

ABSTRACT

Title of Thesis: OPENING UP THE CONVERSATION: AN EXPLORATORY
STUDY OF SCIENCE BLOGGERS

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Over the past decade, science blogs have experienced tremendous growth and changes in organization, becoming an important part of what researchers have called the “evolving science media ecosystem.” This thesis explores the practices and perceptions of science bloggers through 20 in-depth interviews and through a review of the blogs themselves. The research suggests areas where this medium is having a unique impact on how science communication occurs. The interview results revealed that science bloggers are motivated mainly by enjoyment, have a wide variety of routines and reporting/writing processes, strive to incorporate a personal touch, and are very engaged with readers and fellow writers through social media. This research found that science blogs have important roles in complementing other forms of science communication, opening aspects of science to wider view, promoting conversations about science through blog comments and social media, and exploiting digital tools to enhance communication.

OPENING UP THE CONVERSATION:
AN EXPLORATORY STUDY OF SCIENCE BLOGGERS

by

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PREFACE

As teenagers, my brother and I would often drive far into Western Maryland to escape the city lights, parking at the edge of fields in the middle of nowhere to lie on the hood and peer at the stars. He is now an astronomer, making regular trips to a giant telescope in Chile to collect data on distant galaxies. I went in a different direction, but I never lost the sense of wonder that he and I shared as kids. I read popular science books and magazines, and try earnestly to understand my brother when he talks about his research.

I also read science blogs. When I started reading them several years ago, I was intrigued by the diversity of styles I encountered; behind each blog was a distinctive voice, which often combined personal narrative, humor, and nuance in ways I hadn't seen other science writing do. I wanted to learn more about this medium, and this thesis is the result of that curiosity.

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Chapter I: Introduction

This research investigates the practices and perceptions of influential science bloggers and, based on the interviews and reviews of their blogs, suggests areas where this medium is having an impact on science communication. Since emerging about one decade ago, science blogs have become an important part of what Fahy and Nisbet (2011) called the “evolving science media ecosystem.” The last several years, in particular, have brought significant changes to the science blogosphere, as communities of bloggers have formed at major media organizations such as *Wired*, *The Guardian*, *Scientific American*, and *National Geographic*. Although science blogs have attracted some research interest, an in-depth study is warranted because of these recent changes and the fluid, evolving nature of this medium.

I chose to study blogs focusing on a wide range of fields, including medicine and psychiatry, as I considered “science” in the broad sense proposed by Friedman, Dunwoody, and Rogers (1986): “‘Science’ comprises not only the biological, life, and physical sciences but also the social and behavioral sciences and such applied fields as medicine, environmental sciences, technology, and engineering” (p. xv). These authors also argued that “science writing” should be taken to include “the political, economic, and social aspects of science” (p. xv), and this study takes a similarly broad interest in various science-related topics.

STATEMENT OF THE PROBLEM

Science blogs are an important, evolving medium of science communication that is attracting a growing amount of commentary and research. Part of the interest in science blogs stems from the fact that fewer media organizations are employing people with backgrounds in science writing, and science blogs have been presented as a possible replacement to traditional science journalism (Brumfiel 2009). Scholars and others have argued that science blogs can add context often missing from science news coverage (Wilkins 2008), promote interaction between scientists and the general public (Shanahan 2011, Elliot 2006), reveal science-in-the-making (Wilkins 2008), and influence how science itself is conducted (Batts et al. 2008). Several researchers, however, have expressed skepticism about these claims and argued that potentially important uses of science blogs are going largely unrealized (Kouper 2010, Trench 2012, Bell 2012). Kouper (2010), for example, concluded that “science blogs need to stabilize as a genre” before they can begin to facilitate public engagement with science, and Trench (2012) found “little evidence” that science blogs play a significant role in revealing science-in-the-making.

This research attempts to provide qualitative data to shed new light on this discussion; it offers detailed information on the perceptions and practices of many of the most popular science bloggers, as well as examples drawn from their blogs to illustrate how this medium is unique among science communication platforms.

SIGNIFICANCE OF THE STUDY

The information gathered through this research contributes to a small but growing body of scholarship on science blogging and contains some insights relevant to claims often made about the potential of science blogs to change science communication. It expands on existing research by providing detailed information on the practices and attitudes of science bloggers of diverse backgrounds and interests—including both scientist bloggers and professional science writers who blog—as well as numerous examples and cases drawn from an extended review of the blogs themselves.

OUTLINE OF THE THESIS

The second chapter provides an overview of blogs and the science blogosphere as well as a literature review, including existing commentary and research on science blogs. The third chapter presents the research questions, describes the methodology, and offers brief descriptions of the blogs and bloggers selected for this research. Chapter four presents the results of the long interviews with the bloggers. In chapter five, I use specific examples and cases grouped into categories to suggest areas in which science bloggers may be changing how science is discussed in public. The sixth chapter offers final considerations and suggestions for future research.

Chapter II: Background and Literature Review

BLOGS: AN OVERVIEW

The essayist is a self-liberated man, sustained by the childish belief that everything he thinks about, everything that happens to him, is of general interest. He is a fellow who thoroughly enjoys his work, just as people who take bird walks enjoy theirs.

— E.B. White, foreword to *Essays of E.B. White*.

White's description probably would resonate with many writers who have blogs, a portmanteau of "web logs." Bloggers, too, are self-liberated, usually free to write whatever and however they wish, and they also enjoy their work; according to the 2011 *State of the Blogosphere* report by Technorati (www.technorati.com), a blog search engine that also ranks and studies blogs, personal satisfaction was the number one measure of success for people who blog as a hobby.

A blog is simply a platform: a webpage that one or more authors continuously update with date-stamped entries, called "posts," on which readers can comment. Blogs are often said to exemplify "Web 2.0," the "purported new face or phase of the Internet that is genuinely interactive and participatory" (Trench 2012).

As Siles (2011) observed, people use blogs in many different ways: as an outlet to record daily activities or personal reflections, as a place to share interesting images and videos, as a journalistic or literary undertaking, as a tool of mobilization, and often a combination of these uses. This “fluidity” has led communication scholars to define blogs as a “format” or “medium” for sharing various kinds of content on the Web (Siles 2011).

Before the advent of blogging software programs such as Blogger and WordPress, one needed to know how to make a website in order to create a blog. The earliest blogs, which lacked commenting capability, acted as filters for the Web by providing links to interesting material along with personal commentary and essays; an early American exponent named Jorn Barger coined the phrase “web log” in December 1997 for webpages that met this description, and by the start of 1999 only 23 such sites were known to exist (Blood 2000). But that year the number of blogs exploded, especially with the release of several free tools that automated the publication process. Especially popular was Blogger, which many people used to record daily events and spontaneous thoughts in the manner of a diary, without links or the filtering function that initially had characterized blogging (Blood 2004). With time, blogging software incorporated features such as permalinks (URLs for individual blog posts), commenting capability, the ability to search within blogs, archives of earlier posts, and sidebars with links to other blogs (Blood 2004; Siles 2011).

Blogs proliferated over the next several years, and the term “blogosphere” arose to describe certain ecosystem-like characteristics of this new medium. In presenting his

notion of a new media ecosystem in which one could see “evolutionary forces” at work, Hiler (2002) observed that blogs “vie for niche status, establish communities of likeminded sites, and jostle for links to their site.” Technorati—which attempted for years to index the entire blogosphere—was tracking more than 112 million blogs before deciding in the fall of 2009 to narrow its focus (Jalichandra 2009).

Blogs have become mainstream. Reflecting the evolving nature of the blogosphere, Technorati considers websites such as *The Huffington Post* and *The Daily Beast* to be blogs. In addition, as Jones and Himelboim (2010) note, the increasing presence of bloggers at political conventions challenges the once-popular conception of bloggers as people simply sitting at home in their pajamas.

THE SCIENCE BLOGOSPHERE: AN OVERVIEW

Science blogs, understood in this study to mean blogs that primarily or exclusively concern science, are written by a diverse group of scientists, graduate students, teachers, post-doctoral associates, and professional science writers or journalists; thus, the majority of science bloggers may not be actual scientists. As Trench (2012) observes, scientists have used the Internet mainly for communicating professionally, promoting science to media and policymakers, and disseminating research findings—priorities into which “blogging and other more highly interactive applications of the Internet do not fit comfortably.”

Science blogging can be done independently (using, for example, Blogspot or Wordpress) or as part of a larger network of blogs. In addition, some science bloggers are part of a collaborative “group blog,” which may or may not also be part of a network. Seed Media Group’s ScienceBlogs.com network, launched in 2006, was dominant for several years, but networks now exist at *The Guardian*, Public Library of Science (PLOS), *Wired*, *Scientific American*, and *National Geographic*, to name only a few. In addition, science blogs have been created under the banner of major news organizations, such as Dot Earth on the *New York Times* website.

The approaches and formats that science bloggers follow are diverse. These approaches include explaining new research the writers find interesting, countering bad science and debunking anti-science claims, explaining “cool” or intriguing concepts with little apparent news value, providing a venue for student writing, and exploring lives spent doing science. Domingo and Heinonen (2008) proposed the term “journalistic blog” to identify those blogs that have “a clear intention to collect, analyse, interpret or comment on current events to wide audiences,” and while this definition applies to many science blogs, it clearly does not apply to all.

Many science bloggers engage in “research blogging,” or writing about peer-reviewed research in a manner usually accessible to lay readers. The website ResearchBlogging.org aggregates such posts, and bloggers can register with the site to have their posts featured. They can also add a “Research Blogging” icon to posts that discuss peer-reviewed research to distinguish them from other, perhaps less serious,

posts. Most bloggers write not just about peer-reviewed research, but also science-related developments or skirmishes (such as the so-called “climategate” controversy involving hacked e-mails). Other bloggers instead focus on telling stories drawn from personal experiences in the science or health professions. Even those that focus on describing scientific developments frequently use their blogs to tell personal stories or express opinions about social and other aspects of science, such as science education.

Over its short existence, the science blogosphere has undergone significant growth and changes in organization. The number of science blogs cannot be definitely settled, as there is no universal agreement on the definition of a “science blog” (Trench 2012). However, ResearchBlogging.org alone has more than 1,200 registered blogs (Fausto 2012). Despite the large number of science bloggers, Twitter—a microblogging service that most well-known science bloggers use heavily—and other social media tools have helped create a sense of community among them. In addition, since 2007, science bloggers have gathered once a year in North Carolina for the Science Online conference, where they socialize and discuss the challenges and opportunities of science communication online. Emily Willingham, a research scientist and blogger, described attending the 2012 conference in a January 2012 blog post, writing in part: “It really is an oddly constructed, supportive, interactive, and occasionally collectively drunk family. A strangely candid and blunt but simultaneously respectful and loving family” (Willingham 2012).

A Brief History of Science Blogs

The history of science blogs includes several noteworthy innovations and incidents. To trace this history, I draw on a July 2012 blog post by Bora Zivkovic, one of the interview subjects for this study (Zivkovic 2012a). Zivkovic, in addition to being a chronobiologist and early exponent of science blogging, is the Blog Editor at Scientific American and co-founder and organizer of the annual Science Online conference.

The prevailing approach to science blogging has evolved over time, according to Zivkovic. Rather than engage in “research blogging,” most of the earliest science bloggers tended to be “combative and critical of various anti-science forces” in society, with creationism being a frequent target in the years leading up to the 2005 federal ruling against the teaching of intelligent design in public schools. Zivkovic suggests that this approach reflected his and other early bloggers’ experiences with Usenet, the Internet discussion system that, in the pre-blog era, often served as a venue for criticizing anti-science ideas.

Cognitive Daily, a psychology blog started in 2005 by Dave and Greta Munger, “pioneered” the research blogging format, according to Zivkovic. After this, the practice of blogging about a specific research paper in accessible language spread quickly; in this format, the discussed paper, sometimes alongside other papers mentioned in the post to add context, is referenced at the bottom in an academic citation format. The Mungers, in collaboration with Seed Media Group, also developed the ResearchBlogging.org site, described earlier, which, according to Zivkovic, “made this type of blogging attractive to

newcomers.” Editors at ResearchBlogging.org review blog posts to ensure they are of sufficient quality before they are featured on the site.

The 2006 launch of Seed Media Group’s blog network ScienceBlogs.com was another important development. As Zivkovic wrote, “Here was a media organization vouching for the quality of bloggers they hired to write on their site. And they picked bloggers who already had large readership and traffic, as well as clout online...” As a result, reporters in the mainstream media began to visit ScienceBlogs.com as one way to keep up with science news. Although several other science blog networks existed, they “dwelled in the shadow” of ScienceBlogs.com, Zivkovic wrote.

The dominance of ScienceBlogs.com ended in dramatic fashion in the summer of 2010, with an incident that came to be known as “Pepsigate.” Seed Media Group decided to host a blog written by representatives from PepsiCo, which would pay to have its blog hosted on the network. The editor of ScienceBlogs.com, Evan Lerner, announced the “partnership” in a note that read, in part: “...we’ll hear from a wide range of experts on how the company is developing products rooted in rigorous, science-based nutrition standards to offer consumers more wholesome and enjoyable foods and beverages” (Brainard 2010).

Many bloggers reacted angrily, saying that the Pepsi blog—called Food Frontiers—was an unacceptable mix of content and advertising that undermined the credibility of other blogs on the same network. They noted that the new blog lacked a

disclaimer denoting it as paid content. David Dobbs, a science journalist and author, posted a reaction on his blog that read, in part: "...ScienceBlogs has redrawn the boundaries of what it considers legitimate and constructive blogo-journalism about science. In doing so they define an environment I can't live comfortably in" (Brainard 2010). Although Seed Media Group removed the Pepsi blog amid criticism, Dobbs and many other prominent bloggers, including Zivkovic, decided to leave the network; Zivkovic estimates that the network lost about 25% of its bloggers over the incident (Zivkovic 2012a).

In the aftermath, other blog networks sprang up and recruited many of the bloggers that had left. Dobbs joined the *Wired Science* network alongside five other writers when it launched in September 2010, after spending several months blogging independently using WordPress. Zivkovic, meanwhile, accepted a position as Blog Editor at *Scientific American* and helped develop that organization's network, which launched in July 2011. *The Guardian* and PLoS were among other organizations that launched networks in the wake of Pepsigate. Networks that had already existed, at *Nature* and *Discover*, overhauled their site designs and recruited several of the writers who had left ScienceBlogs.com. In addition, some of the writers who departed ScienceBlogs.com worked together to launch Scientopia (<http://scientopia.org>), a "collective of people who write about science because they love to do so." The ecosystem of science blogs had expanded.

Also, a more recent change to the science blogging ecosystem occurred with the December 2012 launch of Phenomena, *National Geographic*'s science blog network. Although *National Geographic* had bought the ScienceBlogs.com network from Seed Media Group the previous year, "it never showed any real enthusiasm for it," as science writer Deborah Blum pointed out; Blum wrote that the new network "represents National Geographic's first serious move into the increasingly high-profile world of science blogging" (Blum 2012a). The network hosts four well-known science writers: Carl Zimmer, Ed Yong, Brian Switek, and Virginia Hughes. Yong and Zimmer were recruited from the *Discover* network, Switek from the *Wired Science* network, and Hughes from the group blog Last Word on Nothing. As Blum observed, "thanks to the quality of its debut bloggers, this new network, although small, represents a move with real power behind it" (Blum 2012a).

Another important development in science blogging mentioned by Zivkovic (2012a) is *The Open Laboratory*, an annual anthology of excellent writing on science blogs of which Zivkovic is the series editor. The first edition was published in early 2007 to coincide with the first Science Online conference. Each subsequent year, entries have been gathered through crowdsourcing, and different guest editors (themselves science bloggers) have taken on the task of sorting and judging entries, with help from multiple reviewers. Zivkovic wrote that *The Open Laboratory* anthology "really helped the community define itself. Gaining an entry into the anthology became a big deal." (The anthology was renamed *The Best Science Writing Online* starting with the 2012 edition.) Another form of recognition for science bloggers is the "3 Quarks Daily" prize, which

started in 2009. Editors at the 3 Quarks Daily website collect submissions from readers and solicit help from prominent figures in science to pick the winners. The first-place winner, or “Top Quark,” gets a cash prize of \$1,000.

Characteristics of Science Bloggers

Shema, Bar-Ilan, and Thelwall (2012) recently investigated research blogging by analyzing data on a sample of 135 bloggers and 126 blogs drawn from the aggregator ResearchBlogging.org. Although not all science blogs follow the research blogging format, many do; the study by Shema et al., therefore, offers an important overview of much of the science blogosphere, and it is worth summarizing their results here.

These authors found that most bloggers were male: two-thirds of the analyzed blogs had a single male author, while 18% had a single female author; another 5% and 4%, respectively, had two male authors or one male and one female author. The bloggers were also highly educated; 27% were graduate students, 32% had a Ph.D., 11% had an MA or an MSc, and 6% were either MDs or MD/PhDs. Most (59%) were either researchers or students in an academic setting. English (86%) was the dominant blogging language. Of blogs in the sample, 69% were done independently, while 31% belonged to a larger group of blogs, such as a network. Most blogs (72%) had an associated Twitter account; all of the “top blogs” in the sample, those that Technorati ranked among the top 100 science blogs, had active Twitter accounts with high numbers of followers. As their main subject, 39% of the sampled blogs focused on life sciences, followed by psychology,

neurosciences, or behavioral science (21%), and medicine (9%). Bloggers showed a preference for writing about papers published in high-impact journals such as *Nature*, *Science*, and *PNAS*.

LITERATURE REVIEW

Science blogs are just one part of the “evolving science media ecosystem” in the “current ‘digital age’ of science reporting” (Fahy and Nisbet 2011). To ground this research, it is useful to briefly examine science reporting before the digital age, as well as other reporting practices and venues that currently exist in the online environment. As many science bloggers do not think of their blogging as journalism or reporting, it is also useful to examine the broader context of science communication, including how scientists have traditionally communicated with the public. After exploring these two areas, I will summarize the existing commentary and research on science blogs.

Science Journalism Past and Present

Science journalism in the U.S. went through distinct phases in the twentieth century. During the Second World War, for example, “science and technology were seen as integral to victory” (Weigold 2001), and newspaper reporters attempted to persuade readers “that science was the salvation of society” (Fahy and Nisbet 2011). In the latter half of the century, science reporters alternated between “promotional” and “critical” styles (Fahy and Nisbet 2011).

Research from the 1980s and 1990s showed that newspaper journalists used the same kinds of editorial gatekeeping criteria for science coverage as for news in general, including controversy, timeliness, proximity, the number of lives affected, and human interest (Weigold 2001). During the same period, research showed that science coverage at large newspapers tended to focus on medicine, technology, and the environment more than the behavioral and physical sciences (Weigold 2001). Newsmagazines and large national newspapers tended to offer more in-depth science coverage than other media, while wire services, small newspapers, and broadcast stations were “least likely to have the time or money for in-depth science coverage” (Weigold 2001).

The digital age brought significant changes to the science media landscape—a landscape that Fahy and Nisbet (2011) attempted to map. As these authors explained, the new ecosystem is mostly online and includes not only “legacy media in their print and online formats,” but also “news and blogging communities” at journals such as *Nature* and science magazines such as *Scientific American*, as well as websites such as MIT’s *Knight Science Journalism Tracker* that provide “reflexive and meta-discussions of science journalism.” These authors also mentioned “innovative business models for producing science-related content,” including Seed Media Group’s ScienceBlogs.com network and “new ventures emanating from inside journalism such as the blogs and content features at the *New York Times* and the *Guardian*.” The new ecosystem also includes “science advocacy blogs and sites,” such as Climate Progress, as scientists are

“using blogs and social media to communicate their work and agendas directly with various publics” (Fahy and Nisbet 2011).

These authors also noted that the expansion in the types and numbers of “actors” writing about science “has mirrored a decline in the numbers of science writers employed by legacy media” in the U.S. (Fahy and Nisbet 2011). In this new landscape, science journalists not only file “traditional edited and vetted stories,” but also frequently self-publish on the Internet through blogs and social media. Based on interviews with 11 science journalists working for elite media, Fahy and Nisbet (2011) proposed that science journalists in this new environment “have moved from their dominant historical role as privileged conveyors of scientific findings to an increasing plurality of roles that involve diverse, pluralistic and interactive ways of telling science news.”

Other Changes in Science Communication

The “key players” in science communication include not just reporters and news organizations but also scientists (Weigold 2001), many of whom, as just mentioned, have embraced ways to reach audiences directly online. Reviewing the literature on science communication in 2001, Weigold wrote, “There is a widespread perception that scientists are not effective communicators, at least when the audience is the general public.”

Although some prominent scientists communicated with the public through popular science books (such as those of Stephen Jay Gould and Stephen Hawking) and articles for magazines such as *Scientific American*, the primary way in which scientists served roles

as public communicators before the Internet was through giving interviews to the mass media (Weigold 2001). According to Dunwoody et al., this remains a significant public communication avenue even in the digital age; a survey of active researchers conducted in 2005 and 2006 found that two-thirds of the sample had interacted with journalists in the previous three years, a proportion “identical to that found in studies from the 1980s” (Dunwoody et al. 2009).

It is clear, however, that researchers are using blogs and other social media for various kinds of communication. As Bik and Goldstein (2013) wrote recently:

Although the type of online conversations and shared content can vary widely, scientists are increasingly using social media as a way to share journal articles, advertise their thoughts and scientific opinions, post updates from conferences and meetings, and circulate information about professional opportunities and upcoming events.

Bik and Goldstein noted that blogs and other social media “offer an ideal medium for extended scientific conversations,” including both “preprint commentary” on papers published on arXiv, a pre-print publication site, as well as “postpublication review.”

While such commentary and review are often aimed at fellow researchers, the target audience for scientist-run blogs can also be the general public: “Along with forging links between scientists, online interactions have the potential to enhance ‘broader

impacts' by improving communication between scientists and the general public" (Bik and Goldstein 2013).

Previous Commentary and Research on Science Blogs

The science blogosphere has attracted attention from journalists and communication scholars for a number of years. Below, I summarize some of the main topics that have been explored in previous research and commentary.

