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Genetically Modified Salmon and the Future of Food: A Qualitative Content Analysis of Twitter

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GENETICALLY MODIFIED SALMON AND THE FUTURE OF FOOD: A QUALITATIVE CONTENT ANALYSIS OF TWITTER

by

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ABSTRACT

This dissertation is a qualitative content analysis of the ongoing online debate on Twitter regarding the AquAdvantage Salmon™, the first genetically engineered animal, fish, and meat product approved by the FDA for sale and consumption in the US. On Twitter, Topics can be discussed by any account user creating a public sphere and forum of discussion. In a time when the anthropogenic impacts on the environment are observable and at times detrimental, it remains in question how we will produce our food; this study problematizes whether or not genetic engineering is the solution and the future of our food, and ultimately questions human mastery rhetoric. Qualitative content analysis was used to assess who the active stakeholder groups are in the conversation on Twitter, their goals and objectives, the sentiment of their messages, the type of conversation (original, conversational, or disseminative), the sentiment of attached links, the sentiment of any embedded visual content; and message themes. Findings indicated the active stakeholder groups on Twitter are: the producers of AA salmon; public citizens; scientists; organizations; news media; food and agriculture groups; yet, policy makers, like the FDA, entrusted with making laws surrounding AquAdvantage Salmon™

are absent from the discussion. The salmon itself does not have a voice in the Twitter conversation and is presented as a commodity to be sold or as a stock for monetary gain, a solution to food insecurity, or a blasphemous “Frankenfish”.

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Chapter One: Introduction

In an era of inequitable health distribution and food insecurity, what direction should the food system take to ensure the basic needs of all citizens are met? The US food system and methods of food production post-WWII have been characterized by industrialization and technology, with the ideology of advancement, increased production, and implied accompaniment of wealth, bounty, and food for all (Clausen & Longo, 2012; Plumwood, 2003). Alongside this commodification discourse of industrialized agriculture comes agricultural technological advances, making it difficult to track and comprehend all of the technology currently used in US agricultural production--progress unchecked and imbalanced (McLeod, Grice, Campbell, & Herleth, 2006). This research will couch its exploration into agricultural technological advances in a genetically engineered salmon, the AquAdvantage salmon (AA salmon), found in online communication on Twitter. Twitter was selected as it is a dynamic and active public forum where those engaged and those with a stake in the outcome can create or add to conversations, dialogue, share, and debate their opinions and concerns. This research is timely since genetic modification, although ubiquitous among US fruits and vegetables, has never been approved and produced in an animal meant for US consumption as food. The findings of this study may help to reveal through observation of communication on Twitter whether stakeholders desire such a food, who the stakeholders involved in the discussion are, and how all vested parties may move forward in dialogue and reach consensus on how the AA Salmon should be raised, bought, and sold.

This chapter provides a discussion of the pros and cons of genetic modification, a problem statement and research goals, the context of AA salmon, a theoretical and methodological overview, an introduction to the stakeholders involved, as well as defining terms relevant to the research study.

The possible pros and cons of genetic modification of food is where this story begins. Samuel Johnson's *Idler* No. 88 (1759) hypothesized a time when society would be idyllic and all of our needs met through innovative technological advancement, as many have and still do:

> When the philosophers of the last age were first congregated into the Royal Society, great expectations were raised of the sudden progress of useful arts; the time was supposed to be near when engines should turn by a perpetual motion, and health be secured by the universal medicine; when learning should be facilitated by a real character, and commerce extended by ships which could easily reach their ports in defiance of the tempest.
>
> But improvement is naturally slow. The society met and parted without any visible diminution of the miseries of life. The gout and stone were still painful, the ground that was not plowed brought forth no harvest, and neither oranges nor grapes would grow upon the hawthorn. At last, those who were disappointed began to be angry; those likewise who hated innovation were glad to gain an opportunity of ridiculing men who had depreciated, perhaps with too much arrogance, the knowledge of antiquity.

The future of food has arrived, whether slow or rapid, it is not 1759 and we have seen modern technology impress us with facial recognition software, self-driving cars,

and industrialized food production methods like genetic modification. This research, will focus on the biotechnological trends of genetic modification of food, but could also be applied in other arenas where the awe of technological innovation, and all it promises, could and should be critically investigated and called into question. We are living in an era of acceptance of tech magic, often without questioning consequence.

The Pros and Cons of Genetic Modification

In a food system driven by supply and demand, demand can outstrip supply, as in the case of salmon. Overfishing, environmental degradation, and pollution have led to the decline and endangerment of wild salmon (Aerni, 2004; Le Curieux-Belfond et al., 2008; McLeod et al., 2006), and aquaculture salmon farms have not solved the problem (Clausen & Longo, 2012). A genetically modified salmon, the AquAdvantage has been invented to solve the problem of demand by providing a salmon that gets to market nearly twice as fast, using less feed (Aerni, 2004; Le Curieux-Belfond et al., 2008). In general, proponents of genetic modification and similar technologies have proposed that the use of genetic modification of food will increase production and yield thereby supplying the increasing global population (save the world discourse), improve desired customer characteristics of food (a tomato that turns red faster and stays ripe longer, or is nutritionally enhanced), lower the cost of food, decrease harmful agricultural practices, and have additional environmental benefits (due to decreases in herbicide and pesticide use) (Grunert, Lahteenmaki, Nielsen, Poulsen, Ueland, & Astrom, 2000); and the AA salmon provides some of these promised benefits or advantages. Objections to the use of genetic modification consist of possible risk of harm to human health from consumption, environmental risk, a consumer's right to choose, a generalized objection to the methods

used in industrialized agriculture, and possible global socio-economic implications of use (Grunert et al., 2000; Schramm, 2007). There is also a 'middle ground' of acceptance, areas that exist between proponents and opponents, dependent on the application of the technology: genetically modified plants are more acceptable than animals, and medical use is more acceptable than food (Grunert, 2000).

Problem Statement and Research Goals

It is important to assess stakeholder groups and attitudes about the AA salmon as it swims up to the plate; no study to date has assessed this, particularly in the US using a social media platform like Twitter. Since the AA salmon is not yet being sold in US markets this study could also aid in gauging stakeholder positions on debated topics like the labeling of genetically modified foods. Proponents and opponents of the AA salmon and technology used to produce it, and the myriad between, may affiliate with one of the following stakeholder groups identified in the relevant research: the producers of the technology, scientists researching and publishing about the technology, the lay public, the policy makers enacting laws regarding genetic modification, and the news media who publish stories about GMOs. Potential disagreements existing between stakeholder groups the literature identified are: a distrust of policymaker's agendas, the public and citizen's need to dispel possible risk (Cook et al., 2006), scientists' inability to communicate and create dialogue with those among the population they are doing research for, i.e. the public citizenry (Devos et al., 2008), fears surrounding the manufacture of an 'unnatural' genetically engineered food (Blancke et al., 2015), and the problematic discourse surrounding the commodification of an animal as a food resource (Escobar, 1999; Plumwood, 2003; Clausen & Longo, 2012; Packwood Freeman, Beckoff,

& Bexell, 2011). There must be a mutual and respectful dialogue surrounding controversial societal issues like GMOs in order for the technology to move forward, be accepted, and understood (Bhatta & Misra, 2016, Clark & Lehman, 2001, Gerasimova, 2016, Wales & Mythen, 2002); a contribution this study wishes to address.

This research focuses on the conversation on Twitter surrounding a genetically modified salmon, the AquAdvantage Salmon (AA Salmon), as it is the only genetically modified animal that the US Food and Drug Administration has approved for sale and consumption but has yet to be publically bought and sold. Twitter was chosen because of its micro-blogging style content, anyone can engage on this platform, 69% of Americans use social media, and 25% use Twitter (Pew Research Center, Social Media Fact Sheet, 2018). This research looked at Twitter posts, or tweets, about AA Salmon and determined whether the Twitter accounts affiliate with a particular stakeholder group or viewpoint (the public, policymakers, producers, scientists, and news media), parsed out the ways meaning and opinions were constructed, assessed each person or group's basic messages to one another (communication between groups/inter-group communication), and analyzed their intended goals and outcomes. Like many technologies there may be cause for concern, evaluation, and explanation of risk, and acknowledgment of the public's concern. Listening and responding, through actions such as labeling GMOs may be ways to assuage fears surrounding GMOs. As Ulrich Beck said, (quoted in Wales & Mythen, 2002, pp. 126), it is, "…imperative that the social and political relations of definitions which support risk negotiation become more democratic: that all affected parties are equally recognized and are enabled to either participate or be represented effectively in risk dialogue."

The goals of this research are to find a common ground between varying perspectives so that discursive space and mutual dialogue can be achieved thereby meeting the needs of all parties involved. Additional goals are to achieve transparency of agenda, message, and goals of each person or group, and to assess if the goal of communication is one of improvement to human social, economic, health, and environmental conditions. Another goal of this research is to give voice to the lesser empowered parties in the debate: the citizens, and their right to choose what to eat and buy, and advocate on behalf of the salmon itself.

My research will look at the online discourse on Twitter surrounding the AquAdvantage salmon to assess the communicative strategies of participants and groups, their message, and find overarching themes in the controversial discussion. Previous research on GMOs has largely found the scientific community opposed to the lay public regarding GMOs, and the media's role as interpreter of science to the public; to date, no research has addressed the online Twitter discussion, and only one US study been conducted on consumer acceptance of the AA salmon (Qin & Brown, 2006), therefore this study is timely since its arrival in US grocery stores is pending and fast approaching.

Context of AquAdvantage Salmon

The producers of AquAdvantage Salmon, Aquabounty Technologies, describe it as, "The world's most sustainable salmon". Developed in 1989, laboratory scientists combined the genes of a Chinook salmon and an ocean pout eel into those of an Atlantic salmon to make it grow faster with less feed and tolerate freezing temperatures (Aerni, 2004; Le Curieux-Belfond, Vandelac, Caron, & Seralini, 2008). Advocates state that the fish has many advantages over its non-genetically modified cousins: enhanced ability to

assimilate food (AA salmon grow 400-600% faster), reproductive control (AA salmon are all infertile females), disease resistance, environmental tolerance (temperature resistance, ability to grow indoors without streams or oceans), and reduction of environmental impact (Aerni, 2004; Le Curieux-Belfond et al., 2008). Concerns revolve around: the environmental impact of a potential escapee salmon into wild populations (Curieux-Belfond et al., 2008; McLeod et al., 2006); farmed fish are denied their instinctual migratory patterns (Clausen & Longo, 2012); waste, pollution, and disease are rampant in aquaculture facilities (Aerni, 2004; Curieux-Belfond et al., 2008; McLeod et al., 2006); research is incomplete and some studies have shown higher allergic responses to GM foods (McLeod, 2006; Powers, 2003); long-term health effects of consuming GM food are unknown. The US Food and Drug Administration (FDA) approved the sale of AA salmon November 19th, 2015, twenty-six years after its invention, under the classification as a "New Animal Drug", and it is the first genetically modified animal approved for human consumption (FDA, 2015). Although Canadian citizens have been purchasing AA salmon in grocery stores since mid-2017, the US has restricted its sale, requiring AquaBounty to spend $100,000.00 to research and develop appropriate labeling (Agdaily, 2017).

Stakeholders

The debate over GMOs has been typified as "The scientists think and the public feel" (Cook, Pieri, & Robbins, 2004). Although perhaps an oversimplification, this is how the news media portrays the "battle" between stakeholders (Augoustinos, Crabb, & Shepherd, 2010). Gerasimova (2016) also found very little dialogue, or any attempt to reach a common ground, has occurred among opponents and proponents, as both sides

were found to be opposed and unable to hear the other side's arguments, or divisive. A dialogue between stakeholders has been suggested as a path forward and method to merge these diametrically opposed viewpoints. To this end, Bhatta & Misra (2016) propose communication strategies to make biotechnology acceptable, understandable, and accessible using a contextual model that is symmetrical in power, and has a two-way path of information from scientists to public using deliberate and intentional framing of the technology. In order for dialogue to occur, two ideological cultures identified by Maeseele (2015): that of 'unproblematized scientific consensus', which impedes democratic debate and defends the status quo, and another ideology that facilitates democratic debate by challenging assumptions, values, and interests and questions scientific certainty, must find consensus.

The lay public, or the average citizen, are classified as, "…unscientific, self-defeating, and elitist" (Schramm, 2007); uniformly opposed and irrational (Augoustinos, Crabb, & Shepherd, 2010); uneducated, unscientific, and irrational (Cook, Pieri, & Robbins, 2004). However, are they really that way? When interviewed, members of the public saw themselves as involved in a debate weighing cost and benefit, questioning moral justification, economic costs, who benefits from the use of this technology, how the technology is currently and will be controlled in the future, its safety, and aesthetic concerns (Cook, Pieri, & Robbins, 2004). Whereas scientists viewed themselves and their research as objective, empirical, and infallible (Cook, Pieri, & Robbins, 2004). In another study of public opinion, Marris (2001) discovered that the public opinion of GMOs was nuanced and were in support under certain circumstances, wanted reassurance

that health and environmental risks were controlled, and that the science may lack proper regulatory authority.

The media has been depicted as the intermediary interpreter and disseminator of scientific findings to that of the public. The media frames GMOs as a risk conflict, divided into either "unproblematized scientific consensus" or a questioning of science and encouraging of debate, as this may encourage more readership (Maeseele, 2015). The media employs various discursive frames: scientific achievement/progress/modernization (Lockie, 2006; Maeseele, 2015; Motion & Weaver, 2005); agricultural revolution/food security (Casaus, 2010; Lockie, 2006); anti-science irrationalism (Augoustinos, Crabb, & Shepherd, 2010; Cook, Robbins, & Pieri, 2006; Lockie, 2006); moral and environmental conflict (Howarth, 2013; Lockie, 2006); mistrust of government and corporate interests (Augoustinos, Crabb, & Shepherd, 2010; Cook, Robbins, & Pieri, 2006; Howarth, 2013); a war, battle, or stalemate (Cook, Robbins, & Pieri, 2006; Howarth, 2013; Hughes, 2007); hegemony and power (Hughes, 2007; Motion & Weaver, 2005); organic foods as natural, GMO foods as unnatural or conventional (Casaus, 2010; Lockie, 2006); and health and environmental risk (Casaus, 2010; Lockie, 2006).

Another stakeholder involved in the debate is that of the policy makers. Researchers have investigated risk and trust surrounding policy creation and the citizenry's involvement (Clark & Lehman, 2001; Maeseele, 2015; Wales & Mythen, 2002). A GMO is considered a manufactured risk and is distinguished from natural hazards because they are humanly created, illimitable in time and space, uninsurable, and potentially catastrophic, and we rely on policy makers to enact laws that are protective of

the populous, regarding possible risks, manufactured or inherent (Wales & Mythen, 2002). Similarly, Clark & Lehman (2001) assert that there is a scarcity of evidence evaluating the risk of GMOs to health and environment and question the science behind "substantial equivalence" (FDA, 1992), a term used by the FDA regarding GMOs to state they are substantially equivalent to their genetic forefathers, as a "dubious argument by analogy" and that it is poorly defined and unjustified.

And what of the fish itself, as a stakeholder? The genetically engineered salmon, the AquAdvantage salmon, in animal rights circles, is being subject to mistreatment and considered a commodity, much like many factory-farmed animals, instead of as an animal with rights to humane treatment and living conditions (Glenn, 2004; Mak & Longley, 2010). If this is to remain unchecked, as the future of our food, then we may see in our future the same emergent problems we see in aquaculture and factory farming, such as pollution, antibiotic use, and inhumane living conditions.

In sum, the literature portrays stakeholders as divided. The public and scientists are usually positioned as opposed regarding GMOs. Rarely is there a gray area, spectrum of opinion, or middle ground, and this opposition devolves into a stalemate, battleground, or heated spousal argument between the rational, educated, scientists and the irrational, inflammatory, uneducated public (Augoustinos, Crabb, & Shepherd, 2010; Cook, Pieri, & Robbins, 2004; Lockie, 2006, Wales & Mythen, 2002). However, many articles assert that there is a lack of dialogue or democratic debate between stakeholders (Bhatta & Misra, 2016, Cook, Pieri, & Robbins, 2004) and therefore, a need for conversation. Yet still, many of the public's concerns are logical and remain unaddressed by scientific

research (Cook, Pieri, & Robbins, 2004; Clark, & Lehman, 2001; Marris, 2001; Wales & Mythen, 2002).

Theoretical and Methodological Overview

This study will be a qualitative content analysis of the discussion of AA Salmon found on Twitter. Using a qualitative content analysis approach that combines tenets used in thematic analysis, a grounded approach to discourse analysis, and select linguistic elements, the Twitter discussion of AA salmon from 2015-2018 was analyzed. Content analysis screened the posts for elements being discussed: their purpose (share information or persuade), the prospective sentiment of the individual or organization posting (pro, con, or neutral), how engaged the individual or organization is in the discussion, any demographic data on the individual or organization posting including if they are affiliated with a particular stakeholder group, and a sentiment-based assessment of any hyperlinks and visual material.

Theoretical Overview

Communication theories do inform my work and research process, although care will be taken to reduce these biases in the development of themes and frames contained within each stakeholder group, as recommended by Emerson, Fretz, and Shaw (2011). Below I will concisely outline a few theoretical lenses that may prove useful that can be categorized into three areas: social constructivist theories, theories pertaining to media and its transmission, and critical environmental theorists. Social constructionists believe that meaning is defined through social interaction, or that we, as a society, come to knowledge through communicated construction of meaning. Delia and colleagues

proposed Constructivism, a social constructivist theory that pertains to message construction, whereby we categorize, interpret, and make meaning out of our world by categorizing it into constructs. Constructivism draws in perspectives, message complexity, and opinion making (Littlejohn & Foss, 2011). Another theory of social construction I draw from is Groupthink Theory by Irving Janis (as cited by Littlejohn & Foss, 2011, pp. 281-283). Groupthink specifically addresses how stakeholder groups come to believe and behave in similar ways, even if detrimental to the group.

From media transmission theories I draw from theories that explain how messages are constructed and received. In particular, Beacco, Claudel, Doury, Petit, & Reboul-Toure's (2002) extension of Moriand's *Didactic Transmission,* that describes message transmission being filtered, then received, to arterial transmission where the message is intertextual, polyphonic, and plurilogal. Agenda Setting, especially as Shaw & McCombs postulated, may explain how news stories gain popular attention and also can contort our opinion through 'gatekeeping' or intentionally withholding certain pieces of the full story to sway others toward an opinion. Although not a theory associated with media, Diffusion of Innovation (Rogers, 1962/2008) also applies to acceptance or rejection, however usually to technological innovations, which the AA salmon may be viewed as among those engaging with the online Twitter discussion.

Critical environmental theories provide reflexive intermingling of thought and analysis that enrich this research, and particularly Escobar's theory of *Technonature*, Plumwood's thoughts on *insturmentalization*, and Clausen and Longo's *Tragedy of the Commodity* (Clausen & Longo, 2012; Escobar, 1999; Plumwood, 2003). Technonature can be applied as the AA salmon is often viewed as a technological innovation to serve

the human need for food and sustenance, and therefore not an animal to be treated humanely (Escobar, 1999) and could also be combined alongside Diffusion of Innovation (Rogers, 1962/2008). Instrumentalization is in line with this perspective as it questions whether nature, particularly animals, are being viewed as only valuable in their uses for humans (Plumwood, 2003). The tragedy of the commodity proposes that the human valuation of a commodity (in this case salmon) prizes the monetary value and efficiency of production over environmental impacts and ecosystem effects (Clausen & Longo, 2012). The critical theoretical lineage in sum may prove a valuable lens as it draws in underlying tensions of power, capitalism, and control.

Methodological Overview

I conducted a content analysis to describe and quantify the data: the users, the tweets themselves, links to other websites and articles found on the internet, and any visual information. Then an open coding method described and detailed in Elo & Kyngäs (2008) for qualitative content analysis was inductively conducted to create categories and frames to assist in theory creation through abstraction. The process will be described in more detail in the methodology section and was wed with the discourse analysis approaches described briefly here. To complement and delve deeper into the qualitative side of content analysis, I drew from elements of thematic analysis, and grounded discourse analysis, outlined below.

Thematic analysis, as outlined by Braun and Clarke (2006), is a constructivist method of qualitative research that generates themes, or observable patterns, from a corpus of data to make sense of the underlying, often unspoken, meanings being made

(shared/rejected, spoken/unspoken) by various stakeholders. This data driven approach can yield results that land outside of predictable results or researcher driven biases.

Emerson, Fretz, and Shaw (2011) propose a similar approach to coding data. Their coding steps are like Braun and Clarke's (2006) but also offer additional areas to focus on in the coding process such as formulation (how concepts are formulated and explained), stories (narrations intentionally recounted), contexts and contrasts (what the context of the utterance was and what may differ in another's experience or utterance), terms, types, and typologies (the language used to express meaning and perspectives), and explanations and theories (an attempt to find the objective or purpose for message communication).

Definition of Terms

This section will outline some of the most commonly referenced terms in this study. Since this study utilizes elements of discourse analysis then the meaning of words is paramount. It is first ethical that I state how they are commonly used and how I perceive them, and second, necessary to define a meaning for these terms as they will be used in this study. Defining terms serves as a baseline for their possible intertextual fluidity among the multiple agents of discourse observed in the data.

Genetically Modified Organism (GMO). — A GMO is an organism whose genes (DNA) have been altered in a way that cannot be reproduced naturally (by mating or natural recombination) (WHO, 2016). "Genetically modified organisms (GMOs), also known as 'biotechnology,' 'biotech,' or 'agbiotech,' remains a relatively new and untested technological development in methods of agricultural production. GMOs are

'crops contain[ing] specific gene sequences artificially inserted into their genome" (Schramm, 2007).

Genetically Modified Food. – Same as above substituting "organism" with "food". (WHOb, 2016)

Transgenic. —Another term for a GMO that refers to the actual genetic transfer of the DNA of one organism into the DNA of another organism.

Genetic Engineering. — is defined as "…the development and manufacture of GMOs, can exponentially accelerate the development of new crop varieties (compared to traditional methods of crop breeding) to exhibit desired traits such as resistance to diseases, pests, pesticides, herbicides, drought, and other environmental conditions. GE varieties of major staple crops such as corn, potatoes, rice, and soy are already in widespread use, particularly in the United States, Canada, and Argentina" (Schramm, 2007, p. 98). GE is the same process as a GMO. Genetic engineering is taking place in both plant and animal species.

(in-vitro) Recombinant DNA (rDNA). —Simplistically, rDNA is when one strand of DNA from one organism is combined with that of another. It is sometimes also referred to as a "chimera" or molecular cloning (Kuure-Kinsey & McCooey, 2000).

Biotechnology. —Coined in 1917 by Karl Ereky to describe a large scale feedlot of pigs, the term today is applied broadly to mean anything from selective breeding to DNA alteration. For this paper the term 'biotechnology' will be used to refer to the use of recombinant DNA (rDNA) where the genes of one organism have been inserted into another organism's genetic code (Rodemeyer, 2001).

Bioengineering.. — Modification of the genetic code of a plant or animal in a scientific laboratory.

Traditional Breeding Techniques. —The practice of selecting specific valuable traits or characteristics to cultivate plants and animals exhibiting the best traits, such as saving seeds from a productive plant, or breeding the finest cattle (Rodemeyer, 2001).

Hybridization. —The practice of breeding two genetically dissimilar plant species with valuable contrasting characteristics (through cross-pollination) over the course of several generations; may produce higher yields or organisms that are resistant to disease (Rodemeyer, 2001). Many gardeners and farmers recognize that the disadvantage to hybrid seeds is that they do not produce true the second generation, which increases dependency on seed producers.

For the purposes of this paper biotechnology, bioengineering, genetic engineering, genetically modified, and transgenic will be used interchangeably to refer to the same process of recombining genetic DNA from one organism to influence the genetic outcomes of another.

Summary

In this chapter I have articulated and introduced the context in which the AA salmon is situated, my rationale and purpose for conducting this research, and the proposed methodology and theories that will be used to find out the underlying objectives of those involved in the online Twitter discussion. This study is being undertaken to clarify the discourse, meaning, and stories being woven by online discourse on Twitter among groups and individuals participating in the Twitter colloquy that pertain, describe, and ascribe meaning to a genetically engineered salmon (the AA salmon). Possible

stakeholder groups identified from previous literature are: the public, the producers, the policy makers/governmental agencies making decisions, scientists researching the AA salmon, and news media engaging in the debate. It is hoped that through a process of decoding Twitter messages between and among stakeholder groups a dialogue can be composed that is egalitarian and democratic, and that voice, agency, and power will be given to the public citizenry and the AquAdvantage salmon. In addition, this study hopes to advance the agenda of labeling genetically modified food so that the American consumer has the ability to choose what foods they wish to purchase and eat.

The next chapter contains a detailed context for the study, and a comprehensive review of the relevant research literature to frame the proposed study and research questions.

Chapter Two: Literature Review

Genetically modified foods were introduced to the US food system in the 1990s, and since have become ubiquitous (FDA, 2018). It is estimated that 60-70% of processed food found in American grocery stores contain some genetically modified food ingredient (Hallman, Hebden, Cuite, Aquino, & Lang, 2004). In 2012, 93% of all soybean planted, and 88% of all corn, in the US was genetically modified (FDA, 2015). Genetic modification, or engineering, is done in a laboratory and selects and isolates a genetic trait from one organism and inserts it into the genetic code of another organism. It can occur between species, or even between the animal and plant phylas and kingdoms (FDA, 2015; Rodemeyer, 2001). Genetic modification differs from selective breeding practices because it requires the precise manipulation of organisms at the molecular and genetic level (recombinant DNA), whereas selective breeding occurs when one selects the best tomato to save seeds or the prize cattle to breed (Rodemeyer, 2001). Recombinant DNA technology (GMO) is accomplished by either: one, cutting the genes of one organism and inserting them into another using biochemical "scissors" and bacterial replication; two, using a "gene gun" to inject micro projectiles of the genetic isolate into a plant's tissue; or three, "hitchhiking" into the plants genetic code via bacterial infection (Rodemeyer, 2001). Sax (2017) argues that all of our food is technically genetically modified since years of selection has created domesticated plants and animals through conventional breeding practices. However, such selection was imprecise as it did not allow the individuals breeding and selecting privy into the exact genes that turned on or off the desired trait or characteristic, and took many generations of selection in order for the characteristic to be reliably exhibited (Rodemeyer, 2001). I uphold that recombinant

DNA or genetic modification of plants and animals is entirely different from selective breeding, as it requires direct manipulation of the genetic code, does not require sexual reproduction, and is not limited to members of the same species/phyla/kingdom (Rodemeyer, 2001).

> It is precisely because the technology is so potentially powerful and capable of novel uses that a number of issues have been raised. These include concerns about the safety of food made from genetically modified plants and animals and concerns about the impact on the environment, as well as the ethical and moral implications of the technology (Rodemeyer, 2001, p. 9).

Strangely enough, the process of genetic modification is akin to the science fiction tale found in Mary Shelley's Frankenstein. The process, in plants at least, involves first the identification and isolation of a desired trait (Rodemeyer, 2001). After isolation of the genetic construct it is cut out using "biochemical scissors" or what are known as a 'restriction enzyme', then copies of the gene are made by inserting the gene into bacteria to replicate (Rodemeyer, 2001). These copies are inserted into the DNA of another organism either using a "gene gun" that shoots 'microprojectiles' coated with the gene into the tissue of the organism, or the gene piggybacks on a "soil bacterium that infects plants" to allow the genetic code to implant itself into the chromosome of the other plant (Rodemeyer, 2001). The process of genetic modification can occur from species that originate in different biological kingdoms (such as from animal to plant).

Outline of Chapter

In this chapter I detail the context of the study and review the relevant literature. An outline of this chapter is presented here:

I. Context of the Aquadvantage Salmon

II. Context of Labeling GMOs

III. Ideological Position

IV. Theoretical Underpinnings

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- A. Social Science Research on Twitter
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Context of the AquAdvantage Salmon

To quote Bredahl (1999), the difference between a genetically modified organism and selective breeding methods is not so black and white; "Most scientists regard the new genetic modification techniques as a natural extension of traditional breeding methods. It is even argued that genetic modification is safer than traditional breeding techniques because of the tight control by the authorities in this area…" (p. 343). Where then does resistance arise regarding a transgenic salmon who has the growth hormone gene of a Chinook salmon and a promoter sequence from an ocean pout eel, to prevent the fish from freezing (Aerni, 2004; Le Curieux-Belfond, Vandelac, Caron, & Seralini, 2008)?

Escobar's term technonature (1999) includes the technology of genetic modification and recombinant transgenic foods, such as AquAdvantage salmon. These are examples of "biology under control", the control of humans, who are creating "radical biological alterity", and from this place of control it is justified to 'modify' fish to serve human purposes—to take advantage of the AquAdvantage. Some hyperbolic advantages of the transgenic fish (for humans) are the increased ability to assimilate food, sexual and reproductive control, disease resistance, improved environmental tolerance, behavioral modification, and reduction of environmental impact (Le Curieux-Belfond et al., 2008).

AquAdvantage salmon have many advantages. AquAdvantage fish grow 400-600% faster than their ancestors, Atlantic salmon, and with 25% less feed (Aerni, 2004). Reproduction is controlled as all AquAdvantage salmon are purported to be infertile females (Aerni, 2004). The process of reproductive control involves several

steps: chromosomal manipulation, masculinizing females with hormones to produce fertile eggs with all female offspring, and pressure and temperature applied to the eggs yielding a triploid (three sets of chromosomes incapable of reproduction) (Aerni, 2004). The first step is failsafe, the success of triploidy introduction is not guaranteed. Its assurance requires personnel, or a person, to manually check that each fish is a triploid, therefore if the producer sells salmon eggs to a customer their triploid state is not certain (Aerni, 2004). Although AquaBounty, the producers of AquAdvantage salmon, have taken precautionary measures to ensure the infertility of the fish and, in addition, raise them inland in tanks far from their habitable environs; what are the possible environmental ramifications if these insurances and protocol are not properly followed? What would happen if a 'reproductively viable' AquAdvantage salmon swam his or her way into 'the wild'?

This concern has been considered as escapees of salmon farms are not uncommon (McLeod, Grice, Campbell, & Herleth, 2006). One possibility if a genetically engineered salmon were to swim its way into wild populations is termed the Trojan Gene Effect, where regardless of reproductive viability, the 'biggest fish in the sea' may be the most attractive to potential mates, and will exhibit spawning behavior attracting female mates who would have otherwise mated with reproductively viable salmon, slowly causing the extinction of salmon, who are already endangered (McLeod et al., 2006; Reichhardt, 2000; & van Aken, 2000). On the flipside, the logic is that the fish are not reproductively viable, are hatched and grown in inland facilities, so the likelihood that they would cause any reduction to the wild salmon population is unlikely.

Although little is known about what the actual environmental impacts of transgenic salmon on 'wild' habitats would be, we know that it would be irreversible (Curieux-Belfond et al., 2008). The hatchery salmon designed to increase the 'wild' salmon populations actually decreased the biodiversity of wild species because they lack genetic variation, and after inbreeding, have decreased the wild population's genetic fitness, i.e. the ability to survive (Curieux-Belfond et al., 2008). As Aerni (2004) states, "…it is not possible to predict the evolutionary consequences of potential introgression of transgenes on the evolutionary future of a natural population. Experience gathered from the conventionally bred farmed salmon on the aquatic environment also remains inconclusive" (p. 334); the impact of a reproductively viable transgenic salmon among 'wild' populations is unknown (Curieux-Belfond et al., 2008).

Aquaculture refers to the process of industrially farming ocean species, as opposed to commercial fishing or fishing in open waters. The Blue Revolution was named after the Green Revolution and both have similar goals—to increase food production using technological innovation. Unfortunately, Aquaculture and the Blue Revolution have created more environmental complications than resolving social or economic problems (Aerni, 2004; Goubau, 2011). The Blue Revolution and their goals, alongside with the Green Revolution, were products of the post-WWII era agricultural movements, termed "Fordist" Food Regimes, in which the goal was to increase food production, efficiency, decrease costs, and have enough food for future generations through the use of industrial advances and technology (McLeod et al., 2006).

Farmed salmon are denied their instinctual migratory patterns and are forced to live, and grow, in tanks for their entire lifespan (Clausen & Longo, 2012). Salmon and shrimp are the most common industrially farmed fish in aquaculture (Goubau, 2011). Salmon are the second most consumed fish, following tuna; 60% of all farmed fish are salmon; 90% of the salmon purchased and eaten worldwide are farmed salmon; farmed salmon are the most profitable aquaculture product (Clausen & Longo, 2012; Le Curieux-Belfond et al., 2008). This may in part be due to their nutritionally beneficial qualities, as salmon have been touted to deliver high quantities of omega 3 fatty acids, also coined a 'virtuous' commodity for its many health benefits (McLeod et al., 2006).

One of the initial purposes behind the industrial production of fish was to make the 'wild' populations so abundant that there would be no need to protect their habitats (in these 'wild' populations 95% of Coho salmon and 70-80% of spring/summer Chinook salmon are released from hatcheries) (Clausen & Longo, 2012). However, hatchery efforts failed to protect the wild salmon population and have had the unintended effect of being instrumental in their decline and endangered species status (Clausen & Longo, 2012). Which, according to the World Wildlife Federation and the Atlantic Salmon Federation, wild salmon populations are endangered (Le Curieux-Belfond et al., 2008). Wild salmon populations are in decline not necessarily due to overfishing, or even the fish canning industry, but more so due to habitat degradation and destruction through the 'commodification of the landscape', such as the building of hydroelectric dams in rivers that served as wild salmon migration routes (Clausen & Longo, 2012). Additionally, the waste, pollution, and disease produced by aquaculture are another reason for the decline of wild salmon populations (Le Curieux-Belfond et

al., 2008; McLeod et al., 2006). Environmental problems linked to industrial fish production of aquaculture include polluted waters discharged into oceans and streams, "the destruction of wetlands and mangroves, dispersion of chemicals and nutrients, and soil salinization" (Aerni, 2004, p. 329).

Weiss wrote for the L.A. Times of farmed salmon (2002):

> If you bought a salmon fillet in the supermarket recently or ordered one in a restaurant, chances are it was born in a plastic tray here, or in a place just like it. Instead of streaking through the ocean or leaping up rocky streams, it spent three years like a marine couch potato, circling lazily in pens, fattening up on pellets of salmon chow. It was vaccinated as a small fry to survive the diseases that race through these oceanic feedlots, acres of net-covered pens tethered offshore. It was likely dosed with antibiotics to ward off infection or fed pesticides to shed a beard of bloodsucking sea lice. For the rich, pink hue, the fish was given a steady diet of synthetic pigment. Without it, the flesh of these caged salmon would be an unappetizing pale grey.

