choices, North Carolina offers the following advice. For more information, see www.epi.state.nc.us/epi/fish/ or call (919)707-5900.

Avoid or limit fish consumption based on the following:	
Women of childbearing age (15 to 44 years), pregnant women, nursing mothers and children under age 15	All other people
Do not eat fish from the HIGH in mercury list.	Eat only 1 meal of fish per week from the HIGH in mercury list.
Eat up to 2 meals per week of fish from the LOW in mercury list.	Eat up to 4 meals of fish per week from the LOW in mercury list.

Eat Fish LOW in mercury

Ocean Fish	Freshwater Fish
Black drum	Pollock
Canned light tuna	Pompano
Cod	Red drum
Crab	Salmon (canned, fresh or frozen)
Croaker	Scallops
Flounder	Sheepshead
Haddock	Shrimp
Halibut	Skate
Herring	Southern kingfish (sea mullet)
Jacksmelt	Spot
Lobster	Speckled trout (spotted sea trout)
Mahi-mahi	Tripletail
Ocean perch	Whitefish
Oysters	White grunt

Avoid Fish HIGH in mercury

Ocean Fish	Freshwater Fish
Albacore (white) tuna** fresh or canned	Little tunny
Almaco jack	Marlin
Banded rudderfish	Orange roughy
Cobia	Shark
Crevalle jack	Spanish mackerel
Greater amberjack	Swordfish
South Atlantic grouper (gag, scamp, red and snowy)	Tilefish
King mackerel	Tuna, fresh or frozen**
Ladyfish	
	Blackfish (bowfin)*
	Black crappie***
	Catfish (caught wild)*
	Jack fish (chain pickerel)*
	Largemouth bass (statewide)
	Walleye in Lake Fontana & Lake Santeetlah (Graham & Swain counties)
	Warmouth*
	Yellow perch*

*High mercury levels have been found in blackfish (bowfish), catfish, jack fish (chain pickerel), warmouth, and yellow perch caught south and east of Interstate 85.
 **Different species from canned light tuna
 ***High mercury levels have been found in black crappie caught south and east of Interstate 95.

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Spanish version: "¿Cuáles pescados son seguros para comer?"

APPENDIX G: PROPOSED PLAN FOR DISSEMINATING INFORMATION ABOUT FISH CONTAMINATION IN TYRRELL COUNTY

Target audience

While all residents of Tyrrell County should have access to information about the risks and benefits of eating locally caught fish, two particular audiences could be targeted for an information campaign. The anglers are the first target, as they are the people who eat their own catch and give fish to friends and relatives. Second, school children are good conduits for bringing information to incorporate in household practices.

Objectives

Posting information at public places will reach some of the target audience, but the effectiveness is difficult to measure, other than enumerating how many flyers were posted and where. Including seafood consumption advisories with each fishing license and waiver would disseminate the information to all licensed anglers, including those who do not use the internet. School children responses would be easier to measure, through science quizzes or questionnaires administered by teachers.

Resources

Fliers with simple language about benefits and risks of local fish consumption could be developed, both in English and Spanish for Tyrrell County, given the number of Hispanic people living there, and in area-appropriate languages in other places. The North Carolina State University Center for Human Health and the Environment has developed a website (NCSUCHHE, 2018) that includes an interactive map and printable advisory signs in English and Spanish along with information about contaminants and species. This excellent source of

information should be supplemented with an informational brochure that accompanies all fishing licenses and waivers.

Several groups could be used to disseminate information. The NC Division of Marine Fisheries maintains boat ramps, and could be asked to post the NC Department of Epidemiology consumption advisories at boat ramps; these advisories do not change frequently so would be little work after the initial posting. The NC Division of Social Services and public libraries could be provided with posters enumerating the risks and benefits of fish consumption.

School teachers could be provided with curriculum to teach a unit on fishing, which could be part of the science or home economics curriculum for older students and younger students could be provided with line drawings of “good” fish and “bad” fish to color. Several types of extension agents could help: agricultural, home economics, and fisheries programs could include information. Middle and high school students might be encouraged to construct science projects regarding fish consumption with appropriate media coverage for winning projects.

Evaluation

As stated above, the effectiveness of posting informational flyers is difficult to assess without conducting surveys of pre- and post- information dissemination knowledge. The NC Division of Marine Fisheries conducts large mail-out surveys to gauge participation in recreational fishing but because of privacy issues, those receiving subsistence waivers through social service programs do not receive the survey. DMF statisticians have expressed interest in including subsistence waiver holders in their surveys (Cathey, 2017) but have not done so, to date.

A program aimed at school children would be much easier to evaluate, through biology or nutrition quizzes, group lectures, and competitive science projects. Curriculum covering

contamination in fish have been developed by the Southern California Sea Grant “What’s the Catch” (<https://dornsife.usc.edu/assets/sites/291/docs/WhatstheCatch.pdf>).