Advantages over Other Channels

Much of the commentary about science blogs comes from proponents and practitioners and is thus positive in nature. It is frequently argued, for example, that this mode of science communication has certain advantages over more traditional channels, such as newspapers and magazines. John S. Wilkins, a science blogger and philosopher of science, asserted that it is "more intimate and responsive" and "relies not merely on press releases, which can be terribly misleading, but on the personal knowledge and expertise of the blogger" (Wilkins 2008). Science bloggers, Wilkins argued, can "demythologize" science by placing studies in the context of previous research, and knowledgeable readers can comment on mistakes, allowing fast and transparent corrections. "This provides a contrast to science magazines and columns in the mainstream media and shows that science and medicine are not always about major breakthroughs or immediate applications" (Wilkins 2008). Wilkins also argued that

revealing science-in-the-making is a “crucial role” of science bloggers: “Unlike laws and sausages, the public should see science during its manufacture, but the lay public is generally ill-equipped to interpret what they see.” This is an explicit goal of some blogs, such as Retraction Watch (<http://retractionwatch.wordpress.com>), which tracks retractions of scientific papers “as a window into the scientific process.”

One of the questions sometimes raised is whether science blogs can supplant or complement more traditional sources of science news, given that newspapers and other media organizations are employing fewer people with extensive experience in science reporting (see, e.g., Brainard 2008, Zara 2013). Science journalist Geoff Brumfiel (2009) presented the results of a *Nature* survey of 493 science journalists, who were found increasingly to look to blogs for story ideas and to have their own work appear on blogs. In addition, Colson (2011) surveyed 73 French science journalists and reported that 82% consult science blogs, seeing them as “valid sources of information.”

Science bloggers occasionally point to blogs as a means of overcoming tensions between science and journalism. In a blog post from March 2011, “Neuroskeptic,” an anonymous British blogger and neuroscientist, crystallized some of the tensions that exist from a scientist’s point of view: Reporters working at “supersonic speed” are unable to give new papers “sufficient consideration,” and they often “draw tenuous conclusions between the science and the hot topics that sell stories—cancer, children, cute animals, and controversies” (Neuroskeptic 2011). He argued that blogging offers a solution, “not as a replacement for science journalism, but as a complement to it.” Elaborating, he wrote:

Each individual blog has a fairly narrow specialist focus, but the other side of that coin is that they dig deeper than journalists can. Maybe it takes them a couple of days—but the stories they uncover are ones that inherently can't be generated any quicker. ... Science blogs are a kind of second source of news stories on top of the primary literature.

Motivations for Science Blogging

Scientists' and science writers' reasons for blogging about science have also received attention. Wilkins (2008) asserted that it should appeal to those in the academic community as "more than a casual hobby," given that it allows "core outreach for their science" and is "an effective way for scientists to counter the misunderstandings, deliberate and otherwise, of popular culture." He also stated that it allows an "isolated researcher" to "become part of a wider social network" through "back-channel forums, personal contacts, and commenting." He cited the annual Science Online conference as an example of this community-building potential. Wilkins also pointed out that science blogging can lead to job opportunities. Amsen (2006), who interviewed five science bloggers, made similar arguments while also pointing out that professional science writers who blog "can use their blogs as a playpen for new ideas."

Kjellberg (2010) conducted in-depth interview with 12 researchers from Sweden, the Netherlands, and Denmark to identify their motivations for blogging. She found that blogging offered these researchers opportunities to "disseminate something they would

like others to read,” to “express opinions in a way that is seldom possible in other academic writing,” to “contact people that would otherwise be outside of the researcher’s normal context,” and to improve their writing skills. Kjellberg summarized the bloggers’ motivations as follows: “The blog helps the researcher share with others, it provides a room for creativity, and it makes the researcher feel connected.”

Colson (2011) conducted in-depth interviews with 17 French-speaking science bloggers, including both scientists and science journalists. Scientist bloggers mentioned “a desire to bypass traditional media” as their “first reason” for creating blogs. Scientists who blog were quoted as saying that science journalists in the traditional media “lack scientific culture,” only slightly alter press releases, engage in sensationalist reporting, and can no longer fill their “watchdog” role. French science journalists who blog, meanwhile, were motivated by enjoyment and a sense of freedom. “They admit that they are not as cautious when writing for a blog post as they are when writing a magazine or newspaper article. They choose more amusing and lighter subjects for their blog” (Colson 2011).

Arsenic Life and Public Peer Review

In late 2010, science bloggers played an important role in subjecting a high-profile NASA study to scrutiny and influencing how it was publicly received. This event and its aftermath stirred considerable discussion about the role of the science blogosphere and science journalism in the digital age. For example, it was mentioned by Shema et al.

(2012) as an example of how science blogs “may influence mainstream science,” and Fahy and Nisbet (2011) wrote that the “various scientific and journalistic voices that emerged in the diverse treatments of the arsenic life story are emblematic of the wider transformations occurring within science journalism.” Therefore, it is worth recounting in some detail here.

A NASA scientist, Felisa Wolfe-Simon, found a form of bacteria in Mono Lake, California, that she and her collaborators claimed used arsenic in its metabolism rather than phosphorous, signifying a new “recipe” for life. NASA’s media advisory on the finding, published on November 29, 2010, was provocative: “NASA will hold a news conference at 2 p.m. EST on Thursday, Dec. 2, to discuss an astrobiology finding that will impact the search for evidence of extraterrestrial life” (NASA 2010).

Even before the news conference was held, and before the paper was posted on the website *Science Express*, stories with sensational headlines began to appear in mainstream media outlets—headlines such as “‘Life as we don't know it’ discovery could prove existence of aliens” (*The Telegraph*, Alleyne 2010) and “NASA astrobiology press conference: Have they made breakthrough in search for extraterrestrial life?” (*The Huffington Post*, Graham 2010). The Washington Post, in a section of its website devoted to covering news in a humorous fashion (called “ComPost”), even ran a picture of an archetypical bug-eyed alien with the story (Petri 2010). Once the paper was released, stories in the mainstream media covered the substantive claims in the study but did not convey a sense that those claims were controversial. A representative article, from the

Christian Science Monitor, summarized the paper as follows: “Scientists have found a microbe in Mono Lake, California, that uses arsenic as a fundamental building block, changing the definition of ‘life as we know it’ and the search for extraterrestrial life” (Spotts 2010).

On certain blogs, meanwhile, the new paper was being dissected and critiqued. On December 3, the chemistry blogger Paul Bracher recorded his “preliminary thoughts” and wrote, “I am not convinced the data presented support the conclusion that these organisms are ‘using’ arsenic” (Bracher 2010). On December 4, the microbiologist Rosie Redfield used her blog to post an extensive critique of the paper, concluding it had “lots of flim-flam, but very little reliable information” and speculating that the authors may have been “unscrupulously pushing NASA’s ‘There’s life in outer space!’ agenda” (Redfield 2010). Another critique followed the next day—this one a “guest post” by the microbiologist Alex Bradley on the We Beasties blog, part of the ScienceBlogs.com network. Bradley declared that the central claim of the study was “almost certainly wrong” (Bradley 2010).

These critiques caught the eye of Carl Zimmer, a science journalist, author, and blogger. He decided to interview these and other scientists to compose a piece about the in-depth criticism, which was published in *Slate* on December 7 (Zimmer 2010). In the piece, Zimmer described his attempt to reach out to Wolfe-Simon and co-author Ronald Oremland before publication for their response to the criticisms. Oremland, as quoted by Zimmer, said, “We cannot indiscriminately wade into a media forum for debate at this

time.” Wolfe-Simon responded in a similar vein, saying, “Any discourse will have to be peer-reviewed in the same manner as our paper was, and go through a vetting process so that all discussion is properly moderated.”

But the criticisms appeared to have an impact. The publication of the paper in *Science* (following its initial web-only publication on the *Science Express* site) was delayed for months amid rumors that many scientists were submitting “technical comments,” or formal critiques, to the journal (Zimmer 2011a). Finally, in May 2011, the *Science* website posted eight such comments along with a response from the authors, and the following month’s print edition included the paper itself and the discussion it had generated. But the content of that discussion was not new to those who had been following the saga, as Zimmer (2011a) pointed out in a follow-up piece published in *Slate*:

In the past, scientists might have kept their thoughts to themselves, waiting for journals to decide when and how they could debate the merits of a study. But this time, they started talking right away, airing their criticisms on the Internet. In fact, the true significance of the aliens-that-weren't will be how it helped change the way scientists do science.

In the same piece, Zimmer wrote that the authors “tried to play the bloggers-in-their-pajamas card, but it was a losing hand. For one thing, the people who were talking on blogs and Twitter were not in their pajamas. Many of them were in lab coats” (Zimmer 2011a). Zimmer noted that this episode was “one of the first cases in which the

scientific community openly vetted a high-profile paper, and influenced how the public at large thought about it.” This process continued when Rosie Redfield, the researcher who had published the most extensive blog critique of the paper, decided to try to replicate its findings using the tools of open science. As Zimmer explained in a 2012 blog post, Redfield “used her blog to chronicle her experiences, from receiving the bacteria from the original authors to failing to replicate their results to posting her paper on arXiv to getting her paper accepted to *Science*, where it’s now in press” (Zimmer 2012a).

Science Blogs as Vehicles for Interaction and Boundary Crossing

Interactivity is another major area where science blogs have begun to attract attention (Trench 2012, Shanahan 2011). In general, blogging environments feature more reader participation and interaction than seen in online non-blog formats, such as online news articles. In journalistic blogs, this phenomenon is partly explained by the widespread practice of linking, which invites readers to become more active participants in negotiating meaning by changing the sense in which “authority” is understood.

Matheson (2004) made this point as follows:

The weblog moves away from the rather abstract authority assumed by such news texts to a more situated authority, in which we hear a journalistic voice choosing material as well as multiple and often discordant journalistic voices accessed through the links. In this context, meaning must be more actively constructed by the user.

Shanahan (2011) drew on this idea in proposing that science blogs act as “boundary layers,” mixing different types of information and facilitating interaction and exchange between people of different social worlds. To illustrate this concept, she highlighted a case involving fruitful exchange between a farmer and scientist that connected via a science blog. That case is summarized below.

In a March 2010 blog post, Ed Yong, the writer behind the blog *Not Exactly Rocket Science*, wrote about a discovery by researchers at the University of Edinburgh that each cell in a chicken is either male or female (Yong 2010a). The researchers made the discovery by studying gynandromorphic chickens (those that have both male and female characteristics). In the comment thread, one of the paper authors thanked Yong for “the excellent representation/explanation of our work.” Given that this comment appeared alongside comments from general non-scientist readers, Shanahan (2011) observed that the blog post brought together, “at least momentarily and through text, actors from both the scientific sphere and the public sphere without a translator sitting between them.”

A more striking example of interaction was still to come, however. Later that year, in September, a farmer from the U.S. e-mailed Yong after finding his blog post while searching for information about a recently hatched chicken that looked unusual. Yong suggested to the farmer that he contact the paper author who had commented on the original blog post, which the farmer did. In the ensuing exchange, the scientist asked whether the farmer would be interested in sending genetic material from the bird to help

resolve the question of how gynandromorphs arise, and the farmer agreed enthusiastically. Yong detailed these interactions with a new blog post titled, “In which I set up a collaboration between a biologist, a farmer and a chimeric chicken” (Yong 2010b).

Shanahan (2011) emphasized that science blogs involve mixing not just people but also information. She reported that Yong routinely mixes different types of information by providing links to primary literature, other blogs, university research websites, online newspapers, and images and videos. The March 2010 post, for example, included a technical diagram drawn from the original paper, which Yong used to help answer certain reader questions. The “mixing of people and information” seen in this case led Shanahan to conclude that blog posts are “more than just sites of science communication”:

They are boundary spaces where writer and reader can engage with each other and a variety of information forms in a way that is not necessarily prescribed by an institutional mandate but instead happens as a result of the social worlds and knowledge practices that come together. Science blog posts are, from this perspective, spaces for interaction in ways that other online sources are not.

Tempering the Enthusiasm

Notwithstanding individual cases, several researchers have expressed doubts as to whether science blogs are serving certain claimed or desired functions on a large scale. In

reviewing the characteristics of 20 science blogs, Trench (2012) found “very little evidence to support the claims” regarding “blogging’s significant role in communicating science or its significant impacts on science.” Regarding interactivity, which he defined as “the scope and quality of exchanges between blog publishers and visitors,” Trench reported that a “low level of discussion and the absence of debate were the most frequently made observation in relation to this criterion.” With regard to science-in-the-making, Trench reported that “less than a quarter of the blogs provided even occasional looks behind the scenes of science.”

Trench singled out physics and climate science as special cases, however. In physics, he found “fairly frequent” connections between discussions occurring on blogs and papers published on arXiv, making debates over certain papers publicly visible. In climate science, Trench pointed out that “communities of bloggers played tangible roles” in how climate science was publicly received in the wake of the “climategate” incident, when a server was hacked at the Climatic Research Unit at the University of East Anglia in England. Holliman (2011), too, observed that climate change skeptics showed an ability to use digital tools, including blogs, to make “visible selected newsworthy aspects of scientific information and the practices of scientists” (Holliman 2011). But Trench viewed this episode in a negative light, arguing that the “tone and tenor” of the ensuing online debates “are cautions against over-optimistic readings of the potential of science blogs to create a new public sphere” where public opinion is “formed through rational discussion.”

Kouper (2010) focused on the ability of science blogs to increase public engagement with science, which can be regarded as one facet of interactivity. After analyzing “modes of communication” in 11 science blogs, however, she concluded that science blogs “provide information and explain complicated matters, but their evaluations are often trivial and they rarely provide extensive critique or articulate positions on controversial issues.” She also stated that the “multiplicity of forms and contents” in the science blogosphere results in a “lack of genre conventions, which for the audience translates into broken expectations and uncertainty” and “impedes the development of stable readership and participation from the larger public.” Kouper said science blogs must “stabilize as a genre” before they can “become a tool for non-scientist participation” and that science bloggers “need to become more aware of their audience, welcome non-scientists, and focus on explanatory, interpretative, and critical modes of communication rather than on reporting and opinionating.”

Chapter III: Research Questions, Methods, and Overview of Bloggers

RESEARCH QUESTIONS

The research and commentary explored in the previous chapter suggest that more remains to be discovered in terms of science blogging's impact on how science is communicated. For one, science blogs continue to evolve, and new norms and practices may be developing. In addition, although Colson (2011) conducted in-depth interviews with 17 French-speaking science bloggers, I am aware of no study that combined a large number of in-depth interviews with a review of the blogs themselves. Lastly, even studies that analyzed a substantial number of blogs limited their analyses to relatively short periods; Trench (2012) reviewed 20 science blogs "in early 2010," while Kouper (2010) analyzed "30 days of activity from less active blogs and five days of activity from very active blogs" in July 2008.

This exploratory study, which attempts to fill those gaps, was guided by two overarching research questions:

1. How do science bloggers operate, and why do they operate in that way?
2. Is there evidence that science blogs are serving new roles in how science communication occurs, such as facilitating high-quality interaction or public access to science-in-the-making?

Although there is overlap, answering the first question is largely the goal of chapter four, whereas chapter five addresses the second question.

METHODS

In-depth Interviews

Between October 2011 and August 2012, I conducted in-depth interviews with 20 science bloggers. The participants, interview procedures, and data collection and analysis methods are described below.

The participant sample was drawn from a list of influential science bloggers as determined by several factors. Most bloggers on the list had been selected for inclusion in *The Open Laboratory* (as of 2012, *The Best Science Writing Online*) anthology or had been among the finalists or winners in well-known science blogging awards: the 3 Quarks Daily Award, Seed Media Group's Research Blogging Awards, and/or the American Association for the Advancement of Science's (AAAS's) Science Journalism Award (online category). Several bloggers on the list did not fit these criteria but were included because their work reaches a wide audience or because their blogging activity had proved influential in some other way; for example, chemistry blogger Paul Bracher was included because of his early role in criticizing NASA's arsenic-based life paper.

Influence was considered more important than representativeness because this study does not aim to generalize results to the entire population of science bloggers; rather, a purposeful sample was selected to provide deep and detailed answers to the research questions. As in Archibald's examination of the practices of environmental reporters, results may not be generalizable but will be "representative of the range of concepts involved" (1996, 45). In any case, as pointed out by Walejko and Ksiazek (2010), "the sheer size of the blogosphere makes it virtually impossible to draw a truly random sample of blogs."

After obtaining approval from the Institutional Review Board at the University of Maryland, I e-mailed interview requests to bloggers on the list and arranged phone or Skype interviews with those who agreed. This process continued until 20 interviews had been completed. Each participant signed and returned an informed consent form. The interviews ranged from 30 minutes to 75 minutes in length, with most lasting around 50 minutes.

During each interview, I used an interview guide that included several questions asked to each participant (such as "How do ideas for blog posts usually come to you?" "What is your vision of your blog's audience"? and "What makes a good blog post?") as well as questions tailored to the particular person (such as how his or her approach might have changed based on moving to a new network or how a particular blog post came about). The questions were open-ended, and I often deviated from the interview guide

when asking follow-up questions to pursue a topic that seemed especially relevant. The basic interview guide is provided at the end of this thesis as Appendix 1.

I recorded and transcribed each interview, and I studied the transcripts to compare blogging practices and personal philosophies. In addition, I paid particular attention to cases and examples that seemed to show blogs serving new roles in how science communication occurs.

Review of Science Blogs

Once a blogger agreed to participate, I added his or her blog to my Google Reader feed. In this way, I kept track of and made written notes about participants' blogging activities, again focusing on cases that seemed to show blogs serving new roles in how science communication occurs. I also made notes related to general characteristics such as content, sources, hypertextuality, and frequency of updates. This review continued for approximately one year, from January 2012 to January 2013. Although I was unable to read every blog post of every participant during this period, the extended nature of the review allowed me to become familiar with each blog and gauge whether individual cases were isolated or part of a pattern.

THE BLOGGERS: AN OVERVIEW

The bloggers who agreed to participate in this research include nine for whom science writing or science journalism is a career (Ed Yong, Carl Zimmer, Deborah Blum, Andrew Revkin, David Dobbs, Ann Finkbeiner, Mo Costandi, Bora Zivkovic, and Ethan Siegel), seven active scientists, professors, or medical professionals (Sean Carroll, Kate Clancy, Chad Orzel, Rhett Allain, Miriam Goldstein, Paul Bracher, and Steve Balt), and four graduate/medical students or recent graduate degree recipients (Jason Goldman, Rebecca Kreston, Shara Yurkiewicz, and Markus Hammonds). Most of the bloggers in the sample are from the U.S., while three (Ed Yong, Mo Costandi, and Markus Hammonds) are British. In addition, Bora Zivkovic was born in Belgrade in present-day Serbia, emigrated to the U.S. in 1991, and became a U.S. citizen in 1998.

Among the blogs considered in this study, most focus on the life sciences (including such fields as marine biology, chronobiology, parasitology, animal cognition, and neuroscience). In addition, four focus on astronomy, two on chemistry, two on physics, one on natural resources and the environment, one on psychiatry, and one on medical ethics and life as a medical student. Below, I provide basic information on each blogger. Appendix 2 has more detailed information on each blogger and blog.

Rhett Allain (Interview Date: November 17, 2011): Allain runs the Dot Physics blog (<http://www.wired.com/wiredscience/dotphysics/>) as part of the *Wired Science* network.

Steve Balt (Interview Date: December 14, 2011): Balt runs the Thought Broadcast blog (<http://thoughtbroadcast.com>), which he does independently.

Deborah Blum (Interview Date: January 4, 2012): Blum runs the Elemental blog (<http://www.wired.com/wiredscience/elemental/>) as part of the *Wired Science* network, which she joined in May 2012. At the time the interview was conducted, she ran the Speakeasy Science blog (<http://blogs.plos.org/speakeasyscience/>) as part of the PLoS network.

Paul Bracher (Interview Date: November 2, 2011): Bracher runs the ChemBark blog (<http://blog.chembark.com>), which he does independently.

Sean Carroll (Interview Date: June 25, 2012): Carroll runs the Preposterous Universe blog (<http://www.preposterousuniverse.com/blog/>), which he does independently. At the time the interview was conducted, he was a writer for the collaborative group blog Cosmic Variance (<http://blogs.discovermagazine.com/cosmicvariance/>), part of the *Discover* network.

Kate Clancy (Interview Date: August 23, 2012): Clancy runs the Context and Variation blog (<http://blogs.scientificamerican.com/context-and-variation>) as part of the *Scientific American* network.

Mo Costandi (Interview Date: December 15, 2011): Costandi runs the Neurophilosophy blog (<http://www.guardian.co.uk/science/neurophilosophy>) as part of *The Guardian* network.

David Dobbs (Interview Date: December 16, 2011): Dobbs runs the Neuron Culture blog (<http://daviddobbs.net/smoothpebbles/>), which he does independently. At the time the interview was conducted, the blog was part of the *Wired Science* network (<http://www.wired.com/wiredscience/neuronculture/>).

Ann Finkbeiner (Interview Date: June 5, 2012): Finkbeiner contributes to the collaborative group blog The Last Word on Nothing (or LWON, <http://www.lastwordonnothing.com>).

Jason Goldman (Interview Date: June 14, 2012): Goldman runs the blog The Thoughtful Animal (<http://blogs.scientificamerican.com/thoughtful-animal/>) as part of the *Scientific American* network.

Miriam Goldstein (Interview Date: June 9, 2012): At the time the interview was conducted, Goldstein contributed to the collaborative group blog Deep Sea News (<http://deepseanews.com>). In January 2013, she announced a “leave of absence from all public social media.”

Markus Hammonds (Interview Date: May 31, 2012): Hammonds runs the Supernova Condensate blog (<http://supernovacondensate.net>), which he does independently.

Rebecca Kreston (Interview Date: July 19, 2012): Kreston runs the Body Horrors blog (<http://blogs.discovermagazine.com/bodyhorrors/>) as part of the *Discover* network, which she joined in April 2013. At the time the interview was conducted, she was blogging independently.

