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Social Media, Public Participation, and the 2010 BP Deepwater Horizon Oil Spill

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ABSTRACT

This research examines how information about an oil spill, its impacts, and the use of dispersants to treat the oil, moved through social media and the surrounding Internet during the 2010 BP Deepwater Horizon oil spill. Using a collection of tweets captured during the spill, we employ a mixed-method approach including an in-depth qualitative analysis to examine the content of Twitter posts, the connections that Twitter users made with each other, and the links between Twitter content and the surrounding Internet. This paper offers a range of findings to help practitioners and others understand how social media is used by a variety of different actors during a slow-moving, long-term, environmental disaster. We enumerate some of the most salient themes in the Twitter data, noting that concerns about health impacts were more likely to be communicated in tweets about dispersant use, than in the larger conversation. We describe the accounts and behaviors of highly-retweeted Twitter users, noting how locals helped to shape the network and the conversation. Importantly, our results show the online crowd wanting to participate in and contribute to response efforts, a finding with implications for future oil spill response.

Key Words: social media, crowdsourcing, citizen science, emergency response, oil spill response, digital volunteerism, emergent organization.

INTRODUCTION

On April 20, 2010, the Deepwater Horizon oil rig exploded and sank into the Gulf of Mexico off the coast of Louisiana. For 87 days, oil flowed from the seabed, resulting in what became the largest marine oil spill ever along a U.S. coastline (Robertson and Krauss 2010). Oil made its way to the waters and shores of Louisiana, Alabama, Mississippi, and Florida, causing environmental damage, economic impact and concern for human health in the region.

In the immediate aftermath of the explosion more than 47,000 people were involved in efforts to burn, contain, recover, or disperse oil. The use of two chemical dispersants, Corexit 9500 and Corexit 9527, became controversial among both experts and the public who grew concerned about health impacts on marine life and humans. According to the National Commission on the BP Deepwater Horizon oil spill and Offshore Drilling (Graham *et al.* 2011), this controversy was fueled by three factors: the unprecedented amount of dispersants used (1.84 million gallons); the novel, untested application of dispersants underwater; and lack of guidelines about overall amounts used and duration of use.

The BP Deepwater Horizon oil spill sparked considerable conversation on the web—from mainstream news, to the blogosphere, to the social media sites. Twitter is a microblogging platform that allows users to share short messages with their account's "followers" as well as with the general public. At the time of the oil spill, Twitter was just over 4 years old, but was experiencing rapid growth (Costolo 2010). Recent earthquakes in Haiti (January 2010) and Chile (February 2010) had attracted attention to the Twitter platform as a place for information sharing, sense-making, and digital volunteerism during disaster (HHI 2011; Starbird and Palen 2011). Not surprisingly, individuals and organizations, both remote and local to the disaster, turned to Twitter to discuss the spill.

BACKGROUND

Social media are becoming a consistent feature of the crisis response milieu. Affected people are turning to these platforms to share information about event impacts (Liu *et al.* 2008; Palen *et al.* 2010; Bruns *et al.* 2012); to seek information from others (Palen *et al.* 2010); and to coordinate community-based response efforts (Shklovski *et al.* 2008, Qu *et al.* 2009; Sutton 2010). Remote audiences are converging into online interaction spaces both as spectators (Hughes *et al.* 2008) and as digital volunteers (Starbird and Palen 2011). The live mapping of

public information shared over social media and other public forums, an activity that is itself coordinated using social media and other online tools, has become a common activity during disaster events (Liu and Palen 2010; Goolsby 2010; Zook *et al.* 2010).

On one hand, researchers (*e.g.,* Palen *et al.* 2010), practitioners (Harvard Humanitarian Initiative 2011; Merchant *et al.* 2011), and media (Ngak 2012; Yeomans 2012) have been optimistic about the potential for social media to play a productive role in getting timely information to affected people and thereby improving their decision making. Along these same lines, digital volunteerism has been characterized as having the potential for improving response outcomes by facilitating connections between people and resources—in the form of information, responders, supplies, *etc*. (Starbird and Palen 2011).

But there are also concerns about the use of these tools during disaster events, including the potential spread of misinformation (Hughes and Palen 2012; Starbird *et al.* 2014) and the disruption of traditional response processes (HHI 2011).

Social Media Use by Emergency Responders

With the knowledge that their publics are already online and expecting them there, emergency responders are increasingly experimenting with social media and other online tools for both outgoing and incoming crisis communications, though these forays are not without their challenges. Latonero and Shklovski (2011) describe how one emergency manager (EM), an early adopter of social media, uses these new tools to broadcast messages, to interact, and to listen to the public. The EM describes how the ability to listen to the public through sites like Twitter is extremely important, as it enables him to identify rumors, misinformation, and concerns of members of his community, and to respond to them with better information in real-time. Monitoring social media can also increase situational awareness for responders, and empirical research shows that platforms like Twitter contain a significant amount of situational awareness information during and after disasters (Vieweg *et al.* 2010).

Hughes and Palen (2012) report that social media use is disrupting the work of response professionals who serve as Public Information Officers (PIOs), repositioning them as translators of information, rather than gatekeepers. However, they note that many PIOs are concerned about these changes, feeling that they do not have the capacity or the training to handle social media communications, and fearing the spread of misinformation through these channels. On the other

side of this relationship, when official channels of emergency-related information are not adequately meeting their information needs, citizens turn to informal channels—and social media are increasingly playing a role in informal information-seeking (Sutton *et al.* 2008).

Social Media Use during the 2010 BP Deepwater Horizon Oil Spill

In June 2010, Pew released a survey conducted June 3-6 of that year, finding that nearly two-thirds of Americans were following the oil spill story closely, and that respondents trusted the news media more for information about the spill than the government or BP (Pew 2010a). Forty-six percent of respondents reported that they had little or no trust in the U.S. Federal Government.

Later that summer, Pew published a related study of the role of media in the event (Pew 2010b), reporting that the oil spill dominated the mainstream news during the 100 days after the spill. They noted that due to the complex nature of the spill itself and the methods for cleaning it, media professionals had to have (or quickly gain) a large amount of technical and scientific expertise, and for the most part, the report claimed, they rose to the occasion. Looking to some of the content of the coverage, their research also indicated that while President Obama had received mixed (both supportive and critical) coverage, BP and BP CEO Tony Hayward emerged as villains.