This commodity driven mentality or "commodity culture" has been "justified by a dominant human-centered ideology of mastery over an inferior sphere of animals and nature. It is this ideology that is expressed in economies that treat commodity animals reductively as less than they are, as a mere human resource, little more than living meat or egg production units", i.e. instrumentalization (Plumwood, 2003, p. 1). Clausen & Longo (2012) further this notion as the 'tragedy of the commodity', as opposed to the long held notion of the 'tragedy of the commons', in their investigation into AquAdvantage salmon. "The tragedy of the commodity posits that capitalist markets

must continually increase the economic efficiency of commodity production to meet the ever present need for growth and profit accumulation. This focus on efficiency of commodity production alone marginalizes the needs of natural ecosystems and fishing communities" (p. 230) but Clausen & Longo (2012) wonder if the paradox is actually that the increased production may in fact increase demand.

Similarly, Glenn (2004) confirmed in their study that factory farm animal discourse was used to affirm human-centric uses of animals: as a resource, for production, commodification, and consumption. Indeed, salmon has been considered a gourmet food item, not a pedestrian or everyday food product, and has been referenced as a 'virtuous' commodity, as it has healthy and beneficial properties such as high quantities of Omega-3 fatty acids (McLeod et al., 2006). Glenn (2004) proposes that the factory farming production discourse uses 'Doublespeak', a misleading, ambiguous, or disingenuous language, a doublespeak also found in the terms 'aquaculture' and the 'green revolution' themselves, or even 'virtuous commodity'.

AquaBounty Technologies, Inc. 'designed' AquAdvantage to increase world food security and decrease production and environmental costs (AquaBounty Technologies, 2013). As stated on their homepage (http://www.aquabounty.com/) AquaBounty's mission is to "…play a significant part in the 'Blue Revolution' – bringing together biological sciences and molecular technology to enable an aquaculture industry capable of large-scale, efficient, an environmentally sustainable production of high quality seafood…" –but will it serve these ends?

Salmon are carnivorous fish. Salmon farmers use about 1.2-1.4 kilograms of pellet feed per each kilogram of salmon produced. The pellets are composed of 4-5

kilograms of fresh fish or shellfish, often sardines or herring, that could be eaten by humans instead to increase food security. The conversion rate and the cost accrued to feed a carnivorous fish like salmon is not sustainable (Le Curieux-Belfond et al., 2008, p.172). Additionally, questions arise about the sustainability of the use of fossil fuels in the production and transportation of the AA salmon eggs from their origin in Canada to the farm in Panama, and eventually to purchasers, wherever they may be (Clausen & Longo, 2012). The question becomes—if a larger salmon is commercially produced, faster, and uses less food than an average salmon; does this actually translate into improved quality of life for humans, the environment, or the salmon? (Stibbe, 2012).

When the US Food and Drug Administration (FDA) approved the sale of AquAdvantage salmon, the first genetically modified animal for human consumption in US markets, it was classified as a "New Animal Drug", and still is (FDA, 2015). A "New Animal Drug" is defined as, "…any drug intended for use in animals other than man, including any drug intended for use in animal feed but not including the animal feed, the composition of which is such that the drug is not generally recognized as safe and effective for the use under the conditions prescribed, recommended, or suggest in the labeling of the drug" (21 U.S.C. § 321(v)) (FDA, 2012c). The definition implies that the altered genetic characteristics have changed the salmon into a drug, no longer an animal and has been criticized as an unsuitable framework to certify safety for human consumption in light of its innovative and novel technology (Goubau, 2011). The basis for the certification that AA Salmon are safe for the environment and human consumption is grounded in the analogy of "substantial equivalence", meaning the genes of the AA Salmon are substantially equivalent to the DNA of their predecessors

and are therefore safe (FDA, 1992).

AquaBounty, the sponsor, applied under the New Animal Drug Application (NADA), and furnished the data to prove the safety of AquAdvantage salmon (Aerni, 2004; FDA, 2012a). The rulings set now by the FDA will apply to all fish derived from the AquAdvantage lineage (Aerni, 2004). Therefore, the burden of affirming that AquAdvantage salmon are safe, for our environment and our consumption, rests with the FDA, and AquaBounty Technologies since they are tasked with providing documents that prove AA salmon are safe for consumption (Aerni, 2004). Using documents furnished by AquaBounty, the FDA conducted an Environmental Assessment (EA) and approved the sale of AquAdvantage salmon on November 19th, 2015 (FDA, 2015). In 2017, the US government passed an additional law requiring AquaBounty to spend $100,000.00 researching and employing appropriate labeling on the GE salmon and has restricted sale until this requirement is met. In Canada however, you may now buy AquAdvantage at the grocery store, unlabeled (Agdaily, 2017).

Context of Labeling GMOs

Through the Nutrition Labeling and Education Act of 1990, consumers were conferred information about what processes, inputs, ingredients, and nutrition were used and are contained in the production of their food, but only some ingredients and processes require labeling. Foods such as alcohol and genetically modified foods are currently exempt from required labeling. Consumer ability to understand and choose foods based on the production methods used are obscured by lack of transparent labeling system, and at times consumers may not know, understand, or question what processes were used in food production (such as in the case of genetic engineering). Our food

system already requires the use of many labels and labeling requirements for each, such as: nutrition labels for vitamins and essential/nonessential nutrients, the inclusion of allergens, the inclusion of potentially harmful additives (sulfites, preservatives, coloring agents), organic/pesticide free, the use of the term "natural" in food labels (etc.), and other voluntary labels like "kosher" or "vegan". The governmental bodies responsible for these policies, the FDA and USDA state that GM foods do not alter the final food product in a genetically significant way and therefore cannot impact one's health ("substantial equivalence") (FDA, 1992). However, many American citizens believe the research is incomplete, and some studies have shown that certain genetic modifications have led to heightened allergic responses (McLeod, 2006; Powers, 2003). Allergies are on the rise, and it is imperative to label all foods that may cause or increase allergic responses in individuals, so that those sensitive to food allergies can choose the product that would best impact their health outcomes.

On July 7th 2016 the National Bioengineered Food Disclosure Act passed and was signed into law requiring mandatory labeling of all genetically modified foods (Davis, 2017; Kerner, 2017). Although the law was vague in requirements and penalties, the current presidential administration has expressed a desire to repeal the law (Davis, 2017; Kerner, 2017). The law will be enacted two years after passage and has proposed labeling using either words/text (such as, "Genetically Modified"), a symbol (like an infinity symbol), or a scannable barcode (QR code) (Prentice, 2016). Some worry this may be unclear and exclusive since only those using smart phones, and have a desire to take the extra step to look up the information will have access to the information. The new federal bill also will require the federal government to set standards to define a food,

good, or product as bioengineered, previously not standardized, and labeled; and will go into effect two years after approval, approximately July 2018 (Dinan, 2016), and enforced in 2020.

How the foods will be labeled is a matter of contention. Critics are concerned that the law is not comprehensive enough allowing foods produced using GM corn syrup and soybean oil (typically refined foods) to avoid carrying the label, and the label may not be easily understood, if in the barcode format, by the average consumer (Dinan, 2016). What the bill proposes to label, as a genetically modified food, is also ambiguous. News sources report that foods modified using in vitro recombinant deoxyribonucleic acid (rDNA) methods or a food that could not be replicated through "natural" methods will be labeled (Strom, 2016). The law defines a genetically modified food, or "Bioengineering…and any similar term…" as, "(A) that contains genetic material that has been modified through in vitro recombinant deoxyribonucleic acid (DNA) techniques; and (B) for which the modification could not otherwise be obtained through conventional breeding or found in nature" (S. 764-1). But an article on Agri-Pulse by Brasher (2016) states that this is meant to protect the biotech industry, "The language is intended to ensure that techniques such as RNA interference and gene editing would be exempt, according to sources". The law states that "the most predominant ingredient of the food will be independently subjected to the labeling requirements"; "the most predominant ingredient of the food is broth, stock, water, or a similar solution; and (ii) the second-most predominant ingredient of the food would independently be subject to the labeling requirements…" (S. 764-2). This to mean that the first and second ingredients will be considered independently of the other ingredients and subject to

labeling. This definition and label will not apply to "…a food where derived from an animal to be considered a bioengineered food solely because the animal consumed feed produced from, containing, or consisting of a bioengineered substance" and that the Secretary of Agriculture will establish a mandatory standard that will "determine the amounts of a bioengineered substance that may be present in food, as appropriate in order for the food to be a bioengineered food…" or how much of a certain food (percentage) would be permissible under the law to not be a GMO yet not require labeling (S. 764-2).

In the European Union laws prevent the importation of GM foods higher than 0.9% of any individual ingredient contained in the food (Weighardt, 2006). There is difficulty to identify a GMO, at a given percentage, and the complexity of the science behind confirming its existence at a given level (Weighardt, 2006). Weighardt (2006) lists many technical problems beginning first with how to constitute a 0.9% level at the molecular level when genes have been modified, if the 0.9% constituted by weight, intraspecies variation of nuclear DNA content, diploid organisms could have both modified homozygous or heterozygous genes, and last that the ploidy of the tissue could vary to become tetraploid or polyploidy. In the US, the FDA and USDA monitor different foods; consequently, meat is under the purview of the USDA (Federal Meat Inspection Act; Poultry Products Inspection Act; and the Egg Products Inspection Act) while other foods, including genetically modified salmon, are under the purview of the FDA (The Federal Food, Drug, and Cosmetic Act); yet the law states that the Secretary of Agriculture will oversee the implementation of the law (S. 764). In other words, how a GMO food or ingredient is quantified and regulated is hard to discern, and is further complicated by which governing body will regulate it.

Ideological Position

All researchers come to their studies with biases. We choose our topics because they relate to our interests and our passions. It is in this section that I will outline my theoretical assumptions, guiding principles, and reasons for choosing this topic and subject.

I must first state there are value laden ecological principles guiding my investigation. My perspective is fivefold. First, I believe that we must move toward a more egalitarian view of our world that is ecocentric, valuing all beings, one that challenges the human/nature binary, the dominant anthropocentric perspective (Plumwood, 1996). Second, I believe there is inherent value in all beings, even those 'manufactured' by humans, that transgenic animals, such as the AquAdvantage salmon, are not machines created to supply the commodity demands of humans, that we are ethically intertwined with the future of these animals, and the future of our food (Escobar, 1999; Plumwood, 2003; Clausen & Longo, 2012; Packwood Freeman, Beckoff, & Bexell, 2011). Third, the discourse we use to talk about our world matters. It constructs ideologies, our social fabric, our culture, influences praxis, politics, and policy (Carbaugh, 1996; Marafiote & Plec, 2006; Stibbe, 2012; Rogers, 1998; Merchant, 1996). Fourth, what we do outside to our environment is reflected internally in our *invironment*, this inside/outside separated by our individual thought and seemingly impermeable skin is false; we are sick if our environment is sick (Bell, 2004). And fifth, collaboration is necessary for change. In order to change our society, it is not enough to analyze discourse. We must offer new ways of thinking and existing; ways that collaboratively cross borders and create overlaps between the scientific producer

discourse, the decision-making and regulatory policy discourse, the questioning and often critical public discourse, and the silenced voice of the animal (Peterson, Peterson, & Peterson, 2007). We must learn to tactfully cross these boundaries, creating a Venn diagram of discourse where we can collaboratively converse. If we are all a part of the future, then we should all be a part of the discussion that leads us there, and in order to speak about it, we must also listen (Carbaugh & Boromisza-Habashi, 2011).

As Carbaugh (1996) states, "…communication helps cultivate particular ways of living as natural. Through everyday practices of communication, people everywhere cultivate ways of being placed with nature, in it, as it, ways of being within the natural realm." We are nature, we are natural—humans are animals, transgenic fish are animals. It is important to remember and include, humans in the definition of animals, if we imagine we are separate we risk 'othering' (Stibbe, 2012), and relegating animals to beasts and elevating humans to civilized. Stibbe (2012) encourages us to adopt and promote *alternative discourses* that do not destroy the ecosystems we are intrinsically a part of, but support them.

Plumwood's (2003) theory of *Ecological Animalism* could be one such alternative discourse as it recognizes that humans are not the dominant animal, but a part of an interconnected web, a reciprocal relationship where we too become food for other animals. Another alternative discourse, that of the deep ecology movement, which also recognizes the interconnectedness of all life and that the exclusion, subjugation, and disenfranchisement of one creature impacts all ecology (Macy & Brown, 1998).

Milstein (2007) suggests that in order to change the dominant discursive structures of our society we must critically and self-reflexively deconstruct our own language. Although there are multiple existent discourses, the English language typically reflects the 'mastery discourse' or humans' dominance over animals, referring to animals as 'it' and in a manner that does not connote agency, and serves to promote speciesism. When we reference and label an animal as 'transgenic' and a 'new animal drug' it reflects and reifies this 'mastery discourse'. At times, other discourses may arise, such as the 'stewardship discourse', where humans care for and are responsible for animals, and the 'mutuality discourse', where humans relate with animals reciprocally (Milstein, 2007). As we take up this call to develop alternative discourses towards animals, Packwood-Freeman et al. (2011) imply that all sentient beings deserve respect and ethical treatment especially as they cannot speak for themselves.

The animal science discourse instrumentalizes animals, turning them into units and products, that are measured and sold (Croney & Reynnells, 2008; Plumwood, 2003). Croney & Reynnells (2008) state that this scientific discourse actually conflicts with the public's general opinion that animals have value aside from their uses. The public discourse, although not considered to be grounded in hard researched facts, may actually be the most significant (Bredahl, 1999). The public support of 'consumers' for genetically modified foods is actually necessary for the continued propagation of these products (Bredahl, 1999). Every time you buy a food product you implicitly or explicitly consent to the treatment of that animal or food through your purchase (Stibbe, 2012). The implication is that the purchasing power is in the hands of the consumer, and therefore the market success of the AA salmon will be measured in dollars. Importantly,

we must continue to reflect on the questions that still exist surrounding a laboratory generated salmon: are animals sentient beings, conscious, with neurological feelings, and are we morally responsible to advocate on their behalf; since they cannot advocate for themselves?

By looking into the multiple discourses used to 'talk' about the AquAdvantage salmon this paper may shed light on some of the relevant questions in the environmental communication literature: Are AquAdvantage salmon an example of essentialized animals or 'others' that are only here to serve our purposes, i.e. food? Does AquAdvantage salmon represent an instrumentalized animal, an instrument that serves only one purpose: ours? (Plumwood, 2003; Plumwood, 1997). Do AquAdvantage salmon have value beyond their marketability? This study will continue these discussions through investigating these questions through Twitter dialogue on AA Salmon, how this conversation may construct social actions. Next I will outline my theoretical underpinnings and methodological foundations followed by a review of the relevant literature regarding genetically modified food, and when available pertaining to the AquAdvantage salmon, in five categories of investigation: health and environmental communication studies of GMOs; social science studies using Twitter data; the media and their role in the GMO debate; science communication and the debate between the public and scientists; and GMO marketing and labeling.

Theoretical Underpinnings

In this section, I will review the theories that inform the coding process retroductively (Emerson, Fretz, & Shaw, 2011). I believe, as expressed by Carbaugh (2007) that the research process should be iterative, a constant hermeneutic cycling back

to the data and the interpretations of meanings, including theory. For this study, genetically modified foods will be seen as a technological innovation in food production, that, although widely disseminated in the US food system is not widely accepted by the US public. Therefore, the Diffusion of Innovations Theory can explain the particular constructions and frames employed by the various stakeholder groups to help explain how each views the novel food technology. Diffusion of Innovations (Rogers, 2008), provides a frame to understand why an innovation or idea, such as technological enhancement of food, becomes adopted societally and to understand the rate of adoption or acceptance. Rate of adoption can be graphically plotted as an S-curve, a slow rate of adoption at first with early adopters beginning to catch on, followed by a slow and steady rise, petering off with the late adopters (like those resistant to getting a cell phone). People adopt based on certain factors such as relative advantage, complexity, compatibility, trialability, cost, observability, ease of incorporation of the innovation into one's life, etc. (Rogers, 2008). This application of DOI is novel in that the technology of genetic modification is not new and has a history of incorporation into our food system, however acceptance and knowledge of the technology, particularly in an animal species such as AA salmon, is relatively low, and thus the relative advantage of the technology is poorly understood. Therefore, the application of DOI is retrospective. This application can test how the theory can be applied in retrospective contexts, where viewpoints vary dramatically.

The following theories of social construction pertaining to message construction and communication will be combined with parts of various theories drawn from research on media and its influence. Delia and colleagues wrote about Constructivism which

serves as a bridge into a discussion on message construction, especially as the message is conveyed via media. We categorize, interpret, and make meaning out of our world by categorizing it into constructs. Something is considered more cognitively complex the more constructs we associate with it. Hale found in their literature review on cognitive complexity that the more cognitively complex a message, the abler we are to take another's perspective and frame it in such a way that it is understandable by others, this is termed 'perspective taking' (as cited by Littlejohn & Foss, 2011, p. 159). For example, the framing and language may differ when a scientist writing a paper for academia on genetic modification, versus a news media outlet or a blog writer writing about the same subject. The scientist will likely include a detailed discussion that is technical and possibly convoluted; whereas the media or a blog post may break down these complex concepts into constructs the general public can make sense of and can then ascribe to a perspective or opinion.

Another theory of social construction informs data analysis, framing, and conclusions are Groupthink Theory from the work of Irving Janis (as cited by Littlejohn & Foss, 2011, pp. 281-283). Drawing from Groupthink Theory is useful to assess how messages are formulated and shared among members of each stakeholder group. Groupthink Theory is unique in that it is critical of collective thought, as groups may form lemming-like decisions where the group may not reflect on the outcomes of group decisions, to their detriment, similar to mob mentality (as cited by Littlejohn & Foss, 2011, pp. 281-283).

In its infancy, Media Effects, proposed that any media conveying a message was like a 'magic bullet' that would lodge its message inside the receiver and have an effect

(Werder, 2009). Lazarsfeld's Two-Step Flow Hypothesis makes this shotgun effect a bit more complex by adding in an intermediary to the cause/effect, which is that of opinion leaders, those people you rely on to follow the entire election process, and you value their opinion and listen to their interpretation of the latest presidential debate (Werder, 2009). In Beacco, Claudel, Doury, Petit, & Reboul-Toure's (2002) discussion on the development of theories surrounding scientific discourse and its dissemination, they cite Moirand's 1992 concept *Didactic Transmission* which is similar to the magic bullet hypothesis and Lazarsfeld's Two-Step Flow Hypothesis in that knowledge was created by the scientific community (source/cause) and then transmitted linearly away from the source through the media (intermediary/interpreter) to the public (receiver/effect). Beacco et al. (2002) further this conceptually stating that knowledge and its dissemination is much more complex than linear distribution, that there is a multiplicity of relationships, actors, and channels involved in the distribution and interpretation of scientific knowledge, and has been termed "'secondary, indirect and sometimes explicit didacticity'", or that knowledge shared among 'ordinary' discourses. Furthering this still, Beacco et al. (2002) speak of a 'scientific diffusion' of thought where knowledge is circulated arterially and is intertextual, polyphonic, or plurilogal. "...The scientist is still present, but is now flanked by other enunciative roles such as the witness, the expert, the politician and the citizen" (Beacco et al., 2002). The role of the journalist as interpreter of scientific information is called into question by the witness and the public who are now a voice in especially contentious and controversial issues like GMOs (Beacco et al., 2002). "A form of new legitimacy is revealed by the boldness of non-specialist web-

surfers, who feel authorized to defend their opinions even against specialists" (Beacco et al., 2002).

Mark Poster proposed New Media Theory, which predicted a second media age, where media is decentralized, democratized, and individual oriented; similar to what we see with the decentralization of news in social media, blogging, and generalized internet media (Werder, 2009). Agenda Setting, Lippmann proposed that the media 'frames' news stories, which helps consumers know what to care about and how to perceive it (Werder, 2009). Shaw & McCombs agreed that the media sets up what to care about and frames the ways we can interpret it through a process of 'gatekeeping' or withholding portions of a story so that we will align our perceptions in a certain way (Werder, 2009).

In Matthes & Kohring's (2008) discussion of media frames using content analysis, they acknowledge that a 'frame' is an abstract object/variable for analysis and when not operationalized adequately leads to serious problems in validity and reliability. Matthes & Kohring (2008) propose a new approach, applied to biotechnology in the media, toward a more rigorous application and definition of media frames. They discuss the five most common types of content analysis of media frames: hermeneutic, linguistic, manual holistic, computer-assisted, and deductive, and offer a new method clustering of frame elements that eliminates methodological problems due to researcher bias and enhances reliability and validity. Matthes and Kohring (2008) state concisely and eloquently that: "Frames can be understood as strategic views on issues put forth by actors. Thus, there can be different frames in a single article. This view is consistent with the journalistic understanding of news diversity" (p. 276). Adding to this, what can be said of discursivity of the discussion and debate between stakeholders, or how various

interlocutors, actors, or stakeholders, construct discourse, or frame, controversial topics like GMOs? This study will attempt to understand just that.

Methodological Approaches

Social Science Research on Twitter

Twitter is a unique social networking site as information is constantly updated creating a perpetual stream of shared content, information, and communication instances unique in their abbreviated composition framework (Burgess & Bruns, 2012). A report issued in 2018 by Statista states that worldwide there are 336 million users, of which 69 million are US users. Originally designed and launched in July 2006 as the "short message service of the Internet" (Shi et al., 2014), it is now referred to as a microblogging site, as users are limited to posts of 280 characters or less (upgraded from 140 characters in November of 2017) also known as a "tweet" (McCormick, Lee, Cesare, Shojaie, & Spiro, 2017). Burgess & Bruns (2012) quote Manovich (p. 461) on Twitter and social media communication practices, "For the first time, we can follow [the] imaginations, opinions, ideas, and feelings of hundreds of millions of people. We can see the images and the videos they create and comment on, monitor the conversations they are engaged in, read their blog posts and tweets, navigate their maps, listen to their track lists, and follow their trajectories in physical space."

Twitter and other social media websites represent important grounds for public communicative interactions, participation in dialogue, potentially between actors not connected in real life, face to face, social interactions or relationships (Bruns & Steiglitz, 2015; Shi, Rui, & Whinston, 2014). Some have even proposed that, "Twitter is arguably

the largest observational study of human behavior to date" (McCormick et al., 2017, p. 18). In 2010, the Library of Congress (LoC) began to archive all Twitter activity, including a backlog of archived tweets beginning in 2006, logging nearly a half billion tweets a day to serve as a window into history and culture; "…to learn about ourselves and the world around us from this wealth of data" (Chang, 2010; Raymond, 2010). The LoC announced in 2017, that beginning in 2018 the library would curate a selection of tweets from important public figures, themes, and current events (Library of Congress, 2017).

Social media use in the US rose from 5% use in 2005 to 69% of Americans using at least one social media platform in 2018 (Pew Research Center, Social Media Fact Sheet, 2018). As adoption has risen, alongside it diversity of users more representative of the US general population rose as well (Pew Research Center, Social Media Fact Sheet, 2018). Facebook remains the most popular and widely used platform (Pew Research Center, Social Media Fact Sheet, 2018). The average social media user is young (18-29 years old), Hispanic (72%, followed by Black 69%, and White 68%), female, earn high average incomes, are college graduates, and live in urban environments (Pew Research Center, Social Media Fact Sheet, 2018). About 25% of active adult US Internet users use Twitter and 95% of Twitter users publish their tweets publicly (Colditz et al., 2018; Greenwood, Perrin, & Duggan, 2016; Liu, Kliman-Silver, & Mislove, 2014).

Twitter specifically, creates unique webs of social interaction as one can follow another user without their consent (unlike the Facebook "friendships" where each member must agree that they are "friends" before the linkage is created between users) and this inherently creates a one-way directional web of social interaction as one can only

see the content of users you are following, not vice-versa (Shi et al., 2014). Communication on Twitter may be original content created by the author (a tweet), a retweet (where another individual shares the original author's tweet with their social network), a reply to a tweet (@reply), or a direct message (or private interaction) (Shi et al., 2014). Shi et al. (2014) suggest that the practice of retweeting, or content sharing on Twitter, is a unique facet of Twitter online communication and exposes information to a broader audience or network, assisting the spread of information, and increasing the possibility of the tweet going viral.

Who uses Twitter and what motivates a user to engage with the platform of microblogging, as a spectator or as an active participant in sharing and producing content? Java, Song, Finin, & Tseng (2007) found in their study "Why we Twitter: understanding microblogging usage and communities" that user intention is motivated by daily chatter, conversations, sharing information/URLs, or reporting news and users to be categorized into either the information source, friends, or information seeker. Another 2016 study by Pentina, Basmanova, & Zhang across two cultures (US and Ukraine) of Twitter user intentions and motivations, largely from a marketing and advertising perspective. Petina et al. (2016) report that among both countries users participate on Twitter for professional development, entertainment, status maintenance, and social interaction and exchange. Alongside these motivations must reside a careful negotiation, curation, and presentation of the self—one's thoughts, opinions, daily activities, hobbies, passions, photos, videos, links to news, etc. (Goffman, 1959, see McCormick). Marwick & Boyd (2010) suggest that users present themselves on Twitter to an 'imagined audience' and strategically present the self as a commodity using practices resembling

that of a 'micro-celebrity' and personal branding, sometimes in conflict with a desire for privacy, self-expression, and intimate social connections. Shi et al. (2014) used Social Exchange Theory positing that people engage in social exchanges because it somehow benefits the initiator/i.e. expect something in return—monetary or material, or intangible like increased respect, status, or approval. Authors use this theory through the process of retweeting since the original author of a tweet benefits by getting information out to more people and those who see the retweet in their network benefit by receiving more information. They suggest the benefit gained by participants is enhanced social network and reputational advancement.

Bruns & Stieglitz (2015), drawing from information science literature, question how representative Twitter data is of the actual Twitter-sphere. Bruns & Stieglitz (2015) state that Twitter data is not representative because it is limited by the time the data was accessed using Twitter's free API (Application Programming Interface – the background software running any online application; when you search on google the API retrieves your query). One can access more comprehensive data using expensive data mining tools and software like Gnip and DataSift, therefore many researchers focus on the "lower hanging fruits" that are easily and freely available, like hashtags (Bruns & Stieglitz, 2015).

Hashtags, popularized by Twitter, are the number sign (#) that precedes a word or phrase the author identifies as indicative of the content of their tweet and is easily searchable using the Twitter search engine, such as #AquAdvantage, and can be used as an archiving tool (Chang, 2010; Colditz et al., 2018). There are however limitations to hashtag research: the Twitter API is limited by its own power (for instance it can only

return 2,000 tweets per minute but if there is a current event that many users are discussing it will only return this limited amount); and people must adopt and use the same hashtag to denote the subject of their tweet, thereby misrepresenting the actual sample size when an author does not use the hashtag. Twitter communication, as hypothesized by Bruns & Moe (cited in Bruns & Stieglitz, 2015) happens in three key layers of communicative groups/layers: first, the macro-layer of information exchanged rapidly through ad-hoc publics; second, the meso-layer of everyday communication between individuals who are networked together through the "following" feature of Twitter; and third, the micro-layer of @replies (the @ sign tags the person whom you are replying to). Authors note that getting at this third tier of communication, or conducting network analysis, can be tedious, arduous, and expensive so is rarely embarked upon by researchers as it is limited by API restrictions imposed by Twitter.

When embarking upon social science and communication research on Twitter some important considerations are how one will collect the data. Some methods are the 'spritzer' or a random selection of current tweets, or the 'fire hose' or a comprehensive feed of all incoming tweets at one instant (Bruns & Stieglitz, 2015). Some questions to consider are: does this hashtag or subject involve multiple players with diverse opinions or do the same people appear to be active in the conversation and are the opinions homogenous? And how large or small is the conversation on Twitter; how many users are active in the conversation (Bruns & Stieglitz, 2015). Who is the creator of the information and how is this information spread or not (number of original tweets, number of retweets (edited and unedited), number of @replies, and URL sharing) (Burgess & Bruns, 2012)?

Bruns & Stieglitz (2014) propose specific metrics for studying Twitter including: the text of the tweet, the username of the author, the numerical ID of the sender, the timestamp of the tweet, the geolocation of the tweet, any reference to the user's profile picture, hashtags used, mentions of other users (@mentions), references to URLs outside of Twitter, replies, and retweets. These metrics can be categorized by type: username and numerical ID describe the sender; @mentions describe the recipient; the timestamp is accurate to the second for chronological categorization; the type of tweet is indicated by whether it is a retweet, an @reply, or original tweet; hashtags are referential subject identifiers; and URLs indicate engagement with a larger conversation on the internet (Bruns & Stieglitz, 2014). Types of communication used by participants may be annunciative (original tweets), conversational (@replies), or disseminative (mostly retweets) (Bruns & Stieglitz, 2014). There are also different types or categorizations of users: those who get a lot of @mentions are *subjects* of conversations; those who receive and reply are active *conversants*; and those who get retweeted a lot but don't engage frequently are *conversation starters* (authors use 'impulse') (Bruns & Stieglitz, 2014). Activity can be graphically understood by a very small number of very active users followed by a long tail of less active users. In percentages this can be understood as 10% very active users to 90% less active (Tedjamulia, Dean, Olsen, & Albrecht, 2005, cited in Bruns & Stieglitz, 2014), or 1% extremely active users, 9% very active users, and 90% less active users. Hashtag research can be tricky since users engaged in the conversation must know to use the hashtag, may be using it ironically (#NMtrue), and will not represent replies to the hashtag, therefore researchers conducting hashtag and keyword search research must, "recognize these inherent distortions in observable communication

patterns" (Bruns & Stieglitz, 2014). Another consideration for conducting research on Twitter is what the unit of analysis is. Vaisman (2016) argued that blogs are usually viewed as a text-based unit for analysis when there are visual elements to analyze, decode, and explore as well.

Limitations of twitter data and research may be that observations cannot be assumed to be applicable in other regions, countries, or communities (Bruns & Stieglitz, 2015). Data is also limited to the typical type of user, a Pew Study (2011) found that Twitter users are predominantly young and African American. Another limitation is that Twitter users may not provide any demographic information at all, may be falsifying their demographic descriptions, or be a fake account, also known as a bot or a troll (Broniatowski et al., 2018; McCormick et al., 2017). Social scientists may be limited too by their training and background in research methodology, lacking the skills to utilize and interpret computational methods (McCormick et al., 2017). Social media must also be presumed to be in flux so taking a snapshot at one point in time is limited (Bruns & Stieglitz, 2015). Additionally, Twitter may be less of a microblogging of original opinions, ideas, and thoughts but a sharing of news media, which may create a reflection of top-down dominant news production instead of a citizen participation model (Verbeke et al., 2017).

However, some benefits are intertwined with the existent limitations, McCormick et al. (2017) state that this is also a benefit since the real-time collection of data avoids some of the pitfalls of survey and interview data collection such as respondent recollection error and bypasses the Hawthorne Bias, or observation bias. The online communication on Twitter is unsolicited or unprompted, word-for-word, can be captured

and stored, researchers can capture unlimited amounts of data, and with large amounts of variability in data as each author is communicating autonomous, unsolicited information (McCormick et al., 2017). Twitter offers Social Scientists the ability to look into behaviors and opinions that may be controversial like racist attitudes, look into collective, real-time experiences like terrorist attacks, and gather data on vulnerable or hard to reach populations (McCormick et al., 2017). Other applications of Twitter that researchers have employed are tracking the spread of communicable diseases, communicating with patients, as well as political analysis and election forecasting (McCormick et al., 2017). Since Twitter is a site where instantaneous dissemination of news, information, and opinions occur it may be useful for journalists, politicians, emergency service providers, and social researchers alike (Verbeke, Berendt, d'Haenens, Opgenhaffen, 2017).

Colditz et al. (2018) document and present the methodological problems and solutions to conducting health research on Twitter; especially as Twitter use has spiked, public health research using Twitter has also increased, yet there is no standardized method to conduct research on Twitter, particularly when utilizing content analysis—the most commonly used method to conduct research on Twitter. First, authors address the issue of privacy. Although Twitter is considered "nonhuman participant research" since tweets are publically available there are risks of tweeting information that could disgrace or create culpability of an individual. Colditz et al. (2018) suggest scrubbing usernames, not directly quoting, or using other identifying characteristics such as user avatar photos. Keyword selection for search criteria may also prove crucial as it could limit or expand data collection. Proper selection of search terms will allow data collection to be refined to relevant tweets, eliminate clutter, enhance generalizability and

validity, and help to recognize limitations (Colditz et al., 2018). Problems can also occur if data is formatted in raw JavaScript Object Notation (JSON) or other text-based extractions as even objects like emojis, images, or weblinks are translated to code that needs to be back translated to language human coders can understand. "Overall, it is important to consider that tweets contain a variety of text and nontext characters that add substantial clarity, and these nuances should be preserved and portrayed in human-readable format as much as possible" (p. 1011). Additionally, how many tweets should be in the sample in order for it to be representative? Dependent on the size of the data pool researchers may choose a random "keep every *n*th tweet" (p.1011) or choose to evaluate more relevant keywords until optimization is met. Coder training and code book development and keyword definitions are also considerations for improving methodological design. Colditz et al. (2018) found that although human coding is inherently time consuming, there are errors that can be avoided. Authors suggest either using a codebook already developed and validated in the literature or using clear and simple definitions for codes. Once the sample has been selected, a first culling of the data for relevance can alleviate coder burden. Then coding for sentiment in simple language such as "pro-hookah" instead of "positive sentiment" can assist with coder confusion and eliminate unnecessary error. The simpler the codebook is, the less error and coder disagreement will be found.

Methods Overview

Content Analysis

Elo and Kyngas (2007) describe a qualitative method for conducting content analysis, since the method is widely used in various fields and methodological approaches. The goal of content analyses is to distill a large amount of data into categories that can assist in describing and explaining the data to either test existing theory (deductive method) or generate new theory (inductive method) (Elo & Kyngas, 2007). Elo and Kyngas (2007) recommend following three phases for processing the data: preparation, organizing, and reporting. In the preparation phase you select the unit of analysis, which in this study is a tweet. Then to make sense of the data, one must organize it into a schema, matrix, or open code; this study created a coding schema (see Table 3). After grouping, processing, and abstracting the data, conceptual maps, categories, models, or themes can be analyzed and reported. At this stage, thematic analysis, as described by Braun and Clarke (2006) will be applied to assist in extracting themes from the data set.