Chad Orzel (Interview Date: June 13, 2012): Orzel runs the Uncertain Principles blog (<http://scienceblogs.com/principles/>) as part of the ScienceBlogs.com network.

Andrew Revkin (Interview Date: August 22, 2012): Revkin runs the Dot Earth blog (<http://dotearth.blogs.nytimes.com>) for the *New York Times* website.

Ethan Siegel (Interview Date: May 24, 2012): Siegel runs the Starts With A Bang blog (<http://scienceblogs.com/startswithabang/>) as part of the ScienceBlogs.com network.

Ed Yong (Interview Date: December 7, 2011): Yong runs the blog Not Exactly Rocket Science (<http://phenomena.nationalgeographic.com/blog/not-exactly-rocket-science/>) as part of the *National Geographic* network, which he joined in December 2012. At the time the interview was conducted, he was part of the *Discover* network (<http://blogs.discovermagazine.com/notrocketscience/>).

Shara Yurkiewicz (Interview Date: August 31, 2012): Yurkiewicz runs the blog This May Hurt a Bit (<http://blogs.scientificamerican.com/this-may-hurt-a-bit/>) as part of the *Scientific American* network, which she joined in January 2013. At the time the interview

was conducted, the blog was part of the PLoS network (<http://blogs.plos.org/thismayhurtabit/>).

Carl Zimmer (Interview Date: October 24, 2011): Zimmer runs the blog The Loom (<http://phenomena.nationalgeographic.com/blog/the-loom/>) as part of the *National Geographic* network, which he joined in December 2012. At the time the interview was conducted, he was part of the *Discover* network (<http://blogs.discovermagazine.com/loom/>).

Bora Zivkovic (Interview Date: January 6, 2012): Zivkovic runs the blog A Blog Around The Clock (<http://blogs.scientificamerican.com/a-blog-around-the-clock/>) as part of the *Scientific American* network, for which he also serves as the Blog Editor.

Chapter IV: Practices and Perceptions of Science Bloggers

This chapter describes science bloggers' practices and perceptions, drawing primarily on interview data and partly on the review of blogs. In addition, the discussion at the end of the chapter contains some supplemental information drawn from other sources.

As this is exploratory research, it aims to shed light on a range of issues that have yet to receive systematic treatment in previously published research. Therefore, this chapter covers many topics, which are organized as follows. First, I discuss the reasons why science bloggers engage in this activity, including their reasons for starting blogs, communication goals, and other motivations. Next, I examine their blogging practices, including their selection of topics, writing processes, and engagement with commenters, as well as the ways in which Twitter and other social media complement their blogging activity. Then, I explore how science bloggers view their audiences and the criteria they use to judge what makes a “good” blog post. This is followed by a discussion of blog networks. After that, I discuss how bloggers view science blogs compared to other platforms. The end of the chapter includes a discussion that highlights several of the main findings and introduces some supplemental information.

WHY BLOG ABOUT SCIENCE?

Many science bloggers are active researchers or professors who set aside time for their blogs in spite of busy professional schedules. Furthermore, as David Dobbs observed in our interview, for professional science writers who also maintain blogs, there is “some tension” arising from the thought that blogging occasionally means “giving stuff away that you could sell,” (i.e., pitch to a magazine editor) (Dobbs 2011). In this section, I summarize many of the factors that appear to make it a worthwhile activity for my interview subjects in spite of these facts.

Reasons for Starting Science Blogs

To begin an exploration of motivation, I examined interviewees’ reasons for starting a science blog. As will be seen, these factors are idiosyncratic, sometimes coinciding with changes in careers or career goals but more often arising from less momentous events.

Bypassing Traditional Media: Not a Primary Reason

For the scientists, professors, and graduate students in my interview sample, the reasons generally did not involve a “desire to bypass traditional media,” as Colson (2011) reported in her sample. Such sentiments were expressed only occasionally and not as primary reasons for creating blogs. Carroll sometimes blogs to point out misleading headlines in mainstream coverage of cosmology. As he observed in the interview, “In the journey from science results to the press releases to the written newspaper article to the

headline, there is a little bit of a degradation of accuracy in every step, and that last step is the worst.” Despite this, he is not motivated by a desire to bypass traditional media: “I don’t want to circumvent the media. I want to work with them. ... I’ve written for newspapers and magazines before, and it’s really, really difficult to be honest and accurate at the same time because of the incredible constraints you’re put under” (Carroll 2012a).

Bracher said journalists in the mainstream media often “do not take the time to get their facts straight,” but he did not mention such shortcomings while explaining the creation of his blog. Instead, he stressed his desire to foster an online “conversation” on issues in chemistry: “It was a chance to talk about what I think most people talk about in the hallways... Online there’s always an opportunity to find someone to have a conversation with and talk about interesting issues in your field.” He said the blog was a “natural progression” considering his long-term interest in online forums and bulletin boards (Bracher 2011). Similarly, Siegel expressed strong feelings about how the mainstream media cover science—and often uses the blog to point out perceived failings—but did not mention this factor in explaining his start.

Several bloggers emphasized dissatisfaction with more specialized outlets in their fields or with academia itself more than they emphasized dissatisfaction with traditional media. Bracher blogs partly in order to highlight areas of the chemistry field that he feels are neglected by such publications as *C&EN* (Chemical & Engineering News, a weekly magazine published by the American Chemical Society) and *Chemistry World* (a monthly

magazine published by the Royal Society of Chemistry). Clancy said that, in her blog, she feels “up against” medical schools, which impart a “health-disease dichotomy” that she said is ill suited to understanding female reproductive health (Clancy 2012a).

Similarly, Balt said he started blogging partly to provide an “alternative voice” in the field of psychiatry, which he feels is too heavily focused on medication in the textbooks and the conventional psychiatric literature (Balt 2011).

How Books Can Play a Role in Science Blogs’ Beginnings

Several professional science writers who blog mentioned book projects in connection with their blogs’ beginnings. Blum and Finkbeiner had both recently finished books; for Blum, the blog started as a place to continue to explore issues connected with the book’s subject: “When the book was about to come out, I thought: I’m going to do a blog partly so I can explore some of the unresolved issues in the book” (Blum 2012b). Finkbeiner started blogging once she realized her book’s completion left her without any fresh ideas: “I was just sort of staring at the screen. So I thought, why not find out what this brave new Internet world is all about?” She had long been immersed in book writing, having written two of them back-to-back. “When I surfaced again after the second book was done, the world really was different,” she said. “I didn’t think that print was necessarily dead at all, but certainly this other thing was alive. ...I wanted to find out if writing was different for print or for a blog (Finkbeiner 2012).

Revkin's blog "grew out of what was going to be a book," he told me. Revkin, who was still working as a full-time reporter for the *New York Times*, had won a John Simon Guggenheim Fellowship to shape a book proposal on sustainability, but he lacked the time to "step off the hamster wheel and think for a while" due to the heavy news flow at the time. He created Dot Earth in October 2007 "as a way to essentially do the process of reporting what might eventually be a book." But he came to view it as a better venue for the discussion of climate change than a book would have been: "In the process, I increasingly questioned the value of writing a book, because a book has an artificial sense of definitiveness to it." He also noted that he attracts more readers with his blog than he could have done with a book; several million people visit Dot Earth at least once or twice a year, he said, calling them "a worldwide audience of engaged people" (Revkin 2012a).

Transitioning from Other Kinds of Blogging

A number of my interview subjects had been involved in blogging of one kind or another before focusing on science. Zivkovic had spent several years commenting on political blogs and writing "diaries," or individual blog posts, on campaign blogs and websites like the Daily Kos. In 2004, he started a personal blog to which he could transfer these posts. He continued to write mostly about politics on that blog until starting a "truly narrow niche science blog" in January 2005, after the presidential election. "I was wavering," he said. "I was getting bored with writing about politics. ... Am I just going to bash Bush for 4 years?" By then, he had started reading and interacting with other science bloggers (Zivkovic 2012b).

Orzel, likewise, was a long-time reader of political blogs. In addition, he started a blog devoted to books in August 2001 called *The Library of Babel* (which he eventually incorporated into *Uncertain Principles*). For about a year after starting the book blog, he debated whether to start a general blog but held back in part because he was “not sure that my half-assed political pontificating would really be any more interesting to read than anyone else's half-assed political pontificating,” as he wrote in his first post in June 2002 (Orzel 2002). But then he realized that he could write about “physics and life as a physicist,” subjects he knew better than most. “That’s something I know about that other people don't. So it seemed like a good theme for a blog” (Orzel 2012a).

Clancy, Hammonds, and Goldman also had experience blogging before writing about science, or before writing about it in a focused way. Clancy had kept anonymous blogs for years, first as an undergraduate writing about her day-to-day life, then as a graduate student “writing about grad school and knitting and my cat and things like that.” Mid-way through graduate school, after she became a union organizer, her blogging began to reflect new interests such as higher education. But she did not write about science “because I wanted to keep my identity fairly secret,” she explained. The transition to writing about science came once she got her tenure-track job “because then I could use my real name and feel safe about it” (Clancy 2012a).

Hammonds started *Supernova Condensate* as a “record of personal thoughts, ideas, things I’d read that I thought were interesting,” and “never intended it to be what it is

right now.” He said it started to “evolve” when he began reading more science blogs and “realized there are actually quite a lot of people out there who are actually quite serious about science blogging. And so I ended up following suit, I suppose” (Hammonds 2012a).

Goldman had “experimented over the years with different blogging platforms,” but did not blog consistently until he started to write about science. The inspiration came only after he had been reading science blogs for some time and realized that no one was writing specifically on his main areas of interest:

Certainly there were some psychology blogs that wrote about animals occasionally, and there were some animal or biology blogs that occasionally covered behavior, but no single blog or single source where I could find specifically things about animal behavior or animal cognition. So I saw a niche that I could fill (Goldman 2012a).

The Influence of Reading Other Blogs

The experience of reading other blogs, scientific or otherwise, was a factor that many interview subjects mentioned in explaining their start. Goldstein, for example, had long been a reader of ocean science blogs—including a previous incarnation of the group blog that she eventually joined—and, after starting graduate school, thought, “I like to write; I can do this” (Goldstein 2012a). For Carroll, inspiration came from reading a blog by an English professor, Michael Berube, whom he found “entertaining and thought-

provoking,” rather than from reading science blogs. “If a professor like him could have a blog, then why not me?”

From Doing Science to Writing About It

Both Siegel and Yong originally had planned to pursue careers in scientific research and started writing about science after those plans changed. Siegel had earned a Ph.D. in theoretical astrophysics and started working as a post-doc, researching theoretical cosmology, when he realized his chosen career path was not a good fit and left him unfulfilled. His response was “to have a crisis and take stock of things and decide, well, what are you going to do next?” Aside from an altered career trajectory (Siegel is now the science and health editor for Trap!t, where he curates content collected from around the Web for scientific accuracy), one result of his deliberations was the blog:

Starting the blog was one of the things that I thought I would try. Hey, I like this stuff; I know this stuff really well. Most people don’t know very much about the universe as a whole, so let’s start telling the story and telling people some of the amazing things I had learned. And let’s try to break it down for them in terms that they can understand (Siegel 2012a).

In 2010, Yong posted on his blog an interview he had given to Zivkovic, in which he described his start as a science writer this way:

I assumed that research was going to be my calling and I spent a year or so as a PhD student before realising that I was apocalyptically bad at it. ...

Thankfully, the insight that I sucked at doing science coincided nicely with the revelation that I wasn't too bad at talking about it (Yong 2010c).

In my interview with Yong, he said he took a training course required for graduate students on the basics of science communication and “ended up doing quite well.” The course, he added, “came at a time when I was going to figure out what I was going to do if I didn't do research” (Yong 2011).

Other Reasons

Other bloggers cited a range of idiosyncratic factors in explaining their start. Allain wanted his physics students to do more “project-based labs” and started the blog to provide examples: “I made a couple of examples for them – like, this is the kind of thing I was looking for. That's why I started, and then I couldn't stop” (Allain 2011). Kreston began blogging as part of her dissertation project on public health. She said the department was at first skeptical that blogging could count as “public health analysis,” but she successfully defended the project idea. Her research questions included “who had tweeted out the blog, what were people searching for, and what led them to the blog itself” (Kreston 2012a). Balt began blogging when, waiting for a new job to start and volunteering as a research assistant at a medical center, he found himself with free time and access to the scientific literature. “I would mess around in the literature and see what struck me as interesting, and then decided to write. ... I didn't even know who my

audience would be. I just started doing it, and I just enjoy writing” (Balt 2011). Costandi started “just out of boredom. I did it to pass the time” (Costandi 2011a).

Communication Goals

The preceding discussion focused on reasons for starting blogs but touched only briefly on communication goals; the following discussion explores this facet of motivation in more depth. Revkin, for example, strives to guide readers through complex issues—a goal that none of the other bloggers expressed. Several others have very definite opinions about issues in their fields and wish to disseminate these perspectives through blogging. Finally, a much larger number expressed motivations related to making science appealing or understandable to a general audience. These three goals are discussed in more detail below.

Serving as a Guide

Revkin, whose blog moved to the opinion side of the *New York Times* in 2010, is unique among my sample in describing himself as a guide:

I’m hoping that what I am for the average reader is a knowledgeable guide to a complex world. I’m not there to tell you what to do or how to think, but I can help you navigate consequential questions through tough science and policy issues.

He contrasted his approach with those of op-ed writers, such as Paul Krugman and George Will: “Most people have a position, articulate it, defend it. And my position, often, on an issue is, ‘Let’s find out,’ or, ‘I don’t know.’ ...I’m not there to make a comfort zone for some particular constituency.”

Spreading a Certain Perspective

While almost all of the writers in my sample incorporate opinions into their blogs to some degree, few have a certain perspective that is a clear driving force for their blogging. Just three bloggers appear to fit this description: Clancy, Balt, and Bracher. As mentioned earlier, Clancy and Balt blog partly in order to offer alternative voices, challenging conventional perspectives in their respective fields. Clancy explained her motivation as follows:

I think I have something worth saying. ... That’s a big reason that I do this; I feel like there are ways in which my perspective on feminism can make a really positive contribution to science and contribution to academia. I think I can inspire a lot of young women to be scientists, too.

Balt said, “Medications are way, way overblown in psychiatry, way overused, and I think we attribute to them effects they just don’t have a lot of the time.” He expanded:

Oftentimes I’ll write about misuse of medications, or certain meds in particular that get a lot of good positive press. I just want to say, “Hey,

wait a minute, it doesn't do that. Here's my experience with this patient, or these patients, or here's a paper that comes out and supports my view."

Lastly, in the "Mission & Editorial Compass" section of his blog, Bracher writes that because he has limited time to spend on blogging, he tends to "focus on issues and stories that have been overlooked by the more traditional media," of which he cites *C&EN* and *Chemistry World* as examples. Publications like those, he writes, have a tendency to "limit themselves to stories that portray our field in a positive light" and neglect "matters of scientific misconduct, ethical dilemmas, dirty politics, misappropriated funds, and petty bickering." In the interview, he said that blogging offers a way to attract more attention to such issues and encourage discussion of them:

These conversations happen at the department level, they happen in the hallways, they happen around labs, they happen around water coolers. But what the blog allows you to do is open these conversations, which are normally behind closed doors, out in the open. ... The whole world can participate.

Science Outreach

Science outreach is a relatively common motivation among the bloggers in my sample. In explaining their motivations, nine bloggers (Allain, Carroll, Clancy, Goldman, Goldstein, Hammonds, Orzel, Siegel, and Yurkiewicz) made some reference to increasing science literacy, showing that science is "cool" or found everywhere,

presenting a human face to science, or providing expertise to the public without a filter. Allain likened blogging to “going out to a late-night soccer game and bringing your binoculars and then showing people Jupiter. ... I find things that I think are awesome and then I like to share them with other people.” Carroll said that Cosmic Variance aims for “public science outreach,” in addition to “an ongoing goal of letting people know what it’s like to be a scientist – that scientists have different kinds of interests other than science itself. We’re human beings too.” Hammonds and Yurkiewicz expressed similar ideas about giving science a human face. In addition, Goldstein said the blog is a way to put expertise “into the service of interested members of the public right away,” citing as an example her group blog’s coverage of the 2010 Deepwater Horizon oil spill.

Several other bloggers, while not emphasizing science outreach as a motivation, expressed the desire to share their fascination with science. Yong, for example, said, “I think people have very lofty ambitions when they talk about science communication. My goal really is just to share the enthusiasm I have with other people.”

Other Motivations

Communication goals often seem secondary to the simple enjoyment that almost every participant said blogging affords. In explaining why he blogs, Balt began by saying, “It’s a nice way to pass the time. I enjoy writing. Purely selfish things.” Likewise, Kreston said she blogs for “really selfish reasons” and enjoys “being able to write about and say the things I really want, and have it be legitimized because of my blog.” Zimmer

said, “The Loom is really, most importantly, something I do for pleasure or for writing about things that I find particularly interesting or peculiar.” Carroll said, “Blogging was never work for me. Blogging has always been a break, entertainment, and recreation for me.” Most other bloggers expressed similar thoughts.

On a somewhat deeper level, several bloggers described having a basic urge to write and seemed to view blogging as an outgrowth of their identities. Allain said, “Communicating and writing is partly what makes us human, and I just happen to do my communicating and writing in a blog ... It’s just part of who I am.” Clancy said, “I blog because it feels like the right thing to do. ... I love to write, and writing just feels like – It’s like breathing and eating for me.” Finally, Revkin said:

Part of it is, I’m just fundamentally – the Yiddish term is *yenta* – someone who says, “Did you hear that?” So sharing what I’ve learned is just an implicit part of how I live, and the blog is a perfect way to encapsulate that, to make it happen.

In addition, several bloggers said they were motivated by the fact that blogging offers them the freedom to write whatever and however they wish. Blum said that “part of the pleasure” of blogging is that there is no editor whom she has to convince: “Never, in any blogging network, has anyone had to come and say to me, ‘No, no, you can’t do that.’” This freedom, Blum said, can give rise to multiple forms of expression by providing “communication latitude to explore what interests you”:

You can, on impulse, write about what interests you and what you think is important. I can be very literary, I can be very silly on occasion, I can tell murder mystery stories if I want, I can do a very serious investigation of a chemical hazard.

Similarly, Finkbeiner said, “The first thing you notice is that you can write whatever you want to write about. Whatever you think is interesting. It doesn’t have to go past some editor.” Receiving editorial feedback on how to focus and structure a piece is “absolutely necessary” in other forms of writing, Finkbeiner said, but blogging offers a “fun” break from those constraints: “I’ve been writing for a very long time, and you really get tired of that. And it is such fun to not have those constraints.”

Others expressed similar ideas about freedom. Carroll said, “One of the great things about blogging is you can tell jokes, you can be very serious, you can be as long as you want, you can be as short as you want.” Blogging is also appealing, Carroll said, because “you can link to other things that expand on what you’re trying to say. You can include pictures and videos. You can go outside your own credentialed area of expertise, be interdisciplinary.” Costandi said, “The blog gives me the freedom to write about anything I want whenever I want to.” Finally, Dobbs said “the beautiful thing about a blog” is that it allows one to self-publish; he explained, “There’s a hazard to only self-publishing. But as a supplement to a life where I’m making my living writing for publications, it’s a delight to have as an outlet. It lets you experiment with form.”

Several bloggers also mentioned motivations related to interactivity. Finkbeiner emphasized the directness of reader feedback and said she enjoys seeing whether her attempt to communicate a particular idea was successful: “I like being talked back to.” Zivkovic said there is something “isolated” about blogging, “but the other part of that loop is that I want to learn. So this is my way of putting out ideas in order to get feedback so I can learn more.” Following the publication of certain blog posts, strangers have e-mailed Yurkiewicz about their own health-related experiences; she mentioned this during the interview as one of her motivations: “On a personal level, I like corresponding with people. I love it when people e-mail me. I guess I want to make it into a conversation” (Yurkiewicz 2012). Lastly, Orzel emphasized the sheer pleasure of seeing others react to a piece of writing:

The reward that you get from it is, people read it, and people respond to something you wrote, or will link to it from other blogs, or will leave comments at your site. ... Knowing that an odd post is something that somebody in Europe read and was annoyed enough by or interested enough in to leave a comment – that’s a kick.

BLOGGING PRACTICES

I asked participants how blogging fits into their routines, how they go about selecting topics and then researching and writing posts, and what kind of activity occurs in comment threads. Most interviews also explored how activity on Twitter and other social media complements science blogging. This section summarizes their answers.

Blogging Routines

First, based on the review of blogs, I noted wide variation in the frequency and regularity with which participants published new blog posts. Yurkiewicz published less than one post per month on average during 2012; Kreston and Finkbeiner about 1 to 3 posts per month; Clancy, Blum, and Bracher about 3 to 6 posts per month; Carroll and Allain about 10 to 12 posts per month; Zimmer and Siegel about 15 to 20 posts per month; and Yong and Revkin about 25 to 30 posts per month. Balt started 2012 with a frequency of about 7 posts per month, but this dropped to, at most, 1 per month by the end of the year. Goldman also began to blog less frequently, starting 2012 with about 15 posts per month and ending the year with about 5 per month. For Costandi, Dobbs, Orzel, Hammonds, Goldstein, and Zivkovic, the month-to-month frequency varied markedly. For example, Hammonds published only 1 or 2 posts in certain months and more than 50 in other months. Usually, bloggers wrote posts to explain periods of quiescence by noting other tasks occupying their time.

The number of posts is not necessarily a good indicator of the time one devotes to blogging, as individual posts can vary a great deal in length and substance; therefore, it is also useful to consider the amount of time spent blogging. Almost all of the interviewees said that the number of hours they spend on the blog varies from week to week.