Sutton *et al.* (2013) examined how government organizations used the Twitter platform during the 2010 BP Deepwater Horizon oil spill, using what they called the "microstructure"—*i.e.,* retweets, mentions, replies, and links—within tweets to characterize tweeting behaviors from government accounts, and mapping out the network of government accounts using friend-following relationships. They report that government accounts were less likely to interact with others using the retweet mechanism and had a larger proportion of non-reciprocal friend-follower relationships than other accounts—supporting a view of government entities using Twitter primarily as a broadcast mechanism.

Spiro *et al.* (2010) looked at rumoring behavior during the oil spill, using quantitative analysis to assess the drivers of social media activity related to the spill. They found that news coverage increased the volume of tweets related to the spill, and concluded that saliency of an event drives online participation. They also found that serial transmission of information (in the

form of retweets) was more common in tweets with event-related keywords. That study did not look at the content of tweets or rumors or at whose information was being transmitted (retweets).

This research complements the largely quantitative studies of Twitter use during the 2010 BP Deepwater Horizon oil spill (Spiro *et al.* 2010; Sutton *et al.* 2013), employing mixed methods, including an in-depth qualitative analysis, to examine the kinds of information that were flowing through social media and to identify the individuals and organizations who played important roles in shaping those flows.

Twitter

The analysis focuses on a dataset collected during the event from public Twitter messages. A vast majority of tweets are public and searchable, an affordance that contributes to the platform's utility during crisis events.

Though the original premise of Twitter was quite simple, users have introduced several linguistic conventions to increase its usability, including the mention (@username), the retweet (often RT @username or via @username) and the hashtag (#keyword). Mentions allow a user to send a public message directed specifically to the attention of another user. Retweets act as a forwarding mechanism, where a downstream user can repost a message that they have seen, giving attribution to its original author or another upstream Twitter user. Retweets also serve, for some, as a recommendation mechanism, both of the information and the author (Starbird and Palen 2010). Hashtags act as a mechanism for Twitter users to mark up their tweets with certain keywords, connecting them with certain groups or conversations and increasing their searchability. In recent years, Twitter has added functionality to support these conventions. At the time of the 2010 BP Deepwater Horizon oil spill, they had recently rolled out one-click retweet functionality, though many Twitter users still employed other methods, including manual ones, for marking their tweets as retweets.

These tweet features can be important for tracking information flow in the space. Hashtags can be used to home in on specific kinds of conversation and sub-groups in the conversation space, and are therefore useful for focused search. Retweets and mentions demonstrate different kinds of connections between users, and can be traversed to create network graphs.

OBJECTIVES

The objectives of this research are to evaluate the social media response to the BP Deepwater Horizon oil spill. We look to the Twitter conversation around the #OilSpill hashtag to assess how members of the public understood—and perhaps more importantly how they *came to understand*—the actual and potential impacts of the disaster, the response efforts, and specifically the use of oil dispersants in the clean-up. We examine the role of Twitter in shaping public understanding, and look at how specific social media actors influenced the conversation. In particular, we focus on the Twitter activities of people who were locals—we designate an account as "local" if the account owner appeared to be tweeting from within 100 miles of the Gulf Coast. We examine the kinds of content locals shared and linked to in their tweets as well as with whom they interacted and how to get a sense of how the conversation affected and was affected by those who had, by some measures, the most at stake.

METHODS

This research consists of an in-depth qualitative analysis of Twitter data, complemented by descriptive network and quantitative analyses, to examine information flow within that social media platform as well as the broader information space of the surrounding Internet.

Data Collection

Total #OilSpill Tweet Collection. Twitter provides several Application Programming Interfaces (APIs) that allow anyone to collect public Twitter data programmatically. The data analyzed in this study were collected using Twitter's Streaming API, which enables a forward-in-time search on a keyword or a set of keywords. We collected on the term #OilSpill (or #oilspill), a hashtag that emerged to signal participation in the ongoing, public conversation around the event. For each tweet, we captured the timestamp, author, and tweet text. This larger dataset is referred to in this paper as the *Total #OilSpill Collection*. Several parts of the analysis refer back to this set, including the network diagrams.

Collection period. The collection period spanned from May 9, 2010 (~3 weeks after the spill began) and August 4, 2010 (~3 weeks after the well was capped). However, during that time our collection software went inactive for several short time periods (less than 8 hours) and one long

period (July 8–July 12) and no tweets were collected at those times. Figure 1 is the volume of tweets per day during the collection period.

***High level description of the Total #OilSpill Collection*.** The collection captured 693,409 tweets sent by 132,075 different Twitter users (see Table 1). Though the mean suggests each Twitter user sent 5.25 tweets, the number of tweets per Twitter user has a heavy-tailed distribution typical of many social media metrics (see Figure 2), and the vast majority of Twitter users contributed only one tweet to our set. Of those, the sole tweet was most often a retweet, indicating relatively low engagement in the #OilSpill conversation. Only 8,464 users sent 10 or more #OilSpill tweets, but those 6.4% users produced more than half the tweets we collected.

***Dispersant-related tweets*.** Within the *Total #OilSpill Collection*, we identified 11,146 tweets as having content related to oil dispersants based on the inclusion of any of the keywords: *dispersant*, its common misspelling *dispersent,* or *Corexit*, the dispersant brand that drew the most discussion during the event. Dispersant-related tweets constitute 1.6% of the tweets in the *Total #OilSpill Collection* and were sent by 3,283 different Twitter accounts. Shown in Figure 3 is the volume of dispersant-related tweets per day.

Data Sampling

Because this research was designed to assess both the broader conversation about the BP Deepwater Horizon oil spill and commentary specifically related to dispersant use, we randomly selected 250 tweets from the *Total #OilSpill Collection* and 250 tweets from the 11,146 that contained a dispersant-related term. We refer to these 500 tweets as the *50-50 Random-Dispersant Sample*. With this sample, we were able to complete an in-depth qualitative analysis of tweet content that is respectively representative of the broader conversation around the oil spill and of the specific conversation that took place concerning dispersants.

Our sampling strategy, in concert with the heavy-tailed distribution of tweets across Twitter users, results in an important discrepancy in representativeness between the overall tweet and Twitter user distributions. Using a tweet-based sampling strategy, users who sent 100 tweets are 100 times more likely to appear in the sample than users who sent one tweet. Therefore, though the 500 tweets in the *50-50 Random-Dispersant Sample* represent a random sample of the overall tweet distribution, the accounts owners in the *50-50 Random-Dispersant Sample* are more likely

to be higher volume #OilSpill tweeters than the average account in the set, a limitation which we account for in the reporting of our findings.

Data Analysis

The analysis took place in four stages: exploratory analysis, qualitative coding of tweets, qualitative coding of articles linked-to by tweets, and mixed-method analysis of results.

