

## Communicating Risks and Benefits of Aquaculture: A Content Analysis of US Newsprint Representations of Farmed Salmon

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### Abstract

It is widely recognized that mass media can affect public perception of risk. In recent years, the public has been exposed to stories on emerging health and environmental risks, including risks from aquaculture. Two key studies (“trigger events”) compared contaminants in farmed and wild salmon and evaluated potential health risks of consumption. This study investigates how US newspaper coverage of farmed salmon fluctuated in the face of this emerging scientific information and which types of purported risks and benefits received the most attention. We hypothesized that media attention to farmed salmon would focus more on negative information (e.g., health risks) than on positive information (e.g., health benefits) and that those health risks highlighted most often would be dramatic, rare, or vivid. US newspaper stories specific to farmed salmon and published from 2000 to 2005 were collected from online databases ( $N = 206$ ). Stories were content analyzed for amount of text covering various human health and environmental risks and health benefits associated with farmed salmon. Over all time periods, 49% of text about farmed salmon discussed human health risks, while benefits were described less than 10% of the time. The two trigger events corresponded with a shift in media attention away from environmental risks to human health risks, as media generally reported the studies’ conclusions as true. Risks emphasized the most tended to be severe or dreadful, such as cancer and developmental defects, while other health risks and all environmental risks received much less attention. This pattern presented the public with a message of severe health consequences from consuming farmed salmon and could induce the public to perceive health risks as being much greater than could be offset by its health benefits.

It is widely recognized that mass media coverage affects public opinion (Nelkin 1995; Althaus and Tewksbury 2002) and behavior (Cassels et al. 2003). To understand how mass media shape public understanding, it is important first to understand the content of messages that are presented to the public as news stories. The particular aspects of risk issues that mass media choose to emphasize or de-emphasize and how these issues are framed in news stories have the potential to influence the ways people perceive the likelihood of occurrence and severity of specific risks (Brown et al. 2001; Bauer 2002).

In recent years, the public has been exposed to a range of stories on emerging health and environmental risks, often focused on food (Miller and Reilly 1994; Frewer et al. 2002; Wilson et al. 2004) or the human health and

environmental risks of biotechnology (Petrie and Wessely 2002). There seems to be growing public unease about the health and safety of modern methods of food production. This leads to concerns that consumers may reject certain foods, oppose innovative developments in food production (Frewer et al. 2002; Tucker et al. 2005), or even forego known food benefits in hopes of avoiding a potential health or environmental risks.

Aquaculture products are a recent example of media controversy over foods. This study focuses on the risks and benefits associated with farmed salmon that have appeared in US media stories. By examining newspaper stories about farmed salmon over a 5-yr period, it investigates how the volume of media attention fluctuated in the face of emerging scientific information about potential risks and benefits to human health and the environment and how the media chose to represent farmed salmon and salmon aquaculture.

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### *Fish Consumption and Aquaculture*

Fish are an important source of protein for many people throughout the world. Global demand for seafood products is steadily increasing, but many capture fisheries have been fished to their maximum potential. As wild stocks of some species decline, aquaculture has assumed a larger part of the market. Between 1950 and 2004, global aquaculture production grew an average of 8.8% per year (FAO 2006). Estimated to account for nearly 50% of the fish consumed worldwide and culturing more than 336 edible species (FAO 2006), aquaculture produces roughly half of the shrimp and salmon consumed worldwide (NMFS 2007). In the USA, consumption of salmon, a species long touted as healthy, has increased nearly 20% per year over the past decade (Hites et al. 2004b; NMFS 2007). Currently, most of the salmon sold in the USA for consumption is farmed. It is believed that aquaculture will soon become the only feasible way to meet worldwide demand for aquatic food products (Brugere and Ridler 2004). Although fish farming has been practiced for centuries, modern aquaculture operations have incorporated many new technologies in recent years, and although technology typically has many benefits, there is also the potential for adverse consequences to arise.

Consequently, the growth of the aquaculture industry and seafood farming practices in the USA have not gone without scientific scrutiny and media attention. Depending on the species being cultured, the benefits and impacts of aquaculture production can vary substantially (Naylor et al. 2000; Nash 2003; Krkošek et al. 2005). A number of recent investigations detailing various risks associated with farmed salmon, both environmental and human health related, have attracted media attention. Some reports have suggested that salmon aquaculture is unsustainable and pollutes the oceans (Naylor et al. 2000) and has substantial effects on wild salmon stocks via the spread of disease and parasites, genetic pollution, and competition for food and habitat from escaped farmed salmon (Nash 2003). Studies have also suggested that contaminants in farmed salmon can contribute

to an increased risk of cancer and developmental defects (Hites et al. 2004b; Foran et al. 2005a, 2005b). How the media report on these studies will affect public perception of the benefits and risks associated with the farmed salmon industry or aquaculture practices in general.

### *Trigger Events and Media Attention*

In many instances, media reporting is initiated by a stimulus or a “trigger” publicity event, which often occurs as a scientific discovery or statement publicized in a scientific journal or a press release from a research institute. Such events have been found to influence the volume of reporting as well as the ways issues are framed within news stories. For instance, specific trigger events were found to be responsible for increased media attention regarding the greenhouse effect as a global issue (Carvalho 2005), disease transmission and health effects associated with bovine spongiform encephalopathy (BSE) (O’Brien 2000), and the risks and benefits of biotechnologies for foods and medicines (Bauer 2002).