Yurkiewicz said she blogs “when the mood strikes,” and she appreciated the lack of pressure from the PLoS network. Bracher said, “First and foremost I consider the blog

more of a hobby, so I don't really stick to a schedule or stick to a rigorous routine.” Dobbs said that some weeks he might spend only an hour on the blog, whereas other weeks he might spend 10. He added, “I try to get something up there every week, but there are weeks where I'm really busy on deadline or traveling around or something.” Carroll said, “It's definitely as inspiration strikes,” adding that most weeks he spends “a couple of hours” on the blog, although sometimes an individual blog post will take several hours to write. “But then that kind of post doesn't happen every day; that happens once a week or even less. Many posts take 10 or 15 minutes.” Goldstein, whose fellow writers on Deep Sea News are also scientists, said the number of hours spent blogging “just varies wildly because all of us have demanding day jobs.”

Zimmer said the amount of time he spends blogging “really varies.” He explained that he might spend more time on it if something happens that excites him:

If there's a really big story ... where I'm just excited to be witness to it, I might write a very long post that could take me an entire day. And then there's other situations where I come across something, maybe a video. What I'll do is I'll just post it – embed the video in a post and publish it, and that's it; I won't do anything else the whole week.

Costandi said he blogs “just once a week or even less.” He explained that, as a full-time freelance science writer, he must budget his time carefully. He pointed out that his blog posts are “not short articles,” each one taking two or three hours to finish. “So

the effort is hugely disproportionate to how much money I earn from it, and I have to pay the bills. So the work that pays real money has to take priority over the blog.”

Several bloggers, however, provided answers indicating a more regular pattern. Yong said he spends about 12 to 15 hours a week on the blog, including evenings and weekends. Orzel said his “morning routine” involves eating breakfast while “reading through my feed reader, and then I’ll usually try and bang out something in the morning and post it then.” Revkin described his routine as follows:

I wake up, I turn on my computer and I go online. And check my e-mail. E-mail is always first for me still. And then I check Google news, the *New York Times* website, and make sure nothing big, bad, and consequential is happening. And then I get to the tasks at hand.

Those tasks, Revkin explained, include checking his “backlog of posts,” reading comments on previous posts, and spending “two to three hours” if there is a new post to write; he said the process of uploading a post to the *New York Times* “is pretty slow in terms of getting up images and stuff.” In the evening, after returning from his main job at Pace University, Revkin “dive[s] back into it just to double-check what’s going on to see if there’s anything I’ve missed, and sifting other blogs.”

Selection of Topics

I asked interviewees how they get ideas for blog posts as well as about the criteria they use for selecting topics. Their answers to both questions are summarized below.

Getting Ideas for Blog Posts

Bloggers draw from a broad range of sources in generating ideas for blog posts. Overwhelmingly, interviewees mentioned using RSS feeds, especially Google Reader, as one way to keep track of information sources (including other blogs). Yong, for example, said that although he has embargoed access to most of the big journals, he also has a Google Reader folder for “about 40 or so smaller journals that I look at periodically, too.” E-mail is another important source, and the primary one for Revkin, who said, “I haven’t adequately established a pattern of tracking Google Reader and the like. . . . I usually rely on e-mail.” Kreston said she subscribes through e-mail to ProMED, a reporting system for tracking disease outbreaks, and the Centers for Disease Control and Prevention (CDC) Weekly Digest Bulletin. Costandi said, “I get several e-mails every day, for example, from Eurekalert, and that will have dozens and dozens of studies, press releases about new studies.” In addition, Blum mentioned using Google Alerts to keep track of news stories about poisoning.

Twitter and other social media also play a significant role in generating ideas for blog posts. Blum mentioned a time when, discovering a shared interest in murder mystery novels with other science bloggers (including Finkbeiner) via Twitter, she and they decided to write posts about the science in such novels, coordinating to publish them on

the same day. Hammonds explained how Twitter interaction led to one of his posts: “Some random silly Twitter conversation ended up with me calculating how many marshmallows would fit into the observable universe.”

Several bloggers also mentioned personal experience and receiving questions or requests as sources of ideas. Balt said about half of his posts “come from clinical experience,” and Bracher said, “Ideas originate just based on working as a chemist and seeing things which are interesting that you’ve never heard anyone really analyze before.” Clancy said people have contacted her on Twitter to request that she write about certain topics. Allain said, “Someone e-mailed me about why mirrors reverse left and right, not up and down, and I thought that was a great question, so I made that a blog post.”

On the whole, bloggers seemed to be never at a loss for ideas. Carroll said, “I have never searched for topics to write about. There’s always far more things that I would like to write about than I have time to do it.” Both Bracher and Clancy have white boards in their offices with sections devoted to blog post ideas. “I’ll occasionally cross one off, but it’s a massive list of things,” Bracher said. Revkin said, “On the back burner I’ve always got things I’m thinking about. When things are slower I try to dive in and explore.”

Criteria for Selecting Topics About Which to Blog

I asked interviewees about their criteria for selecting topics, particularly the balance between personal intrigue and public impact. Overwhelmingly, they said their

blogging was driven by what they found “interesting,” “neat,” or “cool.” Yong said, “Personal intrigue is responsible for about 99% of my posts. I’m doing my blog in my spare time ... so there’s really little impetus for me to write about something that isn’t going to intrigue me.” Finkbeiner said she mostly writes “small essays” through which she expresses and tries to share her fascination: “Isn’t this neat? Isn’t this wonderful? Doesn’t it have a sort of resonance with our own lives in some way?” Dobbs said, “For me, it’s a place to explore, to write about things that are core interests of mine.” He also sometimes blogs about non-science topics that intrigue him: “And that range is huge – that’s sports, and a lot of music, and a lot about writing. There’s a lot about literature. And those things I write because they’re going to be fun for me to do.” Both Allain and Goldman said they blog about important unfolding stories only when they can provide a unique or interesting angle. When Kim Jong Il died, for example, Goldman used the occasion to write a post about research on the psychology of dictators.

Several bloggers said that, while the most important factor is personal intrigue, they will write about topics with an obvious public impact on occasion. Blum said, “I’ll do those public impact stories, but they have to resonate with me in some way.” She mentioned her 2010 post titled “Dishwashing in the Gulf,” which she wrote during the BP oil spill, explaining the hazards of the chemical dispersant that BP was spraying. She also blogged about the chemical dangers of mines following the 2010 mining tragedy in West Virginia and about the hazards of pepper spray after an officer used it on “Occupy Wall Street” protestors in 2011. Blum said, “There are certain issues that really resonate for me and I get indignant about, and I want to write about them. And genuinely, I hate

that the print media aren't doing these things." Similarly, Dobbs pointed to his writing about the NASA arsenic life controversy and the research misconduct of former Harvard evolutionary biologist Marc Hauser, but stressed that these posts combined personal interest and public interest: "Those were very core interests of mine, so I wrote about those for both reasons ... a very keen personal interest and lots of the things I find most interesting about science, but also, very clearly it's of public importance and interest."

In addition to choosing among various topics, science bloggers often must choose among various possible approaches. Revkin said his "reactive" posts, when he feels obligated to challenge "unsubstantiated" claims or "off-base" statements, are not the most fun to write: "Quite often that will lead me in directions I would not normally want to blog on. And I do feel that's kind of a public – in the public interest; I'll sort of gird myself and dive in." He contrasted such posts with his "gee whizz" posts, "looking at the world and saying wow, this is amazing." He added, "So there is a tension between the stuff I can't not write about, I'm just drawn to, and the stuff I feel is obligatory and part of my responsibility."

Related to this, another potentially important question to consider is the proportion of science bloggers who write about science in the "gee whizz" style versus those who choose controversial subjects. While the former predominate in this study, Orzel, who has been blogging about science longer than any other participant in this study, offered an important insight based on his own experience and observation of other bloggers over the years. He said that science bloggers sometimes "drift in the direction"

of writing in a controversial or “extreme” manner, rather than “writing about science in a fairly dispassionate, ‘Hey, this thing is cool’ kind of way,” in order to keep getting attention and responses. Orzel said, “I’m not saying that anybody’s doing it wrong. If that’s what works for somebody, that’s what happens.” He added:

But for me, when I spend too much time writing about stuff that’s controversial so as to generate lots of traffic, then I find that after a little while, I don’t like the way I sound. ...I start to drift into a kind of ranty space. And so I’ve kind of made a conscious effort to pull back from doing that as much as I can, to try to focus more on the science things.

Regarding another aspect of criteria, most interviewees said that it was not important whether they wrote about something before others did. Costandi said that it is “quite easy to predict which stories are going to have dozens of news stories and blog posts,” but he prefers “waiting and writing something afterwards, something a bit more detailed with more background and context. ...I’m not trying to scoop anyone.” Yong said, “I’ve always thought not just with blogging, but also with journalism full-stop, that it’s much more important to be better than to be first.” He added, “I write about things quite happily if others have written about it, as well. I think what matters to me is whether I can bring something new to it.” Many others expressed similar thoughts.

The Reporting and Writing Process

I asked the participants about the reporting and writing that go into creating a blog post. Most of those who blog about research findings said they consult many sources, including the original paper, earlier research, various websites, and other bloggers, while writing. Yong said, “I think it’s essentially journalistic malpractice to look at the press release and not look at the original paper. ...If you’re a journalist or science blogger trying to get at the truth of what actually happened, you have to read the original paper.” Likewise, Costandi said, “I have to have the paper itself. I won’t write about a paper unless I can read it myself.” In addition, Goldman said he reads a large amount of background material: “I do more reading than is sometimes obvious from just what the content of the post is.”

There were various responses with regard to consulting human sources. Revkin said he has “developed a pretty rich process for vetting a new paper.” As he explained:

It started maybe three years ago, where I would pull together kind of a Greek chorus of people who had been publishing in a field – e-mail them, as a group, a paper or link to something noteworthy. And I’ll ask them to comment, and I’ll try to encourage them to reply to the whole group. What that’s resulted in, periodically, are really rich posts that are like a conversation.

Yong routinely interviews researchers, either by phone or e-mail: “I prefer doing phone rather than e-mail; you get better stories. But if I just want a quick couple of lines, or if I just want to clarify a few points, I’ll shoot an e-mail off.” Yong said he uses “discretion”

in deciding whether to consult outside researchers. Costandi said he had “increasingly” been conducting interviews for the blog.

Others indicated that consulting human sources was relatively rare. Zimmer said he often does not talk to the authors “when writing in an area that I’ve been writing about for a long time.” He added, “One of the reasons that it is possible to just write a post without contacting someone, aside from having that familiarity with the subject, is that you can fact-check yourself with a huge range of websites and journal articles.” Blum said she “occasionally” calls people for blogs, but added, “Overall, I think I do far less interviewing for my blogs than I do for my magazine pieces.” She said that blogging “is more comparable to writing an op-ed than to writing a newspaper story. ... It’s your voice, your analysis, your telling of the story.”

Goldman said he rarely contacts researchers before describing their work: “Blogging about science as a scientist, not primarily as a journalist, I don’t need to interview an expert about something because ostensibly I am the expert about something. So I can draw on my own expertise.” Orzel and Siegel expressed similar thoughts. Orzel said, “They put it out there as a research article; it ought to be comprehensible as a research article without having to call the author.”

Two bloggers, Blum and Bracher, mentioned engaging in a more investigative style of reporting for certain blog posts. To write the “Dishwashing in the Gulf” post mentioned earlier, Blum said, “I did a lot of research; those blogs took me hours because

the federal government did such a sucky job of getting information out about the risks of chemical dispersants.” Bracher said he has “twice conducted FOIA requests,” one of them regarding an academic misconduct case for which he did extensive original reporting. He added, “There were plenty of people I talked with in terms of uncovering details for that story.”

There was considerable variation in the time that bloggers said they invest in individual posts, although most indicated that a typical post takes no more than several hours. Siegel, for example, said, “You’re probably looking at maybe two to three hours per post on a typical post that I write, as far as gathering images and videos, writing it, getting all of the different HTML codes correct.” For several others, blog posts take much longer to complete. For Clancy, a typical post takes about eight hours spread over a couple of days. Balt said the time from “idea to publication” is about a day. For each of her posts, Kreston said she spends several days gathering, reading, and annotating research articles “and basically coming up with an idea for how I want to do things,” and then “another two or three days” writing the post. She added, “When I’m about 90 percent done with it, I send it over to my brother and I’ll ask him about it: Is this interesting at all?”

In addition, several bloggers said they have different categories of posts that take different amounts of time and effort. As mentioned earlier, Carroll said he spends as little as 10 minutes on some posts and several hours on others. Costandi sometimes writes extensive blog posts that delve into the history of certain issues: “Some of my favorite

blog posts are actually sort of feature-length things about certain historical aspects of brain research and neuroscience. ... They can sort of be brewing for months and months, those ones.” Bracher said, “If it’s an important post ... I’ll open a Word doc and just jot down ideas and sentences and piece together the post over weeks, months, and add to it as I have time.” Dobbs said two categories of posts “tend to be pretty fast”: those that “call quick attention” to something interesting and “reaction” posts that respond to something he has read. But occasionally he uses the blog to write “more of a developed essay.” As an example, he said he had been “picking at” a photo essay for about a year: “It’s a chance for me to explore a sort of idiom, or form, that I’ve never done before. ... So that’s why it’s taken a while.”

What Happens in Comment Threads

I asked participants about the kind of activity that occurs in comment threads following the publication of a blog post, as well as their interaction with people who leave comments. I asked these questions partly to begin exploring the audience for science blogs (an issue that I will address in more depth in the section titled “How Science Bloggers View Their Audiences”), but several interviewees emphasized that people who leave comments represent a small fraction of the actual audience. Revkin, for example, said the following:

The thing I always have to remind myself is that the commentary is a very tiny portion of the overall readership. And almost every day I have to remind myself, don’t get too hung up in what people are saying in

comments, even when they're angry and being tiresome in some ways, because they're a tiny chunk of the readership.

The following discussion, therefore, should be interpreted as an analysis of people who leave comments rather than of science blog readers in general.

Activity in Comment Threads

Many interviewees said a “mix” of people leave comments. Zimmer described the various categories of comments he receives, many of which other bloggers echoed:

You get people who may link what I'm saying to something else that they've read. They might just have basic questions. ... Some people will correct me on mistakes I've made. ... And sometimes the scientists who I've written about will jump in and answer questions that people have.

Zimmer also said that people with “a very antagonistic stance” will sometimes enter comment threads: “For example, creationists will say, ‘Oh, how can you possibly believe this crazy stuff,’ and so on, and then many of the commenters will then address what that commenter is saying and point out the mistakes they're making.” Dobbs, too, said various kinds of people comment on his blog, a fact he attributes partly to being hosted on *Wired*, where “you get a demographic that you wouldn't necessarily get if you were at some place that was more strictly all science.” He explained, “That can bring you a few

wingnuts, but it also brings you some fresh stuff that you might not get otherwise. ... I don't get such heavy traffic that it's strings of idiocy, usually, which is nice."

Other blogs, particularly those not hosted by a major network or news outlet, have more stable, less heterogeneous groups of commenters. For example, Balt said his blog has "a core of maybe four or five people who tend to respond to every single one of my posts, and I know that they are patient advocates or former patients themselves." In addition, Clancy said she had a smaller and more polite group of commenters when she was blogging independently, before moving to the *Scientific American* network: "I just was in my own little nice corner of the blogosphere where only other women really ever found me, or other anthropologists. ... Back then it was my little posse." She added, "Even if I made a mistake in a blog post, someone would correct me in a way that was kind as opposed to being a jerk about it. So that's definitely something I miss."

Most of the interviewees said they attempt to engage with commenters when they are able to do so. Kreston said, "I really try to reply to most every comment I get, just out of courtesy." Yong said, "If there's something where I can add some value by either correcting something or responding to a question or engaging people in a joke, I think it's worth doing." Hammonds said, "I try to spend the time to have little comment discussions. Every now and then there are people who like to carry on a little conversation, and that's fine; that's actually quite nice."

Several bloggers said that, although they try to engage with commenters, other priorities often interfere. Carroll said, “I just don’t have time to answer a lot of questions,” but added, “I try to answer questions if they are sincere and put forward in the spirit of actually trying to learn something.” Zimmer said, “I will try to answer as many questions ... as often as I can, but if I’m juggling a bunch of deadlines, I just have to let some of them go by.”

All of the interviewees said they appreciate it when readers point out errors; they fix the mistake in a transparent manner (such as by using strikethrough) and thank the commenter publicly. Several bloggers also said that commenters not only point out mistakes but also occasionally contribute valuable content. For example, Blum said:

Often, because scientists do follow my blog, they’ll know things I don’t know. So they’ll say ... here’s an even better paper, or here’s a new story you missed. So it’s a correction of information but also additional, really good information.

Several of the bloggers in my sample have actively tried to encourage comments. Orzel said that he occasionally pursues “audience participation” by posing questions or creating physics-related polls using special software. Yong, along with other bloggers who followed suit, has an annual tradition of “asking readers to identify themselves, say something about their background, and tell me a bit about why they were reading this blog” (Yong 2012a).

The Negative Side of Comments

As alluded to in several of the above quotes, comments on science blogs often have a tendency to deteriorate into unconstructive quarrelling or irrelevant noise, particularly when the blog is hosted by a major media outlet. Allain drew a distinction between his “normal” posts, on which comments tend to be substantive and discussion-oriented, and more popular posts that draw a larger and more unruly group of commenters. For example, he said a post exploring how much ice one needs to cool beer became “super popular,” and “then it’s just your typical internet mob mentality comments, where you have curious people mixed with trolls, and it just gets out of hand.”

Many people leaving comments on blogs do so anonymously under pseudonyms or just their first names; as Costandi pointed out in the interview, “Because you can be anonymous, you can say whatever you want. It’s easy to be abusive.” Costandi told me that, unlike his former venue at ScienceBlogs.com, he is unable to control the comments on *The Guardian*’s website. “So I get more comments at *The Guardian* than I did beforehand, but there’s more noise. Most of them are nothing to do with what I’ve written.”

Generally, independently hosted science blogs appear to have more civil comments than those hosted by networks. Finkbeiner said, “We really don’t have to police the comments ... because there’s just none of that stuff that you find on the Internet – name-calling. Our readers are really not idiots; they’re really interesting

people.” In addition, Clancy found that she did not have to moderate comments on her independent blog, as her regular readers, or “posse,” were always civil and would drown out anybody who might act rudely; it was only after moving to the *Scientific American* network that she had to institute a commenting policy. She was hesitant at first to block rude comments, as letting them through seemed more “democratic,” but she had eventually had enough. As she explained in the interview, “Every time you let through a rude comment, what you’re telling everybody else is you’re not controlling the situation on your blog and you’re bringing rude people who are potentially going to attack your readers.”

Many of the other bloggers in my sample have developed personal policies for blocking rude comments or banning repeat offenders. Yong explained his own approach to comments in the interview as follows:

I feel quite strongly that comment threads have to be moderated. You have to take responsibility for what happens in them. And if you want good commentary, you need to kind of prune them. You need to encourage the ones that are making good points by responding them, and you need to discourage the ones that are trolling by either ignoring them or by blocking or deleting comments.

Several of the bloggers in my sample have attempted to foster more open and civil communication on their blogs through means other than moderating comments. When announcing her new policy, Clancy also appealed to readers to register on the network

“so that you are more likely to comment and participate in this community,” adding that the policy would give them “the support you need to come back and rebuild our posse” (Clancy 2012b). Revkin has a recurrent feature called “Your Dot,” which, as he explained in the interview, “started as a way to reward non-anonymous, constructive commenters – someone who’s commenting under his own or her own name and says something that’s particularly cogent or well-written. I would elevate that to be a standalone piece.” (Now its function is somewhat different, as Revkin suffered a stroke in 2011 and began to solicit “Your Dot” guest pieces from other writers to help keep the blog active while he recovered. Giving a platform to various voices, rather than just commenters, has remained its main function even though his health has improved.)

Revkin said that despite the negative aspects of comments, he has seen “encouraging” signs, as well:

The commentary can often be murky. There’s a lot of nonconstructive stuff there. But there’s nuggets that are really interesting, and there are people who become engaged with each other through that commentary over the years, and that’s been valuable. I’ve seen people evolve positions.

That’s encouraging.

The Role of Twitter and Other Social Media

Any analysis of science bloggers’ practices would be incomplete without examining how Twitter and other social media enter the equation. Almost all of the

bloggers in my sample are active on Twitter, Balt being the exception. While comment threads are one way for bloggers to interact with readers, social media offer another means to do so. In addition, interviewees pointed out that social media play an important role in building a readership in the first place and becoming connected to a larger online community. Lastly, social media have changed how science writers approach blogging because they have found that certain things are more suitable to share via microblogging platforms such as Twitter or Tumblr than through blogging.

Interacting with Readers

Linking to blog posts on Twitter or Google Plus is one way for writers to connect with readers. Hammonds said, “I wish I got more comments, although, these days, interestingly, quite a lot of the discussion ends up happening on Twitter.” Goldman said, “I certainly engage with readers on Twitter and Google Plus.” Zivkovic said that commenting levels are generally low across the science blogosphere due to “the fact that commenting is happening everywhere else but on the blog.” He said efforts are underway to develop technical solutions to allow comments on various social media to be “pooled” and displayed on the blog itself:

When you look at a blog post right now, it looks pretty deserted. It’s just a post, maybe a couple comments – you don’t see the hundreds and hundreds out on Google Plus. But when those things are imported or aggregated on the blog post itself, it’s going to bring back that community discussion feel that blogs used to have.

Connecting to a Community

Using Twitter and other social media is an important way for science bloggers to build a readership and establish relationships. Kreston said her blog was “struggling a little bit” until a friend urged her to join Twitter. “As soon as I started ‘friending’ people on Twitter I really sent people over to the blog,” she said. Revkin said he views the blog and other social media as “all one continuum”:

A blog only exists in the world of ideas if it’s connected to the world of ideas. So if you’re not doing outreach, if you’re not building a community, if you’re not linking to other people’s blogs and keeping track of their Twitter feeds, then you’re not actually part of the process. You’re just sort of in the digital darkness.

Interviewees acknowledged using Twitter partly for self-promotion by linking to their own blog posts, but this also serves to build a community of readers, as Finkbeiner pointed out: “Promoting is just a matter of finding people who want to read you. ... So that’s why you do Twitter and Facebook, ... to be able to talk to your community and be able to talk to your readers.”