Exploratory analysis

We first approached the *Total #OilSpill Collection* data quantitatively, calculating the larger features of the set (*e.g.,* number of retweets and URLs) and creating network graphs of the interactions. This helped us understand some of the features of the larger set, including which accounts were influential. It also informed our sampling strategy.

Tracing information flow using retweets, replies and URLs. Retweets, replies, and URL links within tweets play important roles in information flow within Twitter and across the broader information space of the Internet. If we think of these information spaces as networks, these linguistic markers within tweets can be inferred to generate connections between accounts (retweets and replies) and between Twitter and other sites (URLs).

Shown in

Table **2** are the number of retweets, replies, and tweets with URLs both within the *Total #OilSpill Collection* and within the subset of tweets that contain dispersant-related terms. Forty-four percent of the tweets we collected are retweets and 69% contain a URL link to an external webpage. For both features, these are much higher rates (approximately three times) than what would be found across a completely random set of tweets in 2010 (Rao 2010; Suh *et al.* 2010). So, #OilSpill tweets were more likely to contain a URL and to be retweets than the average tweet. For dispersant-related tweets these numbers are even higher—53% are retweets and 75% contain a link. Both of these suggest that many Twitter users relied on other sources and websites for the information they were sharing about the #OilSpill. First-hand and other information that was new to the broader information space, though certainly present, was less prevalent.

Network analysis. One way to examine information flow during the event is through network visualizations. Using linguistic conventions in tweet content (like retweets and

mentions) we can construct networks of relationships between Twitter users that are event-specific and separate from their lists of followers and followings.

Figure 4 is a network graph showing the connections created by each retweet in the *Total #OilSpill Tweet Collection.* Each node in the graph represents a Twitter account in our set and is sized by the number of retweets that account received. Each edge (line connecting a pair of nodes) represents a retweet of one account by another and they are sized according to the log number of retweets sent between the two accounts. Accounts in this graph are grouped into and subsequently colored by "clusters"—nodes in the graph that have similar sets of connections to other nodes—as determined by the Louvain method (Blondel *et al.* 2008).

We used this network graph to inform the preliminary analysis of #OilSpill data and later to interpret and contextualize findings.

Qualitative coding of tweets and URL links

We coded the *50-50 Random-Dispersant Sample* data across two separate dimensions: tweet content and URL link content.

Tweet content. For each tweet in the *50-50 Random-Dispersant Sample,* we coded across several dimensions including tweet theme and whether the tweet contained scientific content. Categories for tweet theme coding were initially developed using a grounded approach across a large, preliminary sample of tweets. These thematic categories (see Table 4 for the full list) were therefore ones we found, through an iterative coding process, to be salient in the Twitter data for this event. Later, we grouped these categories according the Drivers-Pressure-State-Impact-Response (DPSIR) framework (Smeets and Weterings 1999).

URL link content. A large portion of tweets in the *Total #OilSpill Collection* (69%) contain an embedded URL link. To capture a picture of the larger information space surrounding Twitter, and the flow of information between Twitter and other sites, we explored the content of embedded links in our sample.

Of the 500 tweets in the *50-50 Random-Dispersant Sample*, 354 contained a web link. Many of these links were still active and we were able to recover others through the Internet Archive online service (https://archive.org/web/). Ultimately we were able to locate the original content of 81.5% of the links nearly three years after the event.

We were particularly interested in the range of sources that were mentioned in different cited articles. We coded individuals and entities mentioned in linked-to web content across multiple dimensions, including role and organizational affiliation. We also captured title, author, domain, and media type (*e.g.,* news article, video, blog, petition). Specific to characterizing the nature of dispersant related tweets, we noted when a link's content contained a high level of scientific or technical content. This analysis allowed us to see the kinds of external sources that different Twitter users brought into the #OilSpill conversation.

Mixed-method analysis

Finally, we analyzed the results of the coding, integrating descriptive statistics of the codes with further qualitative analysis of tweet content, Twitter user behaviors, and network connections between users. This mixed method approach provides a rich set of findings, described below.

Data Limitations

Consistent with other studies on social media data (boyd and Crawford 2011), these data represent only a subset of the broader Twitter conversation about the 2010 BP Deepwater Horizon oil spill and have specific biases related to its collection and sampling. Most significantly, only tweets where the account owner purposefully used the #OilSpill hashtag in their tweets were collected, which means that account owners who were not aware of the hashtag are not represented in this analysis. However, the presence of certain accounts, including several high-volume, local Twitter users and the official Twitter account of Unified Command (@Oil_Spill_2010), suggests that some portion of the relevant oil spill conversation was indeed organized around the use of this hashtag. Unified Command is the term used to describe the authorities responsible for jointly managing an incident near where it occurs. This was the account operated by the U.S. Coast Guard in New Orleans.

RESULTS

Network Analysis: Diverse Voices

The #OilSpill conversation included a variety of different voices, including: wildlife and other non-governmental organizations (NGOs), locals, response organizations, accounts specific

to the event, media, celebrities, and political bloggers. Tracing retweet connections on Twitter allows us to see how some of these accounts interacted with each other (Figure 4). Retweets show how information spreads across different Twitter users. They can also be viewed as a form of recommendation for specific tweets or for accounts (Starbird and Palen 2010). Listed in Table 3 are the 10 most-retweeted accounts in the *Total #OilSpill Collection,* the voices that resonated most among the online "crowd"—the numerous users, connected by information-communication technology, who came together to participate in the online conversation about the spill.

NGOs as independent domain experts

An examination of Table 3 shows the National Wildlife Federation (@NWF) and the International Bird Rescue Research Center (@IBRRC) to be by far the most-retweeted accounts in the *Total #OilSpill Tweet Collection*. These two accounts are also both somewhat central in our network graph. Both organizations are NGOs that focus on the environment and on wildlife protection and rescue, and both existed prior to the 2010 BP Deepwater Horizon oil spill.

The NWF is a non-profit organization that promotes conservation education and advocacy efforts in the United States. During the oil spill, their Twitter account was retweeted 7,677 times by 4,103 different Twitter users, suggesting a broad impact and likely reflecting a high number of followers. They sent 256 #OilSpill tweets during the event, receiving nearly 30 retweets per tweet, the most of any highly-retweeted account in our dataset. Two hundred thirty-six (236) of their tweets (92%) contained a link to a webpage, often to a blog on their own website or to a source in the mainstream media.