In the case of farmed salmon, two recent studies (i.e., trigger events) have compared contaminants in farmed and wild salmon. The first study, conducted by the nonprofit Environmental Working Group (EWG) and released in July 2003, cited much higher levels of toxic chemicals in farmed Atlantic salmon than in wild-caught salmon and claimed that eating farmed salmon would significantly increase the risk of developing cancer or fetal birth defects (EWG 2003). The study met with skepticism from the scientific community because of the small sample of fish used and concern about the objectivity of the organization conducting the study.

The second much larger study, published in the journal *Science* in January 2004, also compared the level of contaminants and toxins found in farmed and wild salmon, reporting that levels of 12 of 13 toxic substances were significantly higher in the farmed salmon (Hites et al. 2004b). Based on Environmental Protection Agency guidelines, the authors recommended highly conservative consumption advisories for farmed salmon, claiming that the toxins found in the fish could increase the risk of cancer

and defects in fetal and child development. However, by Food and Drug Administration (FDA) guidelines, there was no substantial threat to health. The study sparked an immediate, heated debate among scientists about the proper interpretation of the findings and subsequent recommendations (Hardy 2004; Rembold 2004; Senkowsky 2004; Tuomisto et al. 2004). Other scientists and the aquaculture industry subsequently responded with claims that the health benefits outweigh any potential health risks. The situation had quickly become contentious as the issue was shrouded in scientific controversy and disagreement over the findings.

Subsequent studies about contamination and health risks associated with farmed salmon consumption emerged in 2005 (Carlson and Hites 2005; Foran et al. 2005a, 2005b). This series of studies provides an opportunity to investigate how media coverage changes over the evolving history of a story. Other research suggests that there might be an initial peak in media coverage followed by decrease (McComas and Shanahan 1999). For example, in an investigation of media reporting on BSE and the associated health effects, Kitzinger and Reilly (1997) found that media coverage peaked following a sequence of trigger events and then declined over a period of several months, largely because the novelty of the issue had dissipated. Similarly, Barnett and Breakwell (2003) found that structurally similar notifications about health risks initially capture public and media attention when they are novel or distinctive but then wear out and become commonplace for the reading audience as they are repeated. It is possible that media coverage of the health risks associated with farmed salmon follows a similar pattern of fluctuation, wherein the issues become "old news" and fail to sustain media (and therefore public) attention. Understanding such issue attention cycles can provide important insights into how long a particular issue remains in the media agenda and how public opinion may shift over time as a result of intense media attention and could help the aquaculture industry anticipate shifts in market demand. In addition, this study contributes to the larger body of work and theory about the role of the media in public policy debates.

### *Media Emphasis on Negative Information*

While media coverage can affect public awareness, the specific nature of that coverage can influence whether opinion shifts in a negative or a positive direction. This is important because there is evidence that media place more weight on negative information than on positive information (Nelkin 1995). For instance, Abbasi (1998) found that media stories about oral contraceptives focused mostly on the risk of stroke, even though the original scientific study clearly stated that health benefits far outweighed the minor increase in health risk. Similarly, Bartlett et al. (2002) found that even though scientific press releases about various medical studies were generally balanced between positive and negative information, media mostly picked up and reported on the negative stories.

There is also evidence that media preferentially choose to focus on risks and events that are rare, novel, vivid, and dramatic (Singer and Endreny 1987; Soumerai et al. 1992; Nelkin 1995). In attempting to increase a story's ability to grab attention, media can overemphasize or exaggerate the potential impacts of certain risks and deemphasize others, which may ultimately skew public perception of the likelihood of risks to occur. Recent studies have documented this tendency for both health and environmental issues. For instance, the investigation by Gunter et al. (1999) of media representations and public understanding of biotechnology found that journalists' accounts were considered by scientists to be too dramatic and sensationalized. An investigation by Brown et al. (1996) found that media reporting predominantly focused on the dramatic risk of possible disease transmission from a human immunodeficiency virus (HIV)-positive obstetrician to pregnant women, even though the risk of transmission was known to be infinitesimal. Similarly, Frost et al. (1997) showed that news media severely overrepresent more dramatic, rare causes of mortality such as cancer and toxic agents and substantially underrepresent more common causes such as tobacco use and heart disease.

In the case of farmed salmon, the dramatic nature of risk to human health (e.g., cancer) associated with an icon of healthy food (e.g.,

heart healthy, low fat) creates an ideal controversial and novel news story. Few studies of media content have focused on issues characterized by both risks and benefits, and it remains unclear how media report on stories that involve weighing known benefits against potential risks of a situation. Instead, many examinations of issues in the media focus on cases where there are only risks, whether real or potential, either to people or to the environment. For example, the cases of “mad cow” disease (Kitzinger and Reilly 1997), Creutzfeldt–Jakob disease (Wilson et al. 2004), HIV transmission (Brown et al. 1996), and nuclear testing or toxic waste (Gamson and Modigliani 1989) are instances in which no benefits—only risks—are present. Farmed salmon provide an ideal case for media analysis, not only because the occurrence of the two trigger studies provides an opportunity to assess temporal changes in media reporting in response to a publicized risk, but also because the risk issue is complex, with both risks and benefits for human health and the environment. Because it has been previously shown that media tend to emphasize negative aspects of a risk situation, we hypothesize that media attention to farmed salmon will focus more on negative information (e.g., health risks) than on positive information (e.g., health benefits) and that those health risks that are highlighted most often will be those that are more dramatic, rare, or vivid (e.g., cancer).