In addition, Finkbeiner said, “There’s a real conversation going on that’s got very little to do with self-promotion.” I interviewed Finkbeiner on June 5, 2012, the day after NASA announced it had received a donation of two space telescopes from the National

Reconnaissance Office (NRO). She offered this as an example of the role Twitter plays for the online community of science writers, who were, at the time of the interview, using the microblogging service to discuss the news; one of them, Finkbeiner told me, announced via Twitter that he was going to file a FOIA request for a relevant document. She said the episode illustrated how Twitter allows one to see science news unfolding in real-time: “It’s nationally important stuff, and you’re almost watching it happen while the people that are finding out about it are finding out. ... That would not have happened without something like Twitter.”

In addition, Hammonds said that Twitter creates a “level playing field” in allowing people of different professional statures to converse without self-consciousness:

Someone will post a response to something you say, or you’ll post a response to something someone else says, and you’ll just exchange a few words. ... And later on you’ll realize that the person you were talking to was the head of an astronomy department somewhere, ... someone who normally you may be a bit intimidated just to casually talk to.

Replacing or Complementing Science Blogging

Several interviewees pointed out that microblogging services have become a substitute for science blogs when bloggers simply wish to draw attention to something or make a brief observation. Carroll said, “There’s a certain fraction of things I would have put on the blog that now I just put as a link in a Twitter update.” Goldstein said, “A lot of

things that used to be posts – posting a fun video or a link to something else – now are Tweets. So it means that those kinds of very easy posts don't really exist anymore.”

Similarly, Zivkovic said, “There’s plenty of outlets besides the blog where I can go with stuff ... a couple links here, an announcement there, a picture there ... I don’t have to put that on the blog like we all used to.” He said this fact has led some science bloggers to quit, as they are happy to share only those shorter types of messages. “You keep the blog for longer, more serious, more important pieces, more thought-out pieces, more kind of deliberate writing. Which is why some bloggers completely quit, because they’ve never done that kind of writing anyway.” One consequence, Zivkovic said, has been to give science blogs a more “serious” appearance: “So when you look at my blog, you only see ... something that has some substance in it. So the whole blog looks more serious; the whole blog looks more respectable because the fluff is gone from it.”

Zivkovic also said that social media allow science bloggers to engage in “mindcasting,” a phrase coined by the media critic and New York University professor Jay Rosen; this is a process of gathering ideas and sources through social media in preparation for a blog post. According to Zivkovic, the process starts with “pursuing a particular topic a lot on Twitter for a day or two. So you’re finding all sorts of sources and linkages ... getting feedback from others ... getting into debates with others.” Next, “you start compiling bits and pieces of that in some second space,” such as Google Plus or Tumblr, writing “a paragraph here, a paragraph there, collecting the links in one place,

kind of building stuff until it's all clear in your head. ... Then you sit down and write a blog post on it.”

HOW SCIENCE BLOGGERS VIEW THEIR AUDIENCE

Most of the interviewees said they write with a wide audience in mind. Zimmer said, “I’m just trying to think of as wide of an audience as I can, and that’s just how I deal with all the stuff I write about.” Carroll said, “Anyone who’s interested is an appropriate target for the blog audience, and everyone should be interested, we strongly feel.” Goldstein said, “I want anyone to be able to understand it without any background. So if I’m using specialized terminology, I define it or provide links to someplace else that defines it.”

Several others said they write with more specialized audiences, or themselves, in mind. Bracher said he thinks the “vast majority” of his readers are chemists in academia and people who have advanced degrees in chemistry. “The posts are written for chemists. That’s my audience in terms of this blog in particular, and that’s not going to change,” he said. Allain, whose posts usually include physics calculations, said, “I’m writing for myself. It’s kind of a journal, and I’m just letting people look at what I’m talking about. I’m not trying to write for a particular audience.”

Several bloggers remarked on the difficulty of knowing who their audiences actually are. Zivkovic said, “This is a tough thing in the blogosphere because such a

small proportion of readers leave comments, and even when they do, you don't know really who they are." He added, "I think the discussions on Google Plus and Facebook and Twitter are actually more revealing about the audience," given that Facebook and Twitter users provide information about themselves on their profiles.

Using several means, some bloggers have tried to determine who makes up their audience. Yong, as mentioned earlier, asks readers to share information about themselves once a year:

They really are all sorts of people. A lot of them are scientists, sure. ...
But a lot of them are just random ordinary people who have no particular contact or reason to be in contact with science. ... I think the youngest one who ever responded to that thread was 18 and the oldest was 83.

Blum used analytics to examine the characteristics of her Twitter followers; she found that most were from New York and California and that "book-related things" were the primary interest of most, followed by science. Goldstein said one her fellow writers on Deep Sea News had analyzed the blog traffic statistics and found that the audience comprised "high school and college students looking for information to write a report, and then of course people reading about science on the Internet, which is very different than the general audience you might reach through broadcast." Goldstein concluded, therefore, that the "core audience" was "entirely different" from her target audience of general readers.

Goldman and Orzel, too, said science blogs tend to attract readers who are already looking for science information, as opposed to “push” venues with a more general audience. Goldman said, “Most of the people who are reading science blogs and following scientists and science writers on Twitter are part of the ‘pull’ audience. ... They’re sort of the bread and butter.” He added, “But I always have in mind how to get those other people who aren’t already on the Internet looking for science.”

Orzel expressed more ambivalence about the audiences science blogs have managed to attract. As he explained it:

I go back and forth. It hasn’t quite taken off to be as broad an audience as I would like in some respects. ... It reaches mostly people who are already interested in science and knew to look at science blogs. ... In that respect, it hasn’t quite panned out as a medium.

WHAT MAKES A GOOD BLOG POST?

I asked participants how they define a “good” blog post, or what characteristics their favorite posts have in common, in order to explore the writing attributes they care about and strive for. Both Allain and Costandi distinguished “good” posts from “popular” ones, saying the posts they feel best about are not necessarily the ones that get the most traffic or comments.

Unsurprisingly, a frequent theme in their responses was that posts should be well written. In addition, many interviewees said posts should contain an original insight, approach an issue in a unique way, or go beyond simply telling the facts about a new research finding. Balt said a good blog post is one that “makes a statement that is not reflected anywhere else in the world.” Zimmer said, “A good blog post is something that is well written, where there’s a strong voice, and where you’re reading something you would not come across in a hundred newspaper articles.” Yong said, “The ones that I particularly like are the ones with a good storytelling element – so something beyond just, ‘Here is what one paper found.’” Blum said the posts that “resonate” most with her are “ones where you just go, ‘That is so incredibly written. That’s phenomenal research. That changed the way I thought about something. I didn’t know that. I hadn’t considered that.’” Finkbeiner said a good blog post communicates “something that nobody else has thought of before, and that can be a way of looking at something that nobody else has looked at that way before.” Finally, Goldstein said, “I think the strongest ones take a fresh take on an issue of importance, and bring something new to it.”

While the above attributes would be valued in any medium, several of the responses emphasized certain aspects of blogging that distinguish it as a communication platform. Kreston said some of her best posts “are really popular because they have really good media embedded in them.” Orzel and Finkbeiner emphasized the more informal and conversational tone of blogs; asked what makes a good blog post, Orzel said “some of them are just silly jokes that came off particularly well.”

Finkbeiner said that a good blog post should have a different tone than a piece of writing one would find elsewhere:

It's got to go beyond clear and accessible, which is usually all you'd ever want. It's got to go beyond that to personal – and I don't mean revealing of my own life. ... I just mean it's got to sound like I'm talking to you without being condescending ... or chatty or anything. But it's got to sound like you are being addressed individually, personally.

THE ROLE OF BLOG NETWORKS

For those whose blogs are hosted on networks, I was curious how their approaches might have changed after transitioning from blogging independently. Below, I provide some general information about networks and then discuss how they might influence the practices of science bloggers.

General Characteristics of Networks

Science blog networks range widely in size, from four blogs for *National Geographic's* Phenomena network to 60 blogs for the *Scientific American* network. Most science blog networks pay their writers a small amount. Dobbs said the *Wired Science* network paid him a flat “nominal” fee each month, not connected to how much he wrote. Likewise, on the *Scientific American* network, Zivkovic said, “you're paid a particular sum of money every month to write whatever you want how many times you want, and

we redo the contracts ever year.” Siegel said that ScienceBlogs.com pays its writers a small amount “based on the amount of traffic that they bring into the site.” Blum said the PLoS network was not paying its writers, but she added, “That’s a discussion we’ve had with them recently and that may change.”

The *Scientific American* network, in addition to being larger than other networks, may be more diverse. When recruiting bloggers for the network, Zivkovic said he “had a number of criteria, but the operative word was diversity.” In addition to a diversity of expertise, writing styles, and writing levels, Zivkovic said he sought a large age range and gender balance: “I wanted diversity of people in the sense that a lot of the other networks are full of 40-year-old white men living in New York. I did not want that.”

Even after joining a network, science bloggers are free from editorial constraints. As Blum pointed out, “Blogging is a form of self-publishing even when you’re blogging for a network. Networks kind of gate-keep in a way. ... The network gives you a little credibility, it promotes your work, but you’re essentially self-published.” Zivkovic said he sees “99 percent” of the blog posts on his network after they are published. He said this was a factor in selecting bloggers to join the network: “That’s why the nine months were so important, to pick the right kind of people who can be trusted, who write well, who have a good head on their shoulders, have good judgment.” Likewise, Dobbs said the *Wired Science* network imposed “absolutely zero editorial filtering or oversight or anything else. They just don’t want the blog to go dead.” About the PLoS network, Yurkiewicz said, “I actually like the freedom of not getting paid, and having the freedom

to write whatever, and not being edited whatsoever. They say they can edit the titles, but they never have.”

Although Revkin blogs for the *New York Times* rather than for a network, it is noteworthy that he, too, is generally free from editorial constraints. He told me that his year-by-year contract is “without any stipulations,” and he receives little input from editors aside from occasional comments related to *New York Times* standards. For example, he was once told not to embed directly in the blog a YouTube video showing dead bodies in Sudan. “That sort of thing happens once in a while, but not with any frequency and not to the point that I’d call it overarching direction.”

The Potential Impact of Networks

First, several bloggers indicated that being hosted on a network had little or no effect on their approach. Dobbs said he felt “a sort of self-consciousness of being in a different room, as it were, blogging in a network” compared to blogging independently, but he said it was a subtle feeling that did not affect his approach in any meaningful way. Siegel said that he has become more skilled since he started blogging, but he did not attribute that to joining a network:

I’ve got my own voice that I’m more comfortable with. I have a style of combining text and images that I didn’t have. I’m much better at tracking down the correct attributions for photos when I use those. ... But I don’t

think that switching to a large network was as much of a catalyst for that as just continued experience.

However, the manner in which a network pays its writers may have an effect on their approach. Goldman said that, because ScienceBlogs.com pays its bloggers on the basis of traffic, “it created a situation where, I think, many of us learned how to game the system,” increasing page views by posting more frequent, lower-quality posts. “I sort of played that game for a while and then realized that was a silly game to be playing.”

In addition, Zivkovic said he saw changes in how the writers he recruited perceived and approached blogging after joining the *Scientific American* network, becoming more self-conscious. He said that “being a blogger at *Scientific American* means much bigger visibility than having an independent, individual blog” and that it is “a stamp of approval.” This led to certain changes, as he explained:

Writing under the banner of *Scientific American* is a big deal for a lot of them, to the point where I had to spend six months getting some of them to be less intimidated by the fact they’re writing for *Scientific American* so they’d go back to their old freewheeling style. They’re trying to polish too much because it’s a big deal.

The rise of science blog networks has led some to ponder whether science blogging is becoming a more professional activity. Blum said, “Partly because we have had the formation of these networks, you’ve seen a real professionalization of science

blogs. They're well researched; science bloggers watch each other." For example, Blum said that Yong sent her a Twitter message to tell her that one of her links did not work. Zivkovic said he has seen "an increased level of self-awareness that they'll be judged on accuracy. ... We used to write much faster out of our heads. I think people are making much more effort to corroborate their statements with links and papers."

Another potentially important factor is the size of networks. Orzel, who was among the first bloggers to join ScienceBlogs.com when it launched, said he preferred the network when it was smaller: "For a while there, I was reading a bunch of blogs by people who research the biology of fruit flies or whatever ... something very different from what I do, and there was more cross talk between blogs." As the network grew, Orzel said he was unable to keep those other blogs in his regular reading. After the "Pepsigate" controversy, Orzel chose to stay at the network in part because it seemed illogical to leave over the content of another blog on a network so diffuse: "It didn't feel much like a network to me anymore. It felt like sort of a collection of blogs that happen to be sharing a host."

BLOGGING VS. OTHER PLATFORMS

Many of the participants in this study have experience communicating science on a variety of platforms, and I asked about the differences between those activities and blogging. In particular, I asked them how they decide which platform is most appropriate for a given topic and the differences between writing for each platform.

Choosing the Blog vs. Another Platform

The professional science writers in my sample cited various factors that might lead them to judge a particular idea to be more appropriate for the blog than for a magazine or other outlet, or vice versa. Zimmer, for example, said that if there is “something visually striking that goes along with” a research finding, such as a “beautiful reconstruction” of a newly discovered fossil, that might lead him to blog about it “because everything online is extremely dominated by graphics.” Blum told me she had just finished writing a 3,000-word piece on the history of poisonous foods for *Lapham’s Quarterly*, a piece she “didn’t even consider” doing for the blog because of its length and complexity, as well as the money she knew she could make by pitching it: “If I look at it and say, ‘Boy, I can really sell this and I should pitch it,’ then I’ll do that.” Dobbs said that he can “cover more subjects” and “visit something more briefly” on the blog than when he is writing for a publication, and there are certain things that he knows “right away” he will not try to pitch to an editor “for any number of reasons, but it’s plenty interesting enough to blog about.” He expanded as follows:

The beautiful thing about a blog is it sort of has a self-perpetuating audience after a while, and it lets me write as much or as little about anything I want without having to go through all the processes that one has to do to write for a market.

Zimmer said he often blogs “about something that is very interesting but also something that might be difficult to persuade an editor to give me a contract to write about.” Only after the post is published, Zimmer said, do editors see how interesting it could be to their audiences: “So then I’ll do it on the blog, and of course the editors, then they say, ‘Hey, that’s a great article; you should write something like that for us.’”

As an example, Zimmer told me about the time he came across research on wasps “performing brain surgery on cockroaches to parasitize them.” While the topic was “incredibly cool,” Zimmer said, “it wouldn’t be something that I would be able to really successfully pitch to an editor. There wasn’t any particularly bigger picture story there.” In addition, the newest research on the topic was a year old. Therefore, he decided to blog about it. Then people saw how interesting the topic was:

It was a hugely successful post – hundreds of thousands of hits. People who did the research were subsequently contacted by TV people and radio people and so on, because once people saw the story and saw some of these disturbing pictures of what wasps do and so on, then they could see, oh, this is an amazing story, just on its own terms. But if it hadn’t been for the blog I don’t know that I would have actually written about it.

Writing for the Blog vs. Another Platform

As mentioned earlier in this chapter, Blum said she does less interviewing for blog posts, which she sees more as op-ed pieces. Similarly, Finkbeiner said, “For print

I'll make a lot more phone calls." Finkbeiner went on to say that writing for the blog is more "fun" than writing for print:

I have to sound more authoritative when I'm writing for print than when I'm writing for the blog, which doesn't come naturally to me. It's not fun for me to do that. I can't be funny in writing for print, and I can be funny when writing for the blog.

Finkbeiner said that, were she to blog about the NRO's donation of telescopes to NASA, "that blog post would be like I was having a conversation with a bunch of science writers," as she would begin by telling about a similar story she had once worked on. "That's truly how I think of the blog, as part of a conversation instead of a set story," she said.

Revkin, too, said that science blogging offers a kind of conversation that other venues do not. He contrasted his blog with the *New York Times* "Room for Debate" page, "where they'll consult four or five experts on an issue and ask them a question. But it's very static; it's a snap shot, not a conversation."

Blum said an important difference in writing about science on a blog is the ability to use hyperlinks to be more transparent. She made the point as follows:

Blogging about science is really ideal in communicating science in a way that print isn't, because you can write about science in a very transparent way. You can make all your sources immediately visible to your readers.

You can story-tell without having to do incredibly in-depth explanations because you can hot-link to the longer explanations.

In this way, Blum said, readers can “judge the merits of what you’re saying in a very clear, very instant way that you couldn’t do in print.” She also observed, however, that the quality of this form of communication depends on whether readers actually click on the links: “The blogger makes the assumption that you’re going to be interested enough to go to those links. But if you’re not following up on those things, then you actually probably end up being better informed on a print piece.”

The blog platform has no length limits and allows updates and corrections, and Carroll said that it is easier to be accurate given such freedom and flexibility:

I’ve written for newspapers and magazines before, and it’s really, really difficult to be honest and accurate at the same time because of the incredible constraints you’re put under. So I have this luxury – not only can I write 3,000 words, but then I can correct it and update it, and the next day I can add another 3,000 words if I want to do that. I can link to all the things I don’t want to explain.

In addition, Blum, Finkbeiner, and Dobbs emphasized the more immediate interaction with readers on blogs compared with print outlets. Blum explained how, if a reader points out an error in a newspaper article, “there would be a discussion with the editor, and if it was determined there was no error, that would be the end of it, no

correction.” Blogs, in contrast, allow an “open conversation” in which “comments correct, but they also annotate,” Blum said. She expanded as follows:

They say, ‘I think you’ve got that wrong,’ and I say, ‘Yeah, I see your point, but here’s why I did it this way.’ ... And it’s part of the record. The total transparency and the interaction of it, to me – there’s nothing wrong with a newspaper correction, but this is more interesting and more interactive.

Finkbeiner emphasized the directness and intimacy of exchanges between writers and readers on her blog. Explaining to me why blogging is “so seductive,” Finkbeiner said it involves “writing directly to your readers.” She expanded as follows: “You do a print piece, it gets put up on the Internet, it gets comments – it’s still not as direct. You’re not writing directly to the readers.” She drew a contrast between an editor assessing her work and readers assessing it directly:

So I can, in a way, test whether I think those editors are right, you know? Is this interesting or not to the readers? Does this need to be focused differently? Does it need to be written differently? It’s like being able to get direct data instead of having to go through a filter.

Finally, Dobbs pointed out that when he writes for the *New York Times Magazine*, among the “hundreds of thousands” of readers, he will “hear from a handful through the official channels of the *Times* magazine.” On the blog meanwhile, he will hear from that

many readers even for a “minor” post. “It’s an awareness of audience and a quickness of response that adds immediacy to the whole thing.”

DISCUSSION

The interview results revealed great diversity in science bloggers’ motivations, practices, and thoughts about this communication platform, although I identified several themes. Below, I summarize the main findings. After that, I present supplemental information about certain developments that have occurred since I conducted the interviews.

Personal enjoyment was the main motivation for blogging about science. Most of the interviewees, including scientists and graduate students, had either written about science for non-blog outlets or blogged about non-science subjects before starting their science blogs. Writing is a core interest for most of them, and science blogging is a natural way to indulge that interest while serving other simultaneous goals, such as science outreach. In addition, science blogging can serve as a bridge to a career in science journalism, as it did for Yong, or to other modes of science communication. Orzel and Allain, for example, have both written popular science books that grew out of content on their blogs. The professional science writers in my sample said they especially enjoy the freedom and immediacy of interaction that blogging offers compared to other venues.

Science blogging is not, as yet, a full-time occupation (although the relatively new *National Geographic* science blog network, Phenomena, pays its bloggers well, as will be discussed in the supplemental information below). Each blogger has a main job apart from blogging, and this fact partly accounts for the great variability in blogging frequency and routines. Most bloggers write new posts when inspiration strikes and schedule allows, although several, such as Yong and Revkin, exhibit a more regular pattern.

Science bloggers use multiple means, including RSS feeds, Twitter, e-mail, Google Alerts, and simply browsing the Internet, to stay on top of information and generate ideas. In selecting topics, science bloggers overwhelmingly choose topics that intrigue them and pique their curiosity. Indignation is another important, though less common, stimulus, leading Blum to blog about ignored chemical hazards and Bracher to blog about (and do extensive original reporting on) academic misconduct. Revkin often feels compelled to write posts that are “in the public interest,” such as pushing back against “off-base” statements, but these are not his favorite posts.

Most bloggers consult and link to numerous sources when discussing research, although most do not typically conduct interviews. Doing interviews for blog posts is normal practice for Revkin and Yong, but most others tend to draw on their own expertise or fact-check themselves through materials available online. In addition, several emphasized that blogging is analogous to writing an opinion column, with the focus being the blogger’s own voice and analysis. Most said they write in a more

conversational and humorous fashion on the blog than they would in other venues, and many said they strive to approach topics in unique ways and go beyond simply telling facts. This leads to a wide variety of styles, each imprinted with a particular voice and personality. The inverted pyramid is seldom found on science blogs.

Many interviewees said they view blog posts as part of a conversation, and most are happy to carry on conversations in comment threads or on social media such as Twitter, which all but one use heavily. Independent bloggers tend to receive comments from smaller, less heterogeneous, and less unruly groups compared with those who blog for major media organizations with heavy traffic.

Since beginning to proliferate in 2010, science blog networks have played an important role in how science bloggers and others view this activity. Blum and Zivkovic both said they believe networks, despite exercising no editorial control, have a role in making science bloggers more careful and professional. Below, I explore the topic of networks in more depth based on more recent information.

Recent Developments in Science Blogs

There are two areas that warrant further remarks. First, in the time since I conducted the interviews, Dobbs decided to move his blog from the *Wired Science* network back to a self-hosted website, and Carroll decided to leave the *Discover* network and his fellow writers at Cosmic Variance to resume writing on the independent blog he

first created in 2004. Their reasons for doing so are illustrative of the tensions that can arise between desiring complete freedom and blogging at a high-profile venue and/or as part of a group. Secondly, a panel discussion at the 2013 World Conference of Science Journalists, held in June in Helsinki, Finland, yielded important insights about the role of science blog networks and the overall trajectory of the science blogosphere. Yong and Zivkovic were on the four-person panel, along with Betsy Mason, the editor of *Wired Science*, and Alok Jha, a science and environment correspondent at *The Guardian*.

