

CAFOs as *Hotspots*:
Effect on Ecosystem Services and Needed
Change in Environmental Leadership

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Abstract

Many Americans are neither aware that 99 percent of their meat consumed in the United States is produced by large-scale factory farms; nor, are they aware of the deleterious effect these operations have on environmental systems. In North Carolina, the country's second pork producing state, the lack of public awareness and public misperception have a direct impact on environmental decision making, which further exacerbates the challenges posed by concentrated animal feeding operations (CAFOs). As with all businesses they operate based on the law of supply and demand, the growing number of CAFOs is directly related to increased meat consumption and corporate desire for higher profits since the 1950s. This project seeks to determine whether understanding CAFOs as *hotspots* and increasing public awareness about industrial meat production can effectively influence positive environmental change, from the personal food choices of individuals, to the political decisions of leaders and policy makers.

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Introduction

During the past sixty years, Concentrated Animal Feeding Operations (CAFOs) have proliferated in the United States. These giant, industrial factory animal farming operations are classified by the Clean Water Act as point source emitters with potential pollution profiles.¹ Extensive research has concluded that CAFOs emit noxious and potentially harmful gasses, chemicals and pathogens, which have a broad range of detrimental impacts on the environment, economy, public health and society. Corporations that own industrial meat production facilities profit at the risk of detrimental impact on a community's environment, public health and economy.

America's rural landscape has changed dramatically due to the growth of Industrial Farm Animal Production (IFAP). Family farms that once thrived by operating harmoniously with nature and the land have been replaced by large, corporate-owned facilities known as Animal Feeding Operations (AFOs).² Today an estimated 99 percent of meat comes from industrialized factory farms; and, approximately six billion animals per year are slaughtered for food in the United States.³ In 2010, more than 90 billion pounds of red meat and poultry was produced in the United States, with an estimated 80 billion pounds consumed by Americans.⁴

In a relatively short time frame, within the last century, the 180 degree shift from traditional farming methods that functioned for tens of centuries metamorphosed into high density corporate point source pollution epicenters for raising animals as food. As described below, these *hotspots* create environmental peril, and the business model upon which they are founded is flawed and unsustainable.

¹ U.S. Environmental Protection Agency: http://cfpub.epa.gov/npdes/home.cfm?program_id=7

² Pew Charitable Trusts 2008

³ Monson 2010

⁴ U.S. Census 2012 Statistical Abstract: <http://www.census.gov/compendia/statab/2012/tables/12s0869.pdf>

This project asks:

- 1) Are CAFOs understood as environmental “hotspots?”
- 2) What is the comprehensive environmental impact of CAFOs on ecosystem services?
- 3) What level of information will or can create change in environmental decision making by the individual and the policy maker?

Figure 1: Cattle grown for Beef on a Factory Farm⁵



Typical feedlot used in CAFOs (this one located in California) where numerous cattle share cramped and unsanitary conditions.

⁵ Socially Responsible Agriculture Project 2009

History of CAFO Development in the United States- The “Green Revolution”

In order to better understand the context of the questions above, I want the reader to comprehend CAFOs as environmental hotspots, gain an appreciation of the environmental impact of these operations, and to become informed and inspired in order to affect change. From the brief intro above, I want to expand on the Green Revolution and relevant issues surrounding the development of CAFOs.

In the 1920s and 1930s, large-scale slaughterhouses in urban centers such as St. Louis and Chicago paved the way for industrial meat production by proving that mechanization and mass production could increase corporate profits. The Dust Bowl, Great Depression and World War II contributed significantly to declining crop yields and meat production in the United States in the 1930s and 1940s. Following World War II, Americans entered a new era of prosperity with a new goal: to feed starving people around the world. Groups such as DuPont, Ford and Rockefeller foundations flocked to support the efforts by funding scientific research that transformed agriculture worldwide.⁶ Through prolific petroleum technology, these titans of industry made America the most productive agricultural region on earth. Previous civilizations deployed human energy. The green revolution largely replaced human labor with that from machines. Today, wars are waged for petroleum and we are realizing as a human society that this finite resource has reached its peak.⁷

In concurrence with the rise of industrialization, America was experiencing depletion in the amount of tillable land that had not been exhausted. New technology allowed marginal and

⁶ Pew Charitable Trusts 2008

⁷ Pfeiffer 2006

depleted land to be transformed.⁸ Innovations such as synthetic fertilizers, chemical pesticides, irrigation design, seed hybridization and genetic modification significantly increased farm yields, and fueled a “Green Revolution”, a phrase coined for the phase of rapid agricultural development from the mid-1940s to the 1970s.⁹ This Green Revolution was not a result of more sunlight or the discovery of new lands; it was a direct result of fossil fuels, which provided the energy for massive irrigation efforts, fossil fuel-based fertilizers and pesticides.¹⁰

Unfortunately, the Green Revolution had “unwanted ecological impacts, such as aquifer depletion, groundwater contamination, and excess nitrate runoff, largely because of its reliance on monoculture crops, irrigation, application of pesticides, and use of nitrogen and phosphorous fertilizers.”¹¹ As a result of Green Revolution technology, the United States experienced a massive surplus of commodities such as corn and grain in the 1980s. Low prices for corn and grain prompted meat producers to introduce those products to livestock diets and facilitated the emergence of CAFOs.¹² As author Michael Pollan noted in his best-selling book, “*The Omnivore’s Dilemma*,” the superabundance of corn contributed greatly to the metamorphosis of meat production in the United States.¹³

⁸ Pfeiffer 2006

⁹ Pew Charitable Trusts 2008

¹⁰ Pfeiffer 2006

¹¹ Pew Charitable Trusts 2008

¹² Pew Charitable Trusts 2008

¹³ Pollan 2006

POLITICAL SYSTEM and CORPORATIONS

Another factor was the country's ever-changing political climate. President Roosevelt's New Deal farm programs of the 1940s attempted to regulate corn prices through commodity surplus programs. Yet, those policies changed in the 1970s when President Nixon's Secretary of Agriculture, Earl Butz, unveiled a new price-setting system for corn and urged farmers to become "agribusiness men" and to "get big or get out."¹⁴ Set prices prompted farmers to increase production, despite lower demand, creating a glut of corn on the market. Falling prices led to lower profits, especially for small growers. As massive storage silos of corn reached capacity, family farms that could no longer survive economically began to disappear. In contrast, large producers capitalized on the excess corn by feeding it to livestock. It was "from this tangled attempt to make efficient use of what should never have been grown, the factory farm emerged."¹⁵

During the past decade, an increasing number of local farmers have entered into contracts with vertically integrated meat packing companies. In this type of contract, a corporation owns the livestock and controls all aspects of production including the animals' diets. Yet, the local grower, farmer or property owner is often responsible for costs of waste management and pollution abatement. This type of vertical integration model emerged in World War II when the U.S. War Department entered into contracts with poultry producers to raise chickens and eggs to feed soldiers. Years later, Smithfield Farms implemented vertical integration to begin raising pork on a massive scale. ¹⁶

¹⁴ Cassuto 2010

¹⁵ Cassuto 2010

¹⁶ Pew Charitable Trusts 2008

PUBLIC AWARENESS

Over the years, CAFOs have expanded with less oversight and regulation than many industries, due partly to inadequate public awareness and political pressure from strong lobbies that support agribusiness and big oil.¹⁷ For several decades, the public and policy makers have focused their attention and conservation efforts on energy and transportation, even though greenhouse gas emissions from raising animals as food far surpass those from transportation worldwide.¹⁸ Federal farm subsidies, price controls and other economic policies favoring industrial agriculture have enabled giant feeding operations to further expand throughout the U.S. Such policies were originally intended to aid family farms and this “preferential regulatory treatment reflects the national attachment to and political and cultural cachet of family farms” and “stems in large part from a concerted effort by corporate growers to portray themselves as small farmers who live off the land in harmony with their surroundings. But the truth is that they *are not* and they *do not*.”¹⁹

Researchers and others investigating CAFOs often face stiff opposition. For example, scientists and academics involved with the Pew Commission on Industrial Farm Animal Production’s 2008 report, “Putting Food on Table: Industrial Farm Animal Production in America,” encountered “significant influence by the industry at every turn: in academic research, agriculture policy development, government regulation, and enforcement,” and received “responses ranging from open hostility to wayward cooperation,” along with “threats to withhold research funding.”²⁰ In the Pew report’s preface, Commission Executive Director Robert P. Martin cautioned that Americans should be wary of “the agro-industrial complex—an alliance of agriculture commodity groups, scientists at academic institutions who are paid by the industry, and their

¹⁷ Pfeiffer 2006

¹⁸ Pew Charitable Trusts 2008

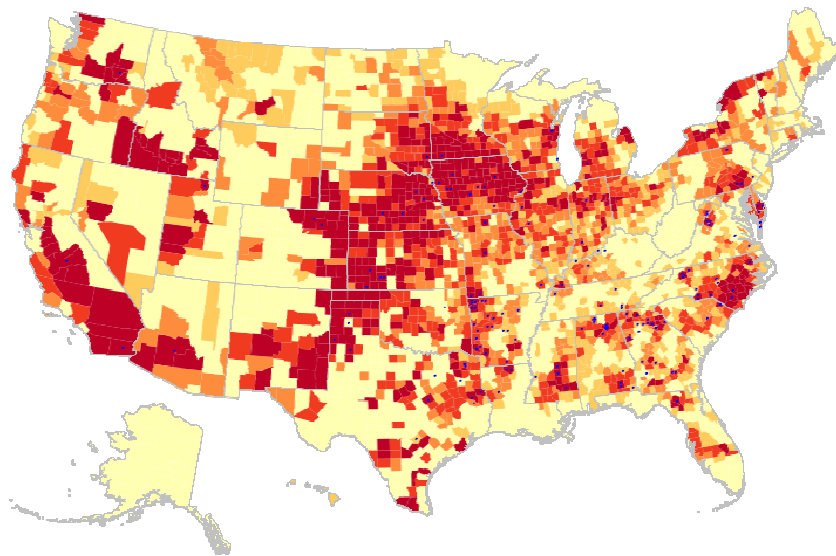
¹⁹ Cassuto 2010

²⁰ Pew Charitable Trusts 2008

friends on Capitol Hill.” Martin also noted that the current system of meat production in the United States “is not sustainable and presents an unacceptable level of risk to public health and damage to the environment, as well as unnecessary harm to the animals we raise for food.”²¹

In another effort to prevent public scrutiny of CAFOs, some states are taking steps to criminalize efforts to document conditions inside industrial farm operations. In March, 2012, Iowa’s governor signed House Bill 589, a new law pertaining to “agricultural production facility fraud,” which makes it illegal to use undercover methods to obtain videos or other evidence inside CAFOs.²² Nebraska, Missouri and other states are also considering similar "ag gag" laws.²³

Figure 2: 2007 Map of CAFOs in US-Darker red areas indicate larger concentrations²⁴



California, Idaho and throughout the Midwest CAFOs dominate the landscape. These lands are dry and flat (albeit CAFOs are not sustainable in any landscape). In NC the CAFOs are located on coastal plains and wetlands. Note southern FL and southern LA have similar ecosystems, but are not home to these operations.