Thematic Analysis

As a method, or "how-to-apply" thematic analysis, Braun and Clarke (2006) suggest the following: become familiar with the data corpus, generate initial codes or spontaneous thoughts on the data, collate codes into themes, review themes and how they interrelate, define/name the themes, and then report the final analysis. Braun & Clarke (2006) warn researchers that biases exist, even our own, so it is best to account for these positions before beginning research. Our vantage point can obscure patterns that may be

obvious to other researchers. In addition, Braun & Clarke (2006) state that it is imperative that the researcher fully document their approach to enhance research rigor, reliability and accuracy of results, and to avoid lose statements such as "themes emerged" or "were discovered" without adequate description of the means in which they emerged. The theoretical underpinnings should align with the direction of the research, research questions, enhance the research, and guide the identification of themes; therefore, themes will align with the epistemological perspectives and researcher assumptions presented in the previous chapter. Following thematic analysis, a grounded approach to discourse analysis, as described by Emerson, Fretz, and Shaw (2011) will be employed to further describe the constructed meanings created by stakeholders through their communication on Twitter.

Grounded Approach to Discourse Analysis

Emerson, Fretz, and Shaw (2011) present a step by step approach to utilizing grounded methodology, or avoiding importing a priori themes, frames, interpretations, meanings, or theory, and allowing meaning to emerge indigenously from the data, in their book *Writing Ethnographic Field Notes.* This approach allows the texts of each individual or group to showcase their own interpretive constructions and descriptions used in the texts composed by each group. Emerson, Fretz, and Shaw (2011) suggest avoiding the tendency to approach research and coding of data with a theoretical lens because it imposes an exogenous concept on the data can pigeonhole the findings into narrow categorizations and concepts that can limit the representation and framing of actual group meanings, however, they recognize this to be impossible.

Emerson, Fretz, and Shaw (2011) offer many suggestions for researchers to pay close attention to in their data. For example, a *formulation* (p. 138) is a particular way in which a group member describes or explains what happened in a particular situation, such as when an individual references Frankenstein, i.e. "Frankenfood", to conjure up a particular formulation of their concerns regarding the AA salmon. They warn researchers to not regard these formulations as facts, or truth, but as social constructions. Emerson, Fretz, and Shaw (2011) encourage researchers to closely attend to the *stories* group members tell, the reasons they are being recounted, and how they may be modified to fit certain situations, times, or audiences—as different narratives are told by different groups, at different points in time, for different purposes. Member *contexts and contrasts* should also be noted. Context refers to "…who was speaking, or when, or where it was said, or by knowing what had been said just previously" (p. 145); context is never fixed but is situated in specific social contexts and is defined by the social actors. Contrasts refers to differences in group member's explanations or experiences "…that may also serve micropolitical purposes that seek to advance the interests of one group in the setting over another" (p. 147). Contrasts should not be viewed as factual information but instead offer insight into a group's values and objectives. Member *terms, types, and typologies* such as language and phrasing may also unveil perspectives, meaning, and objectives. Lastly, member *explanations and theories* should be appraised to find the 'causes' or 'who, what, and why' of the subject and situation, always wary of the unsaid purpose behind communication. They state it is the analyst's goal "…to specify the conditions under which people actually invoke and apply such terms in interaction with others" (p. 167).

To guide this process, Emerson, Fretz, and Shaw (2011) present data coding steps. First, the analyst must familiarize themselves with the data set by close reading of the complete corpus. Next, a line by line analytic coding of the data occurs in two phases: open coding and focused coding. Open coding identifies themes, ideas, and issues, while focused coding targets ideas and categories that may become thematic frames. Insights are elaborated into "code memos" or notes that begin to address group meaning making. Once it becomes more clear which ideas and themes the researcher will develop the researcher begins to create "integrative memos" that connect ideas and themes throughout the data set. Coding is considered complete when no new "ideas, themes, or codes" surface (p. 174).

Although the process is termed a grounded approach, since it attempts to avoid beginning with a theoretical frame, coding does not happen in a vacuum devoid of researcher biases, therefore Bulmer (1979) and Katz (1988) term the approach "retroductive", as opposed to completely inductive or deductive (as cited by Emerson, Fretz, & Shaw, 2011, p. 173). In fact, with the admission of researcher bias and theoretical underpinnings of research, it must be concluded that the entire process is "reflexive and dialectical interplay between theory and data, whereby theory enters in at every point" (p. 198). In this manner,

> Qualitative coding is a way of opening up avenues of inquiry: The researcher identifies and develops concepts and analytic insights through close examination of, and reflection on, fieldnote data…as a way to name, distinguish, and identify the conceptual import and significance of particular observations (p. 175).

Review of the Literature

A comprehensive and exhaustive review of the literature on the controversial and much debated topic of genetic modification proves impossible, as the subject is simply too broad. Therefore, the literature was searched in five narrowed subject categories. First, a broad search was conducted into each category, and relevant targeted studies were evaluated and included herein. Specifically focusing on communication studies that have addressed: science communication and GMOs; the media's role in the communication about GMOs; how GMOs are marketed and labeled; the perceptions and opinions of the public regarding GMO food technology; and previous studies using Twitter for social science research. This review of literature is synthesized in Table 1. Most communication studies have largely focused on the debate surrounding GMOs and how information is being sent, received, understood, and processed in an effort to sway public perceptions to a more positive, accepting view point.

Table Summarizing Reviewed Literature

The reviewed literature was summarized and synthesized in table 1, included here. This table provides an overview for the five areas of literature reviewed researching this study. Following the table a literature review is provided.

Science Communication Studies			
Citation	Method	Findings	Location
Bhatta, A., & Misra, K. D. (2016). Biotechnology communication needs a rethink. *Current Science*, *110*(4), 573.	Literature Review	Scientists must communicate with the public using the contextual model (two-way, symmetrical flow of information) in order for GM tech. to be accepted.	NA (Authors from India)
Cook, G., Pieri, E., & Robbins, P. T. (2004). 'The scientists think and the public feels': Expert perceptions of the discourse of GM food. *Discourse & Society*, *15*(4), 433-449.	Qualitative in-depth interviews of GE scientists and members of public	Scientists view the public as irrational and uneducated, whereas the public see GE tech as a possible risk morally, ethically, economically, politically, and safety.	UK
Clark, E. A., & Lehman, H. (2001). Assessment of GM crops in commercial agriculture. *Journal of Agricultural and Environmental Ethics*, *14*(1), 3-28.	Literature Review	Peer reviewed literature does not back up claim that GMOs are safe for the environment and human health.	NA (Authors are Canadian)
Devos, Y., Maeseele, P., Reheul, D., Van Speybroeck, L., & De Waele, D. (2008). Ethics in the societal debate on genetically modified organisms: A (re) quest for sense and sensibility. *Journal of Agricultural and Environmental Ethics*, *21*(1), 29-61.	Historical Reconstruction	Assessments of GMO risk should be transparent, that scientists should address "non-scientific" concerns seriously, and that the concerns are complex ranging from "environmental, agricultural, socio-economic, and ethical issues"	EU

Gerasimova, K. (2016). Debates on genetically modified crops in the context of sustainable development. *Science and engineering ethics*, *22*(2), 525-547.	Critical discourse analysis (CDA) of stakeholders	Stakeholder groups were scientists, civil society representatives, policy makers/business representatives, farmers, and consumers. Proponents and opponents both argued for "sustainable development" incorporating biodiversity and food security into their arguments. Sides were found to be opposed and not in dialogue with one another.	EU
Wales, C., & Mythen, G. (2002). Risky discourses: the politics of GM foods. *Environmental Politics*, *11*(2), 121-144.	Theoretical application of Beck's Manufactured Risk to GMOs	Recommend to develop a sincere social dialogue that includes democratic decision making to dispel risk and uncertainty of modern science like GMO technology.	NA (Authors from UK)
Media Studies			
Citation	Method	Findings	Location
Augoustinos, M., Crabb, S., & Shepherd, R. (2010). Genetically modified food in the news: media representations of the GM debate in the UK. *Public Understanding of Science*, *19*(1), 98-114.	CDA of UK newspapers	Stakeholders representations (public, government, scientists, and biotech companies) serve to promote rhetorical strategies that support their purported agenda. The news tends to frame the debate as a battleground.	UK

Casaus, M. V. (2010). Press news coverage of GM crops in Catalonia in 2005: A case study in environmental communication. *Catalan Journal of Communication & Cultural Studies*, *2*(1), 23-41.	Content and frame analysis of Catalan (Spain) newspapers.	Six stakeholder groups identified: government, journalists, social opponents, civil society, GMO proponents, & scientists. Frames: scientific-technical enthusiasm; productivism; organic production and consumption; rejection of coexistence decree; approval of coexistence decree; macrostructural; environmental; & postmodern cyber-culture.	Catalonia, Spain
Howarth, A. (2013). A 'superstorm': When moral panic and new risk discourses converge in the media. *Health, Risk & Society*, *15*(8), 681-698.	Discourse analysis of UK newspaper editorials	Media discourse is emotive and provokes anxiety in the public but could potentially lead to policy and social change.	UK
Hughes, E. (2007). Dissolving the nation: Self-deception and symbolic inversion in the GM debate. *Environmental politics*, *16*(2), 318-336.	In-depth textual analysis of UK newspapers and interviews of key media sources	The construct of "nation" was critical, as a technology like GMO could not be controlled nationally which leads to uncertainty, insecurity, and questions the concept of the "nation" in a global economy.	UK
Lockie, S. (2006). Capturing the sustainability agenda: Organic foods and media discourses on food scares, environment, genetic engineering, and health. *Agriculture and Human Values*, *23*(3), 313.	Content Analysis of newspaper articles from US, UK, and Australia	Found that GM foods were untrustworthy and that benefits did not outweigh costs, the media simplifies the debate, the most predominant theme found was that of moral and environmental conflict.	US, UK and Austral

Maeseele, P. (2015). Risk conflicts, critical discourse analysis and media discourses on GM crops and food. *Journalism*, *16*(2), 278-297.	Critical discourse analysis of Belgian newspapers.	Found two opposing ideologies presented in the news, that of unquestioned scientific consensus and challenging scientific certainty. The former stymied democratic debate while the latter encouraged it.	Belgium
Motion, J., & Weaver, C. K. (2005). A discourse perspective for critical public relations research: Life sciences network and the battle for truth. *Journal of Public Relations Research*, *17*(1), 49-67.	Integrated political economy and discourse analysis of biotechnology as presented by the Life Sciences Network in New Zealand	Found that public relations firms like the Life Sciences network employ specific framing and discourse to promote their agenda and company's interests.	New Zealand
Public Opinion Studies			
Citation	Method	Findings	Location
Bowman, A. (2015). Sovereignty, Risk and Biotechnology: Zambia's 2002 GM Controversy in Retrospect. *Development and Change*, *46*(6), 1369-1391.	Oral history interviews with key stakeholders: scientists, policy makers, development workers, and members of the press	During Zambian food crisis, country rejected GM foreign aid. Study investigates why and finds country wanted to retain food sovereignty and control over ag. technology. Did not trust the technology, risk, or corporate interest of the donation.	Zambia

Durant, R. F., & Legge Jr, J. S. (2005). Public opinion, risk perceptions, and genetically modified food regulatory policy: Reassessing the calculus of dissent among European citizens. *European Union Politics*, *6*(2), 181-200.	Uses heteroskedastic probit analysis of the Eurobarometer survey on European opinion of biotechnology	Results suggest that educational campaigns are ineffective and maybe counterproductive; whereas campaigns about regulatory capacity and intention to protect health and environmental safety may be more effective.	EU
Ferretti, M. (2007). Why public participation in risk regulation? The case of authorizing GMO products in the European Union. *Science as Culture*, *16*(4), 377-395.	Two case studies in EU of governmental approval	Increased democratic participation in decision making, better communication between laypersons and government would enhance approval. Structural obstacles have made it difficult for the public to participate in democratic processes.	EU
Harrison, K. L., Geller, G., Marshall, P., Tilburt, J., Mercer, M. B., Brinich, M. A., ... & Sharp, R. R. (2012). Ethical discourse about the modification of food for therapeutic purposes: How patients with gastrointestinal diseases view the good, the bad, and the healthy. *AJOB primary research*, *3*(3), 12-20.	Multi-site focus groups	GI disease patients found probiotics that were GE as 'unnatural' and associated this with 'risk' and 'bad', whereas non-GE was associated with 'natural', less risk, and 'good'. Participants recognized this was not true all of the time.	US
Kikulwe, E. M., Wesseler, J., & Falck-Zepeda, J. (2011). Attitudes, perceptions, and trust. Insights from a consumer survey regarding genetically modified banana in Uganda. *Appetite*, *57*(2), 401-413.	Survey of Ugandan consumer willingness to purchase GM bananas	Consumers are concerned about unknown effects. Price and quality are most important factors influencing purchase.	Uganda

Kim, R. B. (2012). Consumer attitude of risk and benefits toward genetically modified (GM) foods in South Korea: implications for food policy. *Engineering Economics*, *23*(2), 189-199.	Survey research, quantitative model to test consumer attitudes using perceived benefits and risks, and socioeconomic status	S. Koreans are more favorable toward GM food if nutritionally or medically beneficial. Negative attitudes were associated with environmental risk and general uncertainty. Education identified as a viable way to shift negative perceptions.	South Korea
Klerck, D., & Sweeney, J. C. (2007). The effect of knowledge types on consumer-perceived risk and adoption of genetically modified foods. *Psychology & Marketing*, *24*(2), 171-193.	Mixed methods, surveys and interviews	Results suggest a need for cooperation between government, scientific institutions, and food industry to create communication that decreases perceived risks and increases objective knowledge and adoption.	Australia
Kniazeva, M. (2006). Marketing "Frankenfood" Appealing to Hearts or Minds?. *Journal of Food Products Marketing*, *11*(4), 21-39.	In-depth interviews	Acceptance related to personal, moral, and cultural traits. Value is based on what is 'good' for the individual. Author suggests marketing GM food as emotionally and personally beneficial.	US

Marris, C. (2001). Public views on GMOs: deconstructing the myths: Stakeholders in the GMO debate often describe public opinion as irrational. But do they really understand the public?. *EMBO reports*, *2*(7), 545-548.	Used focus group interviews, analysis of documents, and observation during public debates of stakeholder attitudes, discourses, and strategies.	Found "myths" in how the public was presented: either for/against, actually ambivalent; irrational/unscientific, admitted technical ignorance; 'unnatural', unchecked/untrustworthy science; medical more acceptable than agriculture, true but wanted choice and transparency; public oversensitized to food risk, risk and uncertainty cannot be controlled; demand for 'zero risk', false; selfish about developing nations; skeptical GMO corporations were trying to help	EU
Qin, W., & Brown, J. L. (2006). Consumer opinions about genetically engineered salmon and information effect on opinions: A qualitative approach. *Science Communication*, *28*(2), 243-272.	Focus groups testing consumer opinion of GE salmon testing their opinion when given limited versus detailed information.	In order for GE salmon to be accepted by consumers, communication should be basic, specific about it and process used; consumer will understand consequences, and form opinions. Info should include multiple perspectives.	US
Ribeiro, T. G., Barone, B., & Behrens, J. H. (2016). Genetically modified foods and their social representation. *Food Research International*, *84*, 120-127.	Interviewed 48 consumers; analyzed with collective subjective discourse based on the social representations theory.	GM foods perceived as 'unnatural'. Positive attitudes are associated with benefits, negative with risk and fear. GM plants are more favorable than animals.	Brazil

Siegrist, M., Connor, M., & Keller, C. (2012). Trust, confidence, procedural fairness, outcome fairness, moral conviction, and the acceptance of GM field experiments. *Risk Analysis: An International Journal*, *32*(8), 1394-1403.	Quantitative using regression analysis model testing risk, value, trust, fairness, and confidence.	Procedural fairness may be a more important factor, and is moderated by moral conviction. All factors (economy/health and environment, trust of industry/scientists, and competence) significantly influenced acceptance of GM experiments.	Switzerland
Labeling Studies			
Citation	Method	Findings	Location
Caswell, J. A. (2000). An evaluation of risk analysis as applied to agricultural biotechnology (with a case study of GMO labeling). *Agribusiness: an International Journal*, *16*(1), 115-123.	Case study of GMO labeling using economic evaluation of risk analysis	Offers recommended considerations for labeling of GMOs per country: define GMO, voluntary or mandatory, which products or ingredients are covered, etc.	NA (Author is US-based)
Chembezi, D. M., Wheelock, G., Sharma, G. C., Kebede, E., & Tegegne, F. (2008). An econometric evaluation of producers' preferences for mandatory labeling of genetically modified food products. *Journal of food distribution research*, *39*(856-2016-57877), 36.	Logistic regression model of 1887 farmers opinions of GM labeling	Farmers are in favor of labeling, neutral on consumer acceptance, and uncertain of government's ability to regulate it.	US

Hellier, E., Tucker, M., Newbold, L., Edworthy, J., Griffin, J., & Coulson, N. (2012). The effects of label design characteristics on perceptions of genetically modified food. *Journal of Risk Research*, *15*(5), 533-545.	Factorial experimental design testing GMO labeling (color, wording, and source) on consumer hazard perception and intention to purchase	Consumers are wary of any label put on a product and exhibit less likelihood to purchase.	UK
Gruère, G. P., Carter, C. A., & Farzin, Y. H. (2008). What labelling policy for consumer choice? The case of genetically modified food in Canada and Europe. *Canadian Journal of Economics/Revue canadienne d'économique*, *41*(4), 1472-1497.	Analytic modeling and regression analysis of Canadian and EU policies	GM labeling decreases consumer choice and may decrease the likelihood of purchase	International (Autho are US-based)
Gruère, G. P., Carter, C. A., & Farzin, Y. H. (2009). Explaining international differences in genetically modified food labeling policies. *Review of International Economics*, *17*(3), 393-408.	Analytic modeling of factors that influence international labeling of GMOs	Countries producing GM crops, less stringent labeling policies; exporters to EU and Japan have stricter policies.	NA (Authors are US based)
Ling, H. G., & Lakatos, J. P. (2014). California proposition thirty seven: Implications for genetically modified food labeling policy. *International Journal of Business, Marketing, & Decision Science*, *7*(1).	Literature review of GM labeling laws in US, Canada, EU, and Japan; implications for US policy	Offers US GM labeling suggestions and analyzes pros and cons	US

Phillips, D. M., & Hallman, W. K. (2013). Consumer risk perceptions and marketing strategy: the case of genetically modified food. *Psychology & Marketing*, *30*(9), 739-748.	Focus group interviews to assess consumer risk perception of labels, marketing analysis	Findings suggest consumers who are less informed are alarmed by any GMO labeling, those who are more informed were skeptical of GMO labels but perceived a positive label, like "produced with less pesticides" as a benefit	US
Schramm, D. (2007). Race to Geneva: Resisting the Gravitational Pull of the WTO in the GMO Labeling Controversy, The. *Vt. J. Envtl. L.*, *9*, 93.	Policy analysis	Comprehensive coverage of labeling requirements and regulations in international trade by the World Trade Organization.	NA (Author is US-based)
Vujisid, D. (2014). Labeling of genetically modified food and consumers' rights. Proceedings of the Faculty of Law, Novi Sad, 48, 185-199.	Comparative case study of US and EU GMO labeling laws.	Recommend labeling of GM foods in Serbia to promote consumer rights, choice, and information access.	Serbia (but is an analysis of US and EU labeling)
Twitter Studies			
Citation	Method	Findings	Location
Bonilla, Y., & Rosa, J. (2015). # Ferguson: Digital protest, hashtag ethnography, and the racial politics of social media in the United States. *American Ethnologist*, *42*(1), 4-17.	Use their method "hashtag ethnography" to research the shooting of Michael Brown on Twitter as it is unfolding	Twitter and social media are live platforms to watch the non-dominant opinions surface and provide a platform for the real-time observation of political movements.	US

Boulianne, S. (2015). Social media use and participation: A meta-analysis of current research. *Information, communication & society*, *18*(5), 524-538.	Meta-analysis of 36 studies of social media and participation in civic/political arenas	Social media use may increase civic and political engagement	NA (Author is Canadian)
Himelboim, I., McCreery, S., & Smith, M. (2013). Birds of a feather tweet together: Integrating network and content analyses to examine cross-ideology exposure on Twitter. *Journal of computer-mediated communication*, *18*(2), 154-174.	Network and content analysis to assess political ideologies on Twitter	Twitter users are unlikely to be exposed to and engage with alternative viewpoints to their own.	NA (but US-based political issues)
Latonero, M., & Shklovski, I. (2011). Emergency management, Twitter, and social media evangelism. *International Journal of Information Systems for Crisis Response and Management (IJISCRAM)*, *3*(4), 1-16.	In-depth longitudinal case study of Los Angeles Fire Department communications officers	Emergency responders can use applications like Twitter for real-time two way communication during emergencies. It is interactive, participatory, and instantly updated.	US
Newman, T. P. (2017). Tracking the release of IPCC AR5 on Twitter: Users, comments, and sources following the release of the Working Group I Summary for Policymakers. *Public Understanding of Science*, *26*(7), 815-825.	Mixed methods framework to assess who the most active stakeholders were and what their messages were (frequencies of users, subject, and retweeting)	Found that Twitter was a public sphere where non-elite actors were actively engaged in the conversation	NA (US-based author)

Palen, L., Starbird, K., Vieweg, S., & Hughes, A. (2010). Twitter-based information distribution during the 2009 Red River Valley flood threat. *Bulletin of the American Society for Information Science and Technology*, *36*(5), 13-17.	Content analysis of Twitter during flood threat analyzing location and time	In emergency situations, like floods, Twitter can serve as a life line for information, from local and official sources. Locals use it to communicate site specific urgent information, official sources to stream rescue information, and others retweet headlines about the emergency.	US
Paul, M. J., & Dredze, M. (2011). You are what you tweet: Analyzing twitter for public health. In *Fifth International AAAI Conference on Weblogs and Social Media*.	Describe the Ailment Topic Aspect Model (ATAM) to track population health on Twitter. Compare their data to national tracking like CDC data	Twitter can be used as a less expensive method of tracking common health ailments that don't require doctors visits, however many limitations exist such as complete demographic data.	US
Rodríguez-Martinez, M. (2017, June). Experiences with the Twitter Health Surveillance (THS) System. In *2017 IEEE International Congress on Big Data (BigData Congress)* (pp. 376-383). IEEE.	Describes a Twitter data capture application to mine population health defined by the user in real time.	New application allows users to process health information for a particular health topic as it is emerging. Could prove useful in disease monitoring and development.	NA (Author is from Puerto Rico)

Takahashi, B., Tandoc Jr, E. C., & Carmichael, C. (2015). Communicating on Twitter during a disaster: An analysis of tweets during Typhoon Haiyan in the Philippines. *Computers in Human Behavior*, *50*, 392-398.	Typology of Twitter based on previous research to assess time, geographic location, stakeholder, and level of social media engagement during a typhoon in the Philippines.	Results show sharing of information to coordinate research efforts and to memorialize but geographic data could have been affected because infrastructure in the most affected areas was damaged or destroyed.	Philippines (Author are US-based)

Table 1 - Literature Review Summary

Science Communication Studies

The following section summarizes articles that specifically analyze the depiction of the debate between the scientific community, their discourse, and rhetorical strategies; that of the lay public, how they are frequently depicted, and their major objections to biotechnology; and the communication strategies and methods between the two parties (Bhatta & Misra, 2016; Blancke, Breusegem, Jaeger, Braeckman, & Van Montagu, 2015; Clark & Lehman, 2001; Cook, Pieri, & Robbins, 2004; Gerasimova, 2016; Wales & Mythen, 2002).

Bhatta & Misra (2016) in *Biotechnology communication needs a rethink*, address which communication strategies should be used to communicate from scientists to the general public to make biotechnology, such as GMO, acceptable, understandable, and accessible. Their premise states that biotech will become irrelevant if it cannot be used

by society at the right time, implying their pro-genetic modification stance. Authors advocate for the role of better communication by scientists and critique the deficit model of traditional communication practices that assumes the reader or public is deficient in knowledge and that knowledge is transmitted via a one-way transmission of information, like Lazarsfeld's Two Step Flow Hypothesis, where information emerges and via a magic bullet is transmitted without permutation to the uninformed public. Bhatta & Misra (2016) promote the contextual model as symmetrical, and a two-way flow of information from scientists to public, creating space for dialogue, and participative communication where local cultural knowledge is found and valued. Bhatta & Misra discuss Nisbet's many deliberate and intentional frames that are often seen in current scientific debate such as: social progress, economic development, morality and ethics, scientific/technical uncertainty, what is known and unknown, invoking or undermining consensus, and Pandora's box or Frankenstein's monster.

Cook, Pieri, & Robbins (2004) discuss the rift between science and the public in their article, "The scientists think and the public feels: Expert perceptions of the discourse of GM food". "Scientists engage with 'the public' from their own linguistic and social domain, without reflexive confirmation of their own status as part of the public and the citizenry" (p.433). Debate and discourse, including language choice and communication strategies, between scientists and the public in one academic institution in the UK were explored concluding the need for a reparation, as GM technology will affect us all and necessitates communication between 'experts' and 'non-experts'. Using qualitative in-depth interviews of both sides of the debate, scientists viewed themselves and their research as objective, empirical, and infallible. They viewed the public as uneducated,

unscientific, unable to communicate complex ideas, and as emotional and irrational. Whereas the public view the debate in terms of costs and benefits: is it morally justified; what are the economic costs; who is benefiting; who controls this politically; is there an aesthetic advantage; and is it safe? Here we see, in the words of the scientists and public themselves, a definitive divide, an almost fiery and impassioned debate between scientists and the public.

Wales & Mythen (2002) discuss the politics of trust in risk discourse from experts to the public. "Expert systems" usually assess probability of risk but lately the public has been in doubt of the ability of experts to assess social risk. There is a need to "facilitate discursive contestation" before science has defined the issue and set the agenda so that policy and decision making can be a collaborative effort of "specialists, decision makers, and laypersons." GM represents what Beck calls 'manufactured risk' distinguished from natural hazards because they are humanly created, illimitable in time and space, uninsurable, and potentially catastrophic. For instance, GM are humanly created, are not limited temporally or geographically, so are global in scope, their potential to impact the environment and human health is indeterminate and contested, and potentially devastating. "It is quite possible that the production and consumption of genetically altered foods may generate deleterious and irremediable effects on humankind and the 'natural' environment" (from Adam, 2000).

> Under the penumbra of manufactured risks - such as AIDS, global warming and genetic technology - the political, moral, and ethical dimensions of risk are becoming increasingly visible. Thus conceived, it becomes imperative that the social and political relations of definition which support risk negotiation become

more democratic: that all affected parties are equally recognized and are enabled to either participate or be represented effectively in risk dialogue (Wales & Mythen, 2002, p. 125-126).

Similarly, Clark & Lehman (2001) compile and review relevant studies on GMOs and assert in their article, *Assessment of GM crops in commercial agriculture*, a lack in consensus regarding the discourse surrounding GMOs and a scarcity of evidence evaluating risk to health and environment. They state there is a "dearth of peer reviewed work to substantiate the frequently heard assertions of either safety or utility in GMOs." They also question the science behind "substantial equivalence" as a "dubious argument by analogy". Their findings suggest that peer reviewed research does not back up the claim that GMOs are safe for human consumption, and that the commonly used notion of substantial equivalence, or that a genetically modified substance is essentially genetically substantial to a naturally occurring non-GMO, is poorly defined. Similarly, in Devos, Maeseele, Reheul, Van Speybroeck, & De Waele's (2008) historical discussion of the societal debate surrounding GMOs concludes that scientific risk assessments of GM should be made more transparent, allow for the contribution of diverse public voices, implement an "integral sustainability evaluation". Devos et al. (2008) remark on how the public was misconstrued and devalued as a voice in the debate and that their opinion should be valued equally.

In Gerasimova's (2016) *Debates on genetically modified crops in the context of sustainable development*, critical discourse analysis (CDA) is used to assess the perceptions and conflicting viewpoints of GM crops by opponents and supporters. Stakeholder groups identified were: scientists, civil society's representatives or activists,

policy-makers and representatives of business, farmers, and consumers. The study finds very little dialogue, or attempt to reach a common ground, among opponents and proponents and that their arguments are largely based on the same issues, marked by sustainable development. Particularly framed around "environmentalism, social and economic development and the two sub-issues of sustainable development--biodiversity loss and food security". Both sides were found to be diametrically opposed and unable to hear the other side's arguments.

To sum up the research, the public and scientists are found to be in opposition to one another, with scientists depicting the public as: uneducated, irrational, or unscientific (Blancke et al., 2015; Cook, Pieri, & Robbins, 2004); not in support of economic and social progress (Gerasimova, 2016); objecting to GMO technology as unnatural, immoral, or dangerous (Blancke et al., 2015); or objecting out of a mistrust of the corporate and political agendas (Cook et al., 2006). Many articles discussed this divisive debate between scientists and the public as largely revolving around risk and the need to create a better dialogue between scientists that is not dismissive or reductive. GMO risk was seen as human manufactured, uninsurable, and potentially catastrophic, and the public doubted expert's ability to assess this risk, and therefore there is a need for dialogue (Wales & Mythen, 2002). Some studies asserted that the risk assessment of scientists and policy makers is based on a "dubious argument by analogy" (Clark & Lehman, 2001) and should be explained more transparently if they wish to garner public acceptance (Devos et al., 2008). If the debate is to be resolved, democratic dialogue between scientists and the public must occur (Bhatta & Misra, 2016, Cook, Pieri, & Robbins, 2004) and the public's concerns should be addressed by scientific research,

instead of dismissed as irrational (Cook, Pieri, & Robbins, 2004; Clark, & Lehman, 2001; Wales & Mythen, 2002). Gerasimova (2016) identifies stakeholder groups beyond scientists and the public including policy makers and activists. A more thorough look at who is involved in the discussion, and what stakeholder group they identify with, is needed. All of the articles reviewed in this section express a need for dialogue, consensus, and transparency between those involved in the debates swirling around GMOs. Twitter provides a platform where anyone desiring to express their opinion can do so, therefore providing an online arena for discussion and dialogue among those with opposite beliefs.

Media Studies

As discussed in the previous section, the debate surrounding genetic modification is not new and is found to be a divisive debate between those opposed and those in favor. The media is often seen as the interpreter or intermediary of information between scientists and the lay public, via a magic bullet (Lazarsfeld); through framing the agenda or setting up the opinion/perspective to take (Delia; Lippman); didactic transmission (Moriand, 1992); or even the decentralized and democratized new media (Poster) (Beacco et al., 2002; Werder, 2009), therefore, studies investigating the media's spin on GMOs were investigated. In addition, much of the online discussion on Twitter are reposting and sharing news media articles about AA Salmon. The media often reifies the long held perception of the public and scientists in opposition, or in a debate (Augoustinos, Crabb, & Shepherd, 2009; Cook, Robbins, & Pieri, 2006). Those opposed tend to be reduced or stereotyped as environmentalists, uneducated, uninformed, unscientific, and illogical. Those in favor tend to be depicted as more powerful, in

charge, and in control of decisions like politicians, scientists, and agri-tech businessmen, and are described as the opposite of the lay public: educated, scientific, and capable of making logical and rational claims. This section will outline studies that focused on the media's role in shaping the perception of this debate. Articles in this section were segmented into the 'media' subject category since they specifically looked at the framing and communication strategies of GMOs by news media.

Lockie (2006) conducts a content analysis of media discourses in newspaper articles from the US, UK, and Australia discussing food and sustainability. Lockie (2006) finds that:

> mass media representations of food-related issues do provide a useful focus to analyze the ways in which words, symbols, and meanings are deployed in bids to influence others and thus to order, or structure, food production-consumption networks. In light of claims that "consumer demands" are driving the growth of a variety of quality assurance programs and alternative food networks (Lockie, 2006, p. 313-314).

Lockie's approach to the framing of media is taken from Hannigan (1995), and Miller and Reichert (2000) and suggest that media discourses simplify the debate. Generally, GE foods and crops were seen as untrustworthy and their benefits do not outweigh the costs. Frames used to discuss GM foods, moving from more in favor to less were: as a scientific achievement benefiting human progress and modernization; an agricultural revolution that will solve international problems like hunger or food scarcity; an agricultural revolution that farmers must engage in to remain competitive; a moral and environmental conflict reported impartially; an international trade dispute; "the antithesis of anti-

scientific irrationalism"; a source of health or environmental risk; and a threat to democracy of food choice (particularly farmers/growers and consumers) (p. 318). The most prevalent theme in their sample was the moral and environmental conflict.

Maeseele's (2015) article adds to the debate of science versus everyone else/public by investigating the risk conflicts perspective through critical discourse analysis (CDA) of two Belgian newspapers. Two ideological cultures were found: that of 'unproblematized scientific consensus', which impedes democratic debate and defends the status quo, and another ideology that facilitates democratic debate by challenging assumptions, values, and interests and opposes scientific certainty. Maeseele (2015) teases out the idea of "risk conflicts", or a social conflict or debate in which social actors either politicize or depoliticize the controversy depending on their respective interests.

Augoustinos, Crabb, & Shepherd (2010) used CDA to look into how UK newspapers represented the debate surrounding GM food. Authors found that various stakeholder groups (public, government, science, and biotech companies) use rhetoric to make and support their claims. This paper found themes in the presentation of the GM debate such as a "battleground", "the Trojan horse", and "the irrational woman". Largely the governmental interests were seen as being bought by lobbyists of biotech; biotech companies were seen as money-interested, not environmentally-, people-, or scientifically-interested; and the public as uniformly opposed and at times irrational.

Cook, Robbins, & Pieri (2006) analyze various stakeholder groups delineating them into pro and con, or proponent and opponent divisions. Cook et al. (2006) used both cultural sociological and applied linguistic discourse in their analysis of British newspaper articles discussing the GM debate, conduct interviews with key stakeholders

(such as NGO representatives, biotech company representatives, and research scientists), and focus groups with groups of individuals identified as having specific opinions (such as undergraduates, farmers, and birdwatchers). Their findings suggest a divisive debate that is rooted in mistrust of political interests and corporate interests (on the anti-GMO side), whereas the pro-GMO side positioned those opposed as uneducated, unscientific, and akin to Luddites. Interestingly the researchers found many metaphors were employed such as a relationship to the Iraq war (going on at the time of their research) that compared the GMO debate as a "war", "battle", or an example of "bioterrorism". This quote by former US Secretary of Agriculture, Dan Glickman, found in the article sums up the opinion of the pro-biotech side:

> What I saw generically on the pro-biotech side was the attitude that technology was good, and that it was almost immoral to say that it wasn't good, because it was going to solve the problems of the human race and feed the hungry and clothe the naked…And there was a lot of money that had been invested in this, and if you're against it, you're Luddites, you're stupid. That frankly was the side our government was on. (Lambrecht, (2001), quoted in Cook et al., (2006), p. 14).