### *Research Questions and Hypotheses*

Because the media play a potentially pervasive role in setting the public agenda and shaping public opinion, particularly regarding issues of human health and the environment, understanding how the media choose to portray benefits relative to risks has significant implications for public health and environmental policy. To summarize this study, there are three research questions and two hypotheses regarding the nature of newsprint coverage of risks and benefits associated with farmed salmon and salmon aquaculture:

(1) What risks and benefits regarding salmon aquaculture and farmed salmon were represented in US newspaper coverage between January 1, 2000, and December 31, 2005?

(2) Which types of risks and benefits regarding farmed salmon and salmon aquaculture were emphasized most frequently in media stories?

H1: Media attention to farmed salmon will focus more on negative information (i.e., health and environmental risks) than on positive information (i.e., health benefits).

(3) How did media coverage of risks and benefits change in volume over the 5-yr time period in relation to the two events?

H2: Media attention to health risks associated with farmed salmon will peak following the two trigger events and then decline substantially after a short period of time.

## **Materials and Methods**

### *Article Searches*

All articles in daily US national and regional papers were searched for stories about salmon aquaculture and farmed salmon. Keyword searches used terms—“farmed salmon” or “farm-raised salmon” and “aquaculture” or “salmon farming” or “farmed fish” and “risks” or “benefits” and “environment” or “health”—to identify suitable newspaper articles hosted on three online newspaper databases: LexisNexis, ProQuest, and EBSCO Host (which includes Academic Search Premier, MasterFILE Premier, and Communication & Mass Media Complete). These databases offered the most complete collections of US newspapers and included stories published before and after the emergence of the two trigger studies about contaminants in farmed salmon.

News stories, editorials, and commentaries were selected for inclusion in the study if they met the following criteria: subject matter (primary focus of article on salmon aquaculture and/or farmed salmon), article type (wire, feature, or editorial), and time frame (January 1, 2000, to December 31, 2005). This specific time frame was used to (1) establish a baseline of news reporting prior to the emergence of the two key reports and (2) examine changes over time in the volume of news reporting on risks and benefits of salmon aquaculture and farmed salmon. The 5-yr time frame was divided into four periods: Pre-EWG Era (January 1, 2000,

to July 27, 2003; prior to the emergence of the first report), Post-EWG Era (July 28, 2003, to January 7, 2004; following the first report), Hites Era (January 8, 2004, to December 31, 2004; the year following the second report), and Post-Hites Era (2005, or one full year after the second report) to track changes in news media attention.

The article searches resulted in 326 documents (duplicate listings across databases subtracted) to be evaluated using the selection criteria for inclusion in the study. A total of 206 stories and wires (63%) from 67 different sources met the criteria for inclusion: 59 were Pre-EWG, 40 Post-EWG, 84 Hites, and 23 Post-Hites. There were 145 news features, 36 news wires, and 25 editorials. The remaining 120 documents were general food interest pieces such as recipes, letters to the editor, or when the subject matter was not directly related to farmed salmon or salmon aquaculture but featured other fish or seafood choices and, thus, were not included in the study. Articles were downloaded, converted to text file format, and imported into the qualitative data analysis software QSR NUD\*IST version 6 (QSR International Pty Ltd. 2002) for content analysis, a method commonly used in media studies to quantify textual data. The sentence was the unit of analysis (referred to as "text unit"). Because the time periods differed in lengths (the shortest period was the 6-mo Post-EWG period), the number of text units for each time period was standardized to 6 mo to facilitate comparisons. The stories were analyzed for the total amount of text that mentioned farmed salmon. One-tailed *z* tests of differences in proportions were used to test differences in the amount of farmed salmon text that mentioned risks and benefits.

#### *Document Coding Process and Reliability of Methods*

Two coders, both trained carefully for this particular coding task, conducted the coding and analysis. Coding categories of interest and a coding scheme were developed and defined through an initial open reading of a set of news stories from the document pool. Over several iterations, the coding scheme and cate-

gories of interest were refined for comprehensiveness and clarity (Krippendorff 2004). The primary categories included human health risks and benefits, as well as environmental risks of salmon aquaculture (Table 1). There were very few mentions of any environmental benefits in stories, and therefore, those are not included in this analysis. Subcategories were developed to capture the tone of risk statements, that is, whether the journalist used strategies to heighten or ameliorate the sense of risk. Because all benefit statements highlighted benefits, we did not create a code for their tone. It should be noted that the primary categories listed are not mutually exclusive and a sentence could have been assigned multiple codes. For example, the statement, "current practices of farmed salmon are not sustainable and have important human health and ecosystem impacts," would be coded as both "Human Health Risk—Generally Unhealthy" and "Environmental Risk—Generally Bad," as well as the code for "highlighting" under "Tone of Risk."