²¹ Pew Charitable Trusts 2008

²² Iowa Legislature 2012

²³ Reeder 2010

²⁴ Food and Water Watch 2010

KEY ISSUES

Industrial meat production has a broad range of consequences, including detrimental impacts to the environment, economy, public health, and animal health and welfare. Airborne emissions from hog houses, waste lagoons, and crop fields can contain ammonia, hydrogen sulfide, carbon dioxide, volatile organic compounds, dusts, and endotoxins. Water quality can also be severely compromised by industrial meat production and processing. For example, in the late 1990s, a federal judge fined Smithfield Foods \$12.6 million under the U.S. Clean Water Act for allowing wastewater from a meat processing facility to enter the Pagan River in Smithfield, Va.²⁵ Residents living near CAFOs often experience sickening and noxious odors, which can produce mood-altering symptoms including tension, depression, fatigue, and anger. CAFO workers can also contract various types of respiratory and pulmonary disorders.²⁶ In recent years, another issue of concern has emerged: a foamy substance found in some hog manure pits has caused explosions at numerous CAFOs. Scientists are struggling to identify the foam and resolve the problems associated with it.²⁷

GREENHOUSE GASES and EMISSIONS

As is suggested by the term “hotspots,” CAFOs have a dramatic impact on the environment, both locally and globally, with immediate and long term consequences including: degradation of surrounding air and water quality for thousands of miles; destruction of regional aquifers and wildlife habitats; and depletion of the global resources of water, fossil fuels and [rain] forests. “The CH₄ (methane), N₂O (nitrous oxide) and CO₂ (carbon dioxide) released from livestock account for more than 7% of U.S. greenhouse gas emissions (GHGs) and more than 18% of

²⁵ Smithfield Foods 2006

²⁶ Edwards and Ladd 2002

²⁷ Keim 2012

GHGs worldwide.”²⁸ In addition to producing high quantities of GHGs, the emissions from CAFOs have a much higher potential to contribute to climate change. The Pew study states that “the global warming potential of these emissions, compared to a value of one for carbon dioxide, is 62 for methane and 275 for nitrous oxide on a 20-year time horizon.”²⁹ CAFOs produce gaseous emissions from the decomposition of animal manure, and also emit particulate substances, caused by animal movement and handling.³⁰ Swine and poultry CAFOs have led to “a significant increase of agricultural ammonia emissions in the coastal plain region of North Carolina”³¹ because “much of the nitrogen excreted by swine is in the form of urea, which hydrolyzes to NH₃,”³² the primary gaseous base in the earth’s atmosphere.

ENERGY CONSUMPTION

Compared to traditional methods of raising livestock, such as allowing cattle to graze in pastures, industrial meat production is significantly more energy intensive and requires “disproportionately large inputs of fossil fuel, industrial fertilizers, and other synthetic chemicals.”³³ For all US agricultural products combined “the ratio of fossil fuel energy inputs per unit of food energy produced—not including food processing and distribution—averages 3:1, but for industrially produced meat products the ratio can be as high as 35:1 Beef produced in feedlots generally has a particularly unfavorable energy balance.”³⁴

²⁸ Cassuto 2010

²⁹ Pew Charitable Trusts 2008

³⁰ Hribar 2010

³¹ Walker et al 2000

³² Arogo et al 2006

³³ Pew Charitable Trusts 2008

³⁴ Pew Charitable Trusts 2008

EPA DESIGNATION

The U.S. Environmental Protection Agency defined the generic animal feed operation (AFOs), as operations where animals are kept and raised in confined situations” for more than 45 days, during which time “feed is brought to the animals, rather than the animals grazing or otherwise seeking feed in pastures.” The EPA definition specifies that “AFOs generally congregate animals, feed, manure, dead animals, and production operations on a small land area” and that “animal waste and wastewater can enter water bodies from spills or breaks of waste storage structures (due to accidents or excessive rain), and non-agricultural application of manure to crop land.”³⁵ In 2012, there are approximately 450,000 AFOs in the U.S., with an estimated 15 percent of those meeting the size thresholds to be classified as a Concentrated Animal Feeding Operation (CAFO).³⁶

CAFOs are point sources, as defined by the Clean Water Act [Section 502(14)], and have potential pollution profiles. As a result, they are overseen by the EPA’s National Pollutant Discharge Elimination System (NPDES) program. The EPA has designated three categories of CAFOs: large, medium and small (see Table 1).³⁷ The relevant animal unit for each category varies depending on species and capacity. For example, a swine finishing plant was classified as a large CAFO if it contained at least 10,000 pigs weighing less than 55 pounds.³⁸

(See TABLE 1, APPENDIX A)

³⁵ U.S. Environmental Protection Agency: http://cfpub.epa.gov/npdes/home.cfm?program_id=7

³⁶ U.S. Environmental Protection Agency: <http://www.epa.gov/Region7/water/cafo/index.htm>

³⁷ U.S. Environmental Protection Agency: http://cfpub.epa.gov/npdes/home.cfm?program_id=7

³⁸ U.S. Environmental Protection Agency: http://www.epa.gov/npdes/pubs/sector_table.pdf

ECOSYSTEM SERVICES

Our ecosystems serve us in many ways. Understanding them as dynamic service providers can create appropriate valuation of ecosystems and their services. Filtering through the water cycle, providing oxygen through the air cycle, and providing useful and healthy soil are three main services of ecosystems. Other benefits include providing wildlife habitat, along with areas for human recreation and spiritual well being. The pages below illustrate how CAFOs significantly disrupt ecosystem services and often cause prolific harm to wildlife and humans.

AIR CYCLE IMPACTS

One of the most noticeable impacts of CAFOs is the stench often associated with their presence. In addition to the unpleasant smell, these industrial operations can have devastating effects on rural communities with lower income profiles, as these communities are often “rooted in enjoying the outdoors.” The cherished freedom and independence that comes with lives centered on the outdoors gives way to feelings of “violation and infringement” when faced with the overwhelming odor from CAFOs. Social events, gatherings and recreation create a sense of well being and normative routine. In communities with proximity to CAFOs, “homes are no longer an extension of or a means for enjoying the outdoors. Rather, homes become a barrier against the outdoors that must be escaped.”³⁹ As a result, these monolithic meat manufacturers can effectively ruin the quality of life for residents and visitors in nearby communities.

Since one hog produces more solid waste than approximately *ten* people, a CAFO with 5,000 animals generates as much waste as a city of 50,000 humans; yet, instead of a municipal sewage treatment facility, CAFOs store waste that is often untreated in giant lagoons, which are often

³⁹ Donham et al 2007

unlined and uncovered.⁴⁰ I was unable to find specific data on the quality of incoming water used for CAFOs. In the human use analogy, a town of 50,000 people would have to test their water supply and would have to meet EPA regulations. For previous generations of farmers, waste management was not an issue of imbalance since farm animals spent most of their time in pastures instead of inside giant warehouses. Dry manure was spread onto fields as natural fertilizer for crops. With less animals and more land, these farms relied on natural ecosystems for filtering pathogens and absorbing or diluting nitrate concentrations. Now animals are typically kept in indoor stalls with slatted floors, which allow feces, urine and micro organisms to fall into vast waste pits, which are typically flushed weekly into large outdoor lagoons.⁴¹ One study observed that “seventy-five percent of swine production systems in North America use anaerobic or liquid slurry systems for waste holding or disposal.”⁴²

How CAFOs handle animal waste is a subject of great concern for many citizens, scientists and environmentalists. Since the lagoons are often not lined or covered, the storage sites can emit dangerous levels of ammonia, hydrogen sulfide, dust, mold, pathogens, and bacterial endotoxins.⁴³ Waste from the lagoons is often sprayed on soils tilled near CAFOs, “creating a far-reaching impact on air, water and soil quality, as well as detrimental effects on public health and local economies.”⁴⁴ (See Table 2, APPENDIX B)

⁴⁰ N.C. Riverkeepers & Waterkeepers Alliance

⁴¹ Pew Charitable Trusts 2008

⁴² Sang 2010

⁴³ Pew Charitable Trusts 2008

⁴⁴ Pew Charitable Trusts 2008

WATER CYCLE IMPACTS

More than half of freshwater resources on the planet are used for agriculture with an estimated 33 percent being diverted for food animal production.⁴⁵ For example, according to the U.S. Geological Survey (USGS), the amount of water required for manure disposal and crop production for livestock feed, is more than 16,000 gallons to produce a single pound of beef.⁴⁶ The immense amounts of water required to operate CAFOs can cause rapid depletion of aquifers, especially in areas experiencing droughts.⁴⁷ In states such as North Carolina that have battled droughts for several years, CAFOs put an additional strain on public water supplies.

Livestock waste from factory farms can contaminate wells and drinking water supplies with “Salmonella, Campylobacter and Cryptosporidium, and can pollute drinking water with nitrates in concentrations potentially fatal to infants.”⁴⁸ In addition, CAFOs generate pathogens that cause Chlamydia, giardiasis, meningitis, influenza, and other diseases.⁴⁹

Another method of waste management is ground application, but the high nitrogen content and other nutrients in agricultural runoff can contaminate surface water, stimulate algae growth, and deplete oxygen. Further, this runoff “laden with chemicals (synthetic fertilizers and pesticides) and nutrients is suspected as a major culprit responsible for many *dead zones* in both inland and marine waters thus affecting an estimated 173,000 miles of US waterways.”⁵⁰ This further complicates the process of determining cause of degradation of aquatic resources after such

⁴⁵ Imhoff et al 2010

⁴⁶ U.S. Geological Survey <http://ga2.er.usgs.gov/edu/activity-water-content.cfm>

⁴⁷ Pew Charitable Trusts 2008

⁴⁸ Walker et al 2005

⁴⁹ Donham 1998

⁵⁰ Pew Charitable Trusts 2008

events as the major oil spills like BP Deepwater Horizon in the Gulf of Mexico, which may occur in the same waterways. In addition, widespread application of CAFO waste often creates “excessively high levels” of soil phosphorus concentration.⁵¹

Another contaminant associated with CAFOs is nitrate, which can contribute to human diseases such as hyperthyroidism, insulin-dependent diabetes and “increased risk of adverse reproductive outcomes and neuro-developmental defects.”⁵² In addition, ammonia emissions from CAFOs “contribute significantly to the eutrophication and acidification of soils and waters” by adding excessive nitrates, phosphates and other compounds that can cause “a dense growth of plant life and the death of animal life due to lack of oxygen,” and “put stress on species diversity in the natural environment.”⁵³ “A study by Iowa State University, which was a result of a lawsuit settlement between the Sierra Club and Tyson Chicken, found that two chicken houses in western Kentucky emitted over 10 tons of ammonia in the year they were monitored.”⁵⁴ Subsequently, the complex mixture of chemicals agents emitted by CAFOs may result in a synergistic effect.