In a study of New Zealand's Life Science's Network by Motion & Weaver (2005), public relations are critically analyzed as they pertain to the media representation of biotechnology as presented and promoted by the Life Science Network in New Zealand. Motion & Weaver (2005) state their purpose in the study as a critical approach to public relations scholarship "…to investigate how public relations practice uses particular discursive strategies to advance the hegemonic power of particular groups and to examine how these groups attempt to gain public consent to pursue their organizational

mission" (p. 50). This is especially pertinent as we see the response of the public relations staff of various biotech organizations. Motion & Weaver (2005) point out for instance that in public relations and by proponents of bioengineering the term 'genetic engineering' is used. Whereas when those opposed use the term it is worded as 'genetic modification', a seemingly intentional diction choice. This article states the divide between proponents of genetic modification and those against very clearly. Those in favor claim that output of agricultural goods will be increased, pesticides reduced, shelf-life increased, toxins and allergens reduced (Motion & Weaver, 2005). Whereas those opposed claim that biotechnology poses risks unforeseen to "the environment, biodiversity, and the health and future of all species." (Motion & Weaver, 2005, p. 51). Those in support, proponents, and biotech public relations practitioners are found to "'…strategically deploy texts that facilitate certain socio-cultural practices and not others'" in order to gain 'public consent' (quoted in Motion & Weaver, 2005, p. 52; from Motion & Leitch, 1996, p. 299). Furthering this notion, Motion & Weaver (2005) propose that "…discourse is the vehicle through which power and truth circulate and the means by which public relations practitioners attempt to strategically maintain and reproduce the status quo or transform society" (p. 52). This suggests that those individuals who work to specifically promote biotechnology, such as the PR director of Monsanto, have a monetary and vested interest in ensuring the discourse being circulated and promoted by Monsanto and biotech industry is strategic and reinforces a positive view of the technology. Strategically public relations specialists must promote their products or claims through a process of "'articulation, disarticulation and rearticulation of

elements in a discourse'" (quoted by Motion & Weaver, 2005, p. 53; from Fairclough, 1992, p.93).

Howarth's (2013) discourse analysis of GM food policy in four UK newspaper editorials from the 1990s, "A 'superstorm': when moral panic and new risk discourses converge in the media", explores risk discourse drawing upon both moral panic and new risk theory, and media logic.

> conditions were there for a major scare: a sensitized public, a decade of food scares and a deeply polarized argumentative context between...proponents of GM food who sought to exclude moral and new risk type claims in an amoral-benefit argument for the expansion of the new technology...opponents of GM food sought to include moral and new risk type claims in a moral-harm argument (Howarth, 2013, p. 694).

The sustained media coverage of the GM debate was likened to a 'superstorm' using emotive, evocative, and mutually reinforcing discourses that potentially cause political turmoil and unrest, reinforce the public's distrust of the governmental interests, and potentially drive policy and social change (Howarth, 2013).

Hughes (2007) used in-depth textual analysis of newspaper coverage and interviews with the key media sources to enter the media's framing of the GM debate. Findings discuss how print media covered the consumption and production of GM crops in UK press in relation to the construction of the categorizations of "nation", or "...the symbolic power invested in the concept of nation is an example of the individual and societal self-deception; for in the globalized world we now inhabit, new technologies like genetic modification cannot be controlled by old frontiers like nation" (p.318). In

particular, what Beck and Bauman consider as discursive strategies to construct security, purity, order, and certainty (Hughes, 2007). Bauman (1999)'s concept of 'political economy of uncertainty' as it relates to the construction of 'nation', as there is a need to rectify the old concept of 'nation' in a world of shifting global borders (Hughes, 2007).

Casaus (2010) looked at news coverage and media framing of the 2005 controversy surrounding GM crops and the coexistence decree in Catalonia, Spain; Spain was first EU nation to allow GM agriculture. Casaus (2005) tested the following hypotheses: newspapers did not give the conflict priority; news dependent on groups opposed to GM; newspapers did not frame GM conflict as social and environmental issue but an ambiguous conflict. Authors use frame analysis and content analysis to identify six stakeholder groups: 1. government/political; 2. journalists; 3. local/social GMO opponents; 4. civil society; 5. GMO proponents; 6. scientists. Frames identified were: scientific-technical enthusiasm (GM is not the problem, it's public distrust); productivism (save the world, feed the hungry, the elimination of poverty); organic production and consumption (seen as the viable alternative to GM); rejection of coexistence decree; approval of coexistence decree; macrostructural (global neoliberal structures are to blame); environmental (but not many); and postmodern cyber-culture (GM as a cyborg). Framing of GM as social and environmental issue was not found to be as strong as scientific frames.

This section outlined studies that look into the media framing of the debate surrounding GMOs. Most analyzed UK newspapers, presumably since the UK debate is lively and they have historically outlawed the sale of GMOs (Augoustinos, Crabb, & Shepherd, 2010; Cook, Robbins, & Pieri, 2006; Howarth, 2013; Hughes, 2007; Lockie,

2006; Maeseele, 2015). GMOs were framed as a risk conflict, divided into either "unproblematized scientific consensus" or questioning science and encouraging debate (Maeseele, 2015). Breaking this down into the various discursive strategies employed were: scientific achievement/progress/modernization (Lockie, 2006; Maeseele, 2015; Motion & Weaver, 2005); agricultural revolution/food security (Casaus, 2010; Lockie, 2006); anti-science irrationalism (Augoustinos, Crabb, & Shepherd, 2010; Cook, Robbins, & Pieri, 2006; Lockie, 2006); moral and environmental conflict (Howarth, 2013; Lockie, 2006); mistrust of government and corporate interests (Augoustinos, Crabb, & Shepherd, 2010; Cook, Robbins, & Pieri, 2006; Howarth, 2013); a war, battle, or stalemate (Cook, Robbins, & Pieri, 2006; Howarth, 2013; Hughes, 2007); hegemony and power (Hughes, 2007; Motion & Weaver, 2005); organic foods as natural, GMO foods as unnatural or conventional (Casaus, 2010; Lockie, 2006); and health and environmental risk (Casaus, 2010; Lockie, 2006). Other less commonly found frames were: international trade disputes (Lockie, 2006); threats to democratic food choice (Lockie, 2006); and GMOs as cyborgs (Casaus, 2010). These studies make the viewpoint of the public more nuanced as new arguments emerge such as a distrust of the government and suspicion of corporate interests (Cook, Robbins, & Pieri, 2006; & Howarth, 2013). It should be noted that the majority of these studies are international, emerging from countries with stringent policies and regulations, or an emergent policy, or controversy. This indicates a gap in the literature, or a lack of studies addressing how the news media has represented the debate surrounding GMOs in the US.

Public Opinion Studies

Communication studies also focus on the perceptions and opinions of consumers on GM foods and are positioned here to emulate Beacco et al. (2002) and Moriand's (1992) Didactic Transmission, or that scientists produce the knowledge/information (source), the media interprets and transmits it, and then the public receives it. Therefore, this third subject, the public, reveals how GMO information is being processed, interpreted, and acted upon. Some studies are from a marketing perspective and research possible avenues and approaches to increase acceptance of GM foods by consumers.

Ribeiro, Barone, & Behrens (2016) assessed the opinions, beliefs, attitudes, and behavior towards GM food of 48 Brazilian consumers to see how these consumers were viewing/perceiving/acting on GM food so that GM food producers, food companies, policy makers, and regulators can direct their communication strategies. Using a Quali-Quantitative approach and Social Representations theory (Moscovici, 1988) and collective subjective discourse (CSD), authors looked at Brazilian consumers' beliefs, attitudes, opinions, and behavior. "Social representations are 'sets of values, beliefs and metaphors expressed by the members of a social group as a code of social exchange, so they can name and classify unambiguously the various aspects of their world and their personal and group history." Findings suggest consumer perception of GM food is, "GMF and transgenics are considered synonyms and anchored in the domain of the artificiality, 'made in the lab' and then, unnatural" (p. 126). Positive attitudes and willingness to purchase are associated with personal and social benefits; negative attitudes are associated with risk and fear. Plants that are GM are viewed more favorably than animals since it is seen as easier to control the technology. The study goes on to say

that when anything is unfamiliar and differs from the norm, individuals must find their own definitions that place the new technology somewhere in the common knowledge (Ribeiro, Barone, & Behrens, 2016). Authors suggest that future research be directed toward understanding the ethical and symbolic values underlying this distinction.

Harrison, Geller, Marshall, Tilburt, Mercer, Brinich, & Sharp (2012) studied the perceptions, benefits and risks, of persons suffering from chronic GI disease on a possible genetically modified probiotic, or therapeutic foods. Using focus groups (n=22) totaling 136 patients with GI disease found participants associated "natural" with less risk and morally "good"; whereas "unnatural" with "risky", "foreign", and morally "bad". If a probiotic was "natural" and unmodified it was seen as better than a modified one which carried inherent associated risks. Participants recognized that this was reductionist and not always true all of the time. Authors suggest future research address normative appeals embedded in language of "natural" and "unnatural" (Harrison et al., 2012). Authors end with this insight:

> Food occupies a unique place in society, as a substance necessary to continued existence (daily eating), an element of social and religious rituals (both fasting and consuming particular food products as symbols), a marker of class (organic, free-range, grass-fed meat products) and a key component in human health (p. 19).

Qin & Brown (2006) look into US consumer opinions about genetically engineered salmon and how information affects those opinions. "Lack of trust" has been identified as the main consumer objection to GE foods, over "knowing more", by communication scholars, therefore researchers conducted focus groups on consumer

objections. Findings suggest, communication about GE salmon should be basic yet specific, include process and product specific information, help consumer understand consequences and opinions. However, is it possible to address and assuage all uncertainty and possible risk through increasing knowledge through an educational campaign?

Kniazeva (2006) researched consumer perceptions of GMF to assess what would make concerned consumers change their minds and become more accepting. Using in-depth interviews framed with the theory of symbolic consumption researchers found that "consumers value goods for what they are symbolically to them." Consumers perceive GMFs with suspicion and do not readily accept them. The author suggests possible rebranding of GM foods with an emotional and personal benefit to the consumer (since the message that the technology will "feed the world", is not enough to allay all fears).

Kim (2012) looked into South Korean consumers' attitudes of the risks and benefits toward genetically modified (GM) food. The purpose was to understand how to market and create policy surrounding the labeling of GMF in South Korea. Generally, South Koreans are concerned about the potential risks, such as potential environmental hazards, of consuming GMF but found medical benefits and nutritional enhancement were viewed positively. Socioeconomic status and perceived benefits of a GMF were strongest indicators of purchase intention.

Klerck & Sweeney (2007) also looked at consumer opinions of GMF in Australia, the effect of knowledge types on consumer-perceived risk and adoption of genetically modified foods. They examined both the objective and subjective knowledge of consumers on GMOs to determine its relationship to perceived risk, and consumer

behavior. Using a mixed method approach employing surveys and face-to-face interviews, the authors found a need to increase communication targeting increasing consumer objective knowledge, reducing risk perceptions, and encouraging adoption, specifically from credible sources that are unbiased. Klerck & Sweeney (2007) conclude that since consumers have been consuming GE for "some time without knowing it and no human has been harmed" then therefore they are safe for consumption, however it is unclear how they reach this conclusion. The article also notes that US culture is relatively 'risk-accepting' when compared with other countries.

For instance, in Zambia, Bowman (2015) examined the controversy surrounding the 2002 Zambian rejection of food aid that was GM during a food shortage crisis in their article, “Sovereignty, risk and biotechnology: Zambia's 2002 GM controversy in retrospect”. Qualitative interviews of the oral histories of twelve key stakeholders and a review of Zambian newspapers were assessed for themes of political sovereignty, risk and biotechnology, and the presentation/memory of the food shortage. Policy makers blocked the receipt of GM corn to alleviate famine because they wanted to preserve their sovereign control as a nation of their agricultural supply (however, threats to health and environment were often cited by the government as the reason for rejection of aid). The Zambian government ultimately did not trust the historical, economic, and political context surrounding the introduction of the technology; or how it would be controlled. Risk became an important theme and frame for the researchers. Beck states (1992, p. 21)"…'risk' is understood here as a 'systematic way of dealing with hazards and insecurities induced and introduced by modernization itself'" (Bowman, 2015); "Risk is rarely 'reducible to the product of probability of occurrence multiplied with the intensity

and scope of potential harm' but is instead a social construction, in which 'even the most restrained and moderate objectivist account of risk implications involves a hidden politics, ethics and morality" (Beck, 2006, 333; quoted in Bowman, 2015, p. 1370). The importance of the article revolves around not only health and environmental risk perceptions of GMOs but also the implications of global politics and food sovereignty felt by the international community, particularly in the developing world, even during times of crisis.

Siegrist, Connor, & Keller (2012) also analyzed risk as well, but in a Swiss study, "Trust, confidence, procedural fairness, outcome fairness, moral conviction, and the acceptance of GM field experiments". During the time of the study, Switzerland had voted on a moratorium of the production of GE until 2013, but scientific research was not included and continued. The purpose of the study was "to examine how trust, confidence and fairness influenced the participants' acceptance of the field experiments". Quantitative modeling using regression analysis resulted in three factors significantly influencing participant's acceptance of GMO technology "economy/health and environment" (value similarity based trust), "trust and honesty of industry and scientists" (value similarity based trust), and "competence" (confidence). Authors also looked into "fairness" as this variable was found to play an important role in the acceptance of environmental hazards and found that it may be moderated by moral conviction, so if moral conviction is strong then procedural fairness will also be important to the individual.

Ferretti (2007) argues that the risk assessment of the public in the European Union could be mitigated by their involvement in regulation and policy, or to

'democratize risk'. Ferretti delineates this process into a 'legitimatory' and 'epistemic' claim; the former being that increased participation increases democratic legitimacy, the latter being that better quality outputs will come about if risk assessment includes value judgments. Ferretti argues that participation in regulatory decision making between the public and policy makers would resolve hegemonic tensions and reduce structural inequalities. Ferretti states that, "Citizen scrutiny is supposed to bring about better governance, and greater participation in public policy decision is usually regarded as a sign of a healthy and lively democracy" (p. 391), however structural inadequacies have made it hard to impossible for the public to participate in meaningful ways.

Kikulwe, Wesseler, & Falck-Zepeda (2011) used factor analysis of Ugandan attitudes, perceptions, trust, and factors influencing acceptance/rejection/purchase intention of a genetically modified banana. Findings suggest, that in Uganda, price and quality are the most important factors and even though there was concern about the negative impacts of the technology, the potential for purchasing based on perceived quality benefits was positive and high.

Durant & Legge (2005) used heteroskedastic probit analysis of a Eurobarometer survey (1999) that assessed European opinion of biotechnology. Since the survey was conducted in 1999 many opinions may have changed, at the time many were hopeful that GE technological advances in science, medicine, and cloning would resolve current problems, whereas the current public opinion has swayed more negatively in light of actions by GMO producers like Monsanto. The study finds that objective knowledge of GMO and the surrounding technologies to be low and poorly understood, however the study did not find that more education would be beneficial since those respondents with

the most knowledge were the most ambivalent about the technology. The largest predictive factor in their study was trust in the government, meaning governments and policy makers should increase their regulatory capacity and focus on rebuilding public trust in order to improve public opinion of GMOs.

Marris (2001) along with the Public Acceptance of Agricultural Biotechnologies (PABE) conducted focus group interviews with identified stakeholders (biotech companies, food manufacturers, food distributors, governmental regulatory agencies, expert committees, scientists, environmental and consumer protection groups, NGOs, and the general public), analyzed public documents, and public forums to study the attitudes, discourses and strategies of each stakeholder group, but to particularly parse out whether the public was being fairly represented in the GMO debate in Europe. Marris exposes what they call "myths" of public opinion and perception of GMOs. The first myth is that the public are either "for" or "against", and that no spectrum of opinion exists. Marris finds that in fact, public opinion is more nuanced and informed than usually portrayed, as they discriminated between various types of GMOs, understood contradictions in argument, and were not necessarily opposed to the technology but the institutional development of it (development, regulation, and control), aligning with findings of Durant & Legge (2005) who state that the public are skeptical of the government's ability to regulate and protect the population and environmental health. Marris' second myth, that the public is irrational and unscientific was debunked and further supported Durant & Legge's (2005) claim that it is not more education that the public needs but reassurance that risk will be controlled. In fact, the more educated the individual, the more skeptical the individual may be (Durant & Legge, 2005). Another myth exposed

was that of the public feeling that GMOs are unnatural. This was in fact confirmed but the public saw other technologies like pesticide use and antibiotics in animal feed as unnatural and troubling too, and also stated concern that agricultural science continues to push forward in a mode of unchecked productivity disregarding health and environmental concerns, as well as disregarding factors such as quality and taste. Other myths were that the public was conflating GMOs with other food controversies such as Bovine Spongiform Encephalopathy (a.k.a. "Mad Cow Disease"). It was found that indeed the public was increasingly concerned about food and technology and the risks inherent, and were warier of institutional failure, corruption, and fraud (Marris, 2001). The public demand for "zero-risk" was also found to be untrue. The public recognized risk inherent in many normal activities that were counterbalanced by benefits of those activities. However, what they did demand was a more realistic assessment by regulatory agencies because their constant reassurance of "no risks—[was] disconcerting and untrustworthy" (Marris, 2001, p. 547). The last myth Marris investigated was that of the public being selfish and not wanting to share developing technologies that could feed those in the developing world as unsubstantiated, and hypocritical, since Europe had enough food and was active in global food security efforts.

Studies of consumer perceptions and opinions are largely market driven and focus on consumer knowledge, opinions, beliefs, values, and perceptions held, and what needs to change in order to influence consumer acceptance of GM foods and technology (Durant & Legge, 2005; Kikulwe, Wesseler, & Falck-Zepeda, 2011; Kim, 2012; Klerck & Sweeney, 2007; Kniazeva, 2006; Qin & Brown, 2006; Ribeiro, Barone, & Behrens, 2016). Another subset of the studies of consumer perceptions found that the public has

been misrepresented in their beliefs and opinions of GMOs in research (Marris, 2001), and that the debate surrounding GMOs is much more nuanced, has to do with skepticism of the government's ability to regulate the technology and dubious corporate interests (Durant & Legge, 2005; Marris, 2012; Shiva, 1999/2016). Many of the studies are international in scope (Bowman, 2015; Durant & Legge, 2005; Kikulwe, Wesseler, & Falck-Zepeda, 2011; Kim, 2012; Klerck & Sweeney, 2007; Marris, 2012; Ribeiro, Barone, & Behrens, 2016; Siegrist, Connor, & Keller, 2012), whereas some are domestic (Harrison et al., 2012; Kniazeva, 2006). Studies point to an undefined and unquantified risk assessment, to both the environment and human health, by consumers as an important factor in their decision to question the technology (Bowman, 2015; Harrison et al., 2012; Siegrist, Connor, & Keller 2012). Bowman (2015) also found in their study that the rejection of GMOs pertained to a need for Zambia to retain food sovereignty and protect their food system. Klerck & Sweeney (2007) propose an increase in knowledge from a trusted source to decrease perceived risk and increase likelihood to purchase. Specifically, participants in Harrison et al.'s (2012) study objected that GMOs were unnatural and were therefore "bad", "risky", or "foreign". Whereas some participants objected to GMOs out of distrust, either of the technology itself (Qin & Brown, 2006) or questioned the government's ability to regulate it (Siegrist, Connor, & Keller, 2012). Acceptance of GMOs for Ugandans may be swayed by price and enhanced quality of the food (Kikulwe, Wesseler, & Falck-Zepeda, 2011). Consumer opinion and perspectives of GMOs are moderated by a number of factors such as risk and trust, regardless, GMOs are currently not labeled in US stores. The next section of the literature review apprises studies pertaining to GMO labeling and marketing.

Labeling Studies

The labeling of GMOs is required in 64 countries globally, click here for an interactive map (Center for Food Safety, 2016). Laws in these countries range from a total ban of GMOs, mandatory labeling of all GE foods with a threshold of 0.9-1%, mandatory labeling of many GE foods with a threshold higher than 1% or an undefined percentage, or mandatory labeling for some GE foods with numerous exceptions and no labeling threshold defined, lacks implementation, and enforcement provisions. If the US were listed on this map it would now fall under the last threshold because the law does not offer specifics to how much of an ingredient(s) can be modified or not in order to be labeled, lacks a clear implementation plan, and it does not impose penalties for companies caught breaking the law.

Caswell (2000) lists the policy considerations for GMO labeling laws as a "checklist" in the table, "Elements of GMO Labeling Policy". Some considerations include: how is genetic engineering, modification, or biotechnology defined (broadly or using specific techniques); is the program voluntary or mandatory (for both GMO and

non-GMO); which products are covered (all food, only key products, only certain food categories); which ingredients are covered (all, only the most important ones, all except preservative and additives); when are labeling requirements triggered (X% of product is GM, most important ingredients are GM, important characteristics are altered); how products made from animals fed with GM inputs are handled (labeling required if fed GM, not required if feed is GM); how are restaurant, take-out, bulk, and institutional foods handled (included in requirements, excluded from requirements); how are the companies required to verify GM status (self-certification by seller, testing, third-party certification); and can non-GMO labeling be used on products where there are no GM alternatives (yes or no).

Caswell's (2000) paper is largely a market analysis but is useful for understanding what should be addressed, how it should be addressed and why, and when a policy is enacted to label a food GMO. Caswell (2000) states that labeling is used to deliver information to the consumer that they are unable to evaluate or know, a concept used by economists termed 'credence attribute.' This credence attribute becomes a search characteristic for individuals who value the information. International consensus regarding labeling of GMOs has not been achieved even though many food products made using GMOs are traded internationally.

International trade regulations enforced by the World Trade Organization (WTO) require the labeling of foods grown using GM technologies to protect countries that have outlawed the importation and sale of genetically modified foods. One past story illustrates the impact that an improperly labeled food can have on the international market, that of Liberty Link Rice Strain produced by Bayer CropScience (the recent

purchaser in which Bayer acquired the Biotech giant Monsanto) (Schramm, 2007). First, Liberty Link Rice Strain was not yet approved for human consumption yet was found in long-grain rice in Arkansas and Missouri in August 2006 (Schramm, 2007). Then the European Community required testing of all imported rice over the following three months (Schramm, 2007). In August 2006, three barges of US imported long-grain rice tested positive to containing Liberty Link strain; all three barges returned to the US with all of their cargo. This scandal brought lawsuits, as US agricultural producers of rice's profit margins were affected—the price of wholesale rice, "regulatory burdens", and possible property loss (of rice product and fields that were contaminated by the strain) (Schramm, 2007). How the rice strain contaminated national and international rice is the topic for another paper, however the economic impact of improper labeling is monetarily quantifiable, a cause for lawsuit, and affects international trade regulations in this instance.

Hellier, Tucker, Newbold, Edworthy, Griffin, & Coulson (2012), in their article, "The effects of label design characteristics on perceptions of genetically modified food," analyze various labeling strategies that may increase or reduce perceptions of risk in GM foods such as color, source of warning, wording (probabilistic or definitive), content (GM or Non-GM), product type (synthetic or natural), explicitness of wording, context (GM or preservative). Hellier et al. (2012) conducted an experimental design to test the effects of label color, wording, content, and attributed information source to detect consumer hazard perception and purchase intention. Their findings align with warning label research, that consumers are warier of hazards, and less likely to purchase, when any

label was put on the product, even if the label was to state that the product contained no GM ingredients.

Vujisid (2014) looked into countries, specifically in the EU and the US, and their labeling policies to explore whether Serbia should label GMF. The paper looks into: label complexity, opting for positive or negative labeling, voluntary or mandatory labeling, minimal GM percentage, focus of regulation, size and spot of label on package. Vujisid (2014) suggests labeling GMFs in Serbia to promote consumer rights, choice, and access to information.

Gruère, Carter, & Farzin (2009) used analytic modeling to explain which factors most influence international genetically modified food labeling policies. Authors identified three interest parties in labeling: the producers, the consumers/voters, and civil groups. Three parameters affecting adoption of labeling laws were the weight of each interest group in votes, degree of support for labeling within groups, and expected welfare change associated with mandatory labeling. The explanations found for the enactment of labeling laws were domestic political factors, international trade factors, and macroeconomic factors. Labeling countries were more developed and less dependent on agriculture. Whereas countries that did not have a labeling law were found to be aligned with Cartagena Protocol on Biosafety and did not have a green NGO/Anti-GMO organization actively advocating for a labeling law. Countries producing GM crops as exports had more pragmatic and less costly labeling policies. Trade relationships encourage imitation and tend toward similar policies. For instance, the EU and Japan have the most stringent labeling laws and policies, emulated by much of Asian and European countries.

Ling & Lakatos (2014) looked into California's Proposition 37 and the implications it carried for GMO labeling. California's prop 37 that would have required mandatory labeling of GM foods but did not pass by a narrow margin. "The arguments against mandatory labeling of GM foods are largely based on the decrease of consumer food options, higher consumer costs, inefficiencies in the international trade of food and agricultural products, and the higher costs of regulation and compliance" (p. 56).

Chembezi, Chavarest, Wheelock, Sharma, Kebede, & Tegegne (2008) evaluated the perceptions of farmers on proposed mandatory labeling of GE using a multivariate statistics/logistic regression model. Most farmers are in favor of labeling; half completely agree. They believe that biotechnology benefits larger farmers, and that farmers will have to be dependent on the corporations producing it, such as the producers of genetically modified seeds. The farmers were neutral on consumer acceptance of biotechnology and undecided on the government's ability to regulate the technology.

Gruère, Carter, & Farzin (2008) compare Canada and EU choices to enforce labeling laws and how this impacts the (global) market and consumer choice. Using analytical modeling and regression analysis authors found that mandatory labeling decreases consumer choice instead of increasing it, due to the fact that the market may be limited, providing less choices, as consumers may select non-GMO items (study was done largely from a market driven perspective). The existence of GM and non-GM foods at retail depends on labelling policy, consumer perceptions, and the type of product. "According to this view, mandatory labelling is objectionable because it sends a signal that GM food may be undesirable. The North American food industry views the EU labelling policy as disguised protectionism" (p. 1473). This article defines 'choice' as

more products on the market to choose from, not the ability to choose, through an informed decision making process, what to purchase based on what is in your food and then therefore decide whether or not to purchase. These are two different definitions of choice.

Phillips & Hallman (2013) in their article, "Consumer risk perceptions and marketing strategy: the case of genetically modified food", assess risk perception of GM food labels. Phillips and Hallman (2013) use focus group interviews of consumers that they stratify into levels of knowledge of GMO from 'highly informed' to 'less informed'. The authors test various types of labeling language from ambiguous ("may contain GM ingredient"), definitive ("does contain"), worded as a benefit ("increases protein"), or contains a perceived benefit to the environment/for all ("decreased use of pesticides"). Focus group participants in the less informed group were more alarmed by perceived benefits (they were not aware that their foods may contain GM or had pesticides), those highly informed were skeptical of it all but slightly viewed the perceived benefit of decreased pesticide use as beneficial. This study was written for marketing managers and begins with assumption that 95% of new products on the market fail because they are perceived as risky by consumers. Study is based on the hypothesis that increasing consumer knowledge will increase consumer acceptance, but their results counter this as those who are most informed are still skeptical. The study also makes the assumption that there are only two responses to risk in a cost/benefit analysis: that the benefits outweigh costs, or costs outweigh benefits. But is there a grey area suggesting the research is inconclusive, therefore taking an indefinite risk seems risky?

As the US moves forward to enact the new labeling law it may be important to look at and draw from the examples of laws already in place in other countries (Vujisid, 2014), and Caswell's (2000) checklist "Elements of GMO Labeling Policy" that outline all of the considerations policy makers should clearly address/answer and address what should be included in labeling. Particularly in light of market acceptability and attempting to navigate the tricky waters between the food industry and consumers, the real costs and benefits, appropriate label design, and taking into consideration the consumer's right and desire to know may enhance the consumer's likelihood to purchase (Ling & Lakatos, 2014; Phillips & Hallman, 2013). The studies presented in this section run the gamut of range from those who are pro-industry and investigate marketing to improve consumer acceptance (Gruère, Carter, & Farzin, 2008; Hellier et al., 2012; Phillips & Hallman, 2013), and production (Ling & Lakatos, 2014); and those that are in favor of stricter, or mandatory labeling policies (Chembezi et al., 2008). It will depend on the goals of the policy makers as to how they will enact and enforce the new labeling law.

Twitter Studies

"Twitter does not just allow you to peer through a window; it allows you to look through manifold windows at once" (Bonilla & Rosa, 2015, p. 7).

Political

This section highlights some relevant studies that use Twitter to research political phenomena. Using network and content analysis Himelboim, McCreery, & Smith (2013) examined exposure to alternate ideologies on Twitter regarding political tweets in the

2010 US midterm election using popular political topics like global warming and GOP. Researchers coded for content using political stance (neutral, liberal, or conservative); whether the tweet contained a link; what the link connected to (traditional media, grassroots media, government websites, video websites, or other); and the political orientation of the link, if any. Researchers looked at following or followers as a measure of network and interaction, however they do admit that retweets and replies would have been a better measure of actual network connections and engagements but would have decreased their sample size. Findings indicate that although social networking sites like Twitter are increasingly being used as sites for political discussion, like-minded clusters of individuals often conversed upon shared political ideology, and although cross-ideological conversations occur they do not lead to meaningful interaction (Himelboim et al., 2013).

Boulianne (2015) conducted a meta-analysis of social media use and its relationship to civic and political engagement especially in light of the Arab Spring (2011) and the Obama campaign's (2008 and 2012) successful ability to elicit political involvement. Findings support that overall there is a positive relationship between social media use and participation: more than 80% of the coefficients are positive, yet only half of the coefficients are statistically significant. In addition, Boulianne (2015) is unable to affirm whether the relationship is causal or transformative since social science research relies largely on estimates and cannot say with certainty whether the observed relationship is causal or correlational. Boulianne notes that the included studies (36 with 170 observable coefficients), two theories emerged for the effect of social media use: 1. Social media as a forum for gathering information or news from one's network, and 2.

Social media as a space to forge social networks that can be mobilized into actions, larger networks increase exposure including more access to weak ties.

Unlike Boulianne's (2015) meta-analytic approach to measuring civic and political engagement on social media, Bonilla & Rosa (2015) use a method they are calling "hashtag ethnography" to look into the use of the hashtag #Ferguson in the wake of the police shooting in Ferguson, Missouri of unarmed African American teen Michael Brown, and reference other instances of police shootings, violence, and brutality toward black Americans preceding and following Michael Brown's death. An ethnographic approach to Twitter data allows researchers to follow the unfolding in real time of civic and political engagement, in particular, "…around issues of racial inequality, state violence, and media representations" (Bonilla & Rosa, 2015, p. 5). For instance, the week after the shooting, 3.6 million tweets appeared on Twitter referencing Michael Brown, within a month #Ferguson had appeared 8 million times. Researchers note that conducting ethnographic research on a "non-place" based Internet platform that is fleeting and virtual injects multiple new considerations for researchers who are not in-situ or geographically located, it may still serve as a productive site for ethnographic research as it can aggregate multiple perspectives from various stakeholder groups (journalists, citizens, activists, politicians, police, etc.) from many locales instantaneously and simultaneously, providing a space for multivocality and dialogicality (Bonilla & Rosa, 2015 citing Bakhtin, 1981. As stated previously, "Twitter does not just allow you to peer through a window; it allows you to look through manifold windows at once" (Bonilla & Rosa, 2015, p. 7).

Environmental

Newman (2017) used Twitter to assess the release of the IPCC Working Group 1 summary to analyze who the most active user group was (Government, Non-elite, Journalist, Political, Scientist, Media, or NA), the subject most discussed, and the type of media garnering most attention. Findings suggest that non-elite actors were the most active on Twitter which may support theories that social media sites like Twitter do provide an arena for diverse voices to interact, advance, and contest mainstream information (Chadwick, 2013, as cited by Newman, 2017). Newman (2017) used a spreadsheet-based archiving program called Twitter Archiving Google Spreadsheet (TAGS) to aggregate tweets from a specific time at the release of the Working Group 1's report and used a mixed-methods framework inspired by Freelon & Karpf (2015). Their method involved a three tier design using popularity and frequency analyzed via retweets. The first stage appraised which users attracted the most attention based on retweets, then ranked the top 100 based on frequency. The next stage was to assess which subject was most tweeted about and was also determined using frequency of retweets ranking the top 100 tweets. The last stage looked at frequency of retweeting URLs and was again ranked using a frequency analysis, ranking 1-100.

Twitter is a useful platform to disseminate real-time updates, the latest news and officially released information, and get on-the-ground updates from those affected by environmental disasters like earthquakes, typhoons, hurricanes, and flooding. Risk and crisis management communication is a growing field that may benefit from utilizing Twitter and other social media platforms during times of emergency and environmental disaster.

Palen, Starbird, Vieweg, & Hughes (2010) looked into the use of Twitter during the 51-day 2009 Red River Valley Flood threat. Authors used the Twitter API to search "Red River" and "Redriver" subject terms. Of the tweets analyzed, spatial proximity and timeframe predicted the most tweets, as time is of the essence in emergency scenarios and one's spatial proximity to the emergency zone may spike usage. Authors suggest that retweets may help other researchers to denote the most relevant tweets and assist in eliminating noise. Local information was most likely to be retweeted since it was most relevant, locally situated, and most up-to-date; however, official sources on Twitter retain a vital role during emergency management and response efforts. Authors found that communication on Twitter during the flood was enhanced by local, "…active manipulations by interactive members of the information space who add context to it, support it, refute it or, in this case, create new representations of and new distributions for it" (p. 16).