The reliability of the coding scheme was tested by computing intercoder agreement for each of the categories and subcategories of interest. The two coders analyzed samples of news stories equal to 12–15% of the total collection (the number varied with each coding category tested). Refinement and clarification of category definitions occurred until an adequate level of intercoder agreement (>90%) was reached for each top category and all subcategories, based on a new sample of stories (Neuman 2000; Smith 2000; Krippendorff 2004). One coder then coded the remaining stories for all categories and subcategories. Final agreement, calculated as  $(2 \times \text{number of agreements}) / (\text{number of agreements} + \text{number of misses coder 1} + \text{number of misses coder 2})$  (Rust and Cooil 1994), ranged from 90 to 97%, with the exception of environmental risks of farming, for which agreement was 85%. Because reliability for environmental risks was lower than for any other category, both coders coded all environmental risk text independently. These results were compared for agreement, at which time discrepancies were resolved through discussion.

TABLE 1. *Definitions the coding categories and subcategories of interest.*

Categories of interest	Description
Human health risks	Statements about risks to human health, general and specific, including the source or type of real, potential, or implied health problem (e.g., "farmed salmon contain high levels of potentially cancer-causing PCBs")
Specific subcategories	Cancer, PBDEs, colorants, fungicide, developmental defects, generally unhealthy <sup>a</sup>
Tone of risk	The nature or tone of health risks in media reports is categorized as being highlighted, downplayed, or mixed. For example: <i>Highlighting</i> – "eating farmed salmon increases one's risk of cancer" <i>Downplaying</i> – "more commonly consumed foods like butter and brown gravy have tested higher for PCBs than farmed salmon" <i>Mixed</i> – "some types of salmon show traces of potentially cancer-causing contaminants, but can be safely eaten eight times a month"
Human health benefits	Statements about benefits to human health, general and specific, including the vehicle of benefit and specified outcome to health (e.g., "salmon contain fatty acids that contribute to heart health")
Specific subcategories	Brain health, development, generally healthy, heart health, omega-3s, nutritious
Environmental risks of salmon farming	Statements relating to environmental risks such as degradation, general and specific, including the cause and the real, potential, or implied outcome (e.g., "the farmed-salmon industry has come under attack for ecological practices")
Specific subcategories	Chemicals and antibiotics, competition, disease outbreaks (farms), environmental pollution, escapes, genetic modification, genetic pollution, generally bad, <sup>a</sup> impact to wild salmon, impact to other species, pests and disease, unsustainable
Tone of risk	The nature or tone of environmental risks in media reports is categorized as being highlighted, downplayed, or mixed. For example: <i>Highlighting</i> – "fish farms are known to cause water pollution" <i>Downplaying</i> – "salmon farmers maintain that pens are safe for fish and the environment" <i>Mixed</i> – "farming makes salmon cheap and plentiful, but at what cost?"

PCBs = polychlorinated biphenyls; PBDEs = polybrominated diphenyl ethers.

<sup>a</sup> The "generally unhealthy," "generally healthy," and "generally bad" categories refer to mentions of nonspecific health risk or benefit (e.g., "farmed salmon is bad for your health" or "farmed salmon has healthy benefits").

## Results

### *Overview: Trends in Reporting about Farmed Salmon over Time*

The number of farmed salmon stories increased 3.5 times following the emergence of both the EWG report and the Hites scientific study about farmed salmon, from two stories per month in the Pre-EWG period to seven stories per month during the Post-EWG and Hites periods. Reporting subsequently decreased 1 yr after the emergence of the second report ( $M = 2$  stories/mo), even though, as noted earlier, several relevant scientific studies were published during this time. The proportion of story text devoted to farmed salmon (number of story lines specific to farmed salmon/total number of story

lines per time period) varied somewhat across periods: 47.6% of text in the Pre-EWG period (1158/2432), 69.4% in the Post-EWG period (4558/6556), 58.3% in the Hites period (4068/6982), and 40.3% in the Post-Hites period (908/2252).

To compare coverage emphasis across the different periods of time, total counts of text units were standardized to a 6-mo interval. Table 2 shows the standardized number of farmed salmon text units devoted to risks and benefits, while Figure 1 displays this information as a percentage of all farmed salmon text. Farmed salmon received considerable attention even before health concerns arose. This is because environmental risks of farmed salmon in the Pre-EWG period were extensively covered

TABLE 2. Number of farmed salmon text units per 6 mo devoted to risks and benefits.<sup>a</sup>

Category of interest	Time period			
	Pre-EWG (n = 579)	Post-EWG (n = 2279)	Hites (n = 2034)	Post-Hites (n = 454)
Health risk	118	1213	1504	190
Health benefit	12	96	182	41
Environmental risk	254	350	172	129

EWG = Environmental Working Group.

<sup>a</sup> Number of farmed salmon text units in each time period standardized to 6 mo.

compared to other risks and benefits, encompassing 44% of reporting. That is, when farmed salmon was mentioned in Pre-EWG stories, environmental risks were associated with it 44% of the time. The number of text units devoted to environmental risks increased slightly following the first trigger event, but because the total amount of text devoted to farmed salmon increased overall during this time period, the amount devoted to environmental risks actually accounted for only 15% of all farmed salmon text. Thus, the percentage of farmed salmon text associated with environmental risks substantially decreased after the two trigger events (Pre-EWG versus Post-EWG:  $Z = 15.01$ ,  $P < 0.0001$ ; Post-EWG versus Hites:  $Z = 20.35$ ,  $P < 0.0001$ ).