⁵¹ Cahoon 2004

⁵² Pew Charitable Trusts 2008

⁵³ Pew Charitable Trusts 2008

⁵⁴ Hribar 2010

Figure 3: Aerial view of Hog CAFO lagoon showing associated crate facilities



Legend: Fluid and matter in lagoons is often pink in color from growth hormones, aborted fetuses and other matter.⁵⁵

BIODIVERSITY

Depending on its location, a single CAFO can quickly devastate a region's watersheds and ecosystems. Even though some CAFOs are "sited properly with regard to local geological features, watersheds, and ecological sensitivity, others are located in fragile ecosystems, such as on flood plains in North Carolina and over shallow drinking water aquifers in the Delmarva Peninsula and northeastern Arkansas."⁵⁶ In North Carolina, the vast majority of CAFOs are located in the bio-diverse southeastern coastal plain. These facilities intersect major watersheds and create environmental management issues discussed in the next section. They are simply too concentrated and in the wrong locale.

⁵⁵ Quadcities Citizens Against Triumph 2009

⁵⁶ Pew Charitable Trusts 2008

FORESTS

As global meat consumption rises, a growing number of forests are being cleared to create pastures and fields for livestock and corn. Increased manure production and fossil fuel-based fertilizers are exacerbating carbon, methane and nitrous oxide emissions, and accelerating climate change. Rising temperatures negatively impact crop growth and livestock production, increasing the need for fossil fuel-based fertilizers, pesticides and electricity (for climate-controlled confinement areas), which contribute further to greenhouse gas emissions, deforestation and other sweeping environmental consequences. As a result, CAFOs are trapped in “a positive feedback loop.”⁵⁷ During the past decade, “the leading cause of deforestation in the Amazon has been conversion of rainforest to industrial soybean plantations—primarily for CAFO production in Brazil or for export to industrial animal operations in China and Europe,” and “rainforest destruction for feed crop and pasture conversion is occurring at an even faster pace in other Latin American countries.”⁵⁸

ECONOMIC and SOCIAL IMPACT

Proponents of CAFOs often contend that the large operations create jobs for local residents, but demographic data does not seem to support that argument since it has been found that “most often upper management and many of the workers in such operations do not come from or live in the vicinity of concentrated animal feeding operations (CAFOs).”⁵⁹ Instead of contributing money to a local economy by creating jobs, CAFOs often receive government subsidies such as

⁵⁷ Cassuto 2010

⁵⁸ Imhoff et al 2010

⁵⁹ Donham et al 2007

financial assistance for irrigation systems in arid regions.⁶⁰ In 2007, the average factory farm received a subsidy of about \$25 per hog.⁶¹

Studies have shown that CAFOs can negatively impact a community's economic health, social viability and quality of life for residents. It has been observed that "socioeconomic devaluations from the siting of hog operations in rural communities can include the displacement of small, independent farmers, lowered property values, the disruption of recreational and tourist industries, and the impeding of future community development."⁶²

In a study in California, one of the first states to embrace industrial agriculture, researchers compared two communities, one filled with large, industrialized farming operations and another with small, owner-operated farms. The study noted that the community with small farms was "found to have a richer civic and social fabric with more retail purchases made locally and with income more equitably distributed" than the town filled with corporate-owned facilities that had "absentee ownership and a high percentage of hired farm labor."⁶³

Several studies have found that property values decrease when CAFOs move into a community and the controversy that usually surrounds CAFOs can "threaten community social capital" and create "deep and long-standing" rifts between community members that can lead to hostility, harassment and other adverse consequences. For instance, a 2001 study of six Minnesota counties "identified three patterns that reflect the decline of social capital that resulted from the

⁶⁰ Walker et al 2005

⁶¹ Pew Charitable Trusts 2008

⁶² Ladd and Edwards 2002

⁶³ Donham et al 2007

siting of CAFOs” including “widening gaps between CAFO and non-CAFO producers; harassment of vocal opponents of CAFOs; and perceptions by both CAFO supporters and CAFO opponents of hostility, neglect, or inattention by public institutions that resulted in perpetuation of an adversarial and inequitable community climate.”⁶⁴

ENVIRONMENTAL RACISM and SOCIAL JUSTICE

CAFOs are often located in rural areas with low-income populations. A study conducted by the University of North Carolina concluded that “community concerns about environmental injustice in the distribution of hog operations in North Carolina are real” and that “a disproportionate number of hog CAFOs” are located in “predominantly poor and nonwhite communities.” Such communities are typically struggling economically, but “future prospects for these communities are threatened by an industry that produces highly obnoxious odors and reduces the quality of life for neighbors, which can hamper the growth of cleaner industries, reduce land values, and contribute to loss of locally owned land.”⁶⁵ In addition, the study noted that “operations run by corporate integrators are more concentrated in poor and nonwhite areas than are operations run by independent growers.”⁶⁶

Other North Carolina researchers found that “the closer children live to a CAFO, the greater the risk of asthma symptoms. Of the 226 schools that were included in one study, 26% stated that there were noticeable odors from CAFOs outdoors, while 8% stated they experience odors from

⁶⁴ Donham et al 2007

⁶⁵ Wing et al 2002

⁶⁶ Wing et al 2002

CAFOs inside the schools. Schools that were closer to CAFOs were often attended by students of lower socioeconomic status.”⁶⁷

Disproportionate impacts of intensive hog production on people of color and on the poor may impede improvements in economic and environmental conditions that are needed to address public health in areas that have high disease rates and low access to medical care as compared to other areas of the state. Such communities are typically struggling economically, but are threatened by an industry that produces “highly obnoxious odors” and reduces the quality of life for the surrounding area and neighbors. These CAFOs hamper the growth of clean tech industries in the region, reduce land values, and erode local land ownership. ⁶⁸

In addition, economically advantaged people are more likely to eat grain fed meat. One conclusion is that “rich people are more likely to eat grain fed meat than poor people, is significant to the food versus feed debate when the issue of prices, and demand elasticity are factored into the discussion.” ⁶⁹

FOOD SECURITY

With the world population expected to reach 9 billion by 2050, “it is of paramount importance for public health professionals to become aware of and involved in how our food is produced.”⁷⁰

By 2030, global meat production is expected to exceed 375 million tons.⁷¹

⁶⁷ Wing et al 2002

⁶⁸ Wing et al 2002

⁶⁹ Garnett 2010

⁷⁰ Walker et al 2005

⁷¹ Garnett 2010

The price of meat is relatively inexpensive in the United States compared with other countries, but the cheap meat Americans consume comes at the expense of the environment, economy, public health and global food security.⁷² According to World Watch Institute, “the world’s supersized appetite for meat is among the biggest reasons greenhouse gas emissions are still growing rapidly.”⁷³ In order to contend with food shortage and overpopulation, it is imperative to find solution and change in human diet to reduce the demand for industrially produced meat.

According to the United Nations Environment Programme (UNEP), the amount of corn and grain, including human-grade wheat and barley, grown worldwide in 2009 to feed livestock could sufficiently feed 3.5 billion people.⁷⁴ Currently the extreme contradiction we live with is that one billion people are overweight or obese and another one billion lack adequate food resources,” even though the rate of worldwide food production could “feed the 6.3 billion people on Earth if distributed equitably and based on a diet with only moderate amounts of animal products.”⁷⁵ This reality of first world CAFOs is at the root of the food imbalance found in [Third World] developing nations.

PUBLIC HEALTH

Workers in CAFOs can experience severe health problems such as bronchitis, respiratory distress, chronic obstructive airways disease, organic dust toxic syndrome, and interstitial lung disease.⁷⁶ The impact, in addition, extends far beyond occupational hazards for employees. Referring to another health issue one observer says, “Just as second-hand smoke affects not just

⁷² Pew Charitable Trusts 2008

⁷³ WorldWatch Institute: <http://www.worldwatch.org/global-meat-production-and-consumption-continue-rise-1>

⁷⁴ United Nations Environment Programme: http://www.unep.org/pdf/FoodCrisis_lores.pdf

⁷⁵ Walker et al 2005

⁷⁶ Hribar 2010

the smoker, but also impacts the health of those nearby, the process of producing cheap meat can cause health effects not only for workers, but also for their families and local community members.”⁷⁷ For example, “an infectious agent that originates at an IFAP facility may persist through meat processing and contaminate consumer food animal products, resulting in a serious disease outbreak far from the IFAP facility.”⁷⁸

Animal manure is the primary source of bacteria such as E Coli, which costs the United States approximately “\$405 million annually: \$370 million for deaths, \$30 million for medical care, and \$5 million for lost productivity.”⁷⁹ Public health concerns also include “heightened risks of pathogens (disease- and nondisease-causing) passed from animals to humans; the emergence of microbes resistant to antibiotics and antimicrobials, due in large part to widespread use of antimicrobials for nontherapeutic purposes; food-borne disease; worker health concerns; and dispersed impacts on the adjacent community at large.”⁸⁰

Direct Exposure/Risk to Workers and Nearby Communities

Maintaining massive quantities of animals in confined areas increases the potential for pathogen transfer from livestock to humans. Factory farm workers are often exposed to thousands of animals each day, including ones that are diseased, which increases risk of pathogen transfer.⁸¹

⁷⁷ Walker et al 2005

⁷⁸ Pew Charitable Trusts 2008

⁷⁹ Pew Charitable Trusts 2008

⁸⁰ Walker et al 2005

⁸¹ Pew Charitable Trusts 2008

CAFOs can also serve as hotspots to incubate new strains of infectious and transmissible agents, and to generate “novel viruses through mutation or recombinant events that could result in more efficient human-to-human transmission.”⁸² A contributing factor is that livestock may appear healthy or asymptomatic, while carrying microbial agents that harm humans. Asymptomatic animals can quickly “spread the infection to the community before it is discovered in the animal population.”⁸³ A prolific example is pfeisteria, a pathogen that is 1,000 times more poisonous than cyanide and is ranked as a level three biohazard by the Centers for Disease Control. In recent years, pfeisteria has killed more than a billion fish, from Long Island to the Florida Gulf.⁸⁴



Figure 4: Fish kill from pfeisteria epidemic⁸⁵

Pathogens & Antibiotic Resistant Infections -Antibiotic Resistant Bacteria

The Union of Concerned Scientists estimates that more than 70% of all antibiotics produced in the United States are used in industrial meat production. Many of these antibiotics are closely related to those used to treat infections in humans. Resistant strains of bacteria that develop in

⁸² Pew Charitable Trusts 2008

⁸³ Pew Charitable Trusts 2008

⁸⁴ Monson 2010

⁸⁵ Woods Hole Oceanographic Institution 2012

CAFO animals threaten the usefulness of these medicines in treating humans. In addition, 25–75% of antibiotics pass unchanged from feed to manure, creating significant risks to soil and water quality. In 1997, the World Health Organization recommended the end of non-therapeutic use of antibiotics in animal husbandry because resistant strains of human pathogens had been identified. In 2004, the American Public Health Association adopted Resolution 2004-13, ‘Helping Preserve Antibiotic Effectiveness by Stimulating Demand for Meats Produced without Excessive Antibiotics.’⁸⁶

Figure 5: Large Scale Swine Epidemic where carcasses are stacked next to water body ⁸⁷



Meat Diet Risks

Diets high in animal protein and saturated fat lead to higher risk of chronic diseases such as diabetes mellitus, cardiovascular disease, stroke, and some cancers – four of the leading causes of death in the U.S. In addition, the saturated fats found in meat protein “have no identified

⁸⁶ Walker et al 2005

⁸⁷ N.C. Riverkeepers & Waterkeepers Alliance

health benefits or minimum safe intake levels.”⁸⁸ In contrast, the American Dietetic Association states, “Vegetarian diets offer a number of nutritional benefits, including lower levels of saturated fat, cholesterol, and animal protein as well as higher levels of carbohydrates, fiber, magnesium, potassium, folate, and antioxidants such as vitamins C and E and phytochemicals.”⁸⁹

Ironically, even though we all know the old adage “we are what we eat,” studies show that the average physician received less than three hours of nutritional training during medical school.⁹⁰

The health risks associated with meat based diets are simply not a focal point of modern allopathic medicine, despite these glaring realities. As a result, many Americans are not sufficiently informed about the medical implications of meat centric diets.