Takahashi, Tandoc, & Carmichael (2015) found in their study of Typhoon Haiyan in the Philippines in 2013, that most communication on Twitter following the disaster was retweeting secondhand information. However, authors note that Internet and power were down throughout the islands following the typhoon so their data is limited by who had access to Twitter. During times of disaster and crisis various social media sites have launched unique ways users can access information. Twitter launched Twitter Alerts in 2013 to assist and prioritize official sources of information (Takahashi et al., 2015). In 2014 Facebook launched Safety Check so users could check themselves safe during times of emergency and crisis (Takahashi et al., 2015). Social media platforms can provide space for communication, rapid detection, situational awareness, and relief coordination

during environmental disaster and emergency (Takahashi et al., 2015). Best practices for organizations using social media to communicate during times of crisis and emergency are: "…communicate quickly, be credible, be accurate, be simple, be complete, and communicate broadly" (p. 393, Takahashi et al., 2015, citing Freberg, Saling, Vidoloff, & Eosco, 2013).

Latonero & Shklovski (2011) investigate Twitter use by emergency responders through a case study of the Los Angeles Fire Department (LAFD) and their methods using Twitter to respond to fires and crises. Twitter has served a valuable mode of crisis communication in large-scale disaster such as the Banda Aceh Tsunami, Southern California Wildfires, the flooding of the red River Valley, and in times of political crisis such as the protests in Egypt in 2011 the Iranian protests of 2009, and the Democratic and Republican National Conventions. Authors note that Twitter can be used in four different ways in times of emergency management and crisis and risk communication: users self-generating content about the emergency and sharing it among their network, users retweeting other's posts, media posts, official and unofficial sources, emergency responders and management officers using twitter to communicate official and unofficial messages to those affected by the emergency, and emergency management officials monitoring Twitter feeds to gather information about the crisis—no longer a one-way, traditional stream of information and communication from emergency management organizations and responders, to the news, then to the public, but "interactive, participatory, synchronic …reduce[ing] the reliance on the news media" (Latonero & Shklovski, 2011, p. 6). The study finds that typically the adoption of new technologies such as Twitter are led by innovators in their departments, termed "evangelists", and in

the case of the LAFD, the evangelist trailblazing the use of social media is Brian Humphrey. Humphrey believes that, "'Short of motorized fire apparatuses, this technology is the best thing that's happened to our department in 122 years…It holds more potential to save lives than any other civic tool'" (p. 8). Humphrey differentiates news media from social media as appointment-based media (meaning you have to schedule the time to watch the news or listen to it on the radio) whereas social media sites like twitter are 'real-time', allowing for instantaneous dissemination of information. Recognizable drawbacks are that not everyone uses or has access to Twitter, validation of information found on Twitter can be difficult leading to misinformation, and it may not be practical or useful for all organizations (Latonero & Shklovski, 2011).

Health

The internet and social media sites have proven invaluable for health researchers to mine data in areas of population health, disease monitoring and tracking, and public health trends like dieting or tobacco use. Paul & Dredze (2011) suggest Twitter can be used to gauge population and public health measures such as influenza rates, medication use, allergies, obesity, insomnia, etc. and provide a method, Ailment Topic Aspect Model (ATAM), for including illness tracking over time, behavioral risk tracking, geographic analysis, and symptom and medication tracking. Included in data mining of sites like twitter are time stamps, geolocations, languages, and certain demographics associated with the tweet that in aggregate could provide important epidemiological and public health tracking mechanisms. Authors compare their data to that of the CDC and other national tracking and monitors of health ailments. Findings suggest that Twitter provides a path for tracking illnesses that are common and do not typically require a doctor's visit

such as the flu, obesity, and insomnia, and Twitter is less expensive and time consuming than other epidemiological tracking systems. However, limitations exist: it is hard to assess an individual's lived experience as the data collected are population level, geographic analysis is also hard to pinpoint and researchers could only narrow by state, some users tweet about a family member also skewing geographic data, and it is hard to ever report comprehensive data.

Paul & Dredze (2012) developed a model for tracking public health trends and population health self-reporting on Twitter coined Ailment Topic Aspect Model (ATAM). The ATAM model, "1) discovers a larger number of more coherent ailments than LDA [Latent Dirichlet Allocation], 2) produces more detailed ailment information (symptoms/treatments) and 3) tracks disease rates consistent with the published government statistics (influenza surveillance) despite the lack of supervised influenza training data" (p. 1). This model functions by mining word distributions and associated topics in an algorithm to filter and isolate tweets that pertain to users' health experiences, such as the general term "allergies", associated with the symptom "sneezing", and the treatment "Benadryl". Paul & Dredze (2012) advocate for the use of the model in disease tracking and surveillance to save money and time. Another useful data mining tool, "Carmen" was developed by Dredze, Paul, Bergsma, & Tran (2013) to get more accurate geospatial tracking of users for monitoring population health trends, in this case influenza, since the location of Twitter users is only available in two ways: if a user marks or tags their location when tweeting, or contained within their optional profile information.

Rodriguez-Martinez (2017) developed a Twitter Health Surveillance application to monitor population health on the ongoing Twitter stream. The computer application platform developed is unique as it allows users to define the function and topic of their search of the current, live Twitter stream, instead of curating from backlogged archival Twitter. Although the development required a complicated combination of computer software, applications, and programming the resultant monitoring system could prove useful for population health surveillance.

Gaps in the Literature

The extant literature reviewed points to a divisive debate lacking transparency and dialogue. To date, no studies were found that examine the US stakeholder opinions regarding the approval and impending sale of AquAdvantage salmon, especially not using Twitter, although one study (Qin & Brown, 2006) considers US consumer perceptions of GE salmon. The literature also reveals a significant lack in the attempt to value, listen to, and understand the opinions and perspectives of the public in regard to GMO food and its production (Marris, 2001); and this study will focus on the public's discursive frames of GMO and their stated desires. In fact, the opposite is usually highlighted: the public is in a knowledge deficit, and the scientists are all knowing, yet an attempt at dialogue, however called for, has not occurred. Nor was there a study evaluating how the AA salmon is being talked about—as a commodity or as an animal. Most research points to the need to assuage risk, of both the ability of the government to regulate the new technology and also the science behind its production, instead of additional education. In fact, most studies focus on the arguments and perspectives of those opposed and less on possible resolutions or avenues of dialogue. This study will

use qualitative content analysis of Twitter to inductively code data to find out who is involved in the Twitter colloquy of AA salmon, what their opinions are, whether there is a dialogue between discussants on Twitter, and to what end (Braun & Clarke, 2006; Emerson, Fretz, & Shaw, 2011; Gerasimova, 2016); this will be explained in detail in the methods chapter. Further, there is only one US study on consumer perceptions of genetically engineered salmon (Qin & Brown, 2006), and no studies found in other countries to date, especially using an online social media site such as Twitter where anyone can post their opinion. This study will address this dearth of existing explorations into the acceptance or rejection of this novel technology, particularly from a non-market/corporate perspective and pertaining to the AquAdvantage Salmon, and make suggestions to create spaces for dialogue between the stakeholder groups.

Proposed Study

The proposed study is to investigate the online conversation on Twitter regarding AquAdvantage (AA) salmon, the first USDA salmon approved for sale in the US, although still not yet available to purchase domestically. Twitter was identified as a site for data collection since it is a public, democratic space, open to anyone with access to the internet, at any time the individual or organization chooses to share a thought, information, news media, etc. about the AA salmon. This site was the chosen because of the ease and access a variety of stakeholder groups have, in comparison to a hypothetical newspaper article, or online article, featuring the AA salmon would require initial exposure and information seeking. Using the primary methodology of qualitative content analysis (Elo & Kyngäs, 2008) and incorporating selected elements of thematic analysis (Braun & Clarke, 2006) and grounded approaches to discourse analysis (Emerson, Fretz,

& Shaw, 2011) the selected data will be analyzed to answer the research questions. Specifically assessing who the participants engaged in the online colloquy were, their allegiance to a stakeholder group (if one aligns), and their perspectives (for, against, or neutral) were analyzed to understand the framing/themes, definitions, objectives, and possible obfuscations of information to attempt to create dialogue, common ground, and clarity. This study filled gaps in the research regarding US consumer perceptions of the AquAdvantage salmon, deconstructed the rhetorical strategies of engaged discussants, and addressed the need to create common language and dialogue between involved parties. To this end, the following research questions guided the analysis.

Research Questions

RQ1: Which stakeholder group are Twitter users who post about AA salmon affiliated with?

> **RQ1-A:** Are these Twitter users aligned with a perspective, goal, or stakeholder group identified from the literature (Public citizen, policy maker, scientist, news media affiliate, or producer of the salmon)?

RQ2: What themes and frames are used by Twitter users to *construct/make meaning* and *position* themselves in the ongoing GMO debate pertaining to AA salmon?

> **RQ2-A:** How do Twitter users *define* GMOs/AA salmon, the technology used to produce it?
>
> **RQ2-B:** How do Twitter users *operationalize* their constructed discourse to accomplish their objectives; and what are their objectives?
>
> **RQ2-C:** Are there any obfuscations, deletions, or deliberate misconstruals of information present in the online communication analyzed?

RQ3: How is the AquAdvantage salmon presented and constructed? That of a commodity to serve human interests or otherwise; and is that discourse variable among discussants?

Purpose of Research Questions

The purpose of **RQ1** and **RQ1-A** were to assess who is involved in the Twitter colloquy of AA salmon. Which stakeholder group are discussants affiliated with? In what ways are they similar to groups who are identified in the previous literature (public citizen, policy maker, scientist, news media affiliate, or producer of the salmon)? By answering these questions, I was able to understand who is/are playing a role as an active participant in the ongoing debate and discussion surrounding AA salmon on Twitter. These questions were answered and elaborated upon through conducting the basic content analysis schema.

The purpose behind **RQ2** and **RQ2-A-C** was to answer the qualitative portion of the research study. These research questions deal specifically with the intention, sentiment, and meaning created underlying each Twitter post, and reference each tweet's intentions and goals. Additionally, these questions serve in further development of future studies, as they exposed what was being talked about and how, and what wasn't being discussed, thereby illuminating additional questions and paths of discovery.

The purpose of **RQ3** was to provide the ability to delve further into the ways in which this online discourse includes or overlooks animal rights in discussions about AA fish: are fish, like the AA salmon perceived as sentient beings, who have a consciousness and feelings that deserve animal rights, or they presented and referred to as a commodity to be bought and sold? Are the salmon being denied their natural and instinctual needs

and patterns of animal behavior, such as being raised in rivers and spawning in their original locale, or are indoor pens and growing systems adequate and sufficient? Is there a moral responsibility to advocate for their behalf, considering they have no agency or voice of their own?

This question (RQ3) will further future studies and will also serve as a starting point for theory building that may add to critical environmental theory. In addition, the questions Carbaugh (1996) asks in "Naturalizing Communication and Culture": "What expressive means are available for giving 'nature' [the AquAdvantage Salmon] a voice? What meanings are associated with these expressive means? When are they used? By whom? What are the environmental, political, social, and interactional consequences for these expressive means, and the meanings that—in particular times and places—give voice to the natural?" (p. 39). Also, as Aaron Stibbe (2012) investigated in a chapter addressing Atlantic salmon in *Animals Erased*: do salmon have value beyond serving the needs of humans; and is that value reflected in the discourse found on Twitter regarding the AquAdvantage salmon? These questions assume that discourse is hybrid, layered, and multiplicitous and can be used as a social text to be unpacked and deconstructed to understand how our culture views and relates to our world (Marifote and Plec, 2006). How is nature being represented through human language and communication, and what role does this play in the framing and subsequent treatment of AA salmon?

Further, my research, although it leans heavily on the foundational ideas of social construction of relations and meaning, is also wound into environmental relations that have long been thought to not play a part in making human socially constructed meaning, as much of the natural environment is often seen as separate and not equal to human

society. Social construction in the communication scholarship has been largely attributed to human communicative influence. Therefore, a contribution of my research will be to counter this presumption by engaging with scholarship that questions this notion and through my research question that addresses the framing of the salmon (as either a commodity or an animal with rights), thereby giving it a voice and agency (Carbaugh, 1996; Stibbe, 2012).

Conclusion

The review of the relevant literature in the subject areas of science, media, public perceptions, labeling, and Twitter research reveals a debate between stakeholders, often reduced to scientist versus the lay public. However, these arguments are diminished by studies showing that those lay persons with the most knowledge are often the most skeptical of GMOs. On the contrary, increased dialogue that allows for two-way conversations, cultural relevance, reduction of perceived risk, and intuitive reactions to be addressed, may in fact be the path toward resolution. The literature suggests that stakeholder involvement may be motivated by vested agendas and that their discursive strategies may reveal these. This research aims to unearth who the stakeholders are, their agendas, and their motivations through a close read of their communication on Twitter.

This chapter introduced the context of AA salmon, the context of labeling GMOs in the US, the researcher's ideological statement, the research study's theoretical underpinnings and methodological approaches, and a review of the literature broken down into science communication studies, media studies, public opinion studies, labeling studies, and Twitter studies. In addition in light of the literature review, gaps in the

literature, a framing of the proposed research study, and the research questions are presented. The next chapter lays out the methodological approach of the study.

Chapter Three: Methodology

Methodological Overview

This chapter outlines the research project, a brief theoretical approach, and the methods that were used to analyze the data and answer the research questions. Language and meaning represent deeper structures that have been created through social interactions, conversations, and our description and ascription of meaning to objects and words in our life:

> a discourse may be thought of as a set of statements. That set of statements or discourse, according to Foucault (1996), comprised 'the existence of rules of formation for all its objects, for all its operations, for all its concepts, and for all its theoretical options' (p. 35). Thus, discourse is both symbolic and constitutive, structuring how we know, understand, speak about, and conduct ourselves in that world (Motion & Weaver, 2005, p. 52).

Albeit briefly, using only 280 characters, a tweet can convey quite a bit of information: you can embed a link to an outside article or source, you can impart feeling and sentiment, you can share photos, you can converse with others, or you can retweet what someone else has said indicating an alignment in perspective. With this in mind, a methodological process was applied to analyze the data found on twitter to detect stakeholder affiliation, themes, frames, positionalities, definitions, objectives, missing information, and value of the tweets analyzed.

Methodological Approach

The methodological approach is previewed and summarized in the outline below.

Phase 1: Content Analysis

1) Coding Schema Development
    a. Secondary Researcher Assessment/Revision
2) Data Collection
    a. Tweet Data, Stakeholder, Sentiment, Account Information
3) Content Analysis
4) Tweet Sentiment Assessment Second Coder
    a. Revise Codebook Definitions
    b. Reach Consensus

Phase 2: Thematic Analysis of Tweets

1) Familiarize with Data Corpus/Coding Memos
2) Generate Themes
    a. Stakeholder Group Communication Strategies

Phase 3: Grounded Approach to Discourse Analysis

1) Analyze formulations, stories, context, terms/types/typologies, theories
    a. Debates Between Stakeholders

Qualitative Content Analysis and Coding Schema

A qualitative content analysis was conducted first using the coding schema developed (see Table 3) from the relevant research to collect the descriptive data about each tweet; any clear link to a stakeholder group; the overarching sentiment of the tweets, linked content, and any visual information; and data about each Twitter account. After code book and coding schema development, a secondary researcher assessed instruments for error and alleviate coder burden, disagreement, or confusion as suggested by Colditz (2018). Once the schema was verified initial coding took place.

The coding schema collected the following specific data points: Twitter account, tweet text (copied directly from the original), link to the tweet online (Colditz, 2018), timestamp, @mentions of other users, references to external URLs, replies, likes, and retweets (Bruns & Steiglitz, 2014) (see Table 3 for a complete coding schema example). The primary coder then assessed and collected subjective demographic data of the account user: whether they were an individual or organization, if an applicable the sex of the account, stakeholder affiliation (if easily deduced), the type of activity of the tweet (original content, sharing information, or replying) (Bruns & Steiglitz, 2014), the sentiment of attached URL or web content, and sentiment of any attached visual content. Additionally the type of activity the account holder participates on Twitter was recorded including amount of tweets generated, number of followers, amount who are following, number of likes, number of lists subscribed to, and number of moments posted as a method to understand the account's engagement, reach, and activity on Twitter (Burgess & Bruns, 2012). The primary coder created coding memos on any emergent initial themes, ideas, and/or issues to launch the first stage of the open coding process

(Emerson, Fretz, & Shaw, 2011). Next, two coders assessed the sentiment (pro, con, or neutral) of the tweet messages as a way to infer the purpose of tweet, if there was disagreement the codebook definitions were reassessed and revised, and tweets will be conferred upon until consensus is reached (Colditz, 2018).

Thematic Analysis

The next stage the methodological design was a coupling of qualitative content analysis to code for themes and frames (Elo & Kyngäs, 2008) and thematic analysis, as outlined by Braun & Clarke (2006). Thematic analysis is a constructivist method of qualitative research that generates themes, or observable patterns, from a corpus of data to make sense of the underlying, often unspoken, meanings being made (shared/rejected, spoken/unspoken) by various stakeholders.

The first two steps in this process, familiarization with the data corpus, and the generation of initial thoughts, codes, themes, ideas, and issues was conducted during the content analysis stage (Braun & Clark, 2006; Emerson, Fretz, & Shaw, 2011). This stage involved the distillation of the preliminary codes into themes, the ways they interrelate, and defining the themes as put forth by Braun & Clark (2006), and Elo & Kyngäs (2008). The thematic analysis stage determined if the focus/theme was the same as or contrasts with those found in the literature review: scientific achievement/progress/modernization (Lockie, 2006; Maeseele, 2015; Motion & Weaver, 2005); agricultural revolution/food security (Casaus, 2010; Lockie, 2006); anti-science irrationalism (Augoustinos, Crabb, & Shepherd, 2010; Cook, Robbins, & Pieri, 2006; Lockie, 2006); moral and environmental conflict (Howarth, 2013; Lockie, 2006); mistrust of government and corporate interests (Augoustinos, Crabb, & Shepherd, 2010; Cook, Robbins, & Pieri, 2006; Howarth, 2013);

a war, battle, or stalemate (Cook, Robbins, & Pieri, 2006; Howarth, 2013; Hughes, 2007); hegemony and power (Hughes, 2007; Motion & Weaver, 2005); organic foods as natural/GMO foods as unnatural or conventional (Casaus, 2010; Lockie, 2006); and health and environmental risk (Casaus, 2010; Lockie, 2006).

A Grounded Approach to Discourse Analysis

Emerson, Fretz, & Shaw's approaches to coding qualitative data (formulations, stories/narratives, context, terms/types/typologies, expanations, and theories) were used to as the next stage in qualitative data filtration. Formulations and definitions of terms proved useful to decode underlying meaning in terms like "natural" or "frankenfish" dependent on the message and stakeholder group context. Stories and narratives were woven by members of particular stakeholder groups, like the AA salmon being the solution to larger societal and environmental problems like global climate change and global food insecurity. These qualitative coding approaches proved particularly useful when analyzing the debates between and among stakeholder groups, particularly the goals and objectives of stakeholders. A phased methods flow chart is included in Table 2.

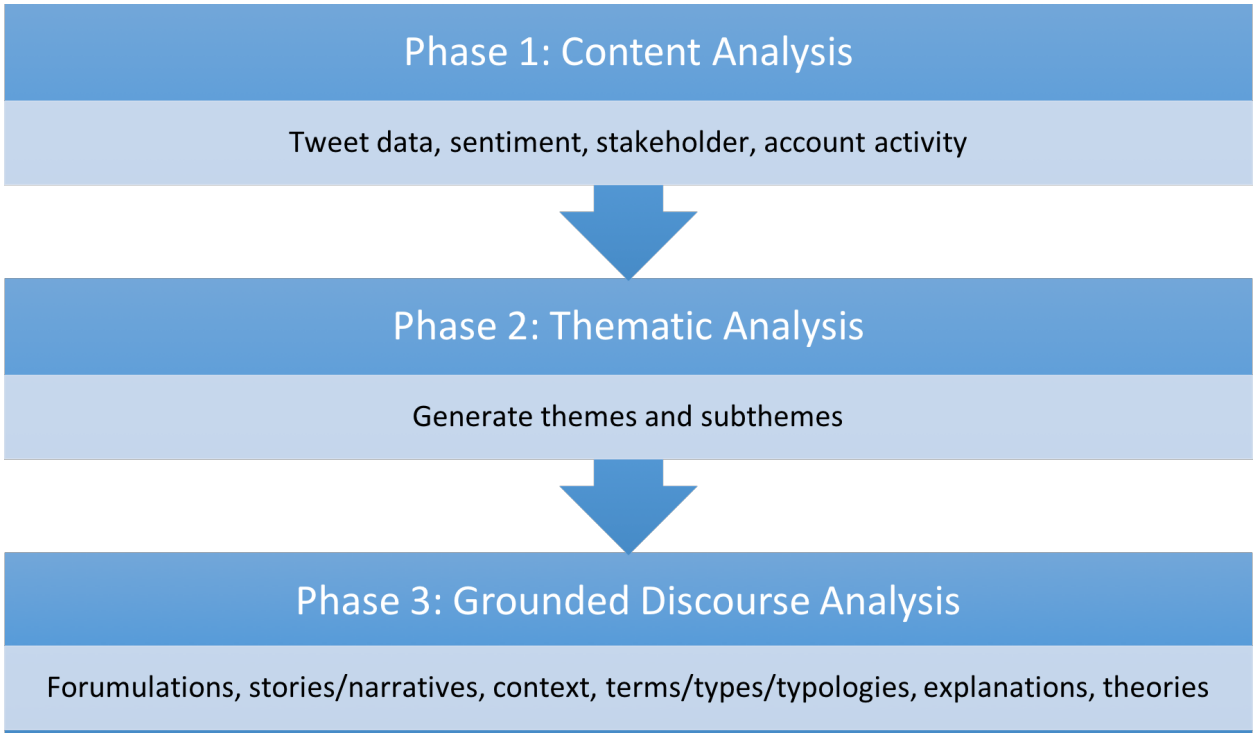

Table 2 - Phases of Data Analysis

The Sample

The Twitter search engine was used applying the keyword search, "AquAdvantage Salmon" to avoid underrepresentation of the sample size limitation found in hashtag research (Bruns & Stieglitz, 2015; Chang, 2010; Colditz et al., 2018). Using the "latest" feature in the Twitter search engine (as opposed to the "top" search feature), all tweets from the time of the sample extraction reverse chronologically to the time AA Salmon was approved of by the FDA (n=649) (November 2015). Tweets were collected until data saturation was achieved. Tweets were excluded if they were composed in any other language than English, or if they were irrelevant (i.e. not pertaining to AA salmon). The data points collected are listed in the coding schema (see

Table 3) and data collection methods. Demographics were also gauged and described, content pertaining to the tweet was collected, engagement of other users, purpose and sentiment of tweet, link (if applicable), and inclusion of attached pictures (if applicable).

Data Collection

The following data points were collected and entered into an excel spreadsheet: a copy and paste of the Tweet (emojis cannot be copied so they were described in brackets), the Twitter handle of the user (ex: *@123456,* this handle links electronically to their account but does not contain their username), an electronic link to the tweet on Twitter, the tweet timestamp, mentions of other users (@mentions), any URLs or internet linked content, replies to others, retweets of the collected tweet, likes of the collected tweet, comments on the collected tweet, tweet type (original, conversational, or disseminative), sentiment of tweet (pro, neutral, con), sentiment of URL (pro, neutral, con), sentiment of any attached visual elements like a photograph (pro, neutral, con), whether the account was an individual or an organization (if able to be identified), stakeholder affiliation, tweets the account had tweeted, amount of followers, amount of accounts the twitter user is following, amount of tweets the twitter account has liked, amount of lists the twitter user subscribes to, the amount of moments they have engaged in, and their gender (if applicable). The following data points were used to assess and describe each twitter accounts' (if an account tweeted more than once in the data set, their most recent tweet's information was used in analysis): whether the account was an individual or organization, amount of tweets per the account, amount of followers, amount following, amount of likes, amount of lists subscribed to, amount of moments, and gender. The following data points were used to describe the unit of analysis, the

tweet itself: the copied Tweet, the Twitter handle of the user, the link to the tweet, the timestamp, mentions of other users, any URLs or internet linked content, replies to others, retweets, likes, comments, tweet type (original, conversational, or disseminative), sentiment of tweet (pro, neutral, con), sentiment of URL (pro, neutral, con), sentiment of any attached visual elements like a photograph (pro, neutral, con), and stakeholder group affiliation. An example of the coding schema is attached in Table 3. I have highlighted the data points that were analyzed per each tweet (in yellow) versus those that were only analyzed per each Twitter account user (in blue).

Example Coding Schema

Data: Tweet #4	
Tweet ID	*@meatgroupie*
Tweet Text	The @USDA released a list of foods considered BE and subject to record-keeping and disclosure (alfalfa, canola, corn, cotton, potatoes, "AquAdvantage" salmon, soybeans, squash, sugarbeets and certain varieties of apple, eggplant, papaya and pineapple.) It's a short list, people.
Link to Tweet	https://twitter.com/meatgroupie/status/1076218390140735488
Timestamp	12:50 PM - 21 Dec 2018
Mentions of Other Users	1
URLs Referenced	NA
Replies	**0**
Retweets	**0**
Likes	**2**
Tweet Type	**Original**
Sentiment of Tweet (Pro, Con, Neutral)	**Neutral**
Sentiment of Linked URL (When applicable)	**NA**
Sentiment of Photo (When applicable)	**NA**
Descriptive Data	

Individual or Organization	**Individual**
Gender (M, F, O, DK)	**F**
Stakeholder Affiliation	**Public**
Tweets	**1,048**
Following	**668**
Followers	**420**
Likes	**759**
Lists	**0**
Moments	**0**

Table 3 - Content Analysis Coding Schema Example (Descriptive data for each tweet highlighted in yellow, for each Twitter account user highlighted in blue)

Data Analysis

The process of data analysis was a tiered approach (see Table 2). In the first phase, I conducted a qualitative content analysis (Elo & Kyngäs, 2008) using the coding schema developed for this study based on the extant literature (Bruns & Steiglitz, 2014; Burgess & Bruns, 2012; Colditz, 2018). The next phase was thematic analysis as outlined by Braun & Clarke (2006) combined with elements of grounded discourse analysis by Emerson, Fretz, and Shaw (2011) to analyze relevant themes and meaning constructed by and pertaining to each stakeholder group.

Data were first processed on an excel spreadsheet using frequency analyses to assess the descriptive data collected to describe the Twitter accounts communicating about the AA salmon. The first stage assessed whether the account was an individual or an organization. This was based on their biographical description, their twitter name and twitter handle, and pronouns used in the text of the tweet. Next, the individual accounts

were assessed to ascertain their gender, implied through account name, bio, picture, or pronoun usage. Following this, stakeholder affiliation was assessed by a close read of the tweet text, biographical information, and other tweets on the twitter user's page. Then, stakeholder groups were analyzed yielding a diverse array of stakeholder groups and answer the first research question. Next, the data points describing the tweet were analyzed using the "COUNTIF" feature on excel. Sentiment of the tweet was assessed by an initial coder and confirmed by a secondary coder to eliminate coder bias. Sentiment of linked internet content or attached visual content was assessed for sentiment by only the first coder. Afterward, the content of the individual tweets, grouped into areas of their sentiment (pro, con, neutral) and their stakeholder alignment were assessed for emergent themes, and any formulations, contexts and contrasts, stories, terms, types, and typologies.

Coding Methods

Tweets were coded in a spreadsheet as to whether the account belonged to an individual user, an organization, could not be categorized, or was excluded from the data set due to exclusionary criteria. These distinctions were decided based on the following: if the account used a personal name, referred to themselves in the first person in their bio or tweets, or did not affiliate with any organization they were categorized as an individual; however, if the account used a group or organizational name, referenced the goals and objectives of the organization in their bio, or consistently referred to the account in the third person "we" or "our" it was categorized as an organization. Most accounts belonged to individual users (n=366) but a surprising amount of organizations (n=233) were involved as active participants in the twitter colloquy on AA salmon.

Gender, whether the person was an individual or organization were also coded. It is understood and recognized that gender is a presumptive and non-dyadic category, however, since it is a common data point used in demography, and can help to verify the representative nature of this sample in comparison to all twitter user data, it was collected and analyzed. In addition, the category of gender is entirely subjective and up to the interpretation of the person collecting data, therefore it is to be assumed that there is a limitation to the reliability of this findings specifically. Gender was categorized using the following data points: the picture of the avatar, the twitter handle, descriptive data in the account bio, and pronoun use. If any of the above were not clear or corroborated it was listed as "don't know" or in the case of an organization, "not applicable".

Information about the tweet itself, including mentions or copy/pastes of another user or their tweet, replies to others (yes=1, no=0), retweets (whether another user retweeted the tweet being coded), likes (how many), and comments generated (how many), were coded, since each tweet could vary dramatically in its reach (potential to go viral), online twitter engagement and/or lack thereof (see Table 6).

Generally, tweets were unlikely to be retweeted, liked, commented on, or otherwise engaged with; typically twitter users engaged with the online colloquy regarding AA salmon were tweeting into the proverbial forest where no one is there to hear them tweet, so did it make an impact/sound? Engagement with the tweets were measured per each tweet by likes, comments, retweets, replying to other tweets, and mentions of other users. In the data points collected to measure user engagement, it was uncommon for users to engage each other.

Tweets were also coded for the type of tweet, or the purpose or intent behind the tweet, to answer the question, "Why did this twitter account tweet this statement specifically?" A tweet was coded as either "original" or that the account wrote an original tweet that did not link to any outside content, these tweets could be opinionated or not. A tweet was coded as "conversational" if the tweet attempted to or did engage with other twitter users in a conversational manner. Typically these tweets referenced another user (and @mention) to ping the user to participate in a conversation via question or response formula, or they were replying to another twitter user's post. A tweet was coded as disseminative (the most common type in the sample) if it shared information with others on Twitter, typically sharing a link to a news article or another internet reference site like Wikipedia. There was occasional overlap which was coded as an instance of both. Also, there were instances where specific tweets were retweeted many times without reference to the originator or any link to additional information, this was coded as the mockingbird effect and is to be noted that most of the accounts tweeting the same tweet were flagged as possible troll accounts since they had no avatar image, abbreviated tweeting styles, and all of the accounts flagged as possible trolls abruptly ended their twitter engagement in 2016.

Additionally, data were collected about the individual accounts and were coded per the account, not per each tweet, so if an account tweeted 16 times about the AA salmon, the account itself was only analyzed once using the most recent data collection point. Data points collected and analyzed on individual twitter accounts were: how many tweets they had tweeted up to the point of collection (a measure of the account's activity on Twitter), how many twitter accounts followed them (a measure of their social

influence), how many accounts they followed (a measure of how engaged they were with other accounts in the network), how many "likes" they had liked of other account's tweets (a measure of their network activity), how many "lists" they had joined (a measure of social group involvement on twitter), and how many "moments" they had (similar to "stories" on other social media platforms, these are "moments" when the account would like to promote a tweet for longer). See Table 7.

Tweet Sentiment

Tweet sentiment was coded according to the following definitions (Table 4). Two coders coded all tweets until consensus was reached. The first coder had access to all contextual information including twitter account, bios, any linked conversational tweets, and organizational and stakeholder affiliation. The second coder was blind to all context and could only assess the content of the tweet itself. Once the second coder coded all tweets, inter-rater agreement was assessed, then coders conferred to discuss disagreement and possible modifications to code book definition of terms. Sentiment was discussed between coders until 100% agreement was reached on all tweet sentiment coded.

Sentiment of tweet – Refers to the feeling imparted by the author of the tweet. For this project sentiment can either be in favor, "pro"; against, "con"; or neutral.

Pro sentiment – is coded when a tweet presents a favorable attitude, opinion, or expression toward the Aquadvantage salmon, the technology used to produce it, the company who produces it, or any other clear favorable expression.

Con sentiment – is coded when a tweet presents a negative attitude, opinion, or expression toward the AA salmon, the technology used to produce it, the company who produces it, or any other clear negative expression.

Neutral sentiment – is coded when a tweet does not present a clear attitude for or against the salmon, the technology, the company, or any other relevant subject.

Table 4 - Codebook Definitions of Sentiment

In the first stage of coding the sentiment of tweets, the first coder had access to all identifying information, so could have potentially been influenced by contextual information like the type of organization (for example, a non-GMO nonprofit) or the embedded conversation, the attached URL (website), or the photograph posted alongside the tweet. The second coder was blind to this context and only used the codebook definitions to assess sentiment. This tested the reliability of the definitions and allowed coders to discuss definitions and reach final consensus in any areas of disagreement and to tweak codebook definitions when necessary. After the second coder made their first pass through the data, inter-rater reliability was assessed at 70.8% agreement. Upon discussion between raters, consensus was achieved by adjusting the definitions of "pro" to include statements that included sentiment that reflected that the salmon was "as safe as" conventionally produced salmon or that the salmon were "not to be feared". The definition of "neutral" was also adjusted to include any tweet that was too ambiguous to clearly define its sentiment. After the definitions in the codebook were adjusted and coders conferred on any tweets that were at first disagreed upon, 100% agreement was

reached. The following tweets represent examples of tweets that were disagreed upon on the initial coding between the two coders.

Examples of coder disagreement and final consensus:

Example 1:

> 'Politics, money and fear' have kept GMO salmon out of American grocery stores - AquaBounty Farms of Indiana is a land-based fish farm designed to raise the revolutionary AquAdvantage salmon. Scientists created the fish in the 1980s by inserting a https://brokenpla.net/blog/politics-money-and-fear-have-kept-gmo-salmon-out-of-american-grocery-stores/ …
>
> (Coded "pro" after consultation between coders)

Example 2:

> FDA Has Determined That the AquAdvantage Salmon is as Safe to Eat as Non-GE Salmon
> http://www.fda.gov/ForConsumers/ConsumerUpdates/ucm472487.htm …
>
> (Coded "pro" after consultation between coders)

Example 3:

> Costco announces that it will not be selling AquAdvantage Salmon, the genetically modified salmon that was just... http://fb.me/5NMr9TatU
>
> (Coded "con" after consultation between coders)

Example 4:

> AquAdvantage Salmon: FDA's new animal drug application
> http://www.fda.gov/AnimalVeterinary/DevelopmentApprovalProcess/GeneticEngineering/GeneticallyEngineeredAnimals/ucm280853.htm …
>
> (Coded "neutral" after consultation between coders)

Conclusion

In this chapter, the methodological approaches and data samples were outlined. This research study will reference theory when necessary but theory did not serve a jumping off point for methodological framing, as an inductive and grounded method was

be employed. Data analysis was iterative, using a phased approach employing qualitative content analysis, thematic analysis, and grounded discourse analysis. The data analysis process and results will be documented in the next chapter and provides a new methodological approach for the application of content and discourse analysis in social media settings like Twitter.