Reporting on human health risks associated with farmed salmon increased substantially following the two trigger events, from 20.0% of farmed salmon text in the Pre-EWG period to 53.3% in the Post-EWG period ( $Z = 14.15$ ,  $P < 0.0001$ ) and then to 74.0% of farmed salmon text in the Hites period, also a statistically significant increase in relation to the sec-

ond time period ( $Z = 14.07$ ,  $P < 0.0001$ ). Thus, at the height of news reporting in the Hites period, nearly three-fourths of all farmed salmon text mentioned in stories was associated with references to health risks. In the Post-Hites period, human health risk coverage dropped significantly ( $Z = 13.26$ ,  $P < 0.0001$ ) but still encompassed twice as much text as the Pre-EWG reporting (20% in Pre-EWG versus 40% in Post-Hites), a difference that was statistically significant ( $Z = 7.49$ ,  $P < 0.0001$ ). The relative emphasis on environmental risks consequently increased again during this time period ( $Z = 11.79$ ,  $P < 0.0001$ ).

Total reporting on health benefits of farmed salmon increased slightly over time but overall remained low. Following the second trigger event, reporting on health benefits increased significantly from 2% in the Pre-EWG period to 9% in the Hites period ( $Z = 5.57$ ,  $P < 0.0001$ ). Despite this, it is clear that media focused substantially more on health risks than on benefits overall (on average, 49% of text in articles in the 5-yr time period was about health risks, whereas an average of 7% was about health benefits) ( $t(163) = 17.51$ ,  $P < 0.0001$ ). These results are consistent with Hypothesis 1.

References to human health risks and benefits occurred in two forms: as one-sided claims, such as “the PCBs in farmed salmon may increase one’s incidence of cancer,” and within a comparative context, such as “scientists argue that the health risk from the contaminants in farmed salmon is far outweighed by its many nutritional benefits.” Sometimes these comparisons amplified perceived risks; other times they attenuated the risk. Between 7% (Pre-EWG) and 31% (Hites Era) of farmed salmon text units made some form of overt comparison of risks

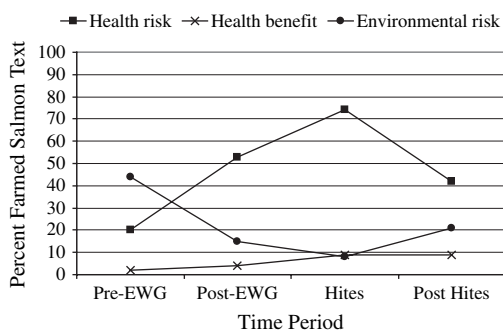


FIGURE 1. Percentage of all farmed salmon text units devoted to risks and benefits.

and benefits. Most of the time, comparisons served to amplify the potential health risks of farmed salmon. For instance, 15% of the text about farmed salmon in the Hites Era claimed that farmed salmon had higher levels of contamination than wild salmon, while only 4% claimed that the health benefits of salmon outweighed any potential health risks.

Interestingly, references to the benefits of farmed salmon often occurred within a comparative context. While 50% of benefit references in the Pre-EWG and Post-EWG Eras were one-sided claims, after the Hites report, this dropped to 18% (15% in the Post-Hites Era). Thus, in the latter two periods, journalists almost always portrayed the benefits of farmed salmon in the context of its potential risks.

*Specific Health Risks*

Reporting on human health risks was organized into six subcategories (Table 3). These are discussed as a proportion of the total number of text units that mentioned health risks as well as the number of text units discussing farmed salmon (Fig. 2). For example, in the Pre-EWG period, human health risks were not commonly emphasized, but when they were, most attention focused on colorants in farmed salmon (79 text units, or 67% of all coded health risk text). Using the same example, colorants in the Pre-EWG period were mentioned in approximately 14% of all text that dealt with farmed salmon

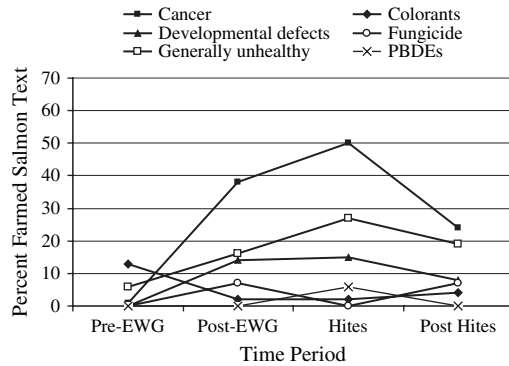


FIGURE 2. Percentage of farmed salmon text units devoted to health risks.

(79 colorant text units/579 farmed salmon text units). This relative emphasis on colorants decreased following the two trigger events as other types of risk garnered priority in reporting.

Following both trigger events, reporting about cancer risks increased significantly from 2% of all farmed salmon text in the Pre-EWG period (8% of all health risk text) to 39% of all farmed salmon text in the Post-EWG period (72% of the all health risk text) ( $Z = 17.17, P < 0.0001$ ) and to 50% of all farmed salmon text in the Hites period (68% of all health risk text) ( $Z = 7.74, P < 0.0001$ ). Although the emphasis on cancer declined in the Post-Hites period, reporting on this risk was significantly greater in this period than in the Pre-EWG period ( $Z = 11.40, P < 0.0001$ ), commanding

TABLE 3. Number of farmed salmon text units per 6 mo devoted to health risks.<sup>a</sup>

Category of interest	Time period			
	Pre-EWG (n = 579)	Post-EWG (n = 2279)	Hites (n = 2034)	Post-Hites (n = 454)
Any health risk	118	1213	1504	190
Colorants	9	51	36	20
Generally unhealthy	39	377	552	85
Cancer	9	878	1022	111
Developmental defects	2	325	308	35
Fungicide	1	160	0	33
PBDEs	0	0	114	0
Tone of risk statements				
Highlighting	80	751	788	111
Downplaying	21	311	457	42
Mixed	17	151	259	37

EWG = Environmental Working Group; PBDEs = polybrominated diphenyl ethers.