Animal Welfare

Since the issue of meat production involves raising animals for human consumption, media attention of industrial meat production is sometimes focused on animal treatment and the realities of animal cruelty. Conditions in CAFOs can be detrimental to the health of livestock. Other countries have more stringent regulations governing animal welfare. In 1997, the Farm Animal Welfare Council (FAWC), an advisory board established by the British government, adopted a guideline for animal welfare that relies on “Five Freedoms” designed to protect animals from unnecessary suffering, including hunger, thirst, discomfort, pain, injury, disease, fear and distress, whether in a CAFO, during transit or at a slaughterhouse.⁹¹

⁸⁸ Walker et al 2005

⁸⁹ Walker et al 2005

⁹⁰ Robbins 1987

⁹¹ Farm Animal Welfare Council: <http://www.fawc.org.uk/freedoms.htm>

In CAFOs, it is common for swine to experience ruptured organs and abscesses, which often go untreated, leading to open sores and cannibalism from other hogs. Tail docking, ear clipping, and teeth cutting without anesthesia are an attempt to curb gnawing. Castration, which some producers contend creates better tasting meat, is also done without anesthesia. Electric prods keep animals at bay and sows are typically restrained in cramped “gestation” cages for breeding and feeding.⁹²

After visiting numerous CAFOs and conducting other research, The Pew Commission on Industrial Farm Animal Production stated that “the most intensive confinement systems, such as restrictive veal crates, hog gestation pens, restrictive farrowing crates, and battery cages for poultry, all prevent the animal from a normal range of movement and constitute inhumane treatment.”⁹³



Figure 6: Hogs in gestation crates in Swine CAFO⁹⁴

⁹² Monson 2010

⁹³ Pew Charitable Trusts 2008

⁹⁴ Cheeseman 2012

North Carolina CAFOs as a Case Study

North Carolina ranks second in swine production across the United States, and its AFOs density is greater than the Mid-West region.⁹⁵ Due to the proliferation of CAFOs in the state, there are more hogs than humans in North Carolina, with more than 9.5 million hogs raised for slaughter in 2012.⁹⁶ Due to climate change awareness, severe weather events, impacts on air and water quality, and other factors, there has been a significant increase in environmental impact awareness of these CAFOs. Yet, there has been [slow] progress in changing the legislation, demand for product, and public policy regarding CAFOs. In reality, the meat producing monopolies that own CAFOs in North Carolina are jeopardizing the environment, public health, economic vitality, outdoor recreation and overall quality of life. By damaging air and water quality in surrounding areas, the CAFOs appear to be preventing many citizens from peaceful enjoyment of their property. The impact is evident. For example, when traveling on Interstate 40 between Wilmington and Raleigh, North Carolina, it is commonly known that a putrid odor persists for approximately forty minutes of the 150-mile drive, which cuts through the dense industrial hog production facilities.

There are approximately 2,400 major swine facilities in North Carolina with the vast majority located in the southeastern coastal plain region of North Carolina, and in areas where many residents rely on wells for drinking water.⁹⁷ Due to the area's sand soils and high water tables, the likelihood of lagoon water melding with drinking water is significantly increased.⁹⁸

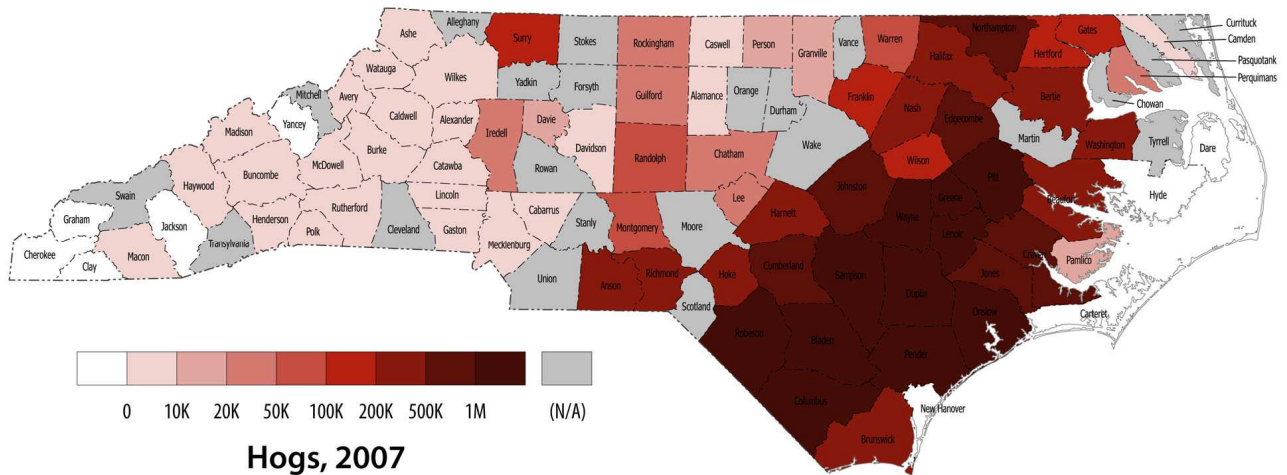
⁹⁵ Sang 2010

⁹⁶ Kudla 2008

⁹⁷ Wing et al 2002

⁹⁸ Sang 2010

Figure 7: Map shows Number of Hogs sold in NC in 2007⁹⁹



Over the last forty years, the hog industry in North Carolina has developed from smaller family farms to huge conglomerate factory farms managed under a few large corporations such as Smithfield Food, the world’s largest pork producer.¹⁰⁰ The majority of CAFO expansion began after 1991, when North Carolina Senator Wendell Murphy co-sponsored legislation that exempted hog farms from local zoning and environmental legislation, which opened the floodgates for hog waste. In 1992, Smithfield opened the world’s largest meat processing plant in Bladen County, NC. Today, 40-80,000 hogs per day meet their death in this single facility.¹⁰¹

Although North Carolina had “approximately 24,000 family farmers raising a little over 2,000,000 hogs”¹⁰² in the mid-1980s, things had changed dramatically by 2000, when “operations that had less than 100 head of hogs controlled less than 1 percent of the total inventory while the 1,500 operations with more than 1,000 hogs made up nearly 99 percent of

⁹⁹ University of North Carolina-Chapel Hill School of Education: Learn NC
<http://www.learnnc.org/lp/editions/nchist-recent/6257>

¹⁰⁰ Pfeiffer 2006

¹⁰¹ Sturgis 2009

¹⁰² N.C. Riverkeepers & Waterkeepers Alliance 2003

the inventory.” Such shift produced significant changes in management of hog waste and the environmental impact of hog farms.”¹⁰³

Now the state’s prolific hog industry produces millions of gallons of hog manure, which are typically stored in unlined open pit lagoons, and often sprayed on neighboring fields and pastures. Based upon a study of the University of North Carolina that compared hog to human waste, these hogs produce more fecal matter in Eastern North Carolina each day than is produced by all the citizens (combined) in the entire states of North Carolina, California, Pennsylvania, New York, Texas, New Hampshire, and North Dakota.¹⁰⁴ As a result, the stench in this region is often overpowering. In 1991, the floodgates of hog waste were opened when North Carolina Senator Wendell Murphy co-sponsored legislation that exempted hog farms from local zoning and environmental legislation. In 1992, Smithfield opened the world’s largest meat processing plant in Bladen County, NC. Today, 40-80,000 hogs per day meet their death in this single facility.¹⁰⁵

Aerial spraying intensifies the impact of these CAFOs. Manure black water is sprayed directly onto fields, contaminating well water, which may be directly linked to an increased number of North Carolinians suffering from bladder cancer and a range of neurological ailments as noted in the above text.¹⁰⁶ “Most North Carolina hog operations, which use waste pits that can contaminate groundwater, are located in areas with high dependence on well water for

¹⁰³ Kudla 2008

¹⁰⁴ NC Riverkeepers & Waterkeepers Alliance 2003

¹⁰⁵ Sturgis 2009

¹⁰⁶ Pew Charitable Trusts 2008

drinking.”¹⁰⁷ Like most environmental issues, the difficulty of dealing with CAFO impacts lies in the economics and the modus operandi of economic development.