This chapter provided an overview of the methods of research and the approach to data collection, coding, and analysis. The next chapter presents the findings of the research study.

Chapter Four: Findings and Discussion

This chapter presents the findings of the study answering the research questions and defines themes and trends that emerged in data analysis. A qualitative content analysis was conducted first using the coding schema developed from the relevant research to describe the demographics and any clear link to a stakeholder group; the overarching sentiment of the tweets; whether the tweet is original, a reply or a retweet; any comments, how many comments generated, and how many liked it; links to other websites and articles found on the internet and their slant in the debate; and code the sentiment of any visual information. Then an open coding method described by Elo & Kyngäs (2008), Braun & Clarke (2006), and Emerson, Fretz, & Shaw (2011) for qualitative content analysis was inductively conducted to create categories and frames to assist in theory creation through abstraction and to flow into the thematic and grounded discourse analysis of the data.

Tweets were collected using the Twitter search engine, searching the terms "AquAdvantage Salmon" using the "latest" feature were collected until saturation was attained. Data collection was saturated at 649 tweets spanning from the 29th of December 2018 to the 20th of November 2015. This time frame collected tweets in high volume engagement periods (for example, following the approval of the AA salmon by the FDA on the 19th of November 2015) and during times when there was no spike in interest or media engagement, thereby representing a gamut of involvement of various stakeholder groups identified. A sample of the data collection coding schema is presented in Table 3. Any Twitter user communicating using the search terms, "AquAdvantage salmon", was picked up by the Twitter search engine using the "latest" search feature, a feature that

collates all tweets in reverse chronological order. Each tweet was the unit of analysis. Tweets that were not written in English, or were not relevant to the AA salmon, were excluded from the data set (n=46). Data were collected and processed on an excel spreadsheet. To answer the first research question, each tweet was coded as belonging to a stakeholder group, either a stakeholder group found in previous literature or one that emerged in the data, and were processed in their own stakeholder group's excel spreadsheet.

Descriptive Data for all Tweets

The descriptive data for all tweets in the sample is summarized in Table 5 and is described here. Of the 649 tweets originally identified, 46 were excluded because they did not fit inclusion criteria (the tweet was irrelevant, or did not contain any information about the AA salmon but used the phrase as a hashtag in the tweet, or the tweet was not in English). The first step in identifying the stakeholder group affiliation was to assess whether the account was an individual or an organization. Using information collected about each Twitter user, 233 originated from organizations such as news organizations, AquaBounty Tech, nonprofits etc., and 366 tweets came from individual or personal twitter accounts. Four were categorized as "uncertain" or "could not discern" whether the tweet originated from an individual or organization (because there was not enough information in the tweet name, picture, or bio; or the twitter account's page was primarily in another language). Of those accounts arising from an individual accounts (n=366), 299 were categorized as either a male or female based on the demographic characteristics of the name, avatar image, or pronoun usage. Of the 299 twitter accounts that could be categorized into a gender, 129 were female and 170 were male.

		Male	Female	
Unidentified Total Tweets Collected	249			
Tweets Excluded	46			
Organizational Tweets	233			
Individual Accounts	366	170	129	67
Uncertain	4			

Table 5 - Twitter Account Information

Each tweet was "liked" approximately 1.5 times, with the most likes at 98, however out of 649 tweets, 439 received no likes indicating that predominantly no other user either saw it or validated the content of the tweet through a "like". The tweet that was liked the most was posted by the user *@nongmoproject*, a non-GMO nonprofit with a large national reach, on November 9, 2018 and quoted senator Lisa Murkowski of Alaska stating:

> "I don't even know if I want to call it a fish," said Alaska Senator Lisa Murkowski, describing the #GMO AquAdvantage salmon. https://bit.ly/2z0FxUd

Retweets are a similar marker of twitter user engagement with a tweet, as they represent other users also restating the exact same sentiment. On average, tweets in the sample were retweeted 1.1 times, with the tweet getting the most retweets at 97 retweets. The one tweet in the sample getting retweeted was the same tweet that received the most likes, is stated above. A tweet was commented on about one out of three times, or 27% of the time. The most commented on tweet received 19 comments and was tweet #361 by user *@CBCNews* and stated:

AquAdvantage salmon: Science journalist says we shouldn't fear 'Frankenfish' http://www.cbc.ca/1.3360038

In general users were unlikely to mention (39%) or reply (10%) to other users (see Table 6). Mentioning another user tags them and encourages them to engage with the conversation or respond to something they have previously posted. Both mentions and replies are seen as conversational as they ping another user to respond and encourage their engagement. It is beyond the scope of this data set and research project to follow all mentions and replies and analyze the larger Twitter social network of engagement, however tweets were often replies in an existing conversation or were linked to tweets that were collected in this data set. The following example is a tweet that was contained within a conversation on Twitter and mentioned other users:

@MikeFoodIQ so how would I know I'm eating AquAdvantage salmon do u really think the co.'ll voluntarily labl it? @_courtneycali @thefoodbabe

	Total	Average	Min	Max
Mentions of Other User	233	.39	0	9
Replies to Other Users	58	.10	0	1
Retweets	666	1.1	0	97
Likes	896	1.5	0	98
Comments	162	.27	0	19

Table 6 - Tweet Data

Data Describing Twitter Accounts

Data were collected per each account to describe their level of activity and network engagement on Twitter. Twitter users appear relatively active on Twitter, averaging per account almost 60,000 tweets, 17,000 followers, following 1,500 accounts, liking 5,000 tweets, and subscribing to about 5 different lists. Moments were not as common at only .28 times per account. This may be because Twitter users are unaccustomed to this feature or because moments are not as popular on this social media platform. The account that tweeted the most frequently was a self-described "journalist - reporter" from Athens Nicosia, *@parishatzi.* The account with the most followers was the Twitter account for New Scientist, *@newscientist*, an account that chronicles the weekly science publication, New Scientist, published in the UK since 1956. The account following the most other user accounts was *@ninjaeconomics,* a self-described "...manic pixie wannabee economist…" from "Silicon Valley, New York City". The Twitter user subscribing to the most lists was *@natashayounge*, an aspiring actress who posted her IMDB website on their twitter bio. The twitter account with the most moments was *@CBCNews*, an account that self-describes themselves as "Canadian breaking news and analysis…".

	Total	Mean	Median	Mode	Min	Max
Tweets	28,685,434	59,267	9,608	18,300	4	2,050,000
Following	722,888	1,493.6	534	0	0	25,700
Followers	8,094,198	16,723.5	794	1	0	3,420,000
Likes	2,496,089	5,157	402	0	0	257,000

Lists	2,169	4.5	0	0	0	232
Moments	135	.28	0	0	0	97

Table 7 - Twitter Account Activity

Stakeholder Groups and Sentiment

Regarding stakeholder groups, the literature identified five common groupings (public, media, government or policy makers, the producers of the technology, and scientists). It is beyond the scope of the current research to verify the validity of all 649 accounts. If a smaller, curated sample, had been collected these details could have been corroborated. Multiple stakeholder groups were identified in this data set including: the public, the media, food and agriculture focused accounts, science organizations or scientists, producers of the AA salmon, organizations with a vested interest, and "other", uncategorizable or infrequently engaged users or accounts (See Figure 1). Each of these groups had member accounts within the group who could be identified as a part of a sub-interest group, however, most accounts could not be determined as to their underlying sub-interest and reason for engagement in the colloquy. For the public, sub-interest groups of stakeholders were found to lie in the following interest groups, typically self-identified as such in their bios: activism, food blogging, conspiracy theorists, science(tist), business/sales, law, science communication, media, pro GMO, stock or investments, environmental advocacy, doctors, health, foodies, farmers, or probable trolls. In the media stakeholder category, the subgroups identified were from the following groups of media focus: science, seafood, financial, agricultural, genetic

modification, food in general, stock investing, governmental, health, law, or a journalist or broadcaster. In the food and agriculture stakeholder group the following sub-interest groups were identified: seafood, agricultural, farmer, biogenetic or genetically modified foods, and aquaculture. In the science stakeholder group, sub-interest groups identified were scientists, media, education, and genetic or genetic modification interests. In the producer stakeholder group, the following sub-interest groups emerged: Aquabounty (AQB) Technologies, GMO/GE, scientist, and the communications director (for AQB). In the organization stakeholder group, sub-interest groups were from the following categories of organizations: anti- or non-GMO nonprofits or groups, science, environmental, religious, educational, stock or investment, business, pro-GMO, law, or health. An "other" stakeholder group was also created to contain unidentifiable twitter accounts, the one government tweet, and twitter accounts that were selling or marketing unrelated products. There is overlap between the groups, as no individual or organization can typically be entirely allocated to one stakeholder group or interest or that the stakeholder groups are not presumed mutually exclusive; however, utmost care was taken in the categorization process to ensure the twitter account was categorized properly. This process, and the categorical assumptions, are outlined next.

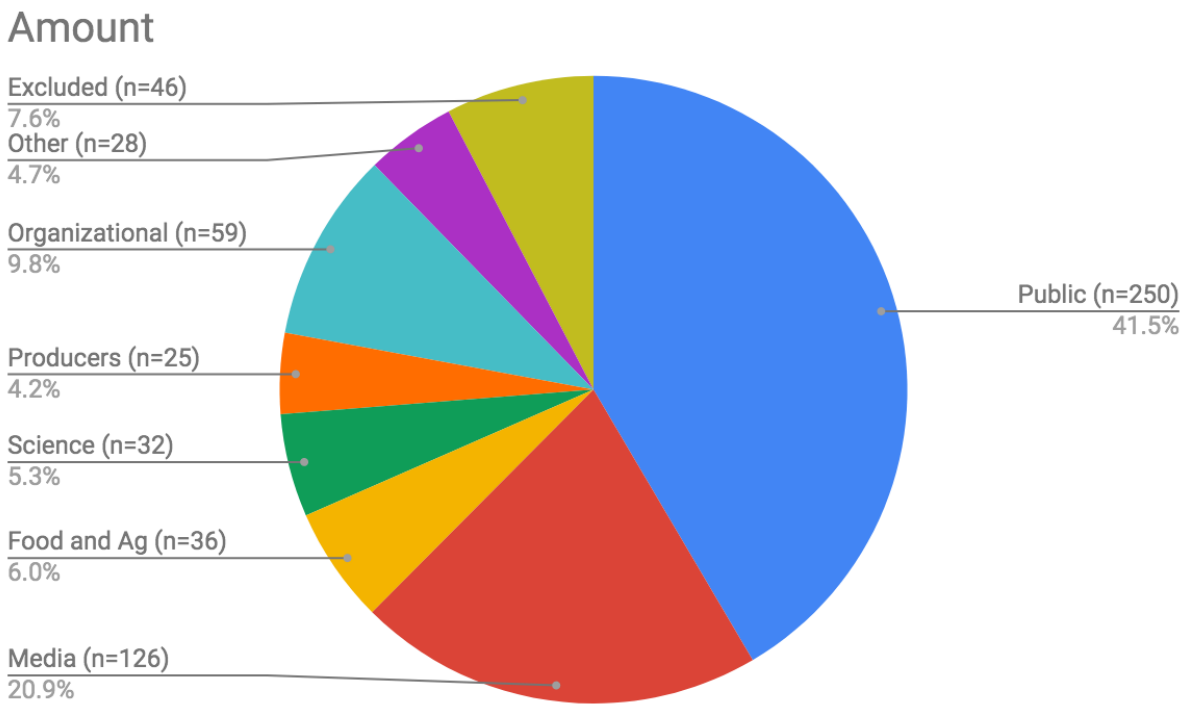

Figure 1 - Stakeholder Groups

Twitter accounts were categorized into the "public" stakeholder group if they fit the following criteria: 1) were an individual who had a multitude of interests in their twitter bio or tweets on their individual or personal page, this could be an international account as long as the tweet collected and analyzed in the data set was completely in English, 2) their name was their twitter handle and it did not contain any affiliation to a media or other type of organization, 3) and they did not primarily identify as a media person (like a journalist affiliated with a news organization), a scientist (who also primarily posted about science), or closely aligned their page with some specific agenda (like aggregating the most recent posts on food safety), and 4) they were not excluded from the data set or could not be identified. The *public* stakeholder group comprised the

largest stakeholder group representing almost half of the data set of tweets (n=250, or 41.5%).

Twitter accounts were considered a part of the "media" stakeholder group if they: 1) used the word "news", "media", or linked to their news/internet/etc. news organization in their account information, 2) if they were an organization that aggregated news and there was no individual or personal characteristics identified with the account, 3) if the account primarily posted news articles or links to articles about a specific subject, and 4) if the individual represented their account in affiliation with a news organization as a broadcaster or journalist. The news category was the second most common twitter stakeholder group identified in this data set (n=126, or 20.9%), likely because twitter is a commonly used news feed outlet.

The "food and agriculture" stakeholder group was identified because many twitter accounts were organizations or individual accounts that's sole purpose were to aggregate details or information for a certain sector of food and agriculture interests. Twitter accounts were allocated to this group if: 1) the account only contained information in their feed that directly related to food and agriculture (if the account also contained personal posts unrelated to agriculture or food, it was allocated to the "public" stakeholder group), and 2) if the account's sole purpose was to get information out to like-minded food and agricultural sectors, such as the aquaculture sub-interest group. Only those who are interested in these accounts and twitter feeds would follow them, so therefore they were allocated to their own category of stakeholders interested in food and agriculture (n=36, or 6%).

The science stakeholder group accounted for 32 twitter accounts (n=32, 5.3%). Although this research revolves around communication of scientific concepts it was difficult to ascertain which voices and accounts had actual scientific credentials to validate their claims as scientifically proven fact, a problem with internet research in general. This group contains the largest crossover than any stakeholder group, as many of the "public" were science bloggers, individuals with a passion for translating science communication, advocates of an arena of science like environmental activists, but did not provide any information about specific membership in any scientific organization, community, or to holding any scientific degrees. To be allocated into this stakeholder group twitter accounts must, 1) have verified proof of their scientific achievements and involvement, 2) must have a proven track record of their engagement in scientific research, or 3) be an account focused only on science related information.

The producer stakeholder group accounted for 25 tweets or 4.2% of the sample. Tweets in the producer category had to belong to either: 1) the actual producer of AA salmon's twitter account (*@AquaBountyTech*), 2) a scientist who worked for AquaBounty, or 3) be from the communication's director for AB Tech (@gmaquascience)'s personal account.

The "organizational" category spanned the gamut on types of organizational involvement and why. An organization was categorized here if they were, 1) representing a specific organization organization, 2) an organization founded on a specific belief that had an interest in the AA salmon (religious, educational, anti- or pro-gmo, etc.), or 3) were an organization with an interest that coincided with the advancement or otherwise of the AA salmon (stock and investments, law and policy

organizations, or health organizations). This category of tweets were notable in their lack of personal opinion and shared information, presumably because an organization needs to uphold an online professional reputation, and one that does not devolve into twitter attacks and other negative trolling (n=59, or 9.8%).

This data set yielded that most stakeholder groups are actively involved in the conversation, excluding the government and/or policy makers, despite the fact that the FDA does have an active Twitter account. There was only one tweet out of 649 that came from a probable government entity, the state of Alaska's twitter account, however this cannot be verified as the account did not have a "verified" stamp so anyone could have created the account and tweeted from it.

` The "other" stakeholder category (n=28) was simply a group of accounts that could not be categorized elsewhere: 1) either they were selling other goods or services, 2) they could not be identified, or 3) they were the only post in their stakeholder group (i.e. the government). In addition, there were 46 tweets were excluded from the data set.

Most stakeholder groups had a clear message and communication style. The public actively debated pros and cons of the AA salmon and did not adhere to an opposed position. This finding aligns with Marris (2001) who suggests that the public's perspective is not comprehensively adamantly opposed but there is nuance, unlike the typical depiction where the public is against the technology and scientists are in favor (Augoustinos, Crabb, & Shepherd, 2010; Cook, Pieri, & Robbins, 2004; Lockie, 2006, Wales & Mythen, 2002). Some of this nuance is revealed in the qualitative analysis of the debated topics found in the data set: 'is the technology natural', labeling, approval of the AA salmon, and the safety. The public was the stakeholder group most involved in

these debates. The findings of this study suggest that members of the public range from concluding that the AA salmon is not a fish at all but some sort of genetic monstrosity, i.e. a "frankenfish", to being "essentially" "biologically" the same, and "as safe to eat as non-GE" salmon. In the labeling debate the public agreed that the AA salmon should be labeled, thereby illuminating a clear message--label the AA salmon. Some expressed that if it were not labeled it would be criminal, fraudulent, and they would not purchase salmon altogether. If the purported "advantages" of the AquAdvantage salmon are as environmentally beneficial as claimed, then the company should have no qualms in labeling the fish as such, as proposed by a member of the public and a member of the food and agriculture stakeholder group. In the third debate, the approval of the AA salmon, the public stakeholder group held mixed opinions. Some expressed horror or deep disappointment, while others trusted the FDA's rigorous approach to the approval, and others simply shared the news of the approval without commentary. In regards to the fourth debate, the safety of the AA salmon on human health and the environment there was a spectrum of opinion ranging from skepticism, to calling it a risk and a danger, to excitement in a new, nutritious form of animal protein.

The media stakeholder group was the second most populous group and the second most likely to tweet about the AA salmon in the data set. Their tweets were typified with neutrality in sentiment and a likelihood to share outside content or information so that their followers on twitter saw their tweet could click on their attached link to get more information, if desired. Twitter is a social media site that is typified by sharing information. In this data set alone, disseminative, or information sharing tweets, constituted 70% of the sample, demonstrating that this is the most common reason twitter

users engaged with the online colloquy regarding AA salmon, this suggests that information sharing may be the most predominant activity of Twitter users.

The organizational stakeholder group was the next most likely to be involved in the online colloquy (approximately 10%). This group was a diverse group representing the following groups or nonprofits: anti-GMO, environmental, religious, health, pro-GM, education, business, stock trading, law and policy, and food. As this group was so diverse, they were not evaluated as a whole. However, organizations, as opposed to individuals, accounted for approximately almost 40% of the sample indicating that Twitter is a viable form of communication with an organization's social networks online.

The food and agriculture stakeholder group was the next most frequent group involved in the colloquy comprising 6% of the tweets in the data set. These tweets emulated the discursive style of media tweets, where they shared unbiased information and articles pertaining to the AA salmon. At times, their expression and sentiment bordered that of 'pro' and approval of the technology to shift aquaculture toward more sustainable practices, but mostly their tweets related current news and events to their followers.

The science and scientists stakeholder group's communication sided mostly with the 'pro' side of the online discussion, in favor of not just the AA salmon, but the technology, and the advancement of researching the technology. At times, their communication was defensive, as demonstrated by *@biobeef* in the qualitative theme "Antagonistic Discourse". Often, scientists were sharing their conference presentations or latest research, expressing their approval of the AA salmon and technology like user *@trevorcharles,* "Take a look at AquAdvantage salmon, a perfect example of using

biotech to enable land-based aquaculture and thereby address most of the environmental concerns of fish farming.", or simply sharing the latest news about the AA salmon in a neutral way. Notably, this subgroup did not express any con sentiment against the AA salmon or technology.

The least active stakeholder group of note in the sample, the producers, used overwhelmingly positive communication strategies to promote and brag about the AA salmon on Twitter. They posted when the news was favorable but not when there was a storm brewing or a debate that could undermine their purposely designed publicly presented portrait of the AA salmon, the technology used to produce it, or the possible monetary influx that could be invested in. Their view was that this is the way of the future for food and to not be behind it, support it, and eat it, is a travesty, that environmentalists should support it, and that it is sustainable agriculture, and that it is the way we will feed our growing global population. Doubts or negativity pertaining to the AA salmon or the technology used to produce it, were not expressed.

Sentiment of Tweets

Regarding sentiment, tweets, any linked internet content like websites, and any visual elements like photographs or videos were coded as pro, con, or neutral. The assessed tweets were mostly neutral (n=288), but 235 were positive or in favor of the AA salmon or the technology associated to produce it, whereas only 86 were against. Similarly, attached content reflected a similar distribution with 151 neutral tweets, 110 in favor, and 40 against. Photographs too had a similar array: 76 were neutral, 40 were in favor, and 10 were against. The observable and remarkable pattern is that it is uncommon to be against the AA salmon or the technology used to produce it. The

question then arises, why is there so much emphasis placed on the debate and not enough placed on the dialogue, which appears to be happening, at least on Twitter.

Another note is, where do the tweets go exactly? Most tweets fall on deaf ears, as most tweets were not commented on, liked, or retweeted. If the proverbial bird tweets in the forest but if no one is there to hear it does it make a sound? In addition, some tweets gained momentum through the process of retweeting, however even though tweets were retweeted they were not actually retweeted in the way that twitter tracks retweets, but instead copied and pasted and repeated, what I am calling the mockingbird effect. Often this effect traveled through circuits. When an account that appeared to be a fake account, perhaps a troll or a bot, tweeted and numerous accounts followed, other similarly false appearing twitter accounts tweeted the exact same thing.

This was not limited to fake accounts, when there was a buzz created on Twitter, the crickets followed in harmony. Two tweets were repeated with numerous iterations, by many users. One expressed that the AA salmon was "as safe to eat as non-GE" (n=81) salmon, while the other that a "science journalist" declared that "frankenfish" was "not to fear" (n=68).

The tweet itself, any linked website (url), and any attached image or visual content were also analyzed into categories of sentiment: pro, con, or neutral, to assist in answering **RQ1-A**, their perspective or goal. A tweet was considered pro-AA salmon or pro-GMO if it spoke positively toward the technology used in production, the AA salmon itself, or the company (AQB) responsible for the AA salmon. A tweet was considered con or against the AA salmon or the technology used to produce it if it clearly demonstrated its disagreement or opposition. A tweet was coded as being neutral if it

presented information, shared an article, retweeted another post that was equally neutral, was ambiguous as to its opinion or leaning, or was excluded based on the study's exclusionary criteria. The same method was used for categorizing the sentiment (pro, con, or neutral) for linked website/online material or attached visual content. See Table 4 for codebook definitions.

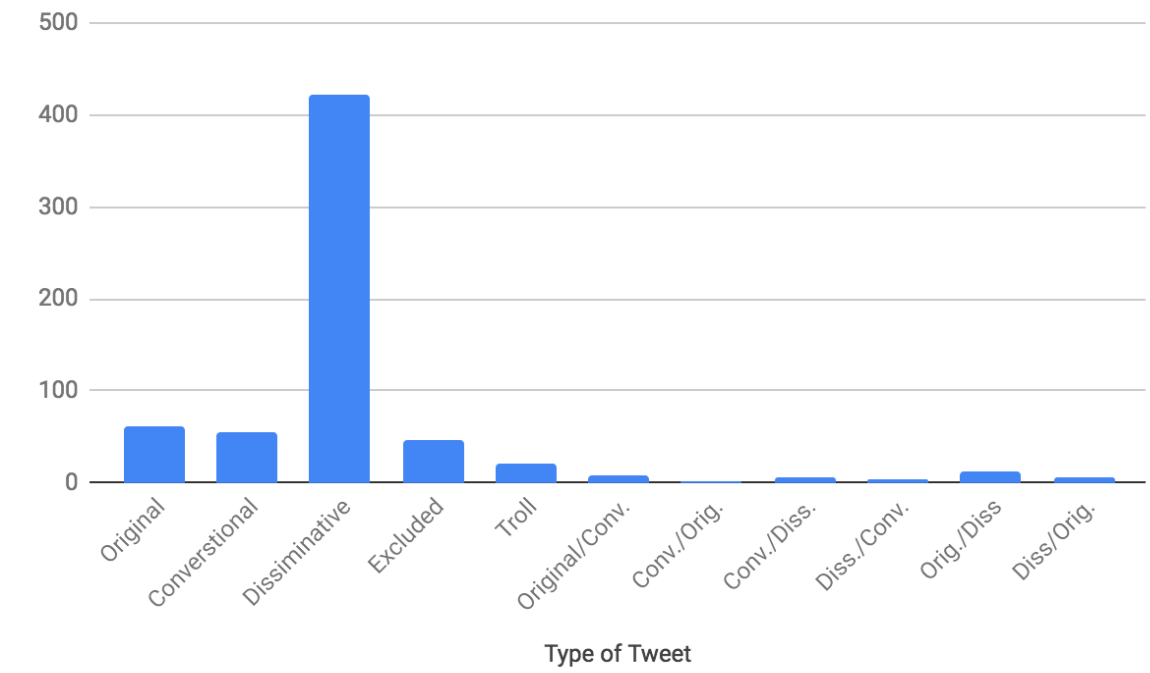

Figure 2 - Type of Tweet

Sentiment of URL

The sentiment of any linked internet material including articles, websites, other linked social media sites, or any other online content were assessed by the primary coder. The same definitions agreed upon by both coders and finalized in the codebook were

used in this analysis as well. The results of the analysis of the URL's were categorized into "na" if the tweet did not contain a linked URL or if the link was broken or no longer linked to the content intended to be referenced; "na" comprised 302 tweets (not including the excluded 46). Of the remaining linked internet content, 110 were identified as positive, 40 as negative, and 151 as neutral.

Examples of URL sentiment

Example 1:

> I just signed this petition. Costco please sell AquAdvantage salmon. http://ipt.io/amyqj via @ipetitions
> (Coded "pro" sentiment; this URL links to an online petition to Costco urging them to carry AA salmon in Costco stores.)

Example 2:

> Not everyone agrees with the FDA. AquAdvantage Salmon were created by mixing the genes of two fish that would never mate in nature. The genetically engineered salmon… [attached photo and headline containing this link: https://www.organicconsumers.org/blog/fda-approves-first-genetically-engineered-salmon-facility-now-what]
> (Coded "con" sentiment; this URL links to an article warning consumers that the, "...science just isn't there to prove the AquAdvantage GE salmon is safe for either human health, or for wild fish stocks.")

Example 3:

> The @USDA Import Alert remains in effect, meaning AquaBounty cannot import #GMO AquAdvantage salmon, including its eggs or food from the salmon, into the US. [There is a link to an article by the Star Press, https://www.thestarpress.com/story/news/local/2018/04/26/fda-oks-genetically-engineered-salmon-facility-albany/556191002/]
> (Coded "neutral" sentiment; this URL is a news article that presents information without exhibiting a clear bias in favor or against the salmon, the technology used to produce it, or the company producing it.)

Sentiment of Visual Content

In addition to analyzing the sentiment of the tweet text and any embedded internet content, any visual content, including photographs, GIFs, and videos were assessed by the primary coder for implied sentiment (pro, con, or neutral). The same definitions agreed upon by both coders and finalized in the codebook were used in this analysis. The results of the analysis of the visual content was categorized into "na" if the tweet did not contain a visual component. Most tweets (n=523) did not contain any visual component. Of the remainder, 40 were coded as pro, ten as con, and 76 as neutral. An example of each category is below.

From tweet #83. Coded "pro" for visual content as the photograph depicts a person holding an AA salmon (presumably) that is impressive in size, the subject is smiling and presents the fish like a trophy.

From tweet #266. Coded "con" for visual content because the photograph depicts a salmon body with the tail of an eel to visually communicate the pairing of two different species' DNA and questions the hybrid joining.

From tweet #465. Coded "neutral" for visual content because the photograph depicts a fish and there is no clear visual indication that the fish, the technology, or the company producing it is being presented favorably or unfavorably.

Qualitative Analysis

Phase One of Qualitative Analysis: Thematic Analysis

In this section, thematic analysis (Braun & Clarke, 2006) was used to answer **RQ2:** What themes and frames are used by Twitter users to *construct/make meaning* and *position* themselves in the ongoing GMO debate pertaining to AA salmon? Themes and frames used by stakeholder groups to construct, make meaning, and position themselves in the Twitter colloquy on AA salmon were qualitatively analyzed and are presented. The process of analysis was to first become familiar with the data corpus, next to generate initial codes or spontaneous thoughts on the data, then the data was collated into themes that were then defined/named. A discussion of each theme and examples from the data corpus and their implications are discussed in detail in this section, Qualitative Themes. This stage involved the distillation of the preliminary codes into themes, the

ways they interrelate, and defining the themes as put forth by Braun & Clark (2006), and Elo & Kyngäs (2008). In the thematic analysis stage I determined if the focus/theme is the same as or contrasts with those found in the literature review: scientific achievement/progress/modernization (Lockie, 2006; Maeseele, 2015; Motion & Weaver, 2005); agricultural revolution/food security (Casaus, 2010; Lockie, 2006); anti-science irrationalism (Augoustinos, Crabb, & Shepherd, 2010; Cook, Robbins, & Pieri, 2006; Lockie, 2006); moral and environmental conflict (Howarth, 2013; Lockie, 2006); mistrust of government and corporate interests (Augoustinos, Crabb, & Shepherd, 2010; Cook, Robbins, & Pieri, 2006; Howarth, 2013); a war, battle, or stalemate (Cook, Robbins, & Pieri, 2006; Howarth, 2013; Hughes, 2007); hegemony and power (Hughes, 2007; Motion & Weaver, 2005); organic foods as natural/GMO foods as unnatural or conventional (Casaus, 2010; Lockie, 2006); and health and environmental risk (Casaus, 2010; Lockie, 2006).

Themes emerged during the qualitative analysis stage of research across stakeholder groups and their communication tactics and strategies. Some overarching themes encapsulating the data were scientific validity versus scientific hubris, i.e. "frankenfish", and that of consumption and capitalism. Sub-themes identified that demonstrate and depict these are: what exactly is AA salmon? is it a fish? is it a plane; the sterile, commercial product; save the world discourse/sustainable and environmental solution discourse; science solves everything; we "aren't here to make friends" (antagonistic discourse); "congratulations team!" or "we did it!!"; and the future is in jeopardy. There were also debate-style themes circling around controversial topics like: whether or not the AA salmon is natural; whether or not to label it; the safety of the

technology for health and the environment; and the FDA approval of the technology. The themes that spurned discussion and debate were used in the second phase of qualitative analysis and follow this section of qualitative thematic analysis of the data set.

Sub-Themes

What exactly is AA salmon? is it a fish? is it a plane?

This theme arose partially to understand how people were defining AquAdvantage Salmon but also because many involved in the colloquy on Twitter had interesting ways to talk and define the fish and technology used, sentiment expressed was on both sides of the debate. Some described the AA salmon as unsure of what to call it and whether it was a fish (tweet 18) or that it were a human/lab creation that is Frankenstenian, i.e. "Frankenfish"), tweet 180 refers to the AA salmon as a scientific "case study" and a "transgenic aquatic organism", tweet 289 a "GE fish for human consumption", and tweet 444 as a commodity that is "ready for sale", is "copyrighted", and is the "first animal created from #Genetics". All of these have different implications. For some, the AA salmon is interpreted as a scientific case study, for others a copyrighted commodity ready for sale, for many its purpose is for human consumption, and still others are wary that it is a Frankenfish or is no longer a fish. See examples listed below.

Tweet Text	#	Twitter Account	Stakeholder Group	Sentiment
"I don't even know if I want to call it a fish," said Alaska Senator Lisa	18	*@NonGMOProject*	Organizational (Sub interest - non-GMO	Con

Murkowski, describing the #GMO AquAdvantage salmon. https://bit.ly/2z0FxUd			organization)	
Yummy frankenfish. AquAdvantage salmon is modified with this guy's gene. [Oh no! Sweating emoji.]	205	*@tobyglanville*	Public (Sub interest - activist)	Con
AquAdvantage Salmon: A case study in the development and approval of transgenic aquatic organisms https://aquabounty.com/aquadvantage-salmon-case-study-development-approval-transgenic-aquatic-oganisms/ …	180	*@AquaBountyTech*	Producer	Pro
"We're deeply disappointed w/the #FDA's approval of #AquAdvantage salmon, first #GE fish for human consumption." http://www.consumerreports.org/consumer-protection/building-a-better-world-together/ … #p2	289	*@avtramontano*	Public (Sub interest - conspiracy theorist)	Con
http://www.scientificamerican.com/article/salmon-is-the-first-transgenic-animal-to-win-u-s-approval-for-food/ … First animal created from #Genetics ready for sale in #America , even has a copyright name i.e. AquAdvantage Salmon	444	*@WifaqulUlama*	Organizational (Sub interest - religious, UK)	Neutral

The sterile, commercial product.

The theme of the sterile, commercial product was seen across multiple stakeholder groups including the producers, media, agriculture and food, and the public and tended to impress that the AA salmon was now a food or meat product solely produced for human consumption, sale of a product, meant for commercial sale. There is a definitive shift in the language and phrases chosen to express the fact that this is a product, not a fish or animal, and that it is meant for profit, sale, and commercial production. Language that typified this theme were the terms, "commercial", "production", "commercial production/product", "product", "grown", "farm", "facility", "commercial facility", "sale", "market", and "stock". This theme was very common across stakeholder groups and implies that after branding the fish as a trademarked product, it no longer retained its animal nature. This will be further deconstructed in the discussion chapter that addresses **RQ3:** How is the AquAdvantage salmon presented and constructed? That of a commodity to serve human interests or otherwise; and is that discourse variable among discussants? See examples of this theme below.

Tweet Text	#	Twitter Account	Stakeholder Group	Sentiment
Think about AquAdvantage Salmon's better feed efficiency Aquaculture to play a key role in global protein production https://aquabounty.com/aquaculture-play-key-role-global-protein-production/ …	184	*@AquaBountyTech*	Producer	Pro
#AquAdvantage #salmon, a genetically	437	*@savingseafood*	Media	Neutral

engineered species of fish, will soon go into commercial production @NewYorker http://ow.ly/VqMBZ				
"With the facility now approved, commercial production of AquAdvantage Salmon awaits only official labeling guideline by the FDA," AquaBounty Technologies, Maynard, Mass., said in a news release. [emoji looking up at the text and frowning]	28	*@IRGnoGMOs*	Organizational	Con

Save the world discourse, Sustainable and environmental solution discourse.

This theme emerged in the online colloquy as a justification argument for the technology and the need to produce the AA salmon and was largely employed by the Producer stakeholder group. One of the examples for this theme is from the public stakeholder group but it is a retweet of an original tweet published by AquaBounty Technologies Twitter account. Additionally the twitter account *@prometheusgreen* self-describes themselves as an "ITIF life sci guru, keynote speaker, professional skeptic, biotech expert, policy wonk, beekeeper, lover of wilderness. will travel miles for dark night skies" so it is unclear their actual stakeholder affiliation or level of expertise in biotechnology. Terms and phrases used in this theme were, "only responsible solution", "sustainable", "eco-friendly", "environmentalist approved" , "climate-smart", "save the wild salmon", "no environmental impact", "very small carbon footprint", "more efficient", "global protein production", "production method promoted by

environmentalists" etc. The implication of this theme is that when it is invoked, particularly by producers, it is a claim that this technology and the AA salmon will help resolve many current environmental issues like food scarcity, problematic food production methods, alleviate pressure on wild salmon, and effect global climate change.