Evidence suggests that NWF's tweets impacted the conversation about dispersants. Though they sent only four tweets referring to dispersant use, those tweets—which were critical of BP's strategy for deploying dispersants—were retweeted 111 times.

@NWF (May 10): Using dispersants on an #OilSpill doesn't reduce the total amount of oil in the environment: http://bit.ly/daeo8q

@NWF (May 25): BP Still Stonewalling EPA on Dispersant Chemicals http://bit.ly/cmXif8 #OilSpill

The IBRRC is an organization of veterinarians and scientists who specialize in cleaning birds after oil spills. They tweeted 1,209 #OilSpill tweets during the event, often with links to photos or articles on their own site that described their clean-up efforts. Many of their tweets contained photos of oiled or recently cleaned birds.

Though the IBRRC was retweeted almost as much as the NWF within the #OilSpill conversation, a deeper analysis shows the crowd interacting with their account in a different way. IBRRC was retweeted 7,327 times by 2,291 different Twitter users, which means that far fewer users retweeted them, but these users were more likely to retweet them multiple times. Significantly, though the NWF had the more prominent position in the larger Twittersphere, the IBRRC was more highly-retweeted among the local, high-volume #OilSpill tweeters in the *50-50 Random-Dispersant Sample*. Put another way, while the NWF had a broader impact on the larger Twitter crowd, messages from the IBRRC seem to have resonated more with those who were more engaged with the event.

Importantly, both of these highly-retweeted organizations had domain expertise relevant to the oil spill. Their accounts also share a degree of independence from the event, which may have contributed to their highly retweeted status.

A local Twitter user at the center of the conversation

There were 41 local Twitter users in the *50-50 Random-Dispersant Sample*. One local Twitter user, @SaintsFan1[1], was the third most retweeted account in the *Total #OilSpill Collection*, with 5,261 retweets. Like several other locals, she was also a high-volume Twitter user, sending 5,173 #OilSpill tweets over the course of the event.

Though her per-tweet impact was not very high—about one retweet for every tweet—her overall impact on the #OilSpill conversation was, especially among other locals and other users who were highly engaged. Significantly, she was retweeted by far fewer unique Twitter accounts than other highly-retweeted accounts in the data. For instance, while the NWF and IBRRC were retweeted by 4,103 and 2,291 different accounts respectively, @SaintsFan1 was only retweeted by 877 different accounts. However, these 877 Twitter users were both more engaged with @SaintsFan1 (each retweeted her on average 6 times) and more engaged with the #OilSpill conversation over the course of the event. People who retweeted @SaintsFan1 sent a mean of 164 and a median of 40 #OilSpill tweets each, far more than the mean (5.25) and median (1) from the dataset at large.

@SaintsFan1 can be seen as having a form of *local authority* (Starbird and Palen 2010), because she lived in an affected area. Our network and retweet analyses show her as central and

[1] This account name is anonymized to protect the privacy of the Twitter user.

highly influential within the network of high-volume #OilSpill tweeters, especially among other locals. She is not the only local in the set—our coded sample identified 40 other accounts that were operated by someone who was in the affected area at some time during the event—but she is by far the most influential individual who is not associated with an organization or the media.

@SaintsFan1 also used the Twitter platform in various ways. One was to engage publicly with government accounts related to oil spill response. She sent 379 "reply" tweets that she also marked with the #OilSpill tag, intentionally calling these tweets to the attention of others following the conversation. These included 4 tweets to the @WhiteHouse, 7 to @BarackObama, 37 to @LisaPJackson (USEPA head during the event), and 26 tweets to the @Oil_Spill_2010 account (described below). Below are a few samples of these tweets:

@SaintsFan1 (May 16, 2010): @WhiteHouse We paid for ALVIN & NR-1 with our taxpayer dollars, so we demand deployment now w/media 14on't14a14. #oilspill #oceans

@SaintsFan1 (May 27, 2010): @BarackObama Mornin Mr. President sir. Please take the WHPressCorps on a tour with Billy Nungesser IN the marsh, not on the shore #oilspill

@SaintsFan1 (July 18, 2010): @LisaPJackson : pls consider disbarring BP from ALL federal contracts including those w/Defense Energy Support Center (DESC) #oilspill

These tweets show a local Twitter user leveraging that platform in attempts to make her voice heard, questioning the government's clean-up strategies and giving directives to government officials. These tweets were often retweeted, which amplified these sentiments across the larger information space. From another perspective, these tweets also represent an opportunity for the recipient accounts of government representatives and organizations to respond directly to constituents, in this case to an influential local Twitter user, through the social media platform.

@SaintsFan1 also engaged with other local users in the set, and sent 44 public tweets to @BP_America, the official account of BP for the spill, including these two:

@SaintsFan1 (June 24, 2010): @BP_America During #oilspill cleanup, your co. has a DUTY 2 ensure that workers R protected frm the harms caused by exp. 2 oil & dispersant

@SaintsFan1 (June 26, 2010): @BP_America : You call this cleaned? The oil is still beneath the sand! http://www.youtube.com/watch?v=5zQydQB7TOQ #oilspill #blacktide

Like many others in the set, @SaintsFan1 was especially critical of BP, accusing them of not doing everything they could to stop and clean up the spill, and also implying that they were more concerned with avoiding responsibility than with protecting the environment and the health of people in the region.

Along another dimension, @SaintsFan1 can be seen to use Twitter to converse with others as opposed to simply broadcasting her views to the crowd—though she certainly used the platform for both purposes. The high volume of tweets she sent suggests an "always on" status; for those following her or following the #OilSpill hashtag, each tweet may have signaled an availability or even a willingness to converse and engage with others. Her tweet stream also contains thousands of links to outside sources, showing her to be performing a kind of curatorial role in addition to her eyewitness reporting. Across the breadth of these tweets, an account "personality" comes through, including some insight into a range of fears, questions, and concerns that this local Twitter user had during the oil spill.

Formal responders using Twitter to communicate and engage

Within the #OilSpill data, there were a handful of accounts that belonged to formal response organizations, including: @Oil_Spill_2010, the official Twitter account of Unified Command's Joint Information Center during the summer of 2010; and @GOHSEP, the Louisiana Governor's Office of Homeland Security and Emergency Preparedness. Both were highly retweeted.

@Oil_Spill_2010 was the fourth-most retweeted account in the *Total #OilSpill Collection*. Though that account is now gone and—problematically—another has taken its place, their profile at the time read, "Official tweets from the Deepwater Horizon Incident Joint Information Center (JIC) on Unified Command response efforts to the oil spill in the Gulf of Mexico." They had significant impact on the broader #OilSpill conversation as indicated by their high retweet rates (4,738 total retweets from 1,600 different accounts). The account was second-most popular—in terms of retweets—among locals in the *50-50 Random-Dispersant Sample*. @Oil_Spill_2010 sent a total of 616 #OilSpill tweets, receiving about 8 retweets per tweet.