Swine Flu epidemics of the late 90’s were traced back to Sampson County’s Hog Slat Inc. In addition, the latest H1N1 epidemic can also be traced to swine containment, which contaminates drinking supplies and the Cape Fear River. Thereafter, the river empties into the ocean, where millions of fish are killed off every year from these dead zones created by heavy nitrate concentrations and toxins like pfeisteria.¹⁰⁸

When North Carolina’s coastal plain floods - as was the case of Hurricane Floyd in 1999 - hog waste lagoons sometimes overflow, spilling millions of gallons of black water into streams and rivers. In 1995, lagoon failure spilled 22 million gallons into the New River, which is twice as large as the Exxon Valdez spill. Even when they are not flooded, hog lagoons are unlined and therefore leach into the groundwater table, contaminating wells and municipal supplies.¹⁰⁹



Figure 8: North Carolina Hog CAFO after a Hurricane Floyd 1999. Estimates of hog deaths in this flood ranged widely from 30,050(officially reported)-400,000¹¹⁰

¹⁰⁷ Kudla 2008

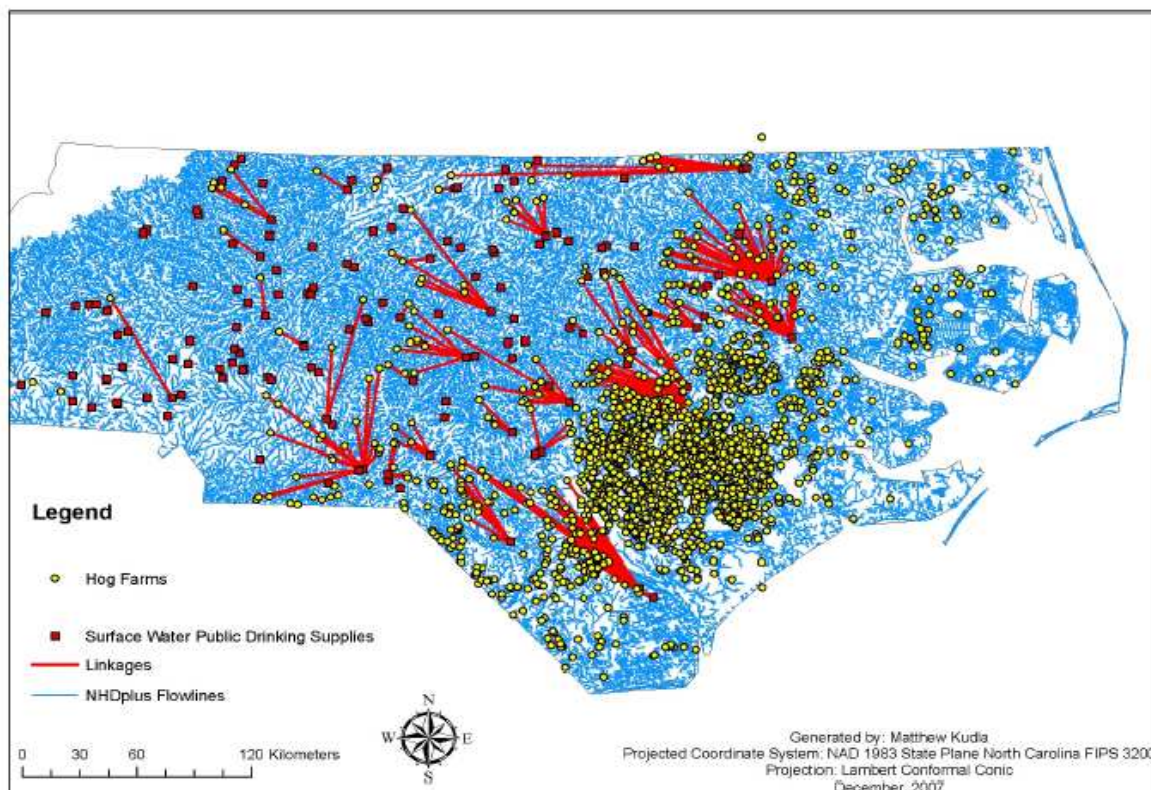
¹⁰⁸ Sturgis 2009

¹⁰⁹ Natural Resources Defense Council 2011

¹¹⁰ Socially Responsible Agriculture Project 2009

Hog CAFO groundwater has been contaminated by nitrates in North Carolina. This is a special concern considering the findings presented here, which show that approximately half of the hog CAFOs are located in block groups of the state where > 85% of households depend on well water for drinking.”¹¹¹ Cases of water contamination are not rare. In July, 2011, William B. Freedman, president of Freedman Farms, Inc. plead guilty in federal court in New Bern, N.C. to violating the Clean Water Act by discharging hog waste from a swine CAFO in Columbus County, NC directly into Browder’s Branch, a stream that leads to the Waccamaw River. “In this case, waste products from nearly five thousand hogs went directly into a sensitive wetland area, jeopardizing the safety and health of water and wildlife.”¹¹²

Figure 9: North Carolina Swine Operations and Downstream Drinking Water Supplies¹¹³



¹¹¹ Wing et al 2002

¹¹² U.S. Department of Justice 2011

¹¹³ Kudla 2008

Project Study

Hog CAFOs in North Carolina have gained a strong foothold, which I believe would not have happened if sufficient notification and information were available to citizenry and community leaders. From the above review, we can clearly conclude this is not an advisable situation or method of food production. It is a situation that I hypothesize would be altered, if there were increased understanding and awareness. I wanted to determine the level of understanding currently held. “From tree to sea,” our North Carolina coastal plain and our way of life are threatened. Hypoxia, dead zones, fish kills, pathogens, air, soil, and water contamination threaten our quality of life, economic vitality and environmental integrity. Public health, worker safety, real estate values, tourism dollars, and our community moral and ethical fiber are at stake. Environmental leadership change is imperative and to effect change, we must gauge awareness and willingness to act. I developed and used specific questions to gauge awareness of a population of individuals described below. The interview questions and criteria received Duke University Institutional Review Board (IRB) approval prior to my contacting and interacting with participants in the study. (See Appendix C)

Subject Selection

Participants in the study were selected based on their involvement and engagement with community based environmental management groups, along with a self-assessed level of environmental awareness. They all reside in the lower Cape Fear region of North Carolina, specifically in the southeastern coastal plain of the state. Local and regional leaders that were asked to participate may or may not have been environmentally aware and may or may not have had prior experience with or knowledge of these CAFO operations.

This project asks:

- 1) Are CAFOs understood as environmental “hotspots?”
- 2) What is the comprehensive environmental impact of CAFOs on ecosystem services?
- 3) What level of information will or can create change in environmental decision making by the individual and the policy maker

Methodology

Each subject participated in a survey/interview where I asked questions regarding that subject’s knowledge of the existence, practices, and impacts of CAFOs. The project focused on interviewing subjects regarding eating habits, and environmental impacts of CAFOs. The four categories of questions were: environmental awareness, political action and change, health and diet, and specifics of North Carolina hog farming operations. There were 15 citizens surveyed. All interviews were conducted over the telephone, or via email. I engaged “environmentally aware” citizenry in an attempt to assess the individual decision making processes of those that are prone to political action and/or environmental consciousness, and how it may affect change with regard to CAFOs.

Subject Research and Results

A dozen subjects were surveyed. Subjects rated themselves 5+ out of 10 for environmental awareness and only (2) rated themselves less than 7. Subjects rated health of family 8+ out of 10 with majority rating 10. Subjects rated the importance of environmental integrity 7+ with the exception of one, and 2/3 of participants rated North Carolina Air and Water Quality 5- on a scale of 1-10. In addition, ¼ of subjects were completely vegetarian, while 5/6 of participants

were willing to pay more for organically produced food. Subjects over 50 in age had not contacted a politician regarding any environmental issue. None of the subjects indicated political action regarding CAFOs. Half of subjects surveyed [grossly] underestimated the NC hog population. Only 50% of subjects accurately assessed contribution of family farms to food production in NC from multiple choices.

I have concluded that awareness of CAFO impacts was moderate to low from subjects in a region surrounded by hog CAFOs. Younger subjects were generally more informed regarding CAFOs and more politically active. “Hotspots” were thought of as [wi-fi] internet related, or areas of concentrated pollution, but not necessarily in terms of North Carolina hog CAFOs. Environmentally aware citizens are generally willing to spend more on healthy food, and on environmental integrity. Plus, the environmentally aware citizen subjects believe air and water quality in NC are poor, while political integrity is rated even lower. Although 120 surveys were sent to North Carolina State legislators, only one responded. From this I can only conclude that the hog CAFO situation is a political debacle that lawmakers don’t want to acknowledge.

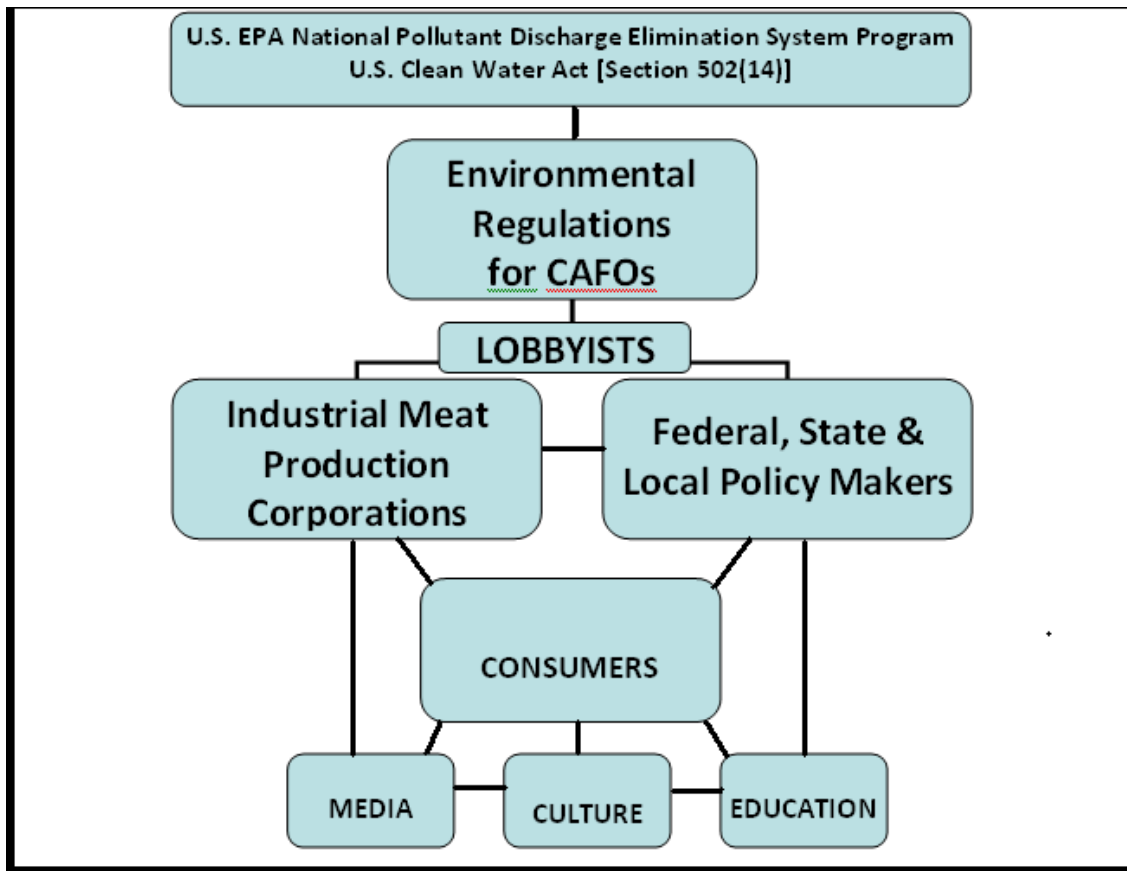


Figure 10: Media, Culture and Education are at the root and all are linked to consumers

Recommendations/Conclusions

Diet and humane treatment of animals are among the most sensitive topics to broach. Eating is an intimate act that sustains our lives and literally transforms the bodies and planet we inhabit. Animals have been a part of human life for millions of years, and in this country most households have at least one pet. Consequently our treatment of animals is a reflection of ourselves. These CAFO facilities remove the general populace of humans from the food they eat. The conditions of these facilities are harsh, cruel and septic. Even those that consider themselves environmentally aware, are lacking in knowledge of CAFOs and their effects, as there is little media coverage, and the interests of large corporations remain paramount.