Tweet Text	#	Twitter Account	Stakeholder Group	Sentiment
ABT's AquAdvantage Salmon satisfies all the criteria! And is more efficient, more sustainable, no env impact, very small carbon footprint	182	*@gmaquascience*	Producer	Pro
Fast-growing AquAdvantage Salmon with better FCRs enables land-based salmon farming, the production method promoted by environmentalists!	150	*@AquaBountyTech*	Producer	Pro
AquAdvantage salmon: climate-smart aquaculture	185	*@prometheusgreen*	Public	Pro
Think about AquAdvantage Salmon's better feed efficiency Aquaculture to play a key role in global protein production https://aquabounty.com/aquaculture-play-key-role-global-protein-production/ …	184	*@AquaBountyTech*	Producer	Pro

Science is the solution/Science solves everything.

This theme emerged in discussions and statements of how technology and science were creating solutions to problems, usually related to food and the environment. One solution science offers in this case was better "FCRs" or "feed conversion ratios" since the AA salmon is engineered to use less feed over the course of its lifetime--it gets to market size in two years as opposed to wild salmon that take three years, and eats the same amount but over a shorter time frame, so uses less food. Some terms and phrases used in this theme were: "solving issues", "more efficient", "a fertile tool", "satisfies all the criteria", "major science event", and "innovation".

Tweet Text	#	Twitter Account	Stakeholder Group	Sentiment
½ time, ¼ less feed - AquAdvantage salmon from @Intrexon solving issues in aquaculture. #SBBSF17	129	@SynBioBeta	Organizational (Sub interest - Genetic Modification Org.)	Pro
The sale of #Aquabounty AquAdvantage Salmon is highlighted as one of the "Major Science Events that Define 2017" http://bit.ly/2pXflri . #innovation #sustainableaquaculture #feedtheplanet	111	*@intrexon*	Organizational (Sub interest - stock investment company managing AQB stock portfolio)	Pro
100% sterile AquAdvantage Salmon may now be possible. A fertile tool for sterile fish http://www.fishfarmingexpert.com/news/a-fertile-tool-for-sterile-fish/#.WJVDKaFT9j4.twitter …	174	*@gmaquascience*	Producer	Pro

Antagonistic discourse: We aren't here to make friends/Proof in the data.

On occasion, conversations trended toward a lack of dialogue and defensive communication tactics and implied that members of other stakeholder groups were reacting and basing their opinion on not credible, unscientific information, this was coded as antagonistic discourse and was typically seen between groups (inter-group communication). This theme was reflective of anti-science irrationalism (Augoustinos, Crabb, & Shepherd, 2010; Cook, Robbins, & Pieri, 2006; Lockie, 2006) and the war, battle, or stalemate referenced in the literature (Cook, Robbins, & Pieri, 2006; Howarth, 2013; Hughes, 2007). Interestingly, the tweets in this theme were exemplified by one active user, *@BioBeef* who is a biotechnologist doing research at UC Davis and a member of the scientific community. The communication this user demonstrated was that of frustration with those with alternative opinions and defensive of the technology as seen in the tweets: "No.", "sick of correcting", "nonsensical", "bad #scicomm", "not helpful", "facts not fear", and "meaningless". In addition, she calls for "facts" but does not offer any factual information to validate her argument and conflates genetic modification with natural genetic selection. Also, she chooses to use "gene editing" instead of "genetic modification" or "genetic engineering" and calls the term "GMOs" "meaningless". The implication here is that the technology is natural and has been happening in nature ad infinitum, so there is nothing to fear and people opposed are being irrational. In addition, tweet #80 states that the "AquAdvantage Salmon is absolutely made with fish DNA", which is true but there is also eel DNA. It is unclear why the user is opposed to the use of the term GMO to represent an animal or plant modified using genetic modification technology. Tweet #152 is also representative of this type of

communication where they state “in fact the data show” insinuating others had not looked at the data, however there is a link offered to visit the data and facts, which is not done in *@BioBeef*’s tweets.

Tweet Text	#	Twitter Account	Stakeholder Group	Sentiment
No. Only approved genetically engineered animal is aquadvantage salmon and only currently available in Canada - no gene edited animals on market except for those edited by nature	33	*@BioBeef*	Science (Sub interest - geneticist and professor)	Neutral
Sick of correcting this nonsensical tweet - AquAdvantage salmon is absolutely made with fish DNA - bad #scicomm not helpful #facts not fear not EVERYTHING is a plant and not all breeders are plant breeders	80	*@BioBeef*	Science (Sub interest - geneticist and professor)	Pro
Except that the AquAdvantage salmon is absolutely fish DNA- why are you using the meaningless term "GMOs" anyway - not helping #scicomm	96	*@BioBeef*	Science (Sub interest - geneticist and professor)	Neutral
in fact the data show AquAdvantage salmon would reduce pressures on/ threats to wild Alaska salmon. See here https://www.fda.gov/animalveterinary/developmentapprovalprocess/geneti	152	*@prometheusgreen*	Public (Sub interest - biotech)	Pro

cengineering/geneticallyengineeredanimals/ucm280853.htm …				

Congratulations team!/We did it!

This theme arose as an in-group communication tactic among producers and those in the biotech field. These tweets use exclamation points, speak of the technology as an "achievement" or "milestone", and build pride and team camaraderie. This theme is exemplified in terms and phrases like: "congratulations", "excellent", "team", "dedication" and "impressive".

Tweet Text	#	Twitter Account	Stakeholder Group	Sentiment
Excellent article in @StarPressMedia on @AquaBountyTech. @AquaBountyTech is ready to start producing #AquAdvantage Salmon in the USA. Congratulations to the team for another impressive milestone. Read now and share: https://tspne.ws/2wXjr6c $XON #Salmon #FarmToTable	45	*@intrexon*	Organizational (Sub interest - stock investment company managing AQB stock portfolio)	Pro
Congratulations @AquaBountyTech on successful 4 yr science-based regulatory process 4 AquAdvantage Salmon #scientificdedication #biotechTHAT	258	*@catemccready*	Public (Sub interest - self-described "biotech booster")	Pro

Genetically-engineered-salmon farm awaits eggs https://tspne.ws/2rU9gtA via @TheStarPress @AquaBountyTech is ready to start producing AquAdvantage Salmon in the USA - another milestone achieved!	47	*@gmaquascience*	Producer	Pro

Future in jeopardy.

This theme arose in those questioning the technology, skeptical of it's possible impact to human health and the environment, those concerned with corporate interests, or other possible ramifications not considered by the FDA (or Health Canada's) in their regulatory assessment. The public and organizational, particularly non-GMO organizations, stakeholder groups were the most likely to express these concerns and the sentiment was typically con. Terms used in to express this theme were: "despite concerns", "jeopardize the future", and "without adequate...review".

Tweet Text	#	Twitter Account	Stakeholder Group	Sentiment
The U.S. FDA announced its approval of the first U.S. facility for production of genetically engineered AquAdvantage salmon despite concerns that these fish could jeopardize the future of wild Atlantic salmon.	66	*@NonGMOProject*	Organizational (Sub interest - non-GMO organization)	Con
#Native American tribes have sued the FDA, saying the GE Aquadvantage salmon was approved without	168	*@iamfreedom777*	Public	Con

adequate environmental review #NOGMO #GMO				

Each of the themes tended to be constructed and reproduced by particular stakeholder groups, at times to accomplish particular objectives that could benefit the group. This was most notable in the producer stakeholder group. The producer group was proud, congratulated one another on hurdles overcome or achievements, and believed in their "product" so much that they promoted it as a solution to global problems like food security, species decline, and climate change. The media tried to present the AA salmon in sound bite or press release style tweets, where opinion was rarely imparted. Whereas the public was more actively involved in the debate and least likely to adhere to a specific message, theme, or identifiable objective, they were however more frequently documented to be questioning what the AA salmon was exactly and whether or not it posed a threat to our environment and health.

Phase Two of Qualitative Analysis: Grounded Discourse Analysis

In the next sections I used Emerson, Fretz, & Shaw's (2011) grounded approach to discourse analysis to answer RQ2-A, B, and C (**RQ2-A:** How do Twitter users *define* GMOs/AA salmon, the technology used to produce it?; **RQ2-B:** How do Twitter users *operationalize* their constructed discourse to accomplish their objectives; and what are their objectives?; **RQ2-C:** Are there any obfuscations, deletions, or deliberate misconstruals of information present in the online communication analyzed?). I also used additional qualitative themes that emerged as discussions and debates among stakeholders: what is natural?/defining natural/inherent differences between the AA

salmon and other salmon; the debate surrounding whether or not to label AA salmon; and the approval of AA salmon and associated topics; and the safety of the technology, to understand how stakeholders are formulating their concerns (*formulations)*, any *stories* used to narrate their perspective, any relevant *contexts* and *contrasts,* the *terms, types,* and *typologies*, and any *explanations and theories* used by discussants involved in these debates as an entry point to phase two of qualitative analysis.

The debates among stakeholders

Debate One: Is AA Salmon Natural?

Twitter users debated whether the AA Salmon natural and if there was a difference between AA salmon and naturally occurring salmon. In the qualitative theme, *What exactly is AA salmon? Is it a bird? A plane?,* language was presented as *terms and typologies* that describe how stakeholders reference the salmon and describe it as a commodity, a scientific study, or even not a fish at all but a permutation of a naturally occurring fish. Here are some examples that further depict this online debate between stakeholders as they position themselves in the colloquy of if AA salmon is natural, and if there is a difference between it and other naturally occurring salmon. When applicable, this section addresses constructed definitions; objectives in the communication and what these objectives attempt to accomplish; and any obfuscations, deletions or misconstruals. Examples 1-4 were coded "con" or negative construals of the fish or technology, example 5 was "neutral", and examples 6-7 were coded "pro" or positively constructing the fish or technology.

Examples of Debate One: Is AA Salmon Natural?

Example 1:

Not everyone agrees with the FDA. AquAdvantage Salmon were created by mixing the genes of two fish that would never mate in nature. The genetically engineered salmon…
(Tweet # 53, *@LaMontanitaCoop,* Food and Agriculture, Con)

Example 2:

#AquadvantageSalmon is not salmon. It has eel DNA. Not only does this make it not pure salmon, but the introduction of genmat from an unclean animal makes it inedible to people who cannot eat things like pork and eel. People like me. This fish would cause me violent indigestion.
(Tweet #8, *@Matthew37478320,* Public, Con)

Example 3:

Yummy frankenfish. AquAdvantage salmon is modified with this guy's gene. [Oh no! Sweating emoji.]
(Tweet #205, *@tobyglanville*, Public, Con)

Example 4:

Worst part is when buying these we won't even know about it. I've just read about the AquAdvantage Salmon in this article and I'm horrified. These products will get approval from FDA and make it to the shelf without declaring its origins.
(Tweet #5, *@kubernawt*, Public, Con)

Example 5:

The premise of the comments seems to be that a lot of fish for consumption is GMO. After a quick Google search, this appears to be false. AquAdvantage salmon was the first GMO fish certified for human consumption, and this was last year, so y'know those sardines are natural [fish emoji]
(Tweet #13, *@hannahsrudd,* public, neutral))

Example 6:

FDA Has Determined That the AquAdvantage Salmon is as Safe to Eat as Non-GE Salmon
http://www.fda.gov/ForConsumers/ConsumerUpdates/ucm472487.htm …
(Tweet #291, *@nuclear94*, Public, Pro)

Example 7:

"no biologically relevant differences in nutritional profile of AquAdvantage Salmon..." http://buff.ly/1MGbf5i
(Tweet #301, *@natashayounge*, Public, Pro)

In the first debate featured, the objections that surface in this debate also contrast among those participating in this debate and swirl around the question of "what is natural?". As proposed by the twitter users, for something to be classified as "natural", must it inherently occur in nature or is something "natural" because its genetic material does not differ substantially from that occurring in nature? Or, is it natural to merge the DNA of two types of salmon with that of an eel, even if this would not actually occur in nature? Two definitions for "natural" are in play in this debate: the first that in order to be natural, it must naturally occur in the natural world/nature (Tweet #8, *@Matthew37478320,* Public, Con). The second definition is the one adhered to by the FDA, that of substantial equivalence, meaning if it is substantially equivalent to other salmon then there are "no biologically relevant differences" (Tweet #301, *@natashayounge*, Public, Pro), it is "as safe to eat as Non-GE" (Tweet #291, *@nuclear94*, Public, Pro), and it is kosher because in its final form it is a fish with scales and fins. The question of whether or not it is a fish remains debated: "#AquadvantageSalmon is not salmon.." (Tweet #8, *@Matthew37478320,* Public, Con), and "Yummy frankenfish." (Tweet #205, *@tobyglanville*, Public, Con), demonstrate some members of the public's hesitancy to describe it as a fish or salmon.

The Producer stakeholder group is absent from this dialogue, perhaps a deliberate discursive move. It may be that their main objective is to convince and persuade other stakeholder groups not that the AA salmon is natural, but that it is an innovation and is a new sustainable form of animal agriculture, therefore they must abstain from claiming it to be natural or religiously acceptable. This discursive move may be deliberate to

accomplish their objective to promote the AA salmon as safe, nutritious, environmentally sustainable alternative, and to never acknowledge any possible negative construal of the fish.

Debate two: Whether or not to label the AA salmon

The labeling of AA salmon was a popularly debated topic on Twitter. Those who were in favor of labeling were adamantly outspoken that it should be labeled and that to not do so would be "fraudulent". A couple (n=2) tweets suggested that if the AA salmon were as beneficial for the environment as claimed then it would befit the company to brag on their label about its benefits, and that they should desire to do so. Below are some highlighted examples of tweets from various stakeholder groups depicting this debate on Twitter to answer how they define the salmon and the technology used to produce it, objectives of stakeholder groups, and potential obfuscations, deletions or misconstruals. Examples 1-11 were coded "con" or expressing sentiment against the AA salmon or technology, examples 12-18 were "neutral", and example 19 was coded "pro". It was challenging to find examples in the labeling debate that were either pro-GE technology or for not labeling the AA salmon.

Examples of Debate Two: Whether or Not to Label the AA Salmon

Example 1:

> Yes, Congress, no need to label #Frankenfish; it tastes better when you don't see the rap sheet. AquAdvantage Salmon http://www.fda.gov/AnimalVeterinary/DevelopmentApprovalProcess/GeneticEngineering/GeneticallyEngineeredAnimals/ucm280853.htm …
> (Tweet #342, *@mgb2010*, Public, Con)

Example 2:

@inartic I get that..But if AquAdvantage salmon is solely labeled as King or Chinook that would constitute fraud.Let's be clear @garyruskin
(Tweet #493, *@robles_jdaniel*, Public, Con)

Example 3:

Ugh. "Under FDA guidelines, the AquAdvantage Salmon will not require a GMO label."
(Tweet #533, *@kallvback*, Public, Con)

Example 4:

@MikeFoodIQ so how would I know I'm eating AquAdvantage salmon do u really think the co.'ll voluntarily labl it? @_courtneycali @thefoodbabe
(Tweet #599, *@robles_jdaniel*, Public, Con)

Example 5:

Worst part is when buying these we won't even know about it. I've just read about the AquAdvantage Salmon in this article and I'm horrified. These products will get approval from FDA and make it to the shelf without declaring its origins.
(Tweet #5, *@kubernawt*, Public, Con)

Example 6:

"HEALTH CANADA will not require AquAdvantage Salmon sold on Canadian grocery store shelves, to be labelled as a genetically modified product." We don't know now, which is which, on the shelves, so I'm forced to stop buying, but more importantly, stop eating SALMON.
(Tweet #103, *@NecktopP*, Public, Con)

Example 7:

@HealthCanada GMO fish should be labeled as such. Health Canada is deceiving the public. Label it GMO or AquAdvantage Salmon. BE HONEST!
(Tweet #230, *@renawoss*, Public, Con)

Example 8:

Really? Unlabelled #GMO #AquAdvantage #salmon Won't find me buying ANY fish ever.
(Tweet #246, *@raincoastmist*, Public, Con)

Example 9:

"HC will not require AquAdvantage Salmon sold on Cdn grocery shelves to be labelled as GM product" - no more salmon for me :(
(Tweet #253, *@christellar*, Public, Con)

Example 10:

#GMO #AquadvantageSalmon #AquabountyTechnologies #LabelGMOs #Cancer #Hague #CrimesAgainstHumanity #FDA #Salmon #Fish
(Tweet #278, *@felicito15*, Public, Con)

Example 11:

If @aquabountytech wishes to protect its rights to its AquAdvantage #Salmon "product" it should label it as such. http://bit.ly/1NH8t1u
(Tweet #327, *@jglarusso*, Public, Con)

Example 12:

The FDA will not require AquAdvantage salmon to be labeled as genetically engineered.
(Tweet #567, *@baxuduqarel*, Public, Neutral)

Example 13:

GMO Salmon is Coming to a Store Near You. Will You Know When it Arrives?: The AquAdvantage salmon will only be... http://binged.it/1IshokY
(Tweet #495, *@dlPanamanews*, Media, Neutral)

Example 14:

US publishes #GMO package labeling rules - packages must state the food is "bioengineered". This will include AquAdvantage #salmon - currently the only genetically #engineered #seafood product approved for sale. Will Canada ever follow suit? @CFIA_Food @CFIA_Canada @EAC_Marine
(Tweet #49, *@SeaChoice*, Organizational, Neutral)

Example 15:

JAMA: #FDA has for the 1st time OK'd genetically engineered animal for food - AquAdvantageSalmon. No special labeling required for this #GMO
(Tweet #307, *@DrOmerIlahi*, Public, Neutral)

Example 16:

The FDA has approved the first genetically modified animal for human consumption, the AquAdvantage salmon—without a labeling requirement.

(Tweet #320, *@JasonOGrady*, Public, Neutral)

Example 17:

> A setback for GM food in the US. Congress insists on labels for AquAdvantage salmon http://on.ft.com/1MltrAX
> (Tweet #329, *@clivecookson*, Public, Neutral)

Example 18:

> The FDA will not require AquAdvantage salmon to be labeled as genetically engineered.
> (Tweet #492, *@fathreinaldos*, Public, Neutral)

Example 19:

> @Pvincell I am sure voluntary labels will be used to highlight benefits, eg., Arctic apple and AquAdvantage salmon.
> (Tweet #288, *@TerryDaynard,* Food and Agriculture, Pro)

In the second debate, on whether to label the AA Salmon, interestingly the contested issue is not the definition of the fish itself, whether it is natural or not, or whether the technology is an acceptable method to use in food production, but whether to label it or not. The definition of a label or how the fish will be labeled (using a QR code, a symbol, or clear, plain language) is not debated in the selected sample. Too there were not many in the debate that were in favor of not labeling the fish as bioengineered. All of the tweets that expressed sentiment that was opposed to the AA salmon or the technology, expressed a desire to see AA Salmon labeled, and all of this communication came from the Public stakeholder group. The tweets that were neutral came from a diverse array of stakeholders including the media, members of the public, or organizations. The one pro sentiment tweet came from the Food and Agriculture stakeholder group. Again, in this debate we find that the public is the most active stakeholder group, and that the science and producer stakeholder groups are not engaging

in this debate. It could be that their objective in refraining from the labeling debate is to allow regulatory bodies the ability to legislate labeling laws without possibly influencing these regulations.

Generally, those in the debate who encouraged enforced labeling were expressing their desire for transparency and consumer knowledge. This was expressed in statements like, “Let's be clear” (Tweet #493, *@robles_jdaniel*, Public, Con), “Ugh. "Under FDA guidelines, the AquAdvantage Salmon will not require a GMO label." (Tweet #533, *@kallvback*, Public, Con), “Will Canada ever follow suit?” [to label GM foods] (Tweet #49, *@SeaChoice*, Organizational, Neutral), “Label it GMO or AquAdvantage Salmon. BE HONEST!” (Tweet #230, *@renawoss*, Public, Con). These statements seem to all have the same objective, to get the regulating bodies (the FDA and Health Canada) to require labeling for the AA salmon.

A formulation used by the con group of tweets was a call for labeling transparency because a lack of labeling would be dishonest, deceptive, fraudulent, and criminal. Some excerpts from tweets using terms and language used to express this sentiment were “if AquAdvantage salmon is solely labeled as King or Chinook that would constitute fraud. Let's be clear” (Tweet #493, *@robles_jdaniel*, Public, Con), “#Frankenfish; it tastes better when you don't see the rap sheet.” (Tweet #342, *@mgb2010*, Public, Con), “Health Canada is deceiving the public. Label it GMO or AquAdvantage Salmon. BE HONEST!” (Tweet #230, *@renawoss*, Public, Con), and “#LabelGMOs #Cancer #Hague #CrimesAgainstHumanity #FDA #Salmon #Fish” (Tweet #278, *@felicito15*, Public, Con). In this formulation, the public stakeholder group is accusatory of the regulatory bodies (the FDA and Health Canada) of committing

"crimes against humanity" (Tweet #278, *@felicito15*, Public, Con) by not labeling the AA salmon. The salmon itself becomes criminal as it has a "rap sheet" (Tweet #342, *@mgb2010*, Public, Con).

Another objective voiced by those opposed from the Public stakeholder group was an ultimatum: if the AA salmon was not going to be labeled, then they would stop purchasing salmon altogether. This was expressed in the following tweet exerts, "We don't know now, which is which, on the shelves, so I'm forced to stop buying, but more importantly, stop eating SALMON." (Tweet #103, *@NecktopP*, Public, Con), "no more salmon for me :(" (Tweet #253, *@christellar*, Public, Con), and "Won't find me buying ANY fish ever." (Tweet #246, *@raincoastmist*, Public, Con). This may present a micro-political advance, where members of the public are wielding one of the powers they have, purchasing power. If the public refuses to buy the salmon, then the company will not profit. It is also a way of bargaining, by trying to communicate that if the company labels it then consumers will choose whether or not to purchase it, but if they are not given the choice they will choose to opt out altogether.

The one pro tweet states they are sure the company will voluntarily label it to highlight the benefits, "I am sure voluntary labels will be used to highlight benefits, eg., Arctic apple and AquAdvantage salmon." (Tweet #288, *@TerryDaynard,* Food and Agriculture, Pro), but other discussants are not so sure, "do u really think the co.'ll voluntarily labl it?" (Tweet #599, *@robles_jdaniel*, Public, Con). Others chimed in too in a more neutral way to the discussion on whether AQB would voluntarily label the AA salmon, "If @aquabountytech wishes to protect its rights to its AquAdvantage #Salmon "product" it should label it as such." (Tweet #327, *@jglarusso*, Public, Con). One tweet

spoke of mandatory labeling required by Congress as being a, "setback for GM food in the US. Congress insists on labels for AquAdvantage salmon" (Tweet #329, *@clivecookson*, Public, Neutral).

Debate 3: The approval of the technology

The approval of AA salmon was unprecedented as the first GE animal approved by the FDA for sale in US markets. This generated an online discussion, debate, and engagement from the stakeholders who were invested in the news of its approval, on all sides of the debate, whether pro, con or neutral.

Examples of Debate Three: The Approval of the Technology

Example 1:

> Worst part is when buying these we won't even know about it. I've just read about the AquAdvantage Salmon in this article and I'm horrified. These products will get approval from FDA and make it to the shelf without declaring its origins. (Tweet #5, *@kubernawt*, Public, Con)

Example 2:

> The U.S. FDA announced its approval of the first U.S. facility for production of genetically engineered AquAdvantage salmon despite concerns that these fish could jeopardize the future of wild Atlantic salmon.
> (Tweet #66, *@NonGMOProject*, Organizational, Con)

Example 3:

> In 2015, the FDA approved a NADA related to the AquAdvantage Salmon, but this approval specified that only AquaBounty's facility on Prince Edward Island, Canada, where the salmon…
> (Tweet #72, *@notsowisewoman*, Public, Neutral)

Example 4:

> Quinault Indian Nation is suing the #FDA for its approval of the #GMO AquAdvantage salmon. #GoNonGMO…
> (Tweet #175, *@TORTRAINER*, Public, Con)

Example 5:

> FDA Sued Over AquAdvantage Salmon Approval http://j.mp/1XIl9ev - By @jonesday
> (Tweet #267, *@LawNewsAmerica*, Media, Neutral)

Example 6:

> "We're deeply disappointed w/the #FDA's approval of #AquAdvantage salmon, first #GE fish for human consumption." http://www.consumerreports.org/consumer-protection/building-a-better-world-together/ … #p2
> (Tweet #289, *@avtramontano*, Public, Con)

Example 7:

> GE plants go through the USDA, AquAdvantage salmon went to FDA - it is most rigorous approval body
> (Tweet #310, *@JMichelleLavery*, Public, Pro)

Example 8:

> On November 19th, the Food and Drug Administration announced its approval of AquAdvantage salmon http://pops.ci/whxrWo via @PopSci
> (Tweet #427, *@Hakan_Gench*, Public, Neutral)

Example 9:

> FASTER GROWG FISH. ALL ABT THE$$$ FDA Has Determined That the AquAdvantage Salmon is as Safe to Eat as Non-GE Salmon http://www.fda.gov/ForConsumers/ConsumerUpdates/ucm472487.htm …
> (Tweet #558, *@gal_jersey*, Public, Con)

Example 10:

> Alaska senators decry FDA approval of AquAdvantage salmon - FIS #alaska http://dragplus.com/post/id/32725249 …
> (Tweet #576, *@alaskastate_dp*, Other, Con)

Example 11:

> "Frankenfish" approval controversy over AquAdvantage salmon genetically modified to grow faster
> (Tweet #635, *@DIYSECT*, Media, Con)

Example 12:

> Opponents Respond to FDA Approval of GMO Salmon The Food and Drug Administration approved AquaBounty Technologies' application for AquAdvantage Salmon , an Atlantic salmon that reaches market size more quickly than non-genetically engineered farm-rai
> (Tweet #2, *@Bridget52182408,* Public, Neutral)

Example 13:

> AquaBounty Technologies, Inc. Announces FDA Approval of First U.S. Facility for Commercial Production of AquAdvantage Salmon #promotion https://cmun.it/zhzwhj - Get your [Free] content here: https://commun.it/grow-your-followers/?tc=n&aid=content_45&origin=content … via @commun_it
> (Tweet #57, *@Arbitrageshub*, Other, Neutral)

Example 14:

> AquaBounty Receives FDA Approval For Commercial Production AquAdvantage Salmon Facility in Indiana http://bit.ly/2Hx3EvT
> (Tweet #67, *@UBseafood*, Food and Agriculture, Neutral)

Example 15:

> More good News for @Intrexon's AquaBounty Technologies subsidiary - They received FDA Approval of First U.S. Facility for Commercial Production of AquAdvantage Salmon - Intrexon started as Genomatix at @HCBCtr https://finance.yahoo.com/news/aquabounty-technologies-inc-announces-fda-151500457.html …
> (Tweet #76, *@HCBCtr*, Organizational, Pro)

Example 16:

> AquaBounty Technologies, Inc. Announces FDA Approval of First U.S. Facility for Commercial Production of AquAdvantage Salmon http://www.globenewswire.com/NewsRoom/ReleaseNg/2237990/en …
> (Tweet #78, *@AquaBountyTech,* Producer, Neutral)

The debate surrounding the approval of AA salmon on Twitter was typified as less of a debate and more expressions of disapproval, concerns over the approval, and questioning the reason for approval by the FDA. Out of the sixteen tweets selected from the larger data set that pertained to the approval debate, seven were con/against, seven

neutral, and two pro/in favor. Stakeholder groups were mixed and it could not be determined whether a group majority was in favor or against the approval.

In the two pro tweets in the sub-set, "More good News for @Intrexon's AquaBounty Technologies subsidiary - They received FDA Approval of First U.S. Facility for Commercial Production of AquAdvantage Salmon" (Tweet #76, *@HCBCtr*, Organizational, Pro), and "GE plants go through the USDA, AquAdvantage salmon went to FDA - it is most rigorous approval body" (Tweet #310, *@JMichelleLavery*, Public, Pro), the former (Tweet #76) is laudatory and congratulatory to Intrexon and Aquabounty for their US facility approval, while the latter (Tweet #310) is referencing the approval by the FDA of the AA salmon. By stating that the FDA is "most rigorous approval body", and implying it is more rigorous than the USDA it is suggests that it is a trustworthy approval process, since it is the most rigorous approval process food can go through in the US. Tweet #76, although referencing a different approval, the expansion into US production, is congratulatory to the producers from a monetary perspective, since Intrexon is the stock company that manages the AQB portfolio. Hence the objective behind Tweet #310 is unclear, but the underlying motivations of Tweet #76 is that with this approved expansion AQB is sure to begin to become profitable.

The neutral tweets used soundbite or headline reporting style without any sentiment expressed on one side or other of the approval debate. For instance, even the producer AQB tweeted but it was simply to share the news of the approval, "AquaBounty Technologies, Inc. Announces FDA Approval of First U.S. Facility for Commercial Production of AquAdvantage Salmon" (Tweet #78, *@AquaBountyTech,* Producer, Neutral). Even when the tweet was specifically about the debate, if no leaning toward

one side was expressed it was presumed neutral as well, “Opponents Respond to FDA Approval of GMO Salmon The Food and Drug Administration approved AquaBounty Technologies' application for AquAdvantage Salmon , an Atlantic salmon that reaches market size more quickly than non-genetically engineered farm-rai” (Tweet #2, *@Bridget52182408,* Public, Neutral). Neutral tweets do still serve a function in an online colloquy and debate as they provide unbiased information to add to people’s knowledge and understanding of a topic, and can influence opinions. The link shared by producer, AQB, was a press release initiated by themselves that includes their stock portfolio projections and is overwhelmingly pro sentiment (http://www.globenewswire.com/news-release/2018/04/27/1489229/0/en/AquaBounty-Technologies-Inc-Announces-FDA-Approval-of-First-U-S-Facility-for-Commercial-Production-of-AquAdvantage-Salmon.html). This indicates that the underlying objective behind their neutral, non-inflammatory tweet was self-promoting and self-aggrandizing.

In the con/against approval selection of tweets, their sentiment is transparent through their diction: “Worst part...get approval from FDA and make it to the shelf without declaring its origins.” (Tweet #5, *@kubernawt*, Public, Con), “approval...despite concerns”

(Tweet #66, *@NonGMOProject*, Organizational, Con), “FDA Sued Over AquAdvantage Salmon Approval” (Tweet #267, *@LawNewsAmerica*, Media, Neutral), “deeply disappointed w/the #FDA’s approval” (Tweet #289, *@avtramontano*, Public, Con), “ALL ABT THE$$$” (Tweet #558, *@gal_jersey*, Public, Con), “Alaska senators decry FDA approval” (Tweet #576, *@alaskastate_dp*, Other, Con), and “"Frankenfish" approval controversy” (Tweet #635, *@DIYSECT*, Media, Con). Implied in the word

choices and definitions are disapproval, controversy, disappointment, and outcry. The objective of those against approval is to express their disagreement. The FDA being sued is a negative consequence of their approval process but it is unlikely that the results of this court case will effect or reverse the FDA decision.

Debate 4: The debate over the safety of AA salmon

The safety of the AA salmon revolves around two central questions of the technology: is it safe for human consumption, or stated differently, does it pose a threat to human health in any way from increasing allergies or other unknown effects?, and if AA salmon were to enter into the environment would they pose a threat to wild salmon, other species, or ecosystem balance?

Examples of Debate Four: The Safety of AA Salmon

Example 1:

> along with approval of AquAdvantage salmon FDA approved new drug/hormone growth for frankenfish [hmm emoji] how safe?NOGMO
> (Tweet #193, *@Love2DIM*, Public, Con)

Example 2:

> Hubris? FDA Has Determined That the AquAdvantage Salmon is as Safe to Eat as Non-GE Salmon http://ht.ly/VkbXp
> (Tweet #304, *@mztorontopainmd*, Public, Con)

Example 3:

> FDA: GMO fish are a danger to ecosystems. REVERSE decision to approve "AquAdvantage Salmon" 4 human consumption, w/o labeling.
> (Tweet #326, *@NLFRTA,* Food and Agriculture, Con)

Example 4:

"Exhaustive and rigorous…review" Really? FDA Determined That AquAdvantage Salmon is as Safe to Eat as Non-GE Salmon http://ht.ly/Vkbwq
(Tweet #331, *@mztorontopainmd*, Public, Con)

Example 5:

FDA Has Determined That the AquAdvantage Salmon is as Safe to Eat as Non-GE Salmon
http://www.fda.gov/ForConsumers/ConsumerUpdates/ucm472487.htm … HUH? How can this be healthy?
(Tweet #522, *@kaemicha*, Public, Con)

Example 6:

resistant to late blight, the disease that caused the Irish potato famine." AquAdvantage salmon, the first genetically modified salmon was deemed safe for consumption in 2010 and will be available as soon as labeling guidelines from the FDA have been #food #vegan #nomeat #nogmo
(Tweet #12, *@CoexistingEarth*, Other, Con)

Example 7:

#Native American tribes have sued the FDA, saying the GE Aquadvantage salmon was approved without adequate environmental review #NOGMO #GMO
(Tweet, #168, *@iamfreedom777*, Public, Con)

Example 8:

AquAdvantage salmon, that's genetically engineered, approved by FDA to be safe and nutritious for consumers! #ANS211
(Tweet #299, *@jackiefusc*, Public, Pro)

Example 9:

FDA Has Determined That the AquAdvantage Salmon is as Safe to Eat as Non-GE Salmon #science #nutrition
http://www.fda.gov/ForConsumers/ConsumerUpdates/ucm472487.htm …
(Tweet #412, *@dave_schnell*, Public, Pro)

Example 10:

Canada - #GMO #AquAdvantage Salmon undergoing another federal risk assessment Officials said this new review will be based on the latest information to determine if there's a risk to human health or the environment from the fish.
(Tweet #6, *@pdjmoo*, Public, Neutral)

Example 11:

> Safety of a transgenic or genetically modified salmon : the AquAdvantage salmon https://lnkd.in/d8vbWVz
> (Tweet #297, *@fruklas,* Other, Neutral)

One tweet, regarding human health that stated the AA salmon was "as safe to eat as non-GE", went viral and was retweeted 81 times in the data set, in various iterations, with people adding on their own commentary, with the sharing of different articles, or tagging others. Tweets stating that the AA salmon was "as safe to eat as non-GE salmon" were coded pro/in favor for sentiment because they regarded the technology to not pose a risk to human health anymore so than a wild or non-GE salmon would (for example tweet #412 in the subset). On occasion, tweets would add additional commentary to the original tweet suggesting they questioned whether this were the case. Examples of this are: "Hubris? FDA Has Determined That the AquAdvantage Salmon is as Safe to Eat as Non-GE Salmon" (Tweet #304, *@mztorontopainmd*, Public, Con), ""Exhaustive and rigorous…review" Really? FDA Determined That AquAdvantage Salmon is as Safe to Eat as Non-GE Salmon" (Tweet #331, *@mztorontopainmd*, Public, Con), "FDA Has Determined That the AquAdvantage Salmon is as Safe to Eat as Non-GE Salmon HUH? How can this be healthy?" (Tweet #522, *@kaemicha*, Public, Con), and "resistant to late blight, the disease that caused the Irish potato famine." AquAdvantage salmon, the first genetically modified salmon was deemed safe for consumption in 2010 and will be available as soon as labeling guidelines from the FDA have been #food #vegan #nomeat #nogmo" (Tweet #12, *@CoexistingEarth*, Other, Con). These additions to the original tweet question whether FDA review was in fact rigorous

and exhaustive, if this form of human technology may be an example of hubris, "how" the technology can be healthy, and also expressions that they will not eat it "#nogmo". These counter spins on the original tweet created a contrast and questioned the validity of the retweeted sentiment. Tweet #29 was unique in that it used an exclamation point and added that the AA salmon was "safe and nutritious for consumers!" they also used the hashtag "#ANS211" (Tweet #193, *@Love2DIM*, Public, Con) which is a hashtag used to denote statements related to food security and alleviation of food insecurity. The implication is that user *@Love2DIM* is excited about this approval to alleviate food insecurity threats, a narrative told by those who promote genetic modification technology as a way to increase global food security.