<sup>a</sup> Number of farmed salmon text units in each time period standardized to 6 mo.

nearly 25% of farmed salmon text (58% of health risk text). Typically, cancer risks were presented as a consequence of polychlorinated biphenyls (PCBs) found in farmed salmon because of fish feed.

A similar pattern of emphasis emerged for references to “generally unhealthy” effects, increasing from few references in the Pre-EWG period to 17% of all farmed salmon text in the Post-EWG period (31% of health risk text) ( $Z = 5.97, P < 0.0001$ ) and to 27% of all farmed salmon text in the Hites period (37% of health risk text) ( $Z = 8.45, P < 0.0001$ ). Reporting on general unhealthiness of farmed salmon decreased significantly 1 yr after the second event (19% of all farmed salmon text) ( $Z = 3.72, P < 0.0001$ ) but maintained a level that was still three times higher than reporting in the Pre-EWG period ( $Z = 5.88, P < 0.0001$ ). Media emphasis on developmental defects from consuming farmed salmon also increased significantly from a minimal level of reporting in the Pre-EWG period (<1% of farmed salmon text) to 14% of text in the Post-EWG period ( $Z = 9.39, P < 0.0001$ ) and to 15% of farmed salmon text in the Hites period, although this second increase was not statistically significant ( $Z = 0.82, P = 0.21$ ).

One unique risk—fungicide—emerged during the EWG period, although it was not discussed in either the EWG or the Hites reports. In other press coverage of salmon, it was reported that some farmed salmon from Chile had been treated with malachite green. Similarly, polybrominated diphenyl ethers (PBDEs) were not mentioned in the EWG report or the original Hites report, although the authors of the Hites study published a subsequent paper in *Environmental Science & Technology* in August 2004 (Hites et al. 2004a), which focused on PBDEs in farmed salmon. It is notable that this paper generated far less press (only 7 stories) than the first Hites paper (73 stories).

With the exception of colorants and fungicide, health risks followed the same general pattern of increase following the two trigger events and subsequent decrease within the following year. Thus, Hypothesis 2 that health risks discussed in the two trigger studies will peak and then decline subsequently is supported.

The tone of reporting about health risks was evaluated to determine whether risks were highlighted or downplayed. Highlighting was achieved by journalistic practices such as quoting the report authors (e.g., David Carpenter was quoted as saying, “Especially for younger people, it’s very unwise to eat these farmed salmon more frequently”) or simply asserting that risks are certain (e.g., one story stated that PCBs “have been linked to health problems from cancer to delayed child development”). Downplaying occurred through similar practices, such as quoting an FDA official who said, “we don’t believe there is a public health concern with the levels seen here . . . . Our message to consumers is not to alter their consumption of wild or farmed salmon. It’s an excellent source of omega-3 fatty acids.”

In general, health risks associated with farmed salmon were highlighted more than they were downplayed. Only 26% of health risk text in the Post-EWG period and 30% in the Hites period were downplayed. Consistent with the overall pattern of increased attention to human health risks after the two reports, the number of text units that highlighted negative consequences rose during those periods. However, the amount of text that downplayed risks increased as well. Hence, as a proportion of health risk text, the tendency of journalists to make amplifying statements remained generally steady (68% in the Pre-EWG period, 62% in the Post-EWG period, 52% in the Hites period, and 58% in the Post-Hites period).

The number of references in which the tone of health consequences was mixed increased slightly after the two events, from 12 to 14% of risk statements in Pre-Hites Era to 17% in Hites Era and 19% in Post-Hites Era. Although these “mixed” statements might suggest to readers an element of uncertainty or conflict about the nature of consequences, they were relatively rare and most stories conveyed a general sense that farmed salmon is dangerous to human health.

### *Specific Health Benefits*

Compared to the amount of health risk coverage, there was little attention to the health benefits of salmon, with statements occurring less than 10% of the time (Table 4). Although the

TABLE 4. Number of farmed salmon text units per 6 mo devoted to health benefits.<sup>a</sup>

Category of interest	Time period			
	Pre-EWG ( <i>n</i> = 579)	Post-EWG ( <i>n</i> = 2279)	Hites ( <i>n</i> = 2034)	Post-Hites ( <i>n</i> = 454)
Any health benefit	12	96	182	41
Generally healthy	8	77	111	30
Omega-3s	8	22	49	20
Heart health	6	21	85	16
Nutritious	2	16	19	0
Development	0	8	3	3
Brain health	0	0	12	1

EWG = Environmental Working Group.

<sup>a</sup> Number of farmed salmon text units in each time period standardized to 6 mo.

number of text units mentioning benefits increased after the two reports, the percentage of farmed salmon text devoted to benefits across time periods remained relatively constant. As noted earlier, all health benefit references were positive (i.e., stories highlighted, but did not downplay, benefits of salmon).