The @Oil_Spill_2010 account was one part of a comprehensive communications strategy employed by Unified Command's JIC that included liveblogging of press conferences; two event-specific websites with audio, video, and transcripts; a YouTube channel; a Facebook group; a Flickr account; a widget; and text messages. The JIC used the Twitter accounts to promote their other communication venues and to broadcast information from government organizations such as health information from the CDC and maps of the spill from NOAA. Each day, a link to a summary of command and government activities was promoted via Twitter along with "status maps" of the event. Actions of the government's oil spill leadership were updated frequently. In addition, non-governmental activities were reported such as BP America's announcement that claims were being taken. Occasionally, @Oil_Spill_2010 linked to media stories from national sources like CNN and the New York Times.

In addition to serving as a newswire, Twitter was employed by the JIC as a way to monitor public concern and, at times, to converse with them directly. Ideas for capping the well were solicited through Twitter. Questions on topics such as how to volunteer in the clean-up were answered. Later in the paper, we return to discuss difficulties this account had with engagement.

The celebrity effect: broad, yet shallow

In research on Sina-Weibo, a Twitter-like microblogging platform that is popular in China, accounts of celebrities and other "VIPs" were shown to play an important role in information diffusion during a crisis event (Qu *et al*. 2011). In the #OilSpill Twitter conversation, two U.S. entertainment celebrities with large Twitter followings, @Alyssa_Milano and @Jason_Pollock, were among the most retweeted. In both cases, large following numbers likely contributed to their highly-retweeted status. Both had peripheral positions in the #OilSpill network graph, a finding supported by the fact that the number of different people who retweeted these celebrities is quite high in proportion to their retweet count—*i.e.,* most people who retweeted them did so only once, and for many of these, this was the only #OilSpill tweet that user sent. This suggests that though celebrities and others with large followings may be able to attract a large number of people to engage in a topic, this engagement is likely to be low.

A local media consortium and a national reporter on the ground

The 2010 BP Deepwater Horizon oil spill was widely covered by traditional journalism outlets (Pew 2010a,b). Two of the 10 most retweeted accounts in the *Total #OilSpill Tweet Collection* are media-related. Ranked #5 in the list of most-retweeted accounts, the most retweeted media account is a consortium of local and regional media outlets that came together for the event to report from the impacted area. @GulfOilCleanup is self-described in its Twitter profile as a collaborative effort of AL.com, Mobile Alabama's *Press-Register*, *The Mississippi Press,* and GulfLive.com. For the most part, the @GulfOilCleanup account tweeted headlines and links to news articles and blogs from these different media organizations.

Also on the top-ten list for the *Total #OilSpill Tweet Collection* is Mac McClelland (@MacMcClelland), a journalist who reported from the affected area during the spill for the national magazine *Mother Jones*. McClelland posted many tweets in real time as she travelled through the impacted area, often walking the beaches and tweeting her observations of oil impacts. Her account is in a central position in our large network graph, but interestingly, she is not highly-retweeted by the high-volume #OilSpill tweeters in our *50-50 Random-Dispersant Sample.* She appears as the 47th most-retweeted Twitter user by locals in that sample. This suggests that she may have been more influential across the broader crowd than among those who were highly engaged in the spill.

Accounts specific to the 2010 BP Deepwater Horizon Oil Spill

@GulfOilCleanup is also one of 21 accounts in the *50-50 Random-Dispersant Sample* coded as being specific to the oil spill. The accounts were created during the event with the expressed purposes of responding in some way to the spill. Two other event-specific accounts, @SaveTheGulf and @BPGulfLeak, were among the 10 most-highly retweeted accounts by *locals* in the *50-50 Random-Dispersant Sample* (see Table 3).

Some of these accounts, such as @SaveTheGulf, represent coordinated groups who aimed to volunteer or otherwise address the event collectively in some fashion. Others, including @BPGulfLeak, appear to be the work of single individuals. Some of these groups may have been purely online organizations, but others seem to have some offline interaction as well (*e.g.,* @GulfOilCleanup and @gulfvolunteers), and some, though certainly not all, had members in the affected areas along the Gulf Coast. The emergence of multiple event-specific accounts supports

other evidence that **members of the crowd sought out ways to actively contribute to response efforts through volunteerism and activism.**

The political echo

Political commentary was part of the overall mix of themes in #OilSpill conversation. The following tweets are just a few examples (among thousands) of how people with different political viewpoints weighed in:

@anonymized1: It took George W Bush two days to waive the Jones Act after Katrina. It took Obama SEVENTY days to do so after #oilspill. **(23 retweets)**

@anonymized2: I don't know if the #oilspill is Obama's Katrina, but Obama is certainly America's Katrina! #tcot #p2 **(15 retweets)**

@anonymized3: If one really needs a metaphor, and employs logic to make one, #oilspill is Cheney's Chernobyl, not Obama's Katrina. **(15 retweets)**

During the exploratory analysis we encountered a large number of tweets of a political nature, and we later determined 20 of the 387 accounts in the *50-50 Random-Dispersant Sample* to be primarily devoted to political commentary. Many political tweets were extremely negative towards and explicitly distrustful of the government in general and the response efforts particularly. They also contained a notable amount of content that we determined to be related to one of several "conspiracy theories" spreading within the space.

@Sami_Shamieh (July 5, 2010): They Must Be Hiding Something Really Big in the Gulf http://bit.ly/bk31ng #tcot #p2 #oilspill #crimeinc

It was therefore not surprising to find a political blogger among the most retweeted. @sami_shamieh, at #9, is a political blogger who sent more than 1000 #OilSpill tweets, many laying blame on the Obama administration for not adequately responding to the event. Significantly, the retweet network graph (Figure 4, largest node in red) shows this account to be at the core of a separate conversation-network related to the spill, and that, though vocal and inflammatory, it was not central to the mainstream #OilSpill conversation. However, a few locals did connect with this account—four local accounts in the *50-50 Random-Dispersant Sample* retweeted @sami_shamieh a total of eleven times—showing some exchange of information

between political outsiders and those affected by the spill, an effect that opened up channels for the transmission of politically motivated speculation and commentary on response efforts.