A few tweets brought up environmental safety of the AA salmon, two were against due to environmental risks, and one was neutral. The neutral tweet shared information about the environmental and health risk assessment the Canadian government was conducting, "Canada - #GMO #AquAdvantage Salmon undergoing another federal risk assessment Officials said this new review will be based on the latest information to determine if there's a risk to human health or the environment from the fish." (Tweet #6, *@pdjmoo*, Public, Neutral). This con tweet does not specify how the fish threaten the ecosystem but that is one drawback of the abbreviated text limit on twitter, "FDA: GMO fish are a danger to ecosystems. REVERSE decision to approve "AquAdvantage Salmon" 4 human consumption, w/o labeling." (Tweet #326, *@NLFRTA,* Food and Agriculture, Con). The other con tweet in the safety debate subset also does not state specifically what threat to environmental safety is imposed, "#Native American tribes have sued the FDA, saying the GE Aquadvantage salmon was approved

without adequate environmental review #NOGMO #GMO" (Tweet, #168, *@iamfreedom777*, Public, Con). Both of the con tweets do express similar sentiment that adequate review was not conducted, the approval decision should be reversed, and the salmon do threaten the environment.

Notes regarding all four debates

It was much more common to see "con" sentiment, or sentiment expressed that was opposed to the AA salmon or the technology used to produce it, than any "pro" or in favor. It may be that those in favor of the salmon and technology prefer to stay out of arguments and contested topics and prefer positive, promotional statements, or that dialogue on debated topics seldom occurs.

Word Frequencies

The frequency of certain terms were evaluated in the data set to see how commonly used they were by stakeholders. This was assessed to assist with unpacking the analysis of terms, types and typologies (Emerson, Fretz, & Shaw, 2011). It can be assumed that the more frequently a word appears in the data the more relevant it is to stakeholders, and vice versa for words that appear infrequently. The accompanying list of words and phrases are ordered from most frequent to least and the number next to the word or phrase represents the amount of times it appeared in the data set. This data set did not include the 46 tweets excluded from analysis in the word count frequency.

The following words were assessed in the data set for frequency: AquAdvantage (600), Salmon (600), GE (600), AquAdvantage Salmon (563), FDA (228), Gene (172), Genetic (164), Fish (141), Approve (125), Eat (115), Engineer (110), Food (103), AquaBounty (98), Safe (91), Genetically Engineered (85), Science (77), Frankenfish

(76), Fear (69), GMO (68), Label (64), Animal (62), Modified (58), News (47), Grow (47), Genetically Modified (41), Product (37), Farm (33), Health (32), Technologies (29), Production (23), Aquaculture (24), Commercial (22), Facility (22), Market (19), Fast (14), Technology (14), Feed (13), Land (13), Land-Based (10), Seafood (9), Sustainable (9), Environment (8), Intrexon (8), Debate (7), Taste (7), Wild (7), Better (6), DNA (6), Edit (6), Genetic Engineering (5), Raise (5), Rear (5), Skeptic (5), Species (5), Stock (5), AQB (4), Bred (4), Ocean (4), Nature (4), Breed (3), Gene Edit (3), Innovation (3), Plant (3), Produce (3), Producing (3), Scicomm (3), Bioengineer (2), Inland (2), Raised (2), Scientist (2), Agriculture (1), Natural (1), Monsanto (1), CRISPR (0), Geneticist (0), Genetically Modified Organism (0), Modification (0), Mutation (0), Selection (0), and Stream (0).

The word frequencies are an amalgamation of all stakeholder groups but can give a window into how discussants are framing the AA salmon and the technology used to produce it in terms, types, and typologies. For instance, "genetically engineered" seems to be the preferred term to depict the technology used to produce the salmon, as opposed to "bioengineer*" which is the term the FDA will be requiring labels to use by 2020. The salmon itself is depicted as the "AquAdvantage salmon", usually referenced by their trademarked name, and is seen as a "genetically engineered" "fish", "approved" for "eat"ing and "safe" as a "food" using "science". But it is also viewed as a "Frankenfish" to be "fear"ed.

Similarly the words that are not in the picture are of note as well: Is this "technology" of "land-based" "seafood" "sustainable" for our "environment"? And where in the conversation are our "stream"s, "oceans", "nature", "natural" world, and

"natural" "selection"?

Summary

Findings suggest a robust and active dialogue between stakeholders found, discussing many topics. Stakeholder groups identified as being involved in the conversation on AA salmon on Twitter were: the public (n=250, 41.5%), the media (n=126, 20.9%), organizations (n=59, 9.8%, food and agriculture (n=36, 6%), science and scientists (n=32, 5.3%), producers (n=25, 4.2%), other (n=28, 4.7%), and those excluded from analysis (n=46, 7.6%). Overarching themes found were: scientific validity versus scientific hubris, i.e. "frankenfish"; and that of consumption and capitalism. Sub-themes identified were: what exactly is AA salmon? is it a fish? is it a plane; the sterile, commercial product; save the world discourse/sustainable and environmental solution discourse; science solves everything; we "aren't here to make friends" (antagonistic discourse); "congratulations team!" or "we did it!!"; and the future is in jeopardy. Debated topics circled around: whether or not the AA salmon is natural; whether or not to label it; the safety of the technology for health and the environment; and the FDA approval of the technology.

In this section the data set was analyzed descriptively, by sentiment, and qualitatively. The demographic data helped to depict the typical discussant involved in the Twitter conversation on AA salmon and identify stakeholder groups. The qualitative data identified common themes and how stakeholder groups were defining the AA salmon and the technology used to produce it. The last phase of qualitative analysis addressed the debates swirling around the AA salmon and the technology. These results, their relationship to past literature, gaps in the literature, and RQ3 will be addressed in

the discussion and conclusions chapter, Chapter 5.

Chapter 5: Discussion and Conclusion

This study used qualitative content analysis to analyze the communicative instances and discursive strategies of stakeholders engaging on Twitter discussing the AquAdvantage salmon, the technology used to produce it, and associated policies and regulations. Genetic modification technology and many of the vegetables and animals it has produced, although utilized and embedded in our food system since the 1990s, has been contested and debated in food production and consumption (Blancke et al., 2015). This study contributes to existing research by finding out who the invested stakeholder groups are, their interests, their goals, and objectives (Cook et al., 2006). If we are to create dialogue and path forward for the future of food production, then the health of the environment, other species, and humans; the resolution of larger issues that face our environment and revolve around food production like agricultural practices, livestock management, and global climate change, (Bhatta & Misra, 2016, Clark & Lehman, 2001, Devos et al., 2008; Gerasimova, 2016, Wales & Mythen, 2002), must be centralized. This research is timely because the AA salmon is the first GE animal approved for sale and production in the US by the FDA but has yet to be sold to consumers. As the first GE animal approved for sale and consumption in US markets, this research questioned the discursive construction of the AA salmon by stakeholders to add to research addressing the treatment of factory farmed and animals meant for food, and the problematic discourse surrounding the commodification of an animal as a food resource (Escobar, 1999; Plumwood, 2003; Clausen & Longo, 2012; Packwood Freeman, Beckoff, & Bexell, 2011). As I quoted Beck at the beginning of this dissertation (quoted in Wales & Mythen, 2002, pp. 126), it is crucial and exigent to dispel risk and find a mutual path

forward, because it is, "…imperative that the social and political relations of definitions which support risk negotiation become more democratic: that all affected parties are equally recognized and are enabled to either participate or be represented effectively in risk dialogue."

As stated in the introduction chapter, the goals of this research were to find a common ground between varying stakeholder perspectives so that a discursive space and mutual dialogue could be achieved, achieve transparency of each stakeholder group's agenda, messages, and goals, and to assess if the goals are to improve the social, economic, health, and environmental conditions for humans and the natural world. Another goal of this research was to give voice to the lesser empowered parties in the debate: the citizens, and their right to choose what to eat and buy, and the salmon itself. This research adds and expands upon previous research in these areas and also contributes a method to conduct communication research on Twitter. This chapter presents a summary of key findings, a discussion of the findings, the theoretical implications, dialogic applications, notes on conducting research on Twitter, addresses the gaps in the literature, limitations, and directions for future research.

Summary of Key Findings

The data set collected included 649 tweets (46 excluded) and their: twitter handle, link to tweet, timestamp, mentions of others, URLs referenced, replies to others, retweets, likes, comments, tweet type (original, conversational, disseminative), sentiment of tweet, sentiment of URL, sentiment of visual content, individual or organization, stakeholder affiliation, and gender; and per each twitter account: number of tweets, amount following, amount of followers, likes, lists, and moments.

It was found that an array of stakeholder groups engaged in the online colloquy on Twitter about the AquAdvantage salmon and the technology used to produce it, genetic engineering. Stakeholder groups identified and active participants on Twitter were: the public (n=250, 41.5%), the media (n=126, 20.9%), organizations (n=59, 9.8%), food and agriculture (n=36, 6%), science and scientists (n=32, 5.3%), producers (n=25, 4.2%), other (n=28, 4.7%), and those excluded from analysis (n=46, 7.6%). Some groups were more active than others: the public accounted for about half of the tweets in the sample and the media a fifth, the producer stakeholder group was the least active but the most adherent to a specific message and objective (to promote the AA salmon).

Overarching themes found in qualitative analysis were: scientific validation versus scientific hubris and consumption and capitalism. Sub-themes found were: what exactly is AA salmon?; the sterile, commercial product; save the world discourse, science solves everything; antagonistic, defensive discourse; congratulatory discourse; and the future in jeopardy. Debated topics circled around: whether the AA salmon is natural; whether or not to label it; the safety of the technology for health and the environment; and the FDA approval of the technology.

The overarching themes and subthemes do emulate past research. The theme 'scientific achievement/progress/modernization' (Lockie, 2006; Maeseele, 2015; Motion & Weaver, 2005) is akin to the sub-theme "science solves everything". The theme 'agricultural revolution/food security' (Casaus, 2010; Lockie, 2006) was similar to "save the world discourse". 'Anti-science irrationalism' (Augoustinos, Crabb, & Shepherd, 2010; Cook, Robbins, & Pieri, 2006; Lockie, 2006) was echoed in the "antagonistic, defensive discourse" albeit from the other side (as the science stakeholder group was

most likely to use this discursive tactic). 'Organic foods as natural/GMO foods as unnatural or conventional (Casaus, 2010; Lockie, 2006) was reflected in both of the subthemes "what is AA salmon" and "the sterile commercial product". 'Moral and environmental conflict' (Howarth, 2013; Lockie, 2006), 'mistrust of government and corporate interests' (Augoustinos, Crabb, & Shepherd, 2010; Cook, Robbins, & Pieri, 2006; Howarth, 2013), 'hegemony and power' (Hughes, 2007; Motion & Weaver, 2005), and 'health and environmental risk' (Casaus, 2010; Lockie, 2006) were all glimpsed in "the future in jeopardy" subtheme. The 'war, battle, or stalemate' theme found in previous research (Cook, Robbins, & Pieri, 2006; Howarth, 2013; Hughes, 2007) was not prevalent in the data. It may be that the debate and controversy over GMOs and GMFs has subsided, there is acceptance that GMOs are in the food system, the debate is now over how should they be regulated and labeled to mitigate unknown health and environmental risks.

Discussion of Key Finding

Discussants and stakeholders did in fact define the AA salmon differently, and more variability was demonstrated in the public stakeholder group. To the producers, the salmon is the solution to our seafood (and food) problem: there is too high of demand for seafood (particularly salmon), aquaculture and commercial fishing practices are environmentally destructive and polluting, and the AA salmon takes less time, uses less feed, and is just as beneficial for human health as other salmon. Aquacultural practices have been known for their concentrated pollutants (Aerni, 2004; Curieux-Belfond et al., 2008; McLeod et al., 2006); it remains to be seen how much different AquaBounty's aquaculture techniques are comparative to current practices.

The public however, fought over the definition of the AA salmon in the debate, what is natural? They questioned whether the AA salmon were natural if it could not be produced under natural circumstances, and yet others in the public stakeholder group aligned with the FDA's definition, that it was substantially equivalent, or biologically akin, to wild salmon, and therefore just as safe. The literature found the public to be uneducated, irrational, or unscientific (Blancke et al., 2015; Cook, Pieri, & Robbins, 2004); not in support of economic and social progress (Gerasimova, 2016); objecting to GMO technology as unnatural, immoral, or dangerous (Blancke et al., 2015); or objecting out of a mistrust of the corporate and political agendas (Cook et al., 2006); this research finds that the public are engaged, have a spectrum of those in favor and against the AA salmon and the technology used to produce it, are concerned due to uncertain manufactured risks (Wales & Mythen, 2002), may mistrust corporate agendas and the government's ability to regulate the technology and protect the environment and human safety, and want the AA salmon labeled. Further, the results of this study suggest that the public may reject the AA salmon altogether if it is not labeled as such. This study adds to the existing interpretation of public opinion on GMOs and found that the members of the public on Twitter held a nuanced, opinion that ranged from acceptance to total rejection of the AA salmon and technology used to produce it.

Resonant of the theme found, 'consumption and capitalism', for many across stakeholder groups, the AA salmon was a commercial food product, it did not retain any animal rights and was questionably, an animal. As with all GMO technology, be it seeds, a chemical fertilizer, or an animal, it is a patented, copyrighted, and owned product. To claim ownership over animals implies that the owner has the right to care for and create

habitat for the animal that is owned, however there was never conversation about the aquaculture facility or the ethical treatment of the AA salmon in the Twitter conversation.

The objectives of stakeholders varied as well. The public's objective was to question and answer. The public shared information, posed ethical questions, debated both sides and between, and expressed concern. The producers main objective demonstrated through their constructed discourse was to convince and persuade that AA salmon was the solution to many overarching societal problems like hunger and global climate change. The media sought to share and inform their followers and beyond with the latest updates and news stories pertaining to the AA salmon. The media stakeholder group and their ability to reach a large, diverse amount of the public, could be an avenue for education and dialogue regarding AA salmon. This study finds the media, although active in the Twitter conversation, did not actively choose a side, or promote an opinion but instead shared news stories related to the AA salmon. The Food and Agriculture stakeholder group's main objective was to share, inform, and promote the AA salmon to their followers and others in their extended network. This stakeholder group did not voice any criticism, perhaps because the sale of a new product on the market would bring resources and revenue to the food and agricultural sector. The science stakeholder group's main objective was to justify and inform, not to question the research, technology, or its applicability.

This study found that the government and policymakers, although an identified stakeholder group in the literature, were inactive in the Twitter conversation, although the FDA does maintain an active Twitter account. The findings of this study also support that a major objection regarding the AA salmon and the technology are unexplained,

unquantified, and unknown risks associated with it. The government could serve a key role in communicating their ability and assurity to control these associated risks.

Deletions, obfuscations, and misconstruals did arise and relate to stories or narrative constructions groups use to talk about and construct their versions (Emerson, Fretz, & Shaw, 2011) of the AA salmon and technology. First, there was the story of environmental sustainability constructed and told by the producer stakeholder group. A salmon that eats less and grows faster and does not put any pressure on wild salmon stocks does at first appear a sustainable solution, however what was deleted from the narrative is that in aquaculture facilities and confined animal feeding operations (CAFOs), the animal waste is concentrated and pollutes the surrounding environment. Another deletion from the story is the sustainability of the transportation cost of the fish as it jet sets from Prince Edward Island in Canada to Panama to whatever grocery store it is sold in. This was noted in the ironic tone of the following tweet, "Wonderful to hear that the environmental benefits of AquAdvantage salmon won't be eaten up by shipping it all the way from Panama." (Tweet #85, *@eatcookwrite*, Public, Con). Food security was another narrative the producers promoted, claiming that the AA salmon would "play a key role in global protein production" (Tweet #185, *@AquaBountyTech*, Producer, Pro). The misconstrual in this story is that first, salmon are carnivorous (Le Curieux-Belfond et al., 2008) and humans could be eating the protein the salmon are eating, or eat a plant-based diet, which is shown to be more sustainable for agriculture and the environment. The last highlighted misconstrual was regarding the technology itself, genetic engineering/modification/bioengineering etc. that must it be done in a lab and is not possible under normal circumstances in nature. When user *@biobeef* stated that "Only

approved genetically engineered animal is aquadvantage salmon...no gene edited animals on market except for those edited by nature" it deliberately conflates genetic selection with genetic modification by choosing to use the terms 'gene edited' and that they can be 'edited in nature' thereby making the technology seem like a natural process.

The Third Research Question

The third research question, was answered at many points in the findings and is discussed here: *How is the AquAdvantage salmon presented and constructed? That of a commodity to serve human interests or otherwise; and is that discourse variable among discussants?*

Generally speaking, the AA salmon is presented and constructed across stakeholder groups as a product, for human consumption/to eat as food, a commodity to sell and earn an income from, a solution to societal and environmental problems, and an innovation in food technology; or as the them found 'a sterile, commercial product'. This reflects Clausen & Longo's (2012) Tragedy of the Commons, in which the salmon is a commodity, for monetary gain, and improved agricultural efficiency. This construction and formulation of the AA salmon also emulates Escobar's Technonature (1999) in which a biologically engineered animal is defined and solely came into being as a technological innovation to serve human needs. In addition, Plumwood's (2003) Instrumentalisation, in which the AA salmon are destined to be instruments for human use as food. Another way the fish is constructed is what the FDA terms "substantial equivalence" or that the AA salmon is 'essentially' the same as a wild salmon. This framing serves to support the assertion that the AA salmon is as safe to eat as other salmon, but does not address the safety concerns of its possible integration or inbreeding

with wild populations. What is not addressed or referenced is its animal rights and animal nature (Packwood-Freeman et al. 2011). Some questions not addressed by any stakeholder group was whether it is appropriate to shorten the lifespan of a salmon? Whether it is ethical to raise it in indoor facilities? Does it strain and stress the animal to never see sunlight, to swim continuously in circular tanks, and to have the temperature regulated unnaturally? These questions are often asked in debates surrounding other animal agricultural practices but were not addressed in the data set. It seems the focus of debate and concern is regarding the genetic engineering technology, and not the agricultural practices nor the instinctual nature of the animal.

This intersects with ecocultural communication, in particular, Carbaugh (1996), Stibbe (2012), Plumwood (2003), and Milstein (2007) whose perspectives coalesce on the theory that in order to transition the dialogue on animals to a more progressive and equitable realm, we must change the way we 'talk' about animals, even if they were 'designed' genetically for food and agriculture, increased efficiency, and productivity. First, it may be important to remember that the AA salmon is still an animal that exists in the natural world, and not some sort of lab-freak or food-product and is a part of the reciprocal web of human-animal interactions (Plumwood, 2003). In this reciprocal web of human-animal ecological relations, humans are not to reify their 'mastery' or dominance, but instead deference to the uncontrollable, wild, feral, and boundless natural world, amongst which we reside (Milstein, 2007).

As shown in the Twitter colloquy, animal science discourse instrumentalizes animals, turning them into units and products, that are measured and sold (Croney & Reynnells, 2008; Plumwood, 2003). Croney & Reynnells (2008) state that this scientific

discourse conflicts with the public's opinion that animals have value aside from their uses; and the public discourse, may be the most significant (Bredahl, 1999). The public support of genetically modified foods is necessary for the continued propagation/production/profit of and by these products (Bredahl, 1999). When the public or consumer purchase a food product they implicitly or explicitly consent to the treatment of that animal or food through their purchase (Stibbe, 2012). This places power in the hands of the consumer, some of whom, in the presented data set, vow to never purchase fish or salmon until it is properly labeled. Importantly, we must continue to reflect on the questions that still exist surrounding a laboratory engineered salmon: are animals sentient beings, conscious, with neurological feelings, and are we morally responsible to advocate on their behalf; since they cannot advocate for themselves (Carbaugh, 1996)?

Conclusions

Theoretical Implications

This research was conducted at a time when the AA salmon was still not available for sale or purchase in US markets. It offers a window into how stakeholders, assessed, viewed, and voiced the opinions they held on Twitter, before its release for sale on the US market. It is reasonable that the tweets sampled viewed the salmon as a product, commercial, and a food, instead of an animal, species, or naturally occurring being; it was in fact created by AquaBounty Technologies for the sole purpose of being consumed as a meat product. Escobar's term technonature (1999) includes the technology of genetic modification, such as AquAdvantage salmon. The discourse on Twitter reaffirms their idea of "biology under control", the control of humans, who create "radical biological

alterity", and 'modify' fish to serve human purposes—to take all the advantages of the AquAdvantage. Toward the possibility of dialogue however, its nature, or how "natural" it is, is being questioned in the online Twitter debate. There is a dialogue going on but the producers and scientists remain on the periphery, especially when it comes to highly contested and debated topics.

Theoretically, the Diffusion of Innovations Theory is applicable in the discursive constructions and frames employed by the various stakeholder groups to help explain how each views the novel food technology (Rogers, 2008). Rate of adoption is still marked by hesitance and reticence and from the communication on Twitter, it is hard to assess the actual acceptance of the AA salmon and the technology used to produce it, and how likely people will be to eat and buy it. People adopt based on certain factors such as relative advantage, complexity, compatibility, trialability, cost, observability, ease of incorporation of the innovation into one's life, etc. (Rogers, 2008). It may be that when the fish is bought and sold in the US market, if it is more affordable (cost), and seen as an innovation that is beneficial to the environment (relative advantage) then people may be more likely to adopt, purchase, and consume it - just as a Ugandan GE banana (Kikulwe et al., 2011). Notably, genetic modification technology is no longer an innovation, but its use in animals that are intended for use as food and agriculture is. This is perhaps why the technology may be being rejected and questioned in some instances.

Delia & colleagues' Constructivism addresses message construction into categories and constructs (as cited by Littlejohn & Foss, 2011). These were seen in the formulations, stories, and narrative (Emerson, Fretz, & Shaw, 2011) arising in stakeholder communication on Twitter and in the framing 'perspective taking' did occur

(as cited by Littlejohn & Foss, 2011, p. 159), although more frequently Twitter users were simply sharing information and articles (about 70% of the sample). The stories and narratives used to construct the AA salmon arose on a spectrum from a freakish "Frankenfish" to the sustainable solution to all environmental and societal current issues from food insecurity to climate change. Under the auspices of Groupthink Theory (Janis, as cited by Littlejohn & Foss, 2011, pp. 281-283), one would expect for all members of each stakeholder group to align in opinion, perspective, and narrative. This was true for the producers and for scientists, but much more nuance and variability was observed among members of the public, which is a finding that supports Marris (2001) and Durant & Legge (2005) but refutes the more typical findings that present adamant opposition among members of the public. Findings also reflect that there is a concern about "an undefined and unquantified risk" to the environment and human health that must be clearly assessed (Bowman, 2015; Harrison et al., 2012; Siegrist, Connor, & Keller 2012). Another method for increasing trust and decreasing risk would be to label the AA salmon, a hotly debated topic on Twitter where the consensus did resolve that the fish should be labeled so consumers have a choice whether or not to purchase it. There was a debate regarding whether the technology was "natural" similar to participants in Harrison et al.'s (2012) study who objected that GMOs were "unnatural" and were therefore deemed "bad", "risky", or "foreign".

Beacco et al.'s (2002) concept of arterial communication online does hold true. There are a multiplicity of actors and stakeholders engaged in the online colloquy, dialogue, and debate of AA salmon. Communication is no longer only that of the media interpreting science and communicating it to the public. Citizen bloggers were actively

engaged, the public frequently added their opinion to tweets sharing articles or information, demonstrating the "intertextual, polyphonic, or plurilingual" communication found online.

Dialogic Applications

The literature consistently reiterates the need for dialogue among those in opposition regarding debated and contested laws and regulations regarding the AA salmon (Bhatta & Misra, 2016; Carbaugh & Boromisza-Habashi, 2011; Cook et al., 2004; Clarke & Lohman, 2001; Devos et al., 2008; & Gerasimova, 2016). This study assessed the general question, is dialogue occurring on Twitter and the short answer was dialogue and debate is lively and active on Twitter among stakeholders, but the opposed parties are not engaging with dialogue between one another that is open, honest, and assesses risk scenarios. Additionally, some stakeholder groups were intentionally absent when it came to more controversial positionings, such as stakeholders, scientists, and the media. These groups tended toward a presentation of opinion that was safe, stuck to their script, and promoted their own agendas. If real dialogue is to happen, these groups must come to the table and listen to the alternative viewpoints without judgment or defensiveness and engage in congenial discourse to reach compromises and agreements and engage in dialogue on risk, labeling, and technological methods, and intentionally and amicably engage with those of opposite opinions.

Some stakeholder groups engaged more frequently. Although the FDA never commented on their stance on the AA salmon (0%), they are an active Twitter user, but were not an active or engaged participant in the Twitter discussion of AA salmon. The public, although presenting a spectrum of opinion and perspectives, were very active in

the online discussion (49.2% of the sample). The scientists (5.3%) and the producers (4.2%) were engaged but not in topics, like debates, that had the widest spectrum of approval and disapproval and dialogic engagement. A recommendation from these findings is that if those in favor of the AA salmon and the technology used to produce it want to win favor by those opposed, then instead of presenting a glossy, promotional style image of the AA salmon they should speak to, and acknowledge the real concerns of health and environmental risks in an honest, forward, and clear communication style.

Notes on Conducting Research on Twitter

Often tweets fall on deaf ears, adding to the wealth of literature commenting on motivations for engagement of users on Twitter. I found, like Java, Song, Finin, & Tseng (2007) that user intention was motivated by engaging in daily chatter, conversations, sharing information/URLs, or reporting news. Among certain stakeholder groups, in particular the media, scientists, nonprofits or organizations, and scientists, they exhibited a careful negotiation, curation, and "presentation of the self", or the organization or group's—thoughts, opinions, photos, videos, links to news, etc. (Goffman, 1959, see McCormick). For members of the public in particular, unlike, Petina et al. (2016) or Marwick & Boyd (2010), I did not find much status maintenance, social interaction and exchange, or strategic presentation of the self as a commodity, branding, or 'micro-celebrity'-dom on Twitter, as this may be a facet of other social media sites like Instagram or Facebook. My findings present Twitter as a space for information sharing not necessarily building an image or brand for a member of the public. It may be that that public uses Twitter to seek and share news stories they find interesting or applicable to their individual life. Perhaps a curation of "followers" or "likes" does demonstrate

social approval or social capital, that Shi et al. (2014) showed benefit the initiator intangibly through increased respect, status, or approval.

The types of tweets observed in the data sample were commonly "mockingbirds"--either official retweets, copy and pastes of other individuals or organizations, or a copy/paste with additional commentary. This echo chamber-like effect often happened in a resonating type of way, in which everyone would be abuzz or "twitterpating" about the same issue or even exact same tweet. Collecting the sample during these twitterpations was monotonous, however in realtime on Twitter it increased the possibility of exposure to the message (visibility) or the message's propensity to become viral, whether that were that the AA salmon was "as safe to eat as non-GE" or that a "science journalist said we should not fear frankenfish". This effect was also reported by Shi et al. (2014) supporting their findings that the practice of retweeting exposes information to a broader audience or network, can assist the spread of information, and increase the possibility of the tweet going viral.

This study adds to the growing body of research on validating methods used to collect and analyze data from Twitter. This study combined a form of content analysis called "qualitative content analysis" (Elo & Kyngäs, 2008), and used thematic analysis (Braun & Clarke, 2006) and elements of grounded discourse analysis (Emerson, Fretz, & Shaw, 2011). This combined approach offered three filtrations of the dataset. First, it used content analysis to see and notice patterns, frequencies, and deduce stakeholder groups. Thematic analysis was able to observe ways of speaking and framing common amongst stakeholder groups; whereas the additional elements drawn from a grounded approach to discourse analysis provided a direct method to dig into definitions, stories,

narratives, and formulations specific stakeholder groups tended to draw from to assert their claims.

This study used and tested Bruns & Stieglitz' (2014) proposed metrics for data collection on Twitter: the text of the tweet, the username of the author, the timestamp of the tweet, any reference to the user's profile picture, mentions of other users (@mentions), references to URLs outside of Twitter, replies, and retweets; and the types of communication in tweets: annunciative (original tweets), conversational (@replies), or disseminative (mostly retweets) and found them comprehensive to assess the data on numerous data points including conversational, network, and debate involvement; demographic data points; frequency analysis of language; and intent for engagement on twitter. Analyzing the sentiment of Tweet, as Colditz et al. (2018) suggest, proved essential for assessing stakeholder opinion, quickly analyzing hotly debated topics, and added to reliability of results using a second coder for verification of results and eliminating potential researcher bias. This study streamlines a system for using content analysis for Twitter research, a problem Colditz et al. (2018) document. Coder training and code book development and keyword definitions did enhance methodological design (Colditz et al., 2018). The data collection method and coding schema template presented in this research could be used by big data and machine learning studies to analyze large data sets, or other contested topic on Twitter.

Addressing Gaps in the Literature

To date, there was limited research on the AA salmon, particularly on US stakeholder opinion, public opinion, construction of the AA salmon, use of Twitter to deduce active stakeholders, and research proposing avenues for stakeholder dialogue.

This study adds to the literature by providing a largely US based study using discourse and qualitative analysis of Twitter to assess the linguistic constructions of stakeholder groups. It finds the public stakeholder group is actively searching unbiased and valid scientific information pertaining to genetically modified foods and in particular the AA salmon. This leads to the study's contribution toward the creation of fruitful dialogue among those in the debate, whether opposed or proponents of the technology and the AA salmon. This study indicates a lack of involvement in the debate and dialogue by stakeholder groups who are invested in the success of the AA salmon and the associated technologies, specifically scientists, the producers, and the government. If these stakeholders wish for the technology to be accepted, it may be necessary to engage in the discussion, answer questions in the debate by providing research and data, and support claims and assertions, and do so in a congenial fashion, not antagonistically or in a way that deletes, misconstrues, or misleads. It may be necessary to address possible risks associated with the consumption and production of AA salmon, even if these risks are ambiguous and uncertain, instead of asserting that it is a 'sustainable solution'. The data were clear on the labeling debate, that the public desires the AA salmon to be labeled as genetically modified when it is sold in US markets.

Limitations

Twitter data like all Internet content, by its nature is in flux, cannot be comprehensive or completely representative as it is tied to the time and date of the query, the parameters of the search, and the use of the Twitter API (Bruns & Stieglitz, 2015). Additionally, observations cannot be assumed to be applicable in other regions, countries, or communities (Bruns & Stieglitz, 2015). Twitter users can easily create false accounts,

falsify demographic information and location, or be a bot or a troll (Broniatowski et al., 2018; McCormick et al., 2017) and it was beyond the scope of this study to identify such false accounts. Although this study indicated a large involvement by US-based stakeholders, it is impossible to isolate and corroborate the actual location of any Twitter user. It was beyond the scope of the current research to verify the validity of all 649 accounts, and corroborate their stakeholder affiliation. If a smaller, curated sample, had been collected these details could have been corroborated through interviews or direct messaging.

Directions for Future Research

This research project illuminates additional avenues for future research. First, key stakeholders identified in the data set due to their frequency of engagement with the twitter dialogue will be interviewed to get a more in-depth and personal assessment of their actual viewpoints, opinions, and agendas. Additionally, the linked internet content will be assessed using discourse analysis and other qualitative methods to delve deeper into the constructions the media and others producing internet content are using to frame the discussion of AA salmon. Since public opinion was shown to exhibit nuance and a spectrum, another next step is to use a national survey or polling system to look into public stakeholder opinion, creating the survey based on the findings and perspectives presented by the public in this study. Further, the methodology presented can be used to analyze additional controversial subjects on Twitter or other social media sites, like vaccines, GMOs, and immigration for example; tested using big data machine learning on similar samples; and used in network analyses.

Conclusion

This study offers insight into the online conversions, opinions, and debates held on Twitter regarding the AA salmon. Further, it presents a method to detangle the social construction of the AA salmon and the technology used to produce it to reveal stakeholder groups and their narratives and opinions, missing information, and show paths forward for dialogue and discussion. Importantly, the way in which the AA salmon is constructed amongst all stakeholder groups was found to be that of a commodity, a product, and not an animal or natural. Although it is true that the laboratory altered genetics of the AA salmon would never occur in nature, the bigger question now is not 'should it be produced' but whether to label it. The public opinion is largely that the salmon should be labeled as transgenic so consumers can make informed purchasing decisions. If the AA salmon is to be sold, then labeling is also a 'should'. The future of our food is dependent on the engagement and dialogue between and among stakeholder groups. The future of food is now, and all stakeholder groups are actively deciding its direction. This dissertation adds insight for the future directions of food research and agricultural developments, stakeholder communication, Twitter communication research, and the path forward for the AA salmon as it swims upstream.

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