The benefits most prominently reported included references to farmed salmon as “generally healthy,” containing omega-3 fatty acids and being “heart healthy,” all of which had the most emphasis during the Hites time period. But—in percentage terms—this emphasis was not significantly more than in other time periods. Overall, the finding that health benefits received only a small proportion of media coverage about farmed salmon further supports Hypothesis 1 in that negative or risk information was more prominent in reporting than positive or benefit information.

### *Specific Environmental Risks*

There was minimal change over time in the types of environmental risks reported. In absolute terms, coverage of most environmental risks increased slightly with the first trigger event, although attention dropped during the Hites period as health risks became more prominent (Table 5). Overall, the purported environmental risks of farmed salmon were distributed across several concerns but accounted for only a small percentage of the total farmed salmon text. Risks receiving the most attention across time periods included farmed salmon being “generally bad” for the environment, pollution from fish farms, and references to impacting

wild salmon (including escaped fish, pest infestations, or transfer of diseases). Following a drop in media attention during the Hites period, reporting of some risks rebounded as a percentage of farmed salmon text more than others, particularly impacts to wild salmon ( $Z = 9.59$ ,  $P < 0.0001$ ), pests and diseases ( $Z = 9.44$ ,  $P < 0.0001$ ), and escaped fish ( $Z = 6.77$ ,  $P < 0.0001$ ).

The tone used in media reporting to describe environmental risks was categorized as highlighting, downplaying, or mixed. The majority of text highlighted negative environmental consequences of salmon aquaculture. For instance, 67% of environmental risk references in the Pre-EWG period (30% of all farmed salmon text) highlighted risks to the environment, whereas only 15% of environmental risk text (7% of all farmed salmon text) downplayed such risks. Attention to environmental risks—highlighting and downplaying—decreased following the two trigger events. However, environmental risks were highlighted significantly more in the Post-Hites period than in the Hites period (74% of text associated with environmental risks and 21% of all farmed salmon text) ( $Z = 10.40$ ,  $P < 0.0001$ ). The most mixed statements about environmental impacts occurred in the Pre-EWG period (19% of risk text and 9% of all farmed salmon text), but by the Post-Hites period, few risks were presented as mixed.

### **Discussion**

Over time, there were substantial changes in newspaper reporting on the nature and degree of risks and benefits associated with farmed

TABLE 5. Number of farmed salmon text units per 6 mo devoted to environmental risks.<sup>a</sup>

Category of interest	Time period			
	Pre-EWG (n = 579)	Post-EWG (n = 2279)	Hites (n = 2034)	Post-Hites (n = 454)
Environmental risk	254	350	172	129
Impact to wild salmon	96	149	50	57
Generally bad	95	103	95	30
Escapes	76	85	33	33
Pollution	53	68	32	31
Pests and disease	50	73	29	44
Competition	26	34	4	8
Chemicals and antibiotics	20	23	12	6
Genetic pollution	17	40	15	7
Unsustainable	16	33	17	7
Impact to other species	14	47	7	12
Disease outbreaks	7	9	3	5
Genetic modification	6	2	11	0
Tone of risk statements				
Highlighting	171	236	116	94
Downplaying	34	62	39	22
Mixed	49	52	17	12

EWG = Environmental Working Group.

<sup>a</sup> Number of farmed salmon text units in each time period standardized to 6 mo.

salmon and salmon aquaculture. It is clear from these patterns that the media acted largely in response to the publicity surrounding the two trigger event studies. Prior to those events, environmental risks associated with salmon aquaculture were the most prominent downsides addressed in the news. However, when the two studies emerged, reporting on potential health risks commanded priority, overshadowing environmental concerns. These findings not only demonstrate the impact that specific trigger events can have on the volume of news reporting but also illuminate how the media report on an issue that contains both known benefits and potential risks to human and environmental health. Both studies emphasized human health risks over benefits, and the media did likewise. Whereas between 64 and 82% of text about farmed salmon (depending on the time period) described human health or environmental risks, only 2–9% described benefits. Overall, then, Hypothesis 1 was supported. Positive environmental consequences of salmon aquaculture or the possibility that farmed salmon could bring low-cost protein to the public was virtually never mentioned. It is notable that most of the benefit claims (salmon is generally healthy, good for you, and nutritious) were rather

generic, particularly in contrast to the specificity of risk statements (e.g., “Salmon raised in ocean feedlots, the main source of supply for American consumers, contains such high levels of PCBs, dioxins and other toxic chemicals that people should not eat it more than once a month, according to an extensive study reported today in the journal *Science*”). Perhaps, journalists assumed that the benefits of salmon were known to the audience and need not be reiterated. Regardless, the consequence is that there was sustained attention to vivid, dire outcomes.

Because of the relative increase in fish consumption over the past few years (NMFS 2007), particularly of salmon, the news stories about farmed salmon may have had a wide audience appeal and been seen as personally relevant to readers. The media emphasis on negative information presented this reading audience with a distinct message of severe health consequences from consuming farmed salmon. Even though there are many known nutritional benefits associated with seafood consumption (Institute of Medicine 2006), in particular salmon (Sidhu 2003), the lack of emphasis on positive information could induce the public to weigh health risks as being much greater than what any of the health benefits could offset.