Tweet Themes: Differences in Dispersant-Related Tweets

Shown in Table 4 is the distribution of tweets from the *50-50 Random-Dispersant Sample* according to the themes that presented. Each tweet was assigned up to two themes from the list. Tweets that were not related to dispersants contained a wide range of themes (see Table 4). Eighteen percent of these tweets were simply about the state of the spill. Fifteen percent dealt with environmental impact. Twelve percent focused on liability issues, with many of these suggesting that BP be held accountable. About 10% were calls to action, including requests to sign petitions or join in volunteer activities. Commentary on how the oil spill was being communicated by official sources, including accusations of a cover-up, constituted about 10% of tweets in the broader conversation. Another 10% of tweets contained remarks on drivers of the event, including environmental and commercial policy. Political impact was a primary theme in 7.5% of non-dispersant tweets.

Dispersant-related tweets focused around a smaller set of themes. Seventy-six percent related to the clean up strategy, including aspects of the risks and benefits of dispersant use. Fifteen percent dealt with environmental impacts and 13% were focused around health impacts, like the tweet below:

@NolaAnn[2] (July 12): .@BP_America I wanna kno what #BP is gonna do for my Daughter age 4 if shes sick b/c of your use of #Corexit in #OilSpill #Toxic #blacktide

Significantly, dispersant-related tweets were much more likely to refer to human health impacts than tweets that did not mention dispersants (13% to 2%, see Table 4, row 3). This suggests that while the social media crowd talked about the oil itself as an environmental disaster, **dispersant use brought up more concerns around human health**.

Though we identified mental health impacts as a potential theme from existing literature on oil spill affected communities (Lyons *et al.* 1999; Palinkas *et al.* 1993) and through interpretation of the emotional tone of tweets during preliminary analysis, tweet coding did not show Twitter users talking explicitly about mental health impacts. In other words, though we perceived that

[2] This account name is anonymized to protect the privacy of the Twitter user.

mental health impacts were, for some users, manifesting within their tweets, none of the 500 tweets in our sample referred to them directly.

The Public Grappled with Scientific Complexity and Uncertainty

Analysis of tweets and URLs shows a public grappling with the scientific complexity and uncertainty that characterized the clean-up efforts after the 2010 Deepwater Horizon oil spill.

@oceandog (July 12, 2010): Researcher says Corexit is toxic at only 2.61 PPM and reacts to warming of Gulf. #OilSpill #ecocide

In the above tweet, a local Twitter user attempted to communicate that Corexit's "low" toxicity measure of 2.61 was actually problematic. Some members of the public may have had a hard time understanding that low toxicity numbers are worse than high numbers; the U.S. Environmental Protection Agency (USEPA) attempted to explain this concept on their website (USEPA 2013). @Oceandog's tweet content addressed some of this complexity. There were a few other tweets that tried to communicate the complexity solely within tweet content, but the scientific sophistication of the information space was even more evident in the URL content linked to from within the tweets. The Material Safety Data Sheet (MSDS) for Corexit, a document that governments require chemical manufacturers to provide to those who handle their products, appeared several times in the dataset in different forms—*e.g.,* as a PDF, or pasted into a blog. Other links contained screenshots of information appearing on Corexit barrels and a product description from a supplier. Four tweets linked to an academic article describing the toxicity of Corexit dispersants. These source documents, intended for a technical or scientific audience, became part of the broader discussion on Twitter, shared by local, unaffiliated users as well as journalists, NGOs, and response accounts.

Tweet data show that, within the complex conversation about dispersant use, **social media users valued the voices of scientists and sought out scientifically sophisticated sources**. A percentage of 6.4% (16) of dispersant-related tweets in the *50-50 Sample* reference a scientist using one of the following terms: *scientist*, *researcher*, *chemist* or *biologist*.

@SaintsFan1 (July 23, 2010): Leading Ocean Scientists Issue Consensus Statement to End Dispersant Use (CNBC) http://bit.ly/ajhfmq #oilspill #blacktide

@oceansforme (June 8, 2010): Alabama scientist: Dispersant worse than oil on shore - Andalusia Star-News http://bit.ly/d4M0gQ #oilspill #ocean

The above examples show how users shared tweets citing scientists in reference to the conversation about dispersant use. Interestingly, only one tweet in the *50-50 Sample* that was not related to dispersants mentioned a scientist.

Examining content linked to within #OilSpill tweets shows an even greater number and diversity of scientific sources. 99 tweets in the *50-50 Sample* (more than one-third of tweets with a URL) link to sources where scientists are mentioned. Another 13 tweets link to sources with an academic or research affiliation. Dispersant-related tweets were significantly more likely to link to content citing scientists—69 dispersant-related tweets (46%) vs. 30 non-dispersant tweets (22%). Cited scientists came from a variety of fields, including ocean and marine scientists, toxicologists, biologists, environmental scientists, chemists, geologists, and engineers.

Interestingly, tweeted links reflected how scientists from different fields had different views on dispersant use. In a press release from Nalco, the company that manufactured the Corexit brand of dispersants, a civil engineer claimed dispersants reduce environmental impacts of the oil; while within a TED Talk, a marine toxicologist stated that the combination of dispersants and oil is more toxic to marine life than oil alone:

@Nalco_News: Do you know what the experts are saying about COREXIT? Find out here: http://bit.ly/9WyQ7R #oilspill

@missionblue: Today on #TED: Toxicologist Susan Shaw shows how dispersant is making #oilspill damage even worse http://bit.ly/bfgDs2

Some social media users demonstrated awareness of these conflicting views and the scientific uncertainty surrounding oil spill clean-up:

@CarmenSisson (July 13, 2010): Nearly 1 million barrels of dispersants have been poured into the Gulf, but scientists can't agree on safety. http://bit.ly/d4PGdV #OilSpill

Taken as a whole, this sample of tweets communicates many conflicting views on safety and efficacy of dispersant use. It also reveals the presence of some alternative views about how dispersants were being applied and about the possibility for negative health impacts. For example, the following tweet is one of about 30 in the *Total #OilSpill Collection* that mention a possibility for toxic rain related to dispersant use:

@Anonymized4 (June 26, 2010): Could #BP dispersant be coming down in the form of rain killing animals and crops #oilspill #NOAA #gulf #wildlife http://fb.me/BMnOzpUm

The Public Wanted to Participate

As Thad Allen, retired Coast Guard Commandant and the National Incident Commander during the response to the 2010 Deepwater Horizon oil spill, said while reflecting on the spill, "There's never going to be a major event in this country again without public participation" (Allen 2011). Sociologists of disaster might argue that public participation has always been a feature of major crisis events (Fritz and Mathewson 1957; Dynes 1970; Tierney *et al.* 2001). However, new technologies are certainly increasing the visibility of public participation and perhaps changing the nature of participation as well. Recent research shows people appropriating social media technologies to both volunteer individually and to improvise collective action after disaster events (Vieweg *et al.* 2008; Qu *et al.* 2009; Starbird and Palen 2011).