Efforts of large-scale environmental awareness campaigns, from groups such as *Food and Water Watch*, or *Cape Fear River Watch* are imperative, and even (national and community-based) environmental groups like these seem to have difficulty getting to the root cause of choice or intentional decision making, and tend to focus on overall policy and mitigation efforts. In the course of this research I have found there are numerous solutions to help mitigate the impact of industrial meat production, ranging from policy changes requiring CAFOs to line and cap lagoons to methane recapture systems. These policies and programs are useful for the short term, which while extremely important, I believe secondary. Even if North Carolina got rid of every CAFO, these facilities would likely migrate to another [poor] community less diligent. In order to end the not in my back yard (NIMBY) attitude, energy and attention to the source is crucial in creating an informed citizenry.

Cutting consumer demand by encouraging more Americans to adopt healthier diets and refusing to consume corporate meat will have an enormous impact. Diminishing demand for higher impact species, like hogs and cattle, must occur in the short term nationwide. To improve public health in the United States and to establish a more equitable distribution of food among the world's populations, Americans must improve dietary choices and curb excessive meat consumption.¹¹⁴ In recent years, a growing number of Americans have adopted lifestyles that embrace veganism, vegetarianism, and thoughtful consumption. According to a study commissioned by the Vegetarian Times, more than 7 million Americans follow a vegetarian-based diet.

¹¹⁴ Pew Charitable Trusts 2008

In recent months, large food corporations like Compass Group, of Charlotte, North Carolina, and its subsidiary, Bon Appetit Management Company, have led the way in abolishing gestation crate methods for their suppliers. Whole Foods Market pioneered this effort in 2003, when it created a policy forbidding its pork suppliers to use gestation crates. Wendy's, Burger King, and McDonald's, the latter being the largest client to Smithfield Foods, have all proposed similar policies.¹¹⁵ Although the proposed changes are positive steps, the new restrictions against gestation crates will not likely be implemented for several years and they do not truly deal with the overall impact of CAFOs. Yet, when corporations take this kind of stance, in concert with promotion of the slow food movement and a reduction of consumer demand, needed change begins to occur. Environmental leaders must lead by example at every level to reach this tipping point.

Raising awareness and support for a return to family farms and the slow food movement in North Carolina is advised. Dependence on industrial meat production can be reduced by an increasing the number of farmer's markets and Community-Supported Agriculture (CSA) programs, which help bolster regional food security and strengthen local economies by connecting consumers directly with local farmers. In Southeastern North Carolina, Feast Down East is a non-profit founded by Dr. Leslie Hossfeld that connects rural farmers to buyers. Along with those types of efforts, developing more sustainable forms of agriculture will also diminish industrial meat production. For example, promoting sustainable poultry production and aquaculture is imperative for North Carolina. Rethinking the industrial agricultural system by establishing a fair and equitable distribution of proteins will help improve the public health, global food security and feed hungry populations around the world.

¹¹⁵ Cheeseman 2012

According to this study, it appears that raising awareness of impacts of CAFOs with citizens under 50 years of age may lead to increased political action. Direct education forums/media related to CAFO impacts on a community and statewide basis is advised for change to occur. Promotion of sustainable poultry and aquaculture may be critical in North Carolina. Linking biodiversity to the health of one's family and environmental integrity to ecosystem services in the mind of citizens could lead to necessary change.

This study illustrates a need for widespread greater understanding of the realities of CAFOs and of a connection between where food comes from and how it is produced in this country. Even those from affluent counties that are environmentally aware, and value their family's health and the outdoors, are woefully unaware. Tax payers must realize we are subsidizing this community and ecosystem degradation, and that these CAFO *hotspots* are of immediate concern. Environmental leadership must increase these activities that will reform policies and diminish demand. Ultimately, the stark realization that there are more hogs than humans in North Carolina, and a sincere understanding of the impact of CAFOs may be the impetus needed to instigate positive change in North Carolina and far beyond.

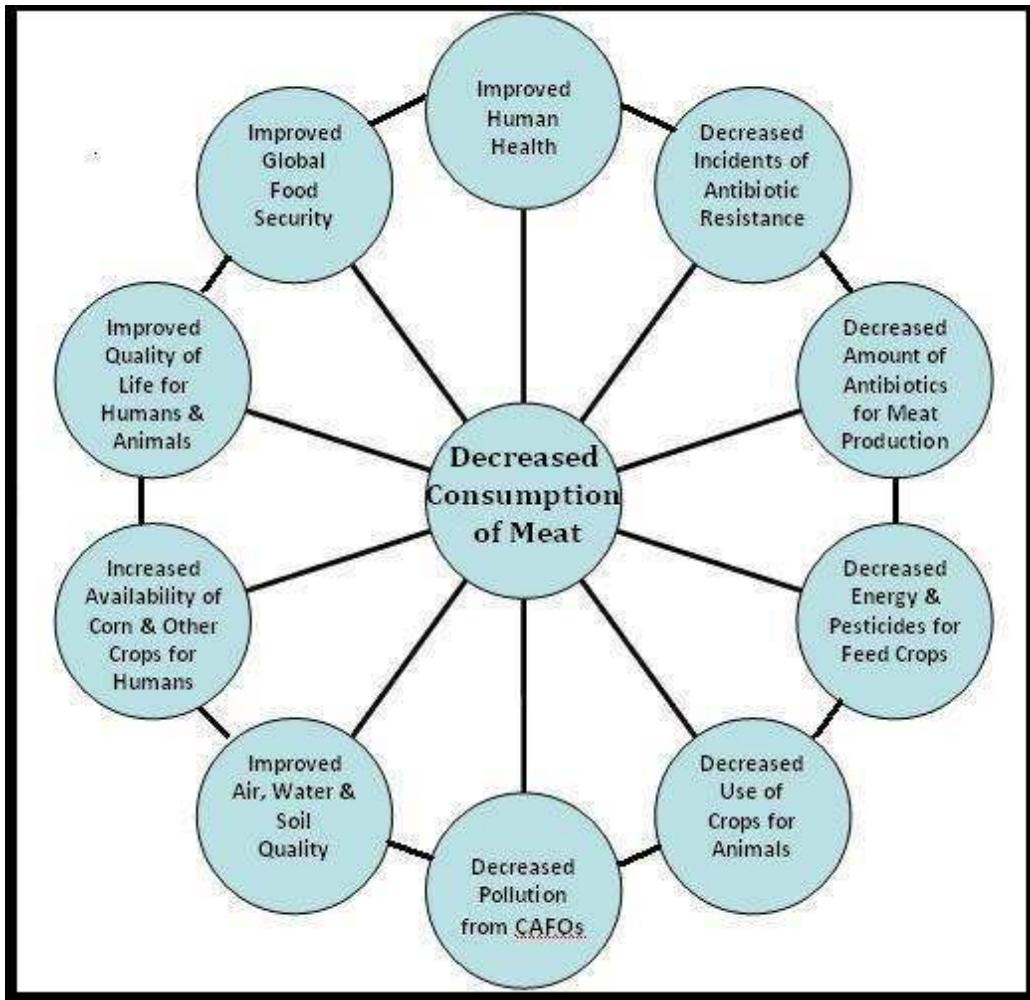


Figure 11: Decreased meat consumption is at the center of environmental and social equity and security

APPENDIX A

Animal Sector	Size Thresholds (number of animals)		
	Large CAFOs	Medium CAFOs ¹	Small CAFOs ²
cattle or cow/calf pairs	1,000 or more	300 - 999	less than 300
mature dairy cattle	700 or more	200 - 699	less than 200
veal calves	1,000 or more	300 - 999	less than 300
swine (weighing over 55 pounds)	2,500 or more	750 - 2,499	less than 750
swine (weighing less than 55 pounds)	10,000 or more	3,000 - 9,999	less than 3,000
horses	500 or more	150 - 499	less than 150
sheep or lambs	10,000 or more	3,000 - 9,999	less than 3,000
turkeys	55,000 or more	16,500 - 54,999	less than 16,500
laying hens or broilers (liquid manure handling systems)	30,000 or more	9,000 - 29,999	less than 9,000
chickens other than laying hens (other than a liquid manure handling systems)	125,000 or more	37,500 - 124,999	less than 37,500
laying hens (other than a liquid manure handling systems)	82,000 or more	25,000 - 81,999	less than 25,000
ducks (other than a liquid manure handling systems)	30,000 or more	10,000 - 29,999	less than 10,000
ducks (liquid manure handling systems)	5,000 or more	1,500 - 4,999	less than 1,500

¹ Must also meet one of two "method of discharge" criteria to be defined as a CAFO or may be designated.

² Never a CAFO by regulatory definition, but may be designated as a CAFO on a case-by-case basis.

Table 1: EPA Regulatory Definition of Large, Medium and Small CAFOs¹¹⁶

¹¹⁶ U.S. Environmental Protection Agency: http://www.epa.gov/npdes/pubs/sector_table.pdf

APPENDIX B

Table 2: Pollutants Found in Air Surrounding CAFOs, their source, traits and health risks¹¹⁷

CAFO Emissions	Source	Traits	Health Risks
Ammonia	Formed when microbes decompose undigested organic nitrogen compounds in manure	Colorless, sharp pungent odor	Respiratory irritant, chemical burns to the respiratory tract, skin, and eyes, severe cough, chronic lung disease
Hydrogen Sulfide	Anaerobic bacterial decomposition of protein and other sulfur containing organic matter	Odor of rotten eggs	Inflammation of the moist membranes of eye and respiratory tract, olfactory neuron loss, death
Methane	Microbial degradation of organic matter under anaerobic conditions	Colorless, odorless, highly flammable	No health risks. Is a greenhouse gas and contributes to climate change.
Particulate Matter	Feed, bedding materials, dry manure, unpaved soil surfaces, animal dander, poultry feathers	Comprised of fecal matter, feed materials, pollen, bacteria, fungi, skin cells, silicates	Chronic bronchitis, chronic respiratory symptoms, declines in lung function, organic dust toxic syndrome

¹¹⁷ Hribar 2010

APPENDIX C

Do **not** use this form if:

- you are an undergraduate; instead, go to: <http://ors.duke.edu/undergraduate-research>, or
- your research activities are limited to analysis of data collected by someone else; instead, go to <http://ors.duke.edu/Research-with-Human-Subjects/forms> for the “Secondary Analysis of Existing Data” form.

Check the type of review requested, or leave blank for IRB staff: Expedited Review Full Review

Submit this form and required attachments:

- Mail Parts A and B with original signatures to: Office of Research Support, Suite 710, Erwin Square, 2200 West Main Street, Durham, NC 27705.
- Send Parts A, B, your project description prepared using the instructions in Part C, and any appendices as **one** Word file by e-mail to ors-info@duke.edu.

Contents:

- A. Investigator and Project Information
- B. Investigator Assurances
- C. Instructions for Preparing Research Description and Appendices

A. Investigator and Project Information

Project Title: “CAFOs as Hotspots: Effect on Biome Cycles, Ecosystem Services and Environmental Decision Making”

Fill in one box below as appropriate.