Returning to Independent Blogging

In June 2013, Dobbs wrote a blog post to explain his decision to move Neuron Culture back to a self-hosted website. The main factor was related to his work on a book:

I know some people manage it, but I've found it hard to reconcile the demands of blogging at a venue like *Wired* and of writing a serious book that requires deep immersion: a matter of not just the time each venture requires, but of what you might call the focal length of one's mental lens.
(Dobbs 2013a)

He added that, in his view, blogging at such a venue requires “either an unrelenting focus on a particular beat or fairly steady and regular surveys of many fields.” He also wrote that blogging independently gives him more freedom to experiment: “I hope to see what sort of more Tumblr-like approach I can take at Neuron Culture now that it's in a self-hosted venue.” Lastly, he wrote that “the economics of blogging” have changed with the

expansion in the number of outlets where he can place “one-off” pieces; now there is a “breadth of opportunity to place pieces in other places that also have high profile, but which don’t require the singular devotion” of being hosted on a network (Dobbs 2013a).

In a post announcing his “transition” from the group blog Cosmic Variance and the *Discover* network, Carroll wrote that he feels “happiest” when he feels “the least amount of responsibility, and the greatest freedom to be personal and idiosyncratic.” He expanded as follows:

Even though I’ve always had perfect freedom here, there was inevitably the (correct) feeling that our efforts represented a group, not just my personal quirks. If a month goes by and I don’t feel like blogging, I don’t want to feel that I’m letting anyone down other than myself. (Carroll 2012b)

Also, in the “About” section of his independent blog (<http://www.preposterousuniverse.com/blog/about-this-blog/>), he wrote that he “came to miss the romantic, carefree frontier days of blogging, when it was just me plugging away at my own little site, declaiming fearless truths into an unheeding void.”

When science bloggers move their blogs, it is typically in order to join a network or to switch from one network to another. The above cases, however, show how a return to independent blogging may be an attractive option, at least for already established writers.

Insights from the 2013 World Conference of Science Journalists

Both Yong and Zimmer moved their blogs from the *Discover* network to *National Geographic's* Phenomena network (where they were joined by two other writers) when it launched in December 2012. During the panel discussion mentioned earlier, Yong explained what blogging for Phenomena is like:

National Geographic ... have given us prime space on their homepage of their website, they promote us to their readers, they give us access to their incredible image library, they feed us with stories, they pay us pretty well, and they let us write whatever we like, without any editorial control.

That's just incredible to me. (WCSJ 2013)

Yong said the situation was completely different five years ago, when “this stuff was quite niche and bit of a hobby, and it was a route *in* to science writing. And now it's just the dream gig.”

Yong also said he saw the network as a symbol of how perceptions of science blogging have improved. He recounted the experience, several years earlier, of asking a press officer for certain information and receiving the reply, “I think you've got all you need for a blog.” Much more recently, the *Knight Science Journalism Tracker* described one of his pieces as “too savvy to have run anywhere but on a blog.” He said it was “amazing” that such a compliment could have been given so few years after he had

encountered attitudes like that of the press officer. “I think that’s kind of reflective of the increase in credibility of the medium as a whole” (WCSJ 2013).

During the same panel discussion, Yong said that Phenomena is unique in how well it compensates its bloggers: “For Phenomena, we get paid well, and probably commensurate with the amount of time we’re putting into it. It’s still not like a full-time wage or anything, but it’s good” (WCSJ 2013). He added that he hopes that “having that top end even exist will help to kind of uplift what everyone else is rewarding their bloggers with.”

At *National Geographic*, Yong said, the bloggers and the regular reporters have access to each other’s spreadsheets for upcoming stories. In addition, Yong said the bloggers sometimes receive e-mails from the news team, asking whether they plan to blog about a particular story or if they would like to write a news piece for the regular website. “There’s a lot of integration – a surprising degree of integration with the normal news team,” Yong said (WCSJ 2013).

Although the bloggers and regular reporters coordinate to some degree, Yong said they sometimes end up writing about the same stories because the bloggers “cover things in a completely different way” (WCSJ 2013). Similarly, Zivkovic, speaking on the same panel, said the following about the *Scientific American* network:

We often notify our bloggers if there is a big news story coming up and actually ask them if they want to cover it, each from a different angle. ...

We can then package all of our coverage of that story in an in-depth report with a single URL, which is quite popular. (WCSJ 2013)

The above insights suggest that science blogging, despite retaining its individualistic qualities, has become a mainstream and respectable form of science communication. Yong pointed out certain challenges, however, saying that bloggers attached to major brands such as *National Geographic* “occupy a hugely privileged position ... without any of the control that the people who traditionally work for those organizations would experience. And that means we have to ensure our own accountability.” In addition, he pointed out that many science blogs “arose as a reaction to poor science reporting in the mainstream press,” and this function will be tested once science bloggers become mainstream themselves:

Now that blogs are part of the mainstream and becoming increasingly ingrained in that way, I think one of our main concerns should be trying to avoid making the very same mistakes that we originally arose to fight against. With great power comes great responsibility. (WCSJ 2013)

Chapter V: Roles of the Science Blogosphere: Categories and Cases

In this chapter, I list six ways in which the science blogosphere appears to have had an impact on how science communication occurs. I also describe cases, drawn from the review of blogs and/or interviews, to illustrate each of these categories.

1. REVEALING SCIENTIFIC UNCERTAINTY OR DISAGREEMENT

This category highlights cases where blogs served as venues for debating science or calling attention to areas of uncertainty and disagreement. Disagreement between those involved in science or reporting science is an important part of the conversation that occurs on blogs and social media. Zimmer (2011b) said watching such disagreement play out gives one “a better sense of how science works,” given that science is not about “revealing fixed truths; rather it’s this constant questioning and testing of hypotheses.”

The concept of science-in-the-making is relevant to those cases where the disagreement concerns new research; in such cases, science blogs provide a window into the type of questioning and challenging by fellow scientists that usually occur through official channels, in spaces hidden from the public. In addition, many argue that “post-publication peer review” through blogs has potential benefits for science practitioners. Revkin (2012b) made the point in a blog post as follows:

While the blogosphere comes with lots of noise, it also is providing a second level of review — after the initial round of closed peer review

during the publication process — that in the end is making tough, emerging fields of science better than they would otherwise be.

Expanding on this point in the interview, Revkin said that this added level of review “leads away from some of the pressures that have damaged science – the pressure to have the big impact paper in the big journal, which then ends up often unwinding, not proving out.” He added, “I think the chances of that happening are going to be lower as this broader kind of commentary spreads.”

Zimmer said, “I think that blogging is having a big effect on how scientists discuss science.” Pointing out that publishing a formal response to a paper could take months, Zimmer said many scientists are motivated to respond more quickly “because so much of science now ends up in the news one way or another, online, and if you wait a year to try to affect the public perception of it ... it’s long gone.” Online, he said, “as soon as a paper comes out, someone can read it and just say, ‘I don’t like it, and here’s why.’” He said this is what happened with the arsenic life case described in the second chapter.

As some of the below cases will demonstrate, the people debating science through blogs are not necessarily bloggers themselves; anyone can join the conversation through comment threads or social media. Zimmer said, “Comment threads are an opportunity for more of the truth to come out.” In addition Carroll said, “Scientists who are not great writers can nevertheless chime in now and again with an expert opinion.”

Cases that highlight disagreement/uncertainty:

- Revkin (2012b) described how the print publication of an online-first study about warming in Australia was “‘put on hold’ by the Journal of Climate after questions were raised publicly about one of the researchers’ methods, starting with a comment on Steve McIntyre’s Climate Audit blog.” As quoted by Revkin (2012b), Ivan Oransky, who runs the Retraction Watch blog, wrote the following in an e-mail:

I see this as a good example of how post-publication peer review can work. In general, blogs and other web critiques are already adding a great deal to the scientific process. Some researchers and journals welcome that, as seems to be true in this case. Others stubbornly refuse to engage with criticism from anywhere other than “official channels.”

- The “herky-jerky” process of science and “the sense of whiplash” that it can cause readers of science news is a frequent theme of Revkin’s (2011a, 2012b, 2012c). For this reason, when disagreement or contradictory findings over a particular issue arise, Revkin often highlights the fact on his blog and reaches out to all of the involved scientists for comment. At such times, the blog serves to shine a spotlight on instances of uncertainty or disagreement that might otherwise play out through official channels alone (or, given the contentiousness of climate science, become mired in ideological debate). In one example (2012c), Revkin reached out to Robert Howarth, a Cornell researcher who had published the finding that shale gas has a larger climate footprint than coal, when other researchers published a study showing

the opposite. Howarth was preparing to publish a formal reply, but Revkin wrote that “the journal editors gave him clearance to offer” a short reaction for the blog. The lead author of the new paper later wrote to Revkin, claiming parts of the statement Howarth had given Revkin were incorrect. Revkin published this communication as an update to the original post.

- Yong (2012b) reacted to a “scathing personal attack” by Yale psychologist John Bargh, which followed the publication of a study that failed to replicate a famous experiment that Bargh published in 1996 and a post by Yong describing the failed replication. Bargh, writing on his own blog, had criticized the study’s methods as well as the study authors, PLoS ONE (the journal that published the study), and Yong himself, dismissing his work as “superficial online science journalism.” Yong addressed Bargh’s scientific criticisms partly by highlighting a point raised by another psychologist in the comments section of Bargh’s post. He also shared reactions from the replication study authors and started a broader discussion: “There is a wider issue here. A lack of replication is a large problem in psychology (and arguably in science, full stop).” Yong concluded the post as follows:

If there’s an element to this farrago that heartens me, it’s that the comments in Bargh’s piece allowed various parties to set the record straight. In concluding his piece, Bargh says, “I’m worried about your ability to trust supposedly reputable online media sources for accurate information on psychological science.” Well, dear professor, this is the era of post-publication peer review. I’m not that worried.

- The previous example and the interaction it inspired led Yong to pursue the topic of replications further and write a feature article for *Nature* about problems in the field of psychology. In a subsequent blog post, Yong (2012c) explained how using his blog to rebut Bargh's criticism was central in alerting him to those problems:

The ensuing discussion opened my eyes to an undercurrent of unrest. Many psychologists came out of the woodwork to mention experiments that were hard to replicate, common practices that they deemed to be dodgy, and a growing willingness to turn a critical eye upon their own field. For every comment that appeared on the blog and Twitter, I've got another that was sent confidentially to me via email. This was clearly something worth writing about.

- Costandi (2011b) described a study showing that people provide smaller estimates of various quantities, such as the height of the Eiffel Tower, when leaning to the left. Then, in the comments section, the psychologist Andrew D. Wilson offered "a few thoughts on some problems with this work," claiming the phenomenon is "not really embodied cognition," as had been claimed, and noting the authors' failure to factor out a potential confounding variable. In response, Rolf Zwaan, one of the co-authors of the paper, entered the comment thread and disputed Wilson's points. These two scientists then exchanged many long and detailed comments; Wilson wrote a total of eight comments, while Zwaan wrote 10. Although his responses to Wilson's specific criticisms were substantive, Zwaan eventually seemed to lose patience: "Criticizing is part of science. I have no problems with it, as long as it is done in respectful manner and ideally in scientific papers. You seem to confuse scientific criticism with

trolling.” Wilson replied, in part, “My critique is that you have not presented certain critical data to support your argument. . . . This is, to me, the essence of scientific criticism, and if I had reviewed your paper, I would have made exactly the same comments.” He also wrote, “I don't see any problem airing these concerns in front of a wider audience, especially given the wide coverage of your paper to that wider audience.”

- After Zimmer published a piece in the *New York Times* about a paper on “multicellularity” in yeast, some scientists expressed skepticism on Twitter. Zimmer collected those tweets using “Storify,” a social network service with which users can create timelines or “stories” of Twitter exchanges, and sent them to the lead author of the paper. Then, on his blog (Zimmer 2012b), he published the tweets along with the author’s response; the author actively engaged in the comment thread, as well.
- After writing a blog post critical of Naomi Wolf’s use of science in her book *Vagina: A New Biography*, Dobbs (2012a) responded to a rebuttal published in *The Huffington Post* written by Jim Pfaus, a psychologist whose work Wolf had drawn on. Dobbs pasted Pfaus’s entire rebuttal on his blog and annotated it with his counterarguments. For example, in response to Pfaus’s suggestion that “a simple Pub Med search” with certain key words would reveal “plenty of peer-reviewed literature” to support one of Wolf’s central claims, Dobbs performed the search and quoted several studies to support his view that they “present an ambiguous and tentative set of findings.” Pfaus responded in the comments section of this post, disputing Dobbs’ characterization of the literature: “Not to be TOO self-aggrandizing, but try mine from 2009 in the

Journal of Sexual Medicine called ‘Pathways of sexual desire’. I think you will see that the science is neither embryonic or ambiguous.”

- Carroll (2012c) wrote about a debate that had surfaced around a comment made by physicist Brian Cox during a lecture, in which “the proffered mind-bending consequences of quantum mechanics aren’t actually correct.” He summarized other scientists’ “intemperately worded” criticisms of Cox that had been made on blogs and Twitter, before devoting the rest of the post to explaining the relevant concepts. Carroll later played a similar role (2012d) by working to untangle the arguments between cosmologist Lawrence Krauss and David Albert, a modern philosopher of science who had written a critical review in the *New York Times* of Krauss’s book *A Universe From Nothing: Why There Is Something Rather Than Nothing*.
- Goldstein had argued that it was inconsistent for the National Geographic Channel to run *Wicked Tuna*, a show about hunting tuna, while pushing a conservation message (2012b). In this follow-up post (2012c), she shared critiques of her original post from two other scientists: “Both of these tuna experts believe that *Wicked Tuna* is good publicity for the Atlantic bluefin.” Her post includes this:

These conversations threw me into a bit of a fisheries existential crisis.

If a marine scientist such as myself can’t read through the peer-reviewed scientific literature and ICCAT stock assessments and form a reasonable opinion on whether eating Atlantic bluefin tuna is Good or Bad, what hope does the general public have?

Goldstein concluded, “Maybe the biggest value of the controversy over Wicked Tuna will be the spotlight that it shines on the complexity of sustainable fisheries.”

2. SHEDDING LIGHT ON SCIENTISTS’ PERSONAL AND WORK LIVES

Besides revealing disagreement, science blogs and social media often reveal aspects of scientists’ day-to-day lives, professional environments, and unique challenges; this gave rise to the second category. In my sample, all of the blogs by scientists revealed aspects of their personalities and private lives to some degree, given that blogging is a personal form of expression. In addition, I found fairly frequent examples of blogs opening a window into the working lives of scientists.

Cases that reveal aspects of scientists’ lives:

- Science blogs often show a less serious side of scientists than the public is accustomed to seeing. For example, Goldstein (2012d) began one post with the following: “Guys....I have an embarrassing confession. Sometimes I think marine mammals are really cute, and want to hug them. I KNOW, I can’t believe I’m actually admitting this on the internet – but it’s true.”
- Science blogs also sometimes shed light on deeply personal struggles of scientists. Clancy (2012c) and Hammonds (2012b) both wrote about their struggles with “impostor syndrome,” which, as Clancy explained, is “when an individual feels she doesn’t belong or deserve her accomplishments.” Hammonds also described dealing

with depression. Hammonds wrote, “I’m not entirely sure why I’m writing this, but this blog is intended to be as much about academic life as it is about science, and this is a part of life which I’m trying to cope with.” Orzel (2012b) quoted another blogger, “SciCurious,” on her struggle with impostor syndrome and used it as a launching pad for talking about societal attitudes toward scientists.

- Science bloggers often point out challenges unique to the science profession. Dobbs (2012b), for example, linked to a post on Retraction Watch highlighting the difficult situation facing collaborators of scientists who commit fraud, and then discussed his experience with a similar issue:

When I did the reporting to cover the Marc Hauser debacle, I talked to and learned of many people who felt this sort of pain — a searing sense of betrayal combined with a sense of being unfairly blamed, often while their own work was coming under a microscope.

- Revkin (2012d), shedding light on a different kind of challenge, interviewed a young researcher who had been pulled into a contentious debate before her work had been peer reviewed:

Hill, despite her initial excitement about getting a chance to add her voice to the fracking debate and discuss her work, is now expressing big misgivings about having stepped into a realm in which caveats melt away — particularly given the early stage of her career.

- In her blog, Yurkiewicz shares stories that give readers a detailed sense of what it is like to work in a hospital. In one case, Yurkiewicz (2013) explored, with specific examples, the reasons why promises to patients sometimes go unfulfilled. “After

spending time on the wards, I am surprised by how easily promises slide from my lips. ‘I’ll see you in the morning.’ ‘I’ll get you that sponge.’ ‘The nurse should be by with your Tylenol soon.’”

- Hammonds (2012c, 2012d) blogged about two Twitter trends that, in different ways, were providing looks behind the scenes of science. In one, Hammonds explained, the hashtag #overlyhonestmethods was being used by “a huge number of the (frankly rather sizeable) community of scientists on twitter sharing hilarious gems of what actually goes on behind the scenes in academia” (2012c). Hammonds collected some of his favorites, including such tweets as “We used a fancy statistical calculation because reviewers are a sucker for that and we want to get published” and “We did a lot of post-hoc tests, which is fancy latin speak for ‘we didn’t plan very well.’” The other trend involved the hashtag @heardatnature. As Hammonds explained, it “purports to be ‘A collection of weird and wonderful things overheard in the corridors of Nature.’ And the funny thing is, I genuinely do believe it” (2012d).
- Many blog posts, in one way or another, opened a window on scientists’ working environments. Goldstein (2012e) provided much more information than general readers would be likely to encounter elsewhere about the structure of ocean science research vessels, with photographs. Zivkovic (2012c), after attending a paleontologist convention, wrote a detailed post about what the field entails, first knocking down the popular perception: “If your paleo diet depends entirely on mainstream media, you may be excused if you think that all paleontologists do is dig fossils and announce discoveries of new species.”

- Two interviewees emphasized the value of “blogging from the field.” Goldstein, who operated a field blog called SEAPLEX (<http://seaplexscience.com/>) while researching the Pacific garbage patch, said such blogs show how science is a process of fits and starts: “I think one of the most valuable things that regular people don’t know about science is how much we fail.” Likewise, Revkin said the Scientist at Work blog on the *New York Times* site, a blog that he said “grew out of some stuff I did on Dot Earth a long time ago,” shows “science as a process.” About such blogs, he said, “I can’t think of a better way to convey science, whether you’re an astronaut on the space station doing a Twitter feed or a scientist in the lab trying to chart your work and your headaches.”

3. SCRUTINIZING HOW SCIENCE REACHES THE PUBLIC

This category reflects a third way in which science blogs are making aspects of science more visible; I found science bloggers to serve an important role in subjecting the norms and methods of science communication to a high level of scrutiny. Broadly, this includes scrutinizing the ways in which researchers and public information officers disseminate findings on the one hand, and having substantive conversations about the craft of science writing and science journalism on the other hand; roughly half of the blogs in my sample served this function at least occasionally. While such discussions are not new, their visibility on blogs may represent an opportunity for citizens to appreciate the forces at work in the production of science news.

Cases that show bloggers scrutinizing how science is communicated:

- Revkin (2011b) pointed out that the opening summary of a certain paper was too definitive in linking precipitation increases to human-driven global warming, while caveats were listed much farther down; he argued that the failure of the study authors to include nuance and caveats in the abstract contributed to an unwarranted “burst of coverage,” raising “big questions about the standards scientists and journals use in summarizing complex work and the justifiable need for journalists — and readers — to explore such work as if it has a ‘handle with care’ sign attached.” He later updated the post with reactions from one of the authors, who wrote in part, “It is very difficult to explain science in a generally understandable way and in a way that includes the uncertainties.” Revkin mentioned this post during the interview, saying:

The scientists there were surprised that I was complaining about the abstracts because they write their abstracts for their fellow scientists, and they’re not thinking about the wider audience. But I think in the realm we’re in now, you have to have that second layer of thinking. (Revkin 2012a)

- Revkin (2012e) wrote that he “saw no basis for the definitive punch” of a headline from a university press office: “Frogs Getting Sick from Climate Change.” He first aired this criticism on Twitter and then, on the blog, expanded his critique and published “Your Dot” contributions by two of the senior authors and the press officer, who wrote in part: “I truly appreciate the exchange that’s occurred here – and I think

it's been a productive one that has many potential lessons on the intersection of scientific research, social media and journalism.”

- Dobbs (2012c) and Zimmer (2012c), as well as other bloggers, strongly criticized a decision by a group of study authors and journalists. As Dobbs explained:

The authors of a small, weak study ... managed to warp media coverage ... by letting journalists read versions of the study before publication (and a big press conference) only if the journalists agreed not to talk to any outside scientists before the embargo date.

- Yong (2012d) pointed out that a press release describing a fossil flatfish as “a new fossil discovery” was inaccurate, as the same authors had described the same species four years earlier in a different paper, for a different journal, which Yong had written about. Yong wrote, “I really don’t think that science is in such a desperate state that we need to wilfully hide information in order to make things more appealing.” There was also a spirited debate in the comment thread that included the journal’s co-senior editor and chair of the journal’s media liaison committee.
- Goldstein (2012f) explained in detail how she described her research on the Pacific garbage patch to the media and revealed how one inaccuracy came about: “I should have realized that I needed to more carefully explain the difference between size (“Size of Texas!” which is not accurate) and concentration (100-fold increase in the number & mass of plastic PER unit seawater, which is accurate.” Goldstein (2012g) also interviewed two authors of children’s books about the garbage patch, asking why they had chosen to depict the patch as a “giant floating island.”