The #OilSpill tweets reveal a public that was both suffering from an impending (and seemingly unavoidable) disaster, and eager to participate somehow in responding to it. Though some Twitter users communicated intent to help directly with the clean-up efforts, as least one remarked that she was unable to find a role in official response activities. Instead, they turned to other forms of participation, including information-sharing, activism, and first-hand reporting from the impacted areas.

It is possible to view the intense information-sharing activities, the work to make sense out of a complex information space, as a form of collective action. Some Twitter users, including a handful of locals, contributed thousands of tweets through which they helped to curate the larger information space. Considering activity across the breadth of the crowd, #OilSpill participants worked to resolve some of the uncertainty of the event by assembling different pieces of information and calling on a range of sources, very often ones with scientific credentials.

Many locals also contributed by posting first-hand reports of oil impacts to Twitter, often including photos along with a textual description:

@SaintsFan1 (May 21, 2010): Baseball-sized tarballs on beach in Waveland, Miss. #OilSpill http://twitpic.com/1ptpna

@OceanDog (July 1, 2010): Oiled brown pelican-La. #oilspill http://twitpic.com/21hs3i

@NolaAnn (July 1, 2010: Ft. Morgan, Gulf Shores & Mobile Bay, AL-no oil, no orange goo, no smell. Lots of birds at mouth of the bay. Pelis 2. SEEMS ok. #oilspill

@CarmenSisson (July 13, 2010): Spent the evening exploring Biloxi to Waveland. Lots of BP workers on the beach at 9 p.m. using work lamps in Long Beach. #oilspill #response

The users whose tweets are featured above, all of whom lived near the coast in areas that were either directly affected or under threat of oil spill impacts, spent time touring coastal areas taking pictures of oil on the shore, oiled wildlife and response efforts. @SaintsFan1 spent several evenings walking her local beaches and tweeting what she saw. On several occasions, @OceanDog would drive from beach to beach, taking photos and noting observations, and then later tweet out what he had seen. This activity likely reflects multiple motivations: to participate actively in the event as a witness; to raise awareness of their situation; and to credential themselves as locals, people who were actually there.

Twitter users also turned to activism—*i.e.,* venting anger and endeavoring to affect change in regards to current response efforts and future policies:

@cleanthegulfnow (May 31, 2010): We must create a unified message and send it in unison. BAN COREXIT! Use better options: http://bit.ly/9MBwVu @epagov @barackobama #oilspill

This activity often focused on communicating outrage at the spill, its causes, its impacts, and what many saw as incompetence or corruption within the clean-up efforts. For many remote participants, activism was their primary method of participation, but locals also participated in this way. Many event-specific accounts seemed to be largely focused around activism.

Locals Used Twitter to Interact with Responders

As mentioned above, Unified Command's @Oil_Spill_2010 account was central account in the #OilSpill conversation network. That account was retweeted 1,390 times, received 268 "mentions" (where other users publicly mentioned them in tweets), and 60 "replies" (where other users directed public tweets to them).

Several Twitter users utilized the mention and reply conventions to attempt to communicate directly with the @Oil_Spill_2010 account, both to ask questions and to voice concern and anger with response efforts. @Oil_Spill_2010 sent 31 reply tweets to various other Twitter users,

showing some level of interaction between that account and the public. The excerpt below shows an interaction between one local Twitter user and that Unified Command account:

@SaintsFan1 (June 10 2010, 1:40am) @Oil_Spill_2010 Admiral STOP SPRAYING DISPERSANTS NOW IN POP AREAS. SEARCH & CLEAR AREA FIRST!!! THIS IS AMERICA!! #OILSPILL

@Oil_Spill_2010 (June 10 2010, 5:28pm): @SaintsFan1 Dispersants are only used in and over H2O. EPA has a 24/7 hotline for concerns 1-888-623-0287. #OilSpill

@SaintsFan1 (June 10 2010, 5:34pm): @Oil_Spill_2010 thank you for your response. What about workers on boats. Are they warned before aerial sprays r conducted? #OilSpill

@Oil_Spill_2010 (June 10, 2010, 6:57pm): @SaintsFan1 No dispersants are released within three miles of any boats #OilSpill

In this exchange, @SaintsFan1 initially sent an all-caps tweet—suggestive of yelling in online communication—to the @Oil_Spill_2010 account, implying that Unified Command forces were spraying dispersants over populated areas and directing Admiral Thad Allen to stop this practice.

Though @Oil_Spill_2010 did not always respond to similar tweets, in this case the account did answer, refuting the claim and offering a phone number where @SaintsFan1 can get more information. On the surface, this seems like a good response, and indeed @SaintsFan1 is noticeably less confrontational in the following tweet. However, the timing of @Oil_Spill_2010's reply, nearly 16 hours after the original tweet, demonstrates an inability for that account's operator to keep up with the real-time pace that many social media users have come to expect, a noted problem for response organizations trying to incorporate social media (Hughes and Palen 2012).

Over the next few weeks, perhaps encouraged by the initial interaction, @SaintsFan1 continued to try to interact with the @Oil_Spill_2010 account, but rarely received any response. Then, a few weeks after their first exchange, on June 27, @SaintsFan1 was in the New Orleans area and complained about air quality.

@SaintsFan1 (June 27, 2010, 6:54pm): L.A. has smog alerts. There R definitely VOCs in the air in N.O. My eyes and nose are burning. Why no Air Quality alerts here? #oilspill

This tweet did receive a response from @Oil_Spill_2010, but the account operator failed to recognize, possibly due to lost context in the tweet propagation, that @SaintsFan1 was actually reporting information from the area. The @Oil_Spill_2010 account made this claim:

@Oil_Spill_2010 (June 27, 2010, 7:41pm): @SaintFan @barbiesnow We're in NoLa and have not received any reports. Stand by as we continue to investigate your questions. #oilspill

It is possible that @SaintsFan1 never saw the reply, as her account name was misspelled in the reply and @Oil_Spill_2010 did not follow up on this exchange. Or she may have been turned off by the fact that her concern was not registered. In either case, her account showed a growing distrust. Hours later, @SaintsFan1 speculated that the lack of information may be intentional:

@SaintsFan1 (June 27, 2010, 11:11pm): Captured ALL of the NOAA NWS surface smoke data over SELA that now comes up empty. Was it scrubbed? Who knows? Nite all. #oilspill

Over the next week or so, the tone of @SaintsFan1's tweets shifted back to frustration, and she seemed to take issue with the management of the @Oil_Spill_2010 account:

@SaintsFan1 (July 6, 2010, 1:32pm): @Oil_Spill_2010 Who manages this twitter account? PIER Communications, USCG or Ogilvy? Please clarify for the public. Thanks. #oilspill

This analysis shows a negative effect of social media engagement when interactions go awry. Though their initial interaction with @SaintsFan1 was quite effective, they were unable to maintain rapport over time, and in this case, the Unified Command's social media operators missed an opportunity to establish trust with a local individual who had significant influence on the larger discourse.