Consistent with Hypothesis 2, which was based on studies of the issue attention cycle in news reporting (McComas and Shanahan 1999), media attention to health risks of farmed salmon peaked following the two trigger events but then subsequently declined. Although additional scientific studies detailing health risks from contaminants in the flesh of farmed salmon and the environmental effects of salmon aquaculture were published in 2005 (Carlson and Hites 2005; Foran et al. 2005a, 2005b), these generated very little media attention or public interest. This suggests that reporting about risks of farmed salmon had perhaps become “old news,” a type of phenomenon that has been demonstrated in relation to reporting of other types of scares (McComas and Shanahan 1999; Barnett and Breakwell 2003).

The consequences of this pattern of reporting over time are unclear. On the one hand, the fall off in reporting may mean that consumer concern has declined as well. On the other hand, the increase in reporting meant that the contaminant issue and associated health risks were a dominant news agenda for over a year. Heightened attention to risks for so long could have had a significant influence on public perceptions of the risks and benefits of farmed salmon. Some research suggests that the public place more confidence and credibility in studies and reports containing negative health risk outcomes than in studies showing no health risk (Siegrist and Cvetkovich 2001). Indeed, anecdotal reports indicate that media coverage did impact sales of farmed salmon as consumers began to demand wild fish (“Wild salmon sells better this year in Massachusetts” 2004).

Other studies have documented a substantial impact of media reporting on public perceptions of food risks. For example, Frewer et al. (2002) showed that a large increase in media attention to the potential risks associated with genetically modified foods led to the intensification of public anxiety in the UK. As media reporting waned later that year, public concern was also reduced. Nevertheless, public acceptance of genetically modified food products remained low. In much the same way, it is possible that the initial media attention to farmed salmon amplified public risk

perceptions about salmon consumption for a period of time during and after the peak in reporting.

We were interested not only in the volume of coverage given to farmed salmon but also on the types of risks that were reported. The literature suggests that the media give preferential attention to certain types of risks over others, and we found this to be the case for farmed salmon. Although a diversity of risks was described over the 5-yr time period, those emphasized the most tended to be severe or dreadful, such as cancer and developmental defects. In their reports, the authors of the EWG and Hites reports calculated that the increased risk of cancer from consuming farmed salmon is approximately 1 in 100,000. Although they interpreted this as unacceptably high, other scientists argued that this was more than offset by the health benefits of eating salmon, farmed or wild (Rembold 2004; Tuomisto et al. 2004). Nevertheless, 70% of stories about the EWG report and 90% about the Hites report highlighted cancer risks.

Other health risks and environmental issues received much less media attention, even though studies were published and some of these concerns might be substantial. For instance, during the time span covered by our study, there were several reports about sea lice infestations from salmon farms being responsible for substantial declines in wild smolt populations (Krkošek et al. 2005). Another analysis by Naylor et al. (2005) suggested that escaped salmon from net pen aquaculture could severely impact native wild fish populations through disease transmission, interbreeding, and competition for habitat and food. Arguably, these risks are noteworthy, but they received very little media attention.

This finding of enhanced attention to human health risks, even when the risks are small, parallels conclusions of other studies of risk perception. Specifically, threats that elicit feelings of dread, uncontrollability, or mortality—regardless of a low probability of occurrence—loom largest for much of the public (Slovic 1987). The media are attracted to these types of dramatic issues that will capture the public’s attention (Singer and Endreny 1987). Reporting thus often emphasizes relatively rare causes of

death, many of which are already overestimated by the public (e.g., death from cancer, toxic agents, or homicide) (Fischhoff et al. 1978; Frost et al. 1997). So, in the case of farmed salmon, the emphasis is not only on risks much greater than benefits but also on health risks that are arguably minor in probability of occurrence. That is, most news discussions focus on a rather trivial cancer risk when environmental impacts of salmon farming or the effects that a continually successful salmon farming industry may have on certain economies may be more important concerns at a societal level.

### Conclusions

The content analytic approach used in this study proved to be an informative empirical method for investigating the nature and magnitude of media attention to risks and benefits associated with farmed salmon. It enabled the transformation of textual information into a quantitative form that clearly depicted the differential amount of space in media stories devoted to different aspects of farmed salmon and how that changed over time. It revealed that the image portrayed is predominantly negative and that there was sustained media attention to severe or dreadful health risks up to 2 yr following the emergence of the Hites report in January 2004. Thus, although the total coverage of farmed salmon was obviously low compared to other social issues, the public was exposed to mostly negative information about farmed salmon. The findings of this study suggest that the public received a largely uniform message about farmed salmon and that the image was based primarily on the conclusions of two studies. Given that there were multiple other studies of salmon, with many being published after the Hites report, it is notable that media attention was so narrowly focused. In the future, it will be important to track how other stories about other aquaculture products are portrayed to the public because it appears that not all research is equally likely to be reported. For instance, a report produced by the EFSA (2005) concluded that there was no difference between farmed and wild fish with respect to contaminants and consumer safety; yet, this report

received very little media attention. The next step for research is to link this media analysis to public perception and behavior. It is likely that the negative image conveyed through extended media attention had impacts on how the public perceives salmon as a healthy food and their personal risk from eating it. However, this conclusion should be examined empirically. Moreover, it is possible that the public may associate a negative image of farmed salmon with other forms of aquaculture and its products, regardless of their relative risks and benefits. If so, this could have significant impacts on the industry. Therefore, understanding how media attention to one sector of an industry spills over to other sectors is an important avenue for future research.

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