Research by Faculty or Administrators

Investigator(s):

Faculty Administrator Other Research Staff: _____

Department/School: _____ E-mail: _____ Phone: _____

Research by Graduate Students, Post-Doctoral Researchers, and Their Advisors

Student/Fellow Investigator(s) **Saranam “Shar” Olivier**

Graduate Student [] Postdoctoral Fellow

Department/School: Nicholas School DEL-MEM

E-mail: sso3@duke.edu Phone: 910-352-9587

Faculty Advisor(s): **Dr. David E. Hinton**

Department/School: The Nicholas School
613-8038

E-mail: david.hinton@duke.edu Phone: 919-

Project Information:

1. Source of Funding:

NA

2. If Federally Funded, Proposal/Grant Number:

NA

3. Research Site:

NA

4. Will the research take place in public elementary or secondary schools? Yes No
If yes, are the schools in the Durham? Yes No

4. Potentially Vulnerable Subject Populations: Please check all that apply (if any).

Minors, as defined at research site (under 18 years old in NC)

Psychology and Neuroscience Undergraduate Subject Pool

Other Duke research subject pool. Please specify: _____

Students or employees of the researcher

Prisoners

B. Assurances (Original signatures are required for final approval.)

Section 1: Investigator(s) Assurance (Required for all researchers listed in *Part A, Investigator and Project Information*)

I affirm the following:

- a. The research will not be initiated until written approval is secured from the IRB. (**Note: Approval will not be provided unless certification to conduct research with human subjects is current for the investigator[s], and if the investigator is a student, the advisor’s certification is also current.**)
- b. I will conduct this study as described in the approved protocol. If any changes are anticipated, I will submit a *Request to Amend an Approved Protocol*, and I will not implement the changes until I receive approval from the IRB. I will contact the IRB staff immediately if any of the following events occur: unanticipated problems involving risks to subjects, protocol deviations, and findings during the study that would affect the risks participation in the study.

Investigator

2/17/12
Date

Section 2: Faculty Advisor:

I affirm that that I have read and approved the protocol, and I assume responsibility (1) for ensuring that student researchers are aware of their responsibilities as investigators, and (2) that the IRB will be immediately informed in the event of research-related unanticipated risks, protocol deviations, or findings during the study that would affect the risks of participation in the study.

Faculty Advisor

2/17/12
Date

FOR IRB USE ONLY

Approved as: Full [] Expedited []

APPROVAL: _____
IRB Member or Human Subjects Program Director **Date**

C. Instructions for Preparing the Request for Protocol Approval

Shar Olivier: “CAFOs as Hotspots: Effect on Biome Cycles, Ecosystem Services and Environmental Decision Making”

1. Research Design

Currently there are more hogs than humans in North Carolina, and other than Iowa, the most of any state in the Union. Due to the impacts of climate change awareness, severe weather events, impacts on air and water quality and acknowledgement at state government, local governments and citizen levels there has been a significant increase in environmental impact awareness of these Concentrated Animal Feedlot Operations (CAFOs). Despite this reality, there has been [slow] progress in changing the legislation, demand for product and public policy regarding CAFOs.

- 4) How are CAFOs understood as environmental “hotspots?”
- 5) What is the comprehensive environmental impact of CAFOs on biome cycles (i.e. water, carbon, nitrogen) and to ecosystem services?
- 6) What level of information will or can create change in environmental decision making of the individual and the policy maker?

Each subject will participate in a 30 minute survey/interview where the researcher will ask the subject questions regarding the subject’s knowledge of the existence, practices, and impacts of these operations. Some subjects may be asked for a follow-up interview for further clarification and will be communicated the possibly of a follow up interview during the initial interview. Please see appendix interview questions attached (Appendix C).

2. Subject Selection

Participants in the study will be selected based on their involvement and engagement with community based environmental management. Local and regional leaders may or may not be environmentally aware and may or may not have experience or knowledge of these operations.

The project will focus on interviewing citizens and key decision makers regarding eating habits, environmental awareness and environmental impacts of CAFOs. There will be approximately 50 citizens interviewed/surveyed and approximately 15 local leaders and politicians surveyed as well. All interviews will be conducted over the telephone, or via email. I plan to enroll “environmentally aware” citizenry in an attempt to assess the individual decision making process and how it may affect change with regard to CAFOs.

I will send the subjects an introductory email and follow up with a scheduled interview date and time.

Please see appendix introductory email attached (Appendix B).

3. Risks and Benefits

There is little to no risk and no individual benefit associated with participating in this study. Respondents' names will not be reported. We hope that a benefit will be increased understanding of the factors that influence consumers and policy makers regarding CAFOs and their impact on the environment.

All subjects will be given a copy of the final research Masters Project.

4. Confidentiality

Subject's identities will remain confidential, and they will be aware that I will collect and use their demographic information like gender, race, age etc. All data collected will be stored on my password-protected DEL-MEM laptop with no other specific storage or security protocol.

5. Compensation

NA

6. Informed Consent

Please see appendix consent form attached (Appendix A).

7. Deception

NA

8. Debriefing

NA

9. Appendices

A. Informed Consent Form

B. Email introducing research and information subject I will be scheduling a 30 minute survey/interview

C. Interview questions (these will be sent via email to subjects prior to the interview)

A. INFORMED CONSENT FORM

For Prospective Research Participants:

Please read this consent form carefully and ask as many questions as you like before you decide whether you want to participate in this research study. You are free to ask questions at any time before, during, or after your participation in this research.

PROJECT INFORMATION

Project Title: “CAFOs as Hotspots: Effect on Biome Cycles, Ecosystem Services and Environmental Decision Making”	Organization: Duke Univ., Nicholas School of Environment
Principal Investigator: Shar Olivier; shar.olivier@gmail.com	Phone: 910-352-9587
Location: Southeastern North Carolina	Other Investigators: None

PURPOSE OF THIS RESEARCH STUDY

You are being asked to participate in a research survey designed to better understand knowledge level and decision criteria used to assess impacts of Concentrated Animal Feeding Operations (CAFOs) or industrial animal farms. The study objectives include: 1) How are CAFOs understood as environmental “hotspots?” 2) What is the comprehensive environmental impact of CAFOs? 3) What level of information will or can create change in environmental decision making of the individual and the policy maker?

Although many existing studies expose the problems surrounding these operations, this study’s goal is to determine what factors or level of knowledge of the reality of issues must exist for elimination of the risks and impacts of these operations.

Information gathered in the survey is intended to contribute to research that will help decision makers and environmental managers mitigate negative impacts the problem(s) created by these operations.

PROCEDURES

You will be asked about your level of knowledge of these operations, their impacts and your decision making processes. The survey will take about 30 minutes. Please do not feel that you must learn any more than you know at this moment in order to participate. I am interested in learning what people already know about Concentrated Animal Feeding Operations.

USE OF THE RESEARCH MATERIAL

Your responses to the interview questions will be used in a research paper that is a requirement to complete a master’s degree in environmental management at Duke

University. I would also like to provide this paper to local/regional leaders as a recommendation on how to evaluate environmental impacts of these operations. I will be happy to send you a copy of my final report.

CONFIDENTIALITY

I would like to use your demographic information like age, gender, etc. I will not include your name in my report.

PARTICIPATION IS VOLUNTARY

You are free to choose whether or not to participate in this study. You are free to answer questions as briefly or in detail as you wish. You can decide to stop participating at any time.

FOR MORE INFORMATION

Please contact me, the Principal Investigator (contact information at the top of this form), and I will be happy to answer your questions. You may also contact my advisor with any questions or concerns: Dr. David E. Hinton, E-mail: david.hinton@duke.edu Phone: 919-613-8038. If you have questions about your rights as a research study participant, you may contact the Chair of the Human Subjects Committee at 919-684-3030.

If you would like to participate, please fill in the lines below. Please keep the second copy of this sheet so that you have this information.

Participant Name: (please print) _____

DATE: _____

Participant Signature: _____

B. RECRUITMENT E-MAIL

Recruitment will consist primarily of an initial email to several list serves of community based groups and to local/regional leaders. A follow-up communication to discuss the proposed structure of the research will take place once the subject has expressed interest in participating in the study.

Hello,

I am currently in the second year of a two-year graduate program at Duke University's Nicholas School of the Environment. My final master's project is focused on the environmental impacts of Concentrated Animal Feeding Operations (CAFOs) and individual impact in decision making and change.

I am writing to invite you to participate in an interview for my research. I'd like to understand what conditions or level of knowledge must exist to affect change in demand and policy surrounding these industrialized "farming" operations. Information gathered during the interview will be useful in informing leadership and decision makers as to level of public knowledge of these impacts and their role in affecting change.

If you would like to participate, please find attached the questions and I will schedule 30 minutes in the next 2 weeks for us to discuss these questions. Thank you for your time and please let me know if you have any questions.

I look forward to talking to you regarding your participation in the study.

With best regards,

Shar Olivier
DEL-MEM 2012
Duke Nicholas School of the Environment
910-352-9587

C. RESEARCH INSTRUMENTS

Interview Questions for CAFOs as Hotspots: Effect on Biome Cycles, Ecosystem Services and Environmental Decision Making

For Citizens

Please indicate your gender _____, age _____

1. How environmentally aware do you consider yourself on a scale of 1 to 10 with 10 being very environmentally aware? _____
2. When you hear the term “hotspot” what comes to mind?
3. Have you ever contacted a politician about an environmental issue?
Yes ____ No ____
4. If yes, what was the issue?
5. What in your life compels you to change your behavior?
6. How important on a scale on 1 to 10 with 10 being the most important is your family’s health? _____
7. How important is environmental integrity to you on a scale of 1 to 10 with 10 being the most important? _____
8. How willing are you to spend more money today on organic food as an investment in your health and that of the environment?
 - a. Very willing
 - b. Moderately willing
 - c. Unwilling
9. On a scale of 1 to 10, with 10 being ideal conditions, how “healthy” do you consider North Carolina’s:
 - a. Air quality _____
 - b. Water quality _____
 - c. Economic vitality _____
 - d. Political integrity _____
10. How many portions of meat do you eat daily? (1 portion = 3 ounces = the size of a deck of cards)
 - a. Never
 - b. A couple of times per week
 - c. One or two portions daily
 - d. Three or more portions daily
11. Do you think that’s above or below the national average?
12. When you were a child how many portions of meat did you eat daily?