- Revkin often points out examples of “bias in the news process toward the front page thought” (2012b) and journalists “succumbing to ‘single-study syndrome’ in search of a hot front-page headline” (2012c), as in two of the cases described earlier.
- Science writers often use their blogs to discuss their craft. There is also a website called The Open Notebook (<http://www.theopennotebook.com>) devoted to such discussions, and Dobbs, Blum, Zimmer, and others contributed answers for an article at that site about the kinds of questions science writers ask. Dobbs (2012d) provided his full answer on his blog.
- Science writers also debate their craft through blogs. Yong (2012e) listed the “many reasons why errors creep into science journalism” but took issue with journalists citing such reasons “to defend shoddy reporting.” Dobbs (2012e) articulated a problem he had noticed in science writing: “pressure from writers, readers, editors, and the entire bookselling and meme-making and talk-fest machine to have the answers. And not just answers, but Big New Answers To Vexing Eternal Questions.”
- Finkbeiner (2013), who had been assigned to write a magazine profile of a female astronomer, declared on her blog that she would not “write about this astronomer as a woman.” She acknowledged that challenges still confront women in science, but, as she wrote, “I’m sick of writing about it; I’m bored silly with it. So I’m going to cut to the chase, close my eyes, and pretend the problem is solved.” This led another journalist to propose “the Finkbeiner test,” which *Columbia Journalism Review* then covered, calling it a way “to avoid gratuitous gender profiles” (Brainard 2013).

4. CONTINUING THE CONVERSATION AFTER PUBLICATION

Because most science bloggers see the medium as a type of conversation, they are happy to engage with readers who make comments about a post after it has been published; such exchanges often take the conversation in new directions. I found that almost all of the bloggers were responsive to questions, appreciative of readers pointing out errors, and willing to enter discussions with readers who were critical but polite. For these reasons, the comment threads of some posts ended up containing as much meaningful content as the original post. In addition, readers' cogent questions or insights drawn from personal experience often ended up driving the conversation, sometimes in subsequent posts.

This category carries two caveats. First, as explained in the previous chapter, some bloggers, particularly those hosted by large media organizations with heavy traffic, said their comment threads often contain irrelevant "noise" and rude remarks. I saw many such examples in my review of blogs; high-quality interaction, while evident at least occasionally on each of the blogs, was not a consistent feature. Second, as Zivkovic pointed out, much of the interaction now occurs on social media, making many comment sections appear "deserted." In my review, I noted that many posts had no significant discussion in the comment threads, and I did not attempt to track the interaction that may have been occurring on other social media. The cases of interaction that I do highlight, however, are meaningful for understanding the kinds of productive exchanges that can occur between science bloggers and readers. In addition, the next category does address some aspects of bloggers' use of Twitter.

Cases that show blog posts promoting conversation:

- In comment threads, many of the bloggers provided very long explanations to questions from general readers. To give one example, Kreston (2012b) replied to a reader, “Colin,” asking how a spinal deformity could result from tuberculosis, as shown in a photograph Kreston had included in her post. This led a different commenter to remark: “An amazing read, including your detailed reply to Colin's question. Thanks.”
- Besides asking questions, readers can enhance posts by adding personal insights. Costandi (2012a) described “Body Integrity Identity Disorder (BIID), an apparently rare condition characterized by a burning and incessant desire to amputate an otherwise perfectly healthy limb.” Then, a person with the condition participated actively in the comment thread, at one point describing the sensation in vivid terms: “The annoyance also involves my hips, so it's not the legs alone. ...In essence, I feel as if I shouldn't feel them, but since I do, it's a sensory intrusion- like an inescapable bad odor.” Costandi thanked the commenter for “encouraging the discussion here.”
- Reader feedback can lead to follow-up posts when it leads bloggers to realize their intended point did not get across. Dobbs (2012f) wrote a post arguing that “culture shapes the expression of mental dysfunction,” but many commenters criticized him, believing he had argued that violent movies lead to actual violence. In an update to the post, he directed readers to a new post in which he “made this argument in a

different way, with more context and specific examples.” In a later post (Dobbs 2013b), he referenced this episode, writing the following:

I took advantage of a blog’s reiterative freedoms to clarify an argument ... that I’d made less than successfully a few days earlier. This is one of the beauties of blogging — it lets you revisit, revise, regroup, and continue a conversation that may not yield much light the first time around.

- Comments can also lead to follow-up posts simply for being interesting and worth highlighting. In the interview, Revkin explained how he had given a platform to someone who had commented on a post about repopulating bison:

There’s a guy named Dale McIntyre, a former oilman. ... So he’s very skeptical of global warming, but he wrote a beautiful piece about bison. And I said this is too good, so I plunked it up as a stand-alone piece, just because it was basically great writing, a good voice. (Revkin 2012a)

- Comments can also lead bloggers to update posts with important information. To give one example, Revkin (2012f) updated a post with relevant congressional testimony after a regular reader “helpfully pointed” to it in the comment thread.
- Comment threads appeared to mix people from different social worlds fairly often; this mixing sometimes led to combative but enlightening exchanges, as when Goldstein criticized the show *Wicked Tuna* (2012b) and commercial fishermen joined in the comments to take issue. One wrote, in part: “...saying you cant catch these fish because they are declining does not make any sense because a large portion of the

Atlantic tuna migrate to Europe and then get ravaged by over fishing no quotas and no oversight!!” Goldstein was active in the comments, at one point writing: “Well, we’re getting rather far afield from whether National Geographic should air *Wicked Tuna* or not, but I am intrigued.” She then engaged the fishermen in conversation about their complaints.

5. EXPLOITING THE TOOLS OF DIGITAL COMMUNICATION

The fifth category deals with how aspects of the blog platform itself—hyperlinks, multimedia, time-stamped updates, and freedom from length restrictions—are used to enhance communication. I also include Twitter in this category, as it, too, is an important digital communication platform for science bloggers.

I found hyperlinks to play an important role in imparting coherence to online conversations, especially when debate over a certain topic involved multiple voices dispersed across the Internet. Of course, bloggers linked not just to different online voices, including other bloggers and journalists, but also to various information sources: full-text research papers, research center websites, Wikipedia, news articles, earlier posts of their own, and images and videos. All of the blogs I examined used links in this manner to some degree. (Yurkiewicz’s had fewer than others, as her posts were mostly narrative accounts of personal experiences.) As mentioned in the previous chapter, Blum said that this practice makes science writing more transparent.

Other aspects of the blog platform enhanced communication in various ways. With freedom from length restrictions, some used the blog space to give a platform to different voices by, for example, copying and pasting e-mail exchanges and allowing others to write “guest posts.” In addition, bloggers often used the extra space to expand on features or stories they had written for print outlets or provide the full transcript of interviews that had been conducted for those pieces. Images and videos embedded directly into posts sometimes inspired conversations in comment threads. Time-stamped updates were used to keep unfolding stories alive and incorporate corrections or relevant insights from readers. Lastly, productive exchanges on Twitter often inspired new posts or led bloggers to update published posts with added insights. By its nature, Twitter interaction is ephemeral, and I found blogs to play an important role in capturing and extending high-quality Twitter exchanges, thus giving them more staying power. These factors, combined with comment threads, contribute to the sense that blog posts remain very active sites for communication after publication.

Cases that reflect the advantages of digital communication:

- Before adding his own voice to an unfolding argument in the astronomy world, Carroll (2012d) used links to guide readers to various other voices. In the following quote, I use bold formatting for words/phrases that were links in the original:

Here’s **Jerry Coyne** (mostly siding with Albert), the Rutgers **Philosophy of Cosmology blog** (with interesting voices in the comments), a **long interview with Krauss** in the Atlantic, comments

by **Massimo Pigliucci**, and **another response by Krauss** on the *Scientific American* site.

- Dobbs (2012h) highlighted the work of another blogger who argued that, in Dobbs' words, "our current concept of PTSD describes a reaction that simply wasn't seen in eras before the Vietnam War." Then, at the end of the post, he directed readers to a very long list of personally annotated sources in support of that view, including primary literature: "...for the deeper pool, or if you're wondering, 'Where do these people get the idea PTSD is overdiagnosed? Where are the *studies*?', see my **annotated list of sources and links.**"
- Bloggers also provided links directly in response to reader questions. In the comment thread, Costandi (2012b) replied to a reader asking about the connection between eye blinking and lying—which was not the focus of the post—by linking to relevant sources, including a primary research article and a mainstream news article.
- Regarding embedded images and videos, the post by Kreston (2012b) mentioned earlier is one example of how such elements can inspire conversation.
- Yong (2012f), after publishing a lengthy post about the international ENCODE project to catalogue DNA elements, made a series of time-stamped updates to reflect feedback he had received. In the comment thread, Yong wrote:

Folks, given some of the critiques and commentary from across the blogosphere, I've updated this post with around 700 extra words. ... I want **this** post to continue being a useful resource about ENCODE. I could do a fresh update post, but any new reader to this one would

have to click over to that as well. Which is why I've edited straight into this one.

- While several of the blogs gave a platform to different voices on occasion, Revkin's did so more consistently than any other. As one example, Revkin (2012g) copied and pasted an e-mail exchange with a scientist, shared a "particularly acute" reader comment from an earlier post, and "invited one comment contributor ... to weigh in with more depth (given the constraints of our comment system)," all in a single post.
- The case mentioned earlier in which Zimmer (2012b) used Storify to collect tweets critical of a study and sent them to the study author is one example of how bloggers can extend and deepen Twitter interaction.
- Often, enlightening exchanges on Twitter are reflected in updates to blog posts. As one example, after publishing a post about a study on "personality and genetics in captive elephants," Goldman (2012b) added a paragraph that began: "Update: Psychologist Dave Nussbaum points out on twitter that personality may not be as stable across environments as personality theorists might argue."
- Siegel (2012b) wrote a post based on a Twitter exchange, while providing a platform to two other scientists in the same post; therefore, this case is particularly illustrative of the ways in which discussions about science can benefit from digital platforms. First, Siegel directed a tweet to the author and former "Wonder Years" actress Danica McKellar: "I really respect a lot that you do, but I don't understand why you feel so negatively about #GMO food." McKellar responded: "Splicing from viruses in food? Splicing shellfish DNA into fruit which could cause allergic reactions? Labeling please!" Then, on his blog, Siegel acknowledged that he was not an expert on GMO

foods and that he would “need to get someone who’s an expert about biology and genetic engineering to provide that nuance.” He then provided lengthy excerpts from e-mail interviews he had conducted with two scientists. The conversation then bounced back to Twitter, where McKellar wrote: “I love the discussion - but one of the scientists said pesticides aren't used on GMOs. Makes me doubt the expertise.”

6. ALLOWING FAST DISSEMINATION OF EXPERTISE

Finally, I found science blogs to play an important role in providing expert perspectives on important, unfolding stories. This speed includes not only the short time it takes to publish a blog post, but also the swiftness with which a post’s influence can spread through being shared via Twitter and referenced elsewhere on the Web. Such speed becomes important when scientists or science journalists with expertise in a certain area are able to comment on breaking news stories through blogs, or on new research findings with important implications.

Cases in which blogs allowed the spread of expertise:

- When the OPERA experiment led to the “faster-than-light” neutrino anomaly in 2011, generating a large amount of news coverage, Orzel and other physics bloggers offered informed opinions on the experimental procedures and circumstances that could have led to the strange result. At the beginning of one such post, Orzel (2011) wrote, “...too much of the commentary I’ve seen has been of the form ‘I am a {theorist,

journalist} so hearing about experimental details gives me the vapors’ (a snarky paraphrase, obviously).” Then, using the question-and-answer-style format he often employs, he explained the purpose of the experiment, its method of velocity measurement, and possible sources of error in the experiment.

- Bracher (2013) offered commentary on a video circulating around the Internet that showed people at a party pouring liquid nitrogen into a swimming pool and parties beginning to suffocate. After explaining why using liquid nitrogen in this manner was an “awful idea,” Bracher included a “note to media” explaining that nitrogen will not “react with chemicals in swimming pools to generate a poisonous gas,” as many outlets had reported. Other science writers quoted Bracher’s explanation of the science, and Blum also drew attention to his “note to media” in a post that she wrote for the *Knight Science Journalism Tracker* (Blum 2013).
- In the interview, Goldstein called her group blog’s coverage of the 2010 Deepwater Horizon oil spill an example of “getting our expertise directly out to the public without a filter or putting it into the service of interested members of the public right away.” She added:

None of us, at the time, were oil spill specialists, but we’re all trained scientists, so we’re able to read and interpret NOAA reports in a way that probably a non-specialist could not do. And we could digest that information for interested people. So for a while, we had – if we do say so ourselves – the best coverage of the oil spill on the Internet until the mainstream media caught up. (Goldstein 2012a)

- Allain also offered insight into the Gulf oil spill as it was unfolding. Although commenting on stories of public importance is not his aim, he told me in the interview, “If I can find some unique angle that I can point out, then I will.” In a blog post written when the story was unfolding (Allain 2010), he wrote the following:

I was going to just leave the oil spill in the gulf topic alone. Not because it isn't important, obviously it is. Rather, I wasn't going to do anything because I didn't really have anything to add to the topic. After a couple of readers requested it, I think I do have something to add. How exactly do you estimate the amount of oil flowing into the gulf?

- Clancy (2012d) offered “some legitimate science” in response to former U.S. Representative Todd Akin's remark about “legitimate rape.” In the interview, Clancy described how she was urged to comment on the incident:

I had several different people on Twitter contact me directly and say, “You're writing a response to this, right?” Because that's sort of the role I have come to play – when that kind of stuff happens, what is Kate Clancy going to say about it?” (Clancy 2012a)

- In the interview, Blum described blogging about the harmful effects of pepper spray following an incident at the University California, Davis, when an officer used pepper spray on “Occupy Wall Street” protesters. The next day, the post was featured as a guest post at the Michigan Center for Risk Communication and *Scientific American*. After that, the *New York Times* and the *Wall Street Journal* picked it up. Three days after publishing the post, Blum discussed it as a guest on the Rachel Maddow show.

Blum told me that, although she would have written the same thing had she still been a science writer at the *Sacramento Bee*, there were differences between what she achieved blogging and what she would have been able to accomplish at a newspaper: “You can get a phenomenal audience through the Internet that you cannot get working at a regional paper.” She said that a newspaper story “would have gone out on McClatchy News Service, and probably a lot of mainstream papers would have picked it up that way.” But the blog post was “referenced in countless blogs” and picked up by aggregator sites, and within days she was discussing the topic on television and radio shows. “The ripple effect of doing the blog was phenomenal” (Blum 2012b). At the same time, she was startled to find that no one in the mainstream media had thought to write about the dangers of pepper spray after the UC Davis incident:

Thrilled as I was to get that much attention, I was horrified – a part of me was horrified that I was the first person who did that post, a woman living in Madison, Wisconsin, in her home office. ... Where was AP, or the Sac Bee? And so that’s also reinforced my feeling that science bloggers really matter. We’re doing things that would fall through the cracks given the state of the current mainstream media. (Blum 2012b)

Chapter VI: Conclusion

This thesis explored the science blogosphere from many angles in an attempt to provide extensive qualitative data on this important part of what Fahy and Nisbet (2011) called the “evolving science media ecosystem.” As a major part of this ecosystem, the science blogosphere has attracted attention from communication researchers, but I saw a need for an in-depth study to shed new light on this medium. Most previous studies have been based on interviews with a relatively small number of bloggers or content analyses covering relatively brief periods. In addition, recent changes to the science blogosphere, such as the proliferation of networks, have not been reflected in most prior research.

By combining in-depth interviews with 20 science bloggers, representing a diverse mix of backgrounds and professions, with an extended review of the blogs themselves, I hoped to provide detailed answers to two questions: 1) How do science bloggers operate, and why do they operate in that way? and 2) Is there evidence that science blogs are serving new roles in how science communication occurs, such as facilitating high-quality interaction or public access to science-in-the-making?

Regarding the first question, I found that science bloggers exhibit a great diversity of approaches, are motivated mainly by enjoyment, strive to write about science in unique ways and incorporate a personal touch, and are very engaged with readers and fellow writers through social media. With respect to the second question, this research does suggest areas where this medium is having a unique impact. In the discussion that

follows, I will summarize these impacts, discuss limitations of the study, and suggest areas that warrant more focused investigation.

MAIN FINDINGS

As several of the interviewees emphasized, a blog is just a platform that one is free to use in whatever manner one chooses. The impacts described below arise from the choices science bloggers make, rather than from the blog platform in and of itself.

Science blogs serve to complement other media in various ways.

One way blogs complement other media is by giving writers the freedom to write whatever intrigues them; in some cases, this leads to broader coverage of issues that might not otherwise come to the public's attention. For example, when Zimmer blogged about wasp behaviors after concluding he would have difficulty pitching the story to an editor, the story ended up attracting "hundreds of thousands of hits" and attention from radio and television media (see page 87).

In addition, science bloggers sometimes cover stories that are of clear public importance but that are overlooked by more mainstream media. About her blog posts on the hazards posed by chemical dispersants, pepper spray, and the gases used in mining, Blum said, "I hate that the print media aren't doing these things," and she added that

science bloggers are “doing things that would fall through the cracks given the state of the current mainstream media” (see pages 60 and 122).

Many of the bloggers in my sample said they strive to provide a fresh take on important stories or write about them in unique ways. In this sense, science blogs not only call attention to more stories, but also offer more ways of looking at the same stories. Furthermore, science journalists who write for various outlets often use blogs to expand on stories published elsewhere, such as by sharing parts that had to be cut due to length restrictions.

In some cases, scientists offer critiques through blogs and social media that end up leading directly to coverage in other media. The arsenic life example described in chapter two was a vivid demonstration of how blogs can function as a complement to mainstream science journalism. Zimmer showed how the two formats can work in tandem to paint a fuller picture of an evolving story; he gathered sources and inspiration from scientist bloggers’ critiques, published an in-depth story in a mainstream outlet (*Slate*) based on those critiques (where he strived to make the technical points of the critiques understandable to a lay audience), and then used his own blog to post updates and details as they emerged. In another example, Yong wrote a feature article for *Nature* about problems in the field of psychology after psychologists’ feedback to one of his blog posts revealed an “undercurrent of unrest” (see page 103).

Science blogs often provide a window into how science is debated, conducted, and communicated.

The arsenic life and psychology examples just mentioned suggest another implication: that science blogs can offer a view behind the scenes of science by revealing uncertainty and disagreement. Trench (2012) reported that in his review of 20 blogs, “less than a quarter ... provided even occasional looks behind the scenes of science.” It is notable, however, that Trench conducted his review “in early 2010,” before the arsenic life episode occurred.

In my review, I found that only Revkin’s blog regularly provided public access to debates over new research; this was not a consistent feature of other blogs, despite several notable cases highlighted in chapter five. I found, however, that many of the blogs revealed more general areas of disagreement not connected to particular research, such as when two fellow scientists took issue with Goldstein’s stance on the Atlantic bluefin tuna fishery (see page 105).

Furthermore, as the study progressed, I saw value in expanding the concept of science-in-the-making to incorporate other ways of looking behind the scenes of science. Science blogs reveal not just disagreement, but also aspects of scientists’ day-to-day lives and working environments that the public is unlikely to encounter elsewhere. As Weigold observed in 2001, “Beyond scientific facts, it is interesting to consider what people understand about the work of science and about the lives of scientists. Science is not a

visible occupation, and people rarely observe scientists at work.” The blogosphere appears to be making this occupation more visible.

Lastly, science blogs have an important role in scrutinizing how science information reaches the public. The “reflexive and meta-discussions of science journalism” that Fahy and Nisbet (2011) said occurs on websites such as the *Knight Science Journalism Tracker* and *Columbia Journalism Review* also occurs on science blogs. In addition, I found cases in which science bloggers engaged scientists and public information officers in conversations and debates about their methods of disseminating findings. In contrast to the “scientific literacy tradition,” which emphasizes knowledge transmission from scientists through journalists to the public, such cases exemplify the “interactive science tradition,” which Logan (2001) described as placing more emphasis on “improving communication among citizens, scientists, politicians, government and corporate officials, and journalists.”

Science blogs are venues for various people to participate in conversations about science.

Many of the bloggers said they view blogging as akin to having a conversation; this attitude translates not only into more personal writing styles, but also a willingness on the part of bloggers to engage with readers in comment threads and elsewhere. Fahy and Nisbet (2011) described the “new science media ecosystem” as “deeply pluralistic, participatory and social,” and the science blogosphere certainly exemplifies these

qualities. In addition, as Shanahan (2011) observed, science blogs have an important role in mixing people from different social worlds. I found examples in which comment threads mixed doctors and patients, scientists and curious laypeople, journalists and press officers, and others.

The responsiveness of science bloggers to reader input bears out the observation made by Secko et al. (2011) that factors such as “the reframing of issues by audience comments” and “the opening up of science journalism narratives to raw experience” are important elements of online science communication, although these authors were writing specifically with regard to the online science section of a newspaper rather than blogs.

The blog platform offers ways to enhance science communication.

In the interviews, many bloggers emphasized aspects of digital communication that help them to communicate science effectively. Several pointed out that the online environment is graphics-driven, and the ability to embed images and videos is often helpful when communicating science. In addition, linking to information sources allows bloggers to write with greater transparency on the blog compared with print, while updates, corrections, and freedom from length limits help enhance accuracy. I also found that science bloggers often use hyperlinks in the manner described by Matheson (2004), to select and guide readers to “multiple and often discordant journalistic voices,” helping to make online conversations involving multiple voices more coherent.

Speed, another communication advantage of science blogs, is a feature of digital communication generally rather than of blogs in particular. When a blog post is linked to and referenced on social media, other blogs, and websites, it can have what Blum called a “ripple effect,” bringing widespread and rapid attention to issues of importance.

LIMITATIONS

Like all studies, this one has limitations. First, it is difficult to generalize the results to the science blogosphere as a whole; given the great diversity of approaches and styles among science bloggers, there may be important trends and practices that this study failed to capture because of the limited number of blogs under investigation. However, as explained in the third chapter, it is not the goal of this thesis to be generalizable, and “the sheer size of the blogosphere makes it virtually impossible to draw a truly random sample of blogs” (Walejko and Ksiazek 2010). Second, I covered many different aspects of science blogging in the interviews, meaning that I did not focus a great deal of time on any one of those aspects in particular. Nonetheless, I saw this approach as necessary to explore the topic from many angles, offering brief insights along the way and leaving more focused investigation to future research.

AREAS FOR FUTURE RESEARCH

The results of this study suggest several areas that warrant more detailed investigation. First, more information is needed on who actually reads science blogs and how closely these audiences align with bloggers' target audiences. Several interviewees said that their blog audiences tend to comprise people already knowledgeable about science and that it is challenging to reach general readers. Others said it is difficult to ascertain who their audiences actually are. Research on science blog audiences should investigate how audiences vary across different online environments, including self-hosted blogs and blog networks.

Another, related, area for future research is the nature of the interaction that occurs following the publication of a blog post, both in comment threads and through various social media. As many bloggers pointed out, much of the interaction now occurs on Twitter and Google Plus rather than on the blog itself. Although I asked interviewees about their use of social media, I did not attempt to track their use of these tools in my review of blogs. Trench (2012), who defined interactivity as "the scope and quality of exchanges between blog publishers and visitors," reported that a "low level of discussion and the absence of debate were the most frequently made observation in relation to this criterion." I, too, found that many posts had no significant discussion, but it is unclear to what extent this fact is due to conversations occurring elsewhere.

Although I found many examples of constructive interaction resulting from blog posts, I did not find any example as striking as the scientist-farmer collaboration that Shanahan (2011) highlighted. This case, as described in chapter two, culminated in an

actual collaboration between a scientist and a farmer with a gynandromorphic chicken, with the farmer sending the scientist genetic material from the chicken. I cannot say definitively that interactions of this sort do not occur, and one limitation of this study is that I did not ask participants whether, to their knowledge, their blogging ever leads to offline exchanges. Future research should examine whether the discussion surrounding science blogs extends to such offline interactions.

Research should also examine the extent to which activity on blogs influences the conduct of science. As Zimmer wrote in *Slate* about the arsenic life episode, online critiques “helped change the way scientists do science” (2011a). Similarly, in one of the cases highlighted in Chapter 5, an instance of “post-publication peer review” led a journal to put on hold the publication of a study after criticisms were raised on the Climate Audit blog (see page 101). It is noteworthy that these criticisms occurred on Climate Audit, a blog devoted to offering critiques of climate change research, and that I came across the case only because Revkin decided to write about it. My sample consisted mainly of journalistic science blogs and those with a science outreach aim rather than an advocacy aim. Future research should also include science advocacy blogs and blogs targeted more toward fellow researchers than toward the public to investigate the issue of post-publication peer review in more depth.

As much of the science blogosphere becomes increasingly part of the mainstream, another important question is how science blogging will continue to distinguish itself as a medium. During the panel discussion summarized in chapter four, Yong said that his

blogging approach has evolved to the point where his “process for writing a blog post and writing a paid news piece for somewhere else are completely indistinguishable,” aside from the “looser and more personal” writing style on the blog (WCSJ 2013).

During the same panel discussion, Alok Jha, a science and environment correspondent at *The Guardian*, said one of his goals for the bloggers at *The Guardian*'s network is “more integration with the rest of the newspaper. ... We'd like our bloggers to be involved in other parts of the website and the newspaper” (WCSJ 2013). Likewise, Betsy Mason, the editor of *Wired Science*, said she is searching for more ways to include the bloggers at her network in the print magazine (WCSJ 2013). In the future, it will be important to examine how such integration influences science bloggers' practices and perceptions.

Lastly, it is important simply to watch for unexpected changes in the science blogosphere. During the panel discussion just mentioned, Yong emphasized the sheer surprise of watching this medium evolve:

The explosion of the Science Blogs network, the diaspora to all these other emergent networks that turned up in its place, the creation of Phenomena – all these were completely unpredictable to me. ... I've given up predicting where blogs are going to go. (WCSJ 2013)

He also said the goal for the future “has always been what it was in 2006, when I started: just to get better at it.”

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Appendix 1: Interview Guide

The following questions make up the basic interview guide used to conduct each interview. I modified the interview guide as needed to include questions relevant to each participant, and I often deviated from the guide to pursue topics that seemed especially relevant. In addition, I asked participants for advice regarding topics worth exploring, and some questions were added for subsequent interviews based on their answers.

1) How long have you been blogging, and why did you start?

If not answered above, elicit:

8) (If a scientist/researcher/medical professional) Had you done any science writing before that?

8) (If joined a blogging network) How did you come to start blogging for _____? Did your approach change after that?

2) How much time do you spend blogging in a typical week? Is there a routine to it?

3) How do you get ideas for blog posts?

Prompts:

- Mention recent blog post, and maybe compare with another blog post.
- Mention possible sources of ideas, such as personal experience with topic, coverage in the news media, Twitter conversations, scientific journal, news release, suggestion from colleague, suggestion from source.
- Do you have a regular routine for finding ideas?

4) How do you decide whether a specific topic is worth blogging about?

Prompts:

- Mention possible criteria, such as personal interest, public impact, dissatisfaction with coverage elsewhere.

5) Once you've decided on something to write a blog post about, what are your procedures?

Prompts:

- Refer to a recent blog post
- What about sources? (Mention possibilities such as government website, news website, other websites, news releases, scientific journal articles, other blogs.)
- When using hyperlinks, what kinds of sources do you tend to link to most often?

6) Do you have any special approach in terms of writing style?

Prompts:

- Do you use humor or other means to engage readers?
- How often do you incorporate your personal opinion into your blog posts?

7) What happens after you publish a post?

Prompts:

- What kinds of people leave comments, and what kinds of comments do they leave?
- How often, or under what circumstances, do you choose to interact with readers in the comments thread?
- Do readers ever point out mistakes?

8) How do you see the people you write for? What is *your* vision of your blog's audience?

9) What makes a good blog post?

10) Why do you blog?

11) Is there anything else you can tell me about your blogging, and how and why you go about it?

12) Are there any other areas or topics related to science blogging that you think I should be looking into?

Appendix 2: Detailed Information on Each Blogger and Blog

Rhett Allain (Interview Date: November 17, 2011)

Allain runs the Dot Physics blog (<http://www.wired.com/wiredscience/dotphysics/>) as part of the *Wired Science* network. Allain, an associate professor of physics at Southeastern Louisiana University, received a Ph.D. from North Carolina State University in 2001 and has research interests in the field of physics education research. He began blogging independently in 2008, moved to ScienceBlogs.com in November 2009, and joined the *Wired Science* network when it launched in September 2010. His blog focuses mainly on using calculations to explore the physics underlying everyday phenomena, although he also writes about physics education. In addition, he is the author of a recent book on the physics at play in the game *Angry Birds*, which grew out of content on the blog.

Steve Balt (Interview Date: December 14, 2011)

Balt runs the Thought Broadcast blog (<http://thoughtbroadcast.com>), which he does independently, as well as serves as editor-in-chief of the *Carlat Psychiatry Report*, a monthly continuing education newsletter. An alumnus of Stanford, Rockefeller University, and Weill Medical College of Cornell University, Balt completed residency training in adult psychiatry at Stanford Hospital and UCLA-Kern Medical Center. He recently started a private psychiatry practice in the San Francisco Bay area. On his blog,

which he started in 2010, he focuses mainly on challenging the prevailing approach to psychiatry, which he feels is too medication-oriented. In doing so, he draws on his own clinical experiences.

Deborah Blum (Interview Date: January 4, 2012)

Blum runs the Elemental blog (<http://www.wired.com/wiredscience/elemental/>) as part of the *Wired Science* network, which she joined in May 2012. At the time the interview was conducted, she ran the Speakeasy Science blog (<http://blogs.plos.org/speakeasyscience/>) as part of the PLoS network. Blum, a Pulitzer Prize-winning science writer, majored in journalism at the University of Georgia and went to graduate school for science writing at the University of Wisconsin-Madison. She then worked as a science writer for McClatchy Newspapers in California, during which time she wrote two books and won a Pulitzer Prize for beat reporting, before returning to the University of Wisconsin in 1997 as a journalism professor. On top of teaching, she has continued to write books and pieces for major publications. She began blogging independently in January 2010; in the same year, she moved her blog twice, first to ScienceBlogs.com and then, in the wake of “Pepsigate,” to the PLoS network. On moving to the *Wired Science* network, she changed its name. She blogs mainly about chemistry, particularly as it relates to crime and culture.

Paul Bracher (Interview Date: November 2, 2011)

Bracher runs the ChemBark blog (<http://blog.chembark.com>), which he does independently. He received a Ph.D. in chemistry from Harvard University in 2010 and completed his postdoctoral research at Caltech. According to his personal website, he will join Saint Louis University as an assistant professor of chemistry starting in August 2013. He began blogging in 2005, but the focus was not strictly on chemistry; the chemistry blog started in 2006. The scope of the blog is very broad, covering “the world of chemistry and chemical research,” as Bracher explains in the “About” section.

Sean Carroll (Interview Date: June 25, 2012)

Carroll runs the Preposterous Universe blog (<http://www.preposterousuniverse.com/blog/>), which he does independently. At the time the interview was conducted, he was a writer for the collaborative group blog Cosmic Variance (<http://blogs.discovermagazine.com/cosmicvariance/>), part of the *Discover* network. Carroll, a theoretical physicist at Caltech, received a Ph.D. in astronomy and astrophysics from Harvard University in 1993. He is prominent both as a scientist and as a science communicator, having authored three books and completed two sets of lectures for The Teaching Company. In December 2012, he decided to return to blogging independently at Preposterous Universe, which he created in 2004 before moving to Cosmic Variance in 2005. While Cosmic Variance focuses mainly on physics and astrophysics, Carroll maintains that his personal blog is “absolutely not a Science Blog.” This study, therefore, addresses his blogging activities at Cosmic Variance rather than his current venue.

Kate Clancy (Interview Date: August 23, 2012)

Clancy runs the Context and Variation blog (<http://blogs.scientificamerican.com/context-and-variation>) as part of the *Scientific American* network. She received a Ph.D. in anthropology from Yale University in 2007 and is now an assistant professor of anthropology at the University of Illinois, Urbana-Champaign. From 2007 to 2008, before starting her tenure-track position in Illinois, she taught expository writing at Harvard University. Clancy started Context and Variation in August 2010, after spending about one year running the Laboratory for Evolutionary Endocrinology Blog, where she had discussed activities in the lab that she co-directs. She moved the blog to the *Scientific American* network when it launched in July 2011. The banner that runs across the top of Context and Variation describes its focus: “Human behavior, evolutionary medicine... and ladybusiness.”

Mo Costandi (Interview Date: December 15, 2011)

Costandi runs the Neurophilosophy blog (<http://www.guardian.co.uk/science/neurophilosophy>) as part of *The Guardian* network. Costandi, who pursued but did not complete a Ph.D. in the MRC Centre for Developmental Neurobiology at King's College London, worked as a secondary school science teacher and then as a security guard before transitioning to freelance science writing as a career. In addition to writing feature articles and news stories for print and online publications, he recently authored his first book on neuroscience. He started the blog in February 2006; he moved it to

ScienceBlogs.com in July 2007 and to *The Guardian* in August 2011. On his personal website, he describes the blog's focus as "molecules, mind and everything in between."

David Dobbs (Interview Date: December 16, 2011)

Dobbs runs the Neuron Culture blog (<http://daviddobbs.net/smoothpebbles/>), which he does independently. At the time the interview was conducted, the blog was part of the *Wired Science* network (<http://www.wired.com/wiredscience/neuronculture/>). Dobbs, who majored in English at Oberlin College, has authored several books and regularly contributes feature articles to major publications. He started the blog in 2006, first naming it Smooth Pebbles, and moved it to ScienceBlogs.com about one year later. He left the network shortly thereafter, finding that blogging was "not a comfortable fit," but returned in January 2009 with a new appreciation for "how this slippery but flexible form can hold a valuable place in both my own writing and in the changing world of journalism" (Dobbs 2009). He ultimately left ScienceBlogs.com over "Pepsigate" and joined the *Wired Science* network in September 2010. In June 2013, he returned to blogging independently. The banner that runs across the top of the blog describes its focus: "On the science of behavior, the behavior of scientists, reading, writing, sports, & other wonders."

Ann Finkbeiner (Interview Date: June 5, 2012)

Finkbeiner contributes to the collaborative group blog The Last Word on Nothing (or LWON, <http://www.lastwordonnothing.com>). A freelance science writer since 1984, Finkbeiner completed a master's degree in science writing from the Writing Seminars program at Johns Hopkins University in Baltimore, where she later returned as a visiting associate professor. In addition to writing articles and book reviews for major publications, she has written three books. She is co-proprietor of LWON, which she created with two other writers; the blog launched in May 2010. Including Finkbeiner, the blog currently has 12 regular writers. While these writers specialize in different areas of science, Finkbeiner writes often about cosmology, physics, and stories drawn from the history of science.

Jason Goldman (Interview Date: June 14, 2012)

Goldman runs the blog The Thoughtful Animal (<http://blogs.scientificamerican.com/thoughtful-animal/>) as part of the *Scientific American* network. In 2013, he received a Ph.D. in developmental psychology from the University of Southern California, where his research focus was social cognition in animals. In addition to his academic career, he communicates science actively; besides the blog, he has written a regular *BBC Future* column, and his writing has appeared in such places as *The Guardian*, *The Huffington Post*, and *Salon*. He began blogging independently in January 2010; he moved the blog to ScienceBlogs.com in March of that year and then to the *Scientific American* network in July 2011. Goldman “writes about psychology and neuroscience, with a special focus on

animal cognition and the evolution of the mind,” as he explains in the blog’s “About” section.

Miriam Goldstein (Interview Date: June 9, 2012)

At the time the interview was conducted, Goldstein contributed to the collaborative group blog Deep Sea News (<http://deepseanews.com>). Goldstein, who in 2012 received a Ph.D. from the Scripps Institution of Oceanography, began blogging independently about science in 2007, with a blog named The Oyster’s Garter. In January 2010, she joined Deep Sea News to blog alongside other ocean scientists; at both venues, she wrote in an often-humorous fashion about current issues in ocean science, science outreach, and her own research on the “Great Pacific garbage patch.” (While at sea conducting research on the garbage patch, she also maintained an expedition blog.) In January 2013, before starting a one-year stint as a Knauss Marine Policy Fellow at the U.S. House Committee on Natural Resources, she announced a “leave of absence from all public social media.” She explained that “independent participation in social media – especially on issues relevant to the Committee – is not compatible with politics” (Goldstein 2013).

Markus Hammonds (Interview Date: May 31, 2012)

Hammonds runs the Supernova Condensate blog (<http://supernovacondensate.net>), which he does independently. In 2013, he received a Ph.D. in molecular

astrophysics from the University of Nottingham. Several of his recent blog posts describe his search for postdoctoral research fellowship positions, as well as his interest in a parallel career as a freelance science writer and his aspiration to write a popular science book. He started the blog in October 2007. On the right side of the blog webpage, Hammonds describes its focus: “Supernova Condensate is a blog about our place in the Universe. Of astronomy, chemistry and life in the big bad bubble of academia.”

Rebecca Kreston (Interview Date: July 19, 2012)

Kreston runs the Body Horrors blog (<http://blogs.discovermagazine.com/bodyhorrors/>) as part of the *Discover* network, which she joined in April 2013. At the time the interview was conducted, she was blogging independently. Kreston, now a first-year medical student, received a Master’s of Science in Tropical Medicine from Tulane University in 2012. Her specialty is infectious diseases, and she has training in microbiology and epidemiology. The blog, which she started in March 2011, focuses on the “history, anthropology and geography of infectious diseases and parasites,” according to the description Kreston provides on the right side of the blog webpage.

Chad Orzel (Interview Date: June 13, 2012)

Orzel runs the Uncertain Principles blog (<http://scienceblogs.com/principles/>) as part of the ScienceBlogs.com network. With a Ph.D. in chemical physics from the University of Maryland, College Park, Orzel is an associate professor in the Department

of Physics and Astronomy at Union College in New York, where he has taught since 2001. His research focus is atomic, molecular, and optical (AMO) physics. He started Uncertain Principles in 2002 and was among the first group of bloggers to join ScienceBlogs.com when it launched. As Orzel explains in the “About” section of his blog, he “blogs about physics, life in academia, ephemeral pop culture, and anything else that catches his fancy.”

Andrew Revkin (Interview Date: August 22, 2012)

Revkin runs the Dot Earth blog (<http://dotearth.blogs.nytimes.com>) for the *New York Times* website. An author and former staff reporter for the *New York Times* (1995 to 2009), where he covered the environment, Revkin now teaches at Pace University with the title of Senior Fellow for Environmental Understanding. He majored in biology at Brown University and later attended the Columbia University Graduate School of Journalism, earning a Master’s in Journalism degree. He created Dot Earth in 2007 under a John Guggenheim Foundation Fellowship. In 2010, the blog moved from the “News” to the “Opinion” side of the *New York Times*. According to information on the right side of the blog webpage, its focus is on examining “efforts to balance human affairs with the planet’s limits,” and he calls it “an interactive exploration of trends and ideas with readers and experts.”

Ethan Siegel (Interview Date: May 24, 2012)

Siegel runs the Starts With A Bang blog (<http://scienceblogs.com/startswithabang/>) as part of the ScienceBlogs.com network. He received a Ph.D. in theoretical astrophysics from the University of Florida in 2006. After that, he taught at the University of Wisconsin, moved to the University of Arizona to conduct astrophysics research, and moved again to Oregon to teach at the University of Portland and Lewis & Clark College. Now he is the science and health editor at Trap!t (<http://trap.it>), which is a “personalized content discovery application” that delivers recommended content from around the Web “based on rich contextual analysis of information and user preferences.” The blog, which Siegel started in January 2008 and moved to ScienceBlogs.com in March 2009, focuses on issues in the astronomy and astrophysics fields.

Ed Yong (Interview Date: December 7, 2011)

Yong runs the blog Not Exactly Rocket Science (<http://phenomena.nationalgeographic.com/blog/not-exactly-rocket-science/>) as part of the *National Geographic* network, which he joined in December 2012. At the time the interview was conducted, he was part of the *Discover* network (<http://blogs.discovermagazine.com/notrocketscience/>). Yong, a full-time freelance science writer whose work appears in major outlets, received an M.Phil. degree in biochemistry from University College London in 2004. He then became health information manager for the charity Cancer Research UK. He started the blog in 2006, the same year that he published his first freelance science piece. He remained in his job at Cancer Research UK until 2010, when he transitioned to science writing as a career. He moved the blog to ScienceBlogs.com in

2008 and then to *Discover* in March 2010. Yong is well known for writing clearly and entertainingly and about new discoveries in a broad range of fields, but his blog focuses mainly on biological research, including animal behavior, evolutionary biology, psychology, and neuroscience.

Shara Yurkiewicz (Interview Date: August 31, 2012)

Yurkiewicz runs the blog This May Hurt a Bit (<http://blogs.scientificamerican.com/this-may-hurt-a-bit/>) as part of the *Scientific American* network, which she joined in January 2013. At the time the interview was conducted, the blog was part of the PLoS network (<http://blogs.plos.org/thismayhurtabit/>). Yurkiewicz, who graduated from Yale University with a degree in molecular, cellular, and developmental biology, is currently a student at Harvard Medical School, from which she expects to graduate in 2014. In addition, through a AAAS Mass Media Science and Engineering Fellowship, she interned as a science and health reporter for the *Los Angeles Times* in 2009, and she has been a freelance medical journalist since 2010. She has been involved in science communication in other ways, as well, such as moderating a session on self-censorship in medical writing at the 2012 Science Online conference. In the blog, which she started in 2010 and moved to the PLoS network in July 2011, she focuses on medical ethics and life as a medical student, drawing mainly on personal experience to craft narratives.

Carl Zimmer (Interview Date: October 24, 2011)

Zimmer runs the blog The Loom (<http://phenomena.nationalgeographic.com/blog/the-loom/>) as part of the *National Geographic* network, which he joined in December 2012. At the time the interview was conducted, he was part of the *Discover* network (<http://blogs.discovermagazine.com/loom/>). Zimmer is an author and journalist who writes a regular column and regular stories for the *New York Times* and essays for numerous other publications; he has also written 12 books about science. Zimmer, who majored in English at Yale University, also lectures at Yale about science writing. He started his career in science writing at *Discover*, where he eventually became a senior editor, before embarking on a freelance career in 1999. His work covers many areas of science, but particularly parasitology and evolution. He started The Loom in 2003 on his own website; a short time later, he moved it to a website called Corante (<http://www.corante.com>), which hosts mostly technology blogs, and then to ScienceBlogs.com in June 2006. In July 2008, he moved it again to the *Discover* blog network. The blog, as he explained in the interview, is a “disheveled mix” of whatever intrigues him (Zimmer 2011b).

Bora Zivkovic (Interview Date: January 6, 2012)

Zivkovic runs the blog A Blog Around The Clock (<http://blogs.scientificamerican.com/a-blog-around-the-clock/>) as part of the *Scientific American* network, for which he also serves as the Blog Editor. Zivkovic received an M.S. degree in the Department of Zoology at North Carolina State University, focusing on circadian rhythm, and continued to conduct research before deciding to devote his time instead to political activism in

2004. This online political activity evolved to blogging about science; eventually, Zivkovic became deeply involved in developing the science blogging community by co-organizing the annual Science Online conference in North Carolina and helping to create *The Open Laboratory* anthology. Through his blogging, he obtained a job as the Online Community Manager at the public access journal PLoS ONE, where he worked from 2007 to 2010. He started his current job with *Scientific American* in September 2010, recruiting dozens of bloggers in preparation for that network's launch the following year. He started his own science blog in 2005 and moved to ScienceBlogs.com in 2006. He left that network in July 2010 because of "PepsiGate." At *Scientific American*, his blogging activity includes a mix of science content and thoughts about science communication.