- a. Never
 - b. A couple of times per week
 - c. One or two portions daily
 - d. Three or more portions daily
13. If the price of meat were higher, would you reduce the amount of meat you eat?
14. If the price was lower, would you eat more?
15. How often do you buy free-range eggs? _____
- a. Never
 - b. I only buy free-range eggs.
 - c. I only buy them if they are on sale at a discounted price.
 - d. I buy them more often than I buy other eggs.
 - e. I buy them occasionally, but less often than I buy other eggs.
 - f. I never buy free-range eggs.
16. Do you buy grass-fed beef?
- a. Never
 - b. I only buy grass-fed beef.
 - c. I only buy grass-fed beef if it is on sale at a discounted price.
 - d. I buy grass-fed beef more often than I buy other beef.
 - e. I buy grass-fed beef occasionally, but less often than other beef.
 - f. I never buy grass-fed beef.
17. Do you consider these factors important when purchasing meat?
- a. Healthy ingredients YES____ NO____
 - b. Minimal packaging YES____ NO____
 - c. Minimal processing YES____ NO____
 - d. Animal health & welfare YES____ NO____
 - e. Environmental impact of raising and producing the meat
YES____ NO____
 - f. Fair treatment and wages for workers involved in production
YES____ NO____
 - g. Whether animals received antibiotics and/or growth hormones.
YES____ NO____
18. How many hogs do you think are raised in NC?
19. Where do you think most of the hogs in NC are raised?
- a. Family farms _____
- OR
- b. Facilities affiliated with large corporations _____
20. If you eat pork, do you have any idea where the last pork you ate was produced?
21. Which of these issue(s) if any, do you consider important for meat producers:
- a. Livestock should have access to outdoor areas at all times.
YES____ NO____
 - b. Livestock should be fed a diet suitable for their digestive system.

- YES___ NO ___
- c. Livestock should not routinely receive antibiotics or hormones.
YES___ NO ___
- d. Animal waste, even if diluted, should not be sprayed into the air.
YES___ NO___
22. Based on your definition of “family farm,” what do you estimate as the percentage of hogs in NC that are raised on family farms?
- Almost 100% are raised on family farms. ____
 - 50 to 90 percent ____
 - 20 to 50 percent ____
 - Less than 20 percent ____
23. Do you any relatives/close friends who work on farms in North Carolina?
YES___ NO _____
24. If yes, what county(s) is the farm located?
25. Is the farm family-owned? YES___ NO___
26. How often do you shop at farmer’s markets?
- Never
 - Rarely
 - Several times a year
 - Several times a month
 - Weekly
27. Do you have any health problems such as diabetes or hypertension?
28. Do you think North Carolina politicians are doing a good job on these issues:
- Environmental protection YES___ NO ___
 - Economic development YES___ NO___
 - Educational improvements YES___ NO___
29. Do you think farms should have more___ OR less___ government regulations regarding how animals are raised for food production?
30. Would you approve___ or disapprove___ if money from a fund such as the North Carolina Lottery was used for environmental protection projects, if the purpose was clearly explained?
-

Politicians

31. Which environmental issue do you consider the most important one for NC at the current time.
 - a. Air quality
 - b. Water quality
 - c. Soil/beach erosion
 - d. Deforestation
32. Which environmental issue prompts the most concern from your constituents?
 - a. Air quality
 - b. Water quality
 - c. Soil/beach erosion
 - d. Deforestation
33. Regarding legislation that is designed to protect the environment, do you think NC is doing a better ____ OR worse ____ job than other states?
34. How many family-owned and operated farms are located in the area you represent?
 - a. Almost none
 - b. 10-30
 - c. 30-50
 - d. 50-100
 - e. 100 or more
35. Have you or your office ever received complaints about a family farm?
YES ____ NO ____
36. How were the complaints addressed?
 - a. Public hearing (i.e. City Council or Zoning Board meeting)
 - b. Private meetings with you, citizen and farmer
 - c. Legal proceedings
 - d. Written correspondence between you and citizen and/or farmer
 - e. Not addressed
37. How many CAFOs are in the area you represent?
 - a. Almost none
 - b. 10-30
 - c. 30-50
 - d. 50-100
 - e. 100 or more
38. Have you ever received any complaints regarding a CAFO?
39. If yes, how were the complaints addressed?
40. Have you ever visited a family farm in your area?
41. If yes, which one(s) and when?

42. Have you ever visited a CAFO in your area?
43. If yes, which one(s) and when?
44. Are you aware of any legislation under consideration regarding NC hog farms?
45. Do you think farms should have more____ OR less____ government regulations regarding how animals are raised for food production?

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WORKS CITED

Cahoon, L.B., S.H. Ensign (2004). "Spatial and Temporal Variability in Excessive Soil Phosphorus Levels in Eastern North Carolina." University of North Carolina: Wilmington. Department of Biological Science. Wilmington, NC

Cassuto, D.N. (2010). "CAFO Hothouse: Climate Change, Industrial Agriculture and the Law. Animals & Society Institute Policy Paper." Accessed Apr. 10, 2012 at <<http://ssrn.com/abstract=1646484>>.

Cheeseman, Gina-Marie. (2012, March 22). "Wendy's Requires Pork Suppliers to Phase Out Cruel Gestation Crates." Triple Pundit. Accessed Apr. 10, 2012 at <<http://www.triplepundit.com/2012/03/wendys-requires-pork-suppliers-phase-cruel-gestation-crates/>>.

Donham, K. J., S. Wing, D. Osterberg, J.L. Flora, C. Hodne, K.M. Thu, P.S. Thorne. (2007). "Community Health and Socioeconomic Issues Surrounding Concentrated Animal Feeding Operations." *Environmental Health Perspectives* 115:317–320.

Foer, J.S. (2009). "Eating Animals." Back Bay Books, New York.

Food and Water Watch. (2010). Factory Farm Map. Web. Accessed on Mar. 18, 2012 at <<http://www.factoryfarmmap.org>>.

Hribar, C. (2010). "Understanding Concentrated Animal Feeding Operations and Their Impact on Communities." National Association of Local Boards of Health.

Imhoff, D., D. Tompkins, R. Carra. (2010). "The CAFO Reader: The Tragedy of Industrial Animal Factories."

Iowa Legislature. (2011). Web. Accessed Apr. 10, 2012 at <<http://coolice.legis.state.ia.us/Cool-ICE/default.asp?Category=billinfo&Service=Billbook&menu=false&hbill=HF589>>.

Keim, B. (2012, Mar. 12). Mysterious Hog Farm Explosions Stump Scientists. *Wired Science*, Retrieved Apr. 10, 2012, from <<http://www.wired.com/wiredscience/2012/03/hog-manure-foam/>>.

Kudla, M. (2008). "Identification of Hog Farm Management Challenges in North Carolina." Duke University. Nicholas School of the Environment. Durham, NC.

Ladd, A., B. Edwards (2002). "Corporate Swine, Capitalist Pigs: A Decade of Environmental Injustice in North Carolina." *Social Justice* 29 (3): 26–46.

Learn NC. (2009) Web. University of North Carolina. Accessed Apr.10, 2012 at <<http://www.learnnc.org/lp/editions/nchist-recent/6257>>

MacDonald, J.M., W.D. McBride. (2009). "The transformation of United States livestock agriculture: Scale, efficiency, and risks." United States Department of Agriculture.

Monson, S. (2010). "Earthlings." Documentary. Nation Earth, Burbank CA.

Nellemann, C., MacDevette, M., Manders, T., Eickhout, B., Svihus, B., Prins, A. G., Kaltenborn, B. P. (2009). "The environmental food crisis – The environment's role in averting future food crises." United Nations Environment Programme. Accessed on Apr. 10, 2012 at http://www.unep.org/pdf/FoodCrisis_lores.pdf>.

North Carolina Riverkeepers & Waterkeeper Alliance. Web. Accessed Apr. 10, 2012 at <<http://riverlawus.com>>.

Natural Resources Defense Council. (2011). "Facts about Pollution from Livestock Farms." Web. Accessed Apr. 20, 2012 at <<http://www.nrdc.org/water/pollution/ffarms.asp>. 2011>.

Pew Charitable Trusts. (2008). "Putting Meat on the Table: Industrial Farm Animal Production in America." Pew Commission on Industrial Farm Animal Production.

Pfeiffer, D.A. (2006). "Eating Fossil Fuels: Oil, Food and the Coming Crisis in Agriculture." New Society Publishers, Canada.

Quadcities Citizens Against Triumph. (2009) Web. Accessed Apr. 25, 2012 at <<http://www.freewebs.com/qcatil/apps/photos/photo?photoid=43528032>>.

Raine, J. (1998). "Environmental Justice Issues of the North Carolina Swine Industry." Duke University. Nicholas School of the Environment. Durham, NC.

Reeder, R. (2012, Mar. 18). "Ag Gag Bill Raises Questions about Legislation's Legality." *Iowa State Daily*. Retrieved Apr. 10, 2012, from <http://iowastatedaily.com/news/article_f340fa68-7132-11e1-907d-0019bb2963f4.html>.

Reuters News Service. (2008, March 15). "Vegetarian Times Study Shows 7.3 Million Americans Are Vegetarians." Accessed Apr. 10, 2012 at <<http://www.reuters.com/article/2008/04/15/idUS145083+15-Apr-2008+PRN20080415>>.

Robbins, J. (1987). "Diet for a New America." Stillpoint Publishing, Canada.

Sang, R.L (2010). "Understanding Ammonia Emissions from Swine Animal Feeding Operations in North Carolina." North Carolina State University. Raleigh, NC.

Smithfield Foods. (2006) Web. Accessed Apr. 20, 2012 at <<http://www.smithfieldfoods.com/RollingStone/>>.

Socially Responsible Agriculture Project. (2009). Web. Retrieved Apr. 10, 2012 at <<http://www.sraproject.org>>.

Sturgis, Sue. (2009, May) "Swine Flu Genes Traced to North Carolina Factory Farm." Institute for Southern Studies. Accessed April 20, 2012 at <<http://www.southernstudies.org/2009/05/swine-flu-genes-traced-to-north-carolina-hog-farm.html>>.

United States Department of Justice. (2011). "North Carolina Corporate Hog Farm and President Plead Guilty to Violating the Clean Water Act." Accessed Apr. 10, 2012 at <<http://www.justice.gov/opa/pr/2011/July/11-enrd-891.html>>.

United States Environmental Protection Agency. (2011) Web. Accessed Apr. 10, 2012 at http://www.epa.gov/npdes/pubs/sector_table.pdf>.

United States Geological Survey. (2011). Web. Accessed Apr.10, 2012 at <<http://ga2.er.usgs.gov/edu/activity-water-content.cfm>>.

University of North Carolina-Chapel Hill School of Education: Learn NC (2009) Web. Accessed Apr. 10, 2012 at <<http://www.learnnc.org/lp/editions/nchist-recent/6257>>.

Walker, P., P. Rhubart-Berg, S. McKenzie, K. Kelling, R.S. Lawrence. (2005). "Public Health Implications of Meat Production and Consumption." *Public Health Nutrition*: 8(4), 348–356. Johns Hopkins Bloomberg School of Public Health, Center for a Livable Future, Baltimore, MD

Wing, S., D. Cole, G. Grant. (2000). "Environmental Injustice in North Carolina's Hog Industry." *Environmental Health Perspectives* 108(3):225–231.

Woods Hole Oceanographic Institution. (2012). Web. Accessed Apr. 20, 2012 at <<http://Whoi.edu>>.

Worldwatch Institute. (2011). Web. Accessed Apr. 10, 2012 at <<http://www.worldwatch.org/global-meat-production-and-consumption-continue-rise-1>>.