DISCUSSION AND CONCLUSION

This multi-method, in-depth analysis of Twitter data collected during the 2010 BP Deepwater Horizon oil spill offers a variety of findings about how the online crowd communicated during a major environmental crisis. Analysis of tweet themes shows a broad interest in response efforts and the strategies that responders were employing, including the use of dispersants. Interestingly, dispersant-related tweets were much more likely to refer to health impacts than tweets across the larger #OilSpill conversation. Network analysis reveals that the Twitter conversation surrounding this event was shaped by a diverse group of influencers,

including NGOs, locals, media, and event-specific accounts. Importantly, network features change when focus shifts from the larger crowd to other subsets, including users who were more engaged with the conversation and those who were local to the event. We identify and describe how locals participated in the conversation, interacting with response accounts, asking questions, using Twitter to voice their concerns and, in many cases, their anger.

This research offers some lessons for emergency responders. An analysis of tweets sent by the Unified Command (OilSpill_2010) account shows those account operators interacting with Twitter users, answering questions, and addressing rumors. However, social media missteps are also uncovered, including inconsistencies in tone and response time. These errors are understandable from an operations standpoint, but they may have damages that account's reputation among locals. This analysis aligns with existing research that suggests a misalignment between traditional work practices among oil spill responders and new norms and expectations of interaction on social media (Hughes and Palen 2012).

These findings underscore the importance of positioning the public as participatory. The social media record shows that people—including both local and remote actors—wanted to contribute to response efforts, and that they used these platforms to report first-hand observations from the impacted areas; to curate the information space by passing along information they felt was important; and to organize and participate in activism (Pavia *et al.*, 2015).

The oil spill was a major environmental disaster in the U.S., characterized by high levels of uncertainty and scientific complexity, and social media users were surrounded by a dense and complex information space. The #OilSpill tweets show members of the public working to make sense of this technically sophisticated space, actively seeking out scientific sources and clearly valuing the voices of scientists. These finding may reflect changing dynamics as people become more active information seekers in an information-rich online environment.

Social media platforms are clearly changing the ways in which people communicate during crisis events. Emergency responders are beginning to understand that they cannot ignore these new channels, even as they recognize that their current modes of operation are not necessarily compatible with emerging norms and expectations of online participation. Hopefully, this research will help them better understand how to work with their connected publics during response efforts.

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KEY ABBREVIATIONS

CDC - Centers for Disease Control and Prevention

DPSIR Framework - Drivers-Pressures-State-Impact-Response Framework

EM - Emergency Manager

IBRRC - International Bird Rescue Research Center

JIC - Joint Information Center

NGO - Non-Governmental Organization

NOAA - National Oceanic and Atmospheric Administration

PIO - Public Information Officer

NWF - National Wildlife Federation

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Table 1. Descriptions of the two datasets.

Dataset	**# of Tweets**	**# of Distinct Twitter users**	**# of Dispersant-Related Tweets**
Total #OilSpill Collection	693,409	132,075	11,146
50-50 Random-Dispersant Sample	500	387	254*

*Consistent with the relative percentages in the *Total #OilSpill Tweet Collection*, 4 of the 250 tweets that were randomly selected from it also contained dispersant-related terms.

Table 2. Retweet and URL counts.

Tweets	**# Tweets**	**# RTs**	**# Replies**	**# with URL**
Total #OilSpill Tweet Collection	693,409	302,759 44%	34,102 4.9%	478,547 69%
Dispersant-Related Tweets	11,146	5,907 53%	556 5.0%	8,317 75%

Table 3. Top 10 most-retweeted in *Total #OilSpill Collection.*

	Twitter User	**# of RTs**	**Affiliation Type**	**Description**
1	NWF	7677	NGO	National Wildlife Federation
2	IBRRC	7327	NGO	International Bird Rescue
3	SaintsFan1	5261	Individual	Local individual
4	Oil_Spill_2010	4738	Government	Account of Unified Command
5	GulfOilCleanup	4538	Informal Group, Media	Informal group of collaborating media partners for oil spill relief
6	Alyssa_Milano	3507	Actress, Celebrity	Early adopter of Twitter, celebrity
7	MacMcClelland	3474	Journalist	Mother Jones journalist in NOLA
8	sami_shamieh	3259	Political Commenter	Remote individual
9	TheOilDrum	3225	NGO	Online news about energy
10	Jason_Pollock	3093	Celebrity	Filmmaker, writer, activist

Table 4. Distribution of tweets across identified themes.

Theme	Dispersant-Related		Not Dispersant-Related	
Response: Clean Up Strategy, Including Efficacy of Dispersants	188	76%	21	9%
Impact: Environmental Impact	36	15%	35	15%
Impact: Health Impact	32	13%	4	2%
State: Clean Up or Spill Status	19	8%	43	18%
Response: Who is in charge?	15	6%	5	2%
Response: Call to Action	11	4%	25	10%
Impact: General/Other Impact	10	4%	18	8%
Response: Communications/Cover Up	9	4%	24	10%
Response: Monitoring	9	4%	4	2%
Response: Responsibility/Liability	8	3%	29	12%
Response: Community Response	6	2%	14	6%
Response: Environmental Policy	6	2%	5	2%
Pressure: Corruption	4	2%	7	3%
Impact: Political Impact	4	2%	18	8%
Pressure: Environmental/ Commercial Policy	3	1%	24	10%
Response: General/Other	3	1%	8	3%
Other	2	1%	19	8%
Unknown, Unclear or Off topic	2	1%	19	8%
Response: Recovery-Assistance	1	<1%	3	1%
Response: Wildlife Response	1	<1%	8	3%
Impact: Economic Impact	0	0	2	1%
Impact: Mental Health Impact	0	0	0	0
Response: Evacuation/Safety Regulation	0	0	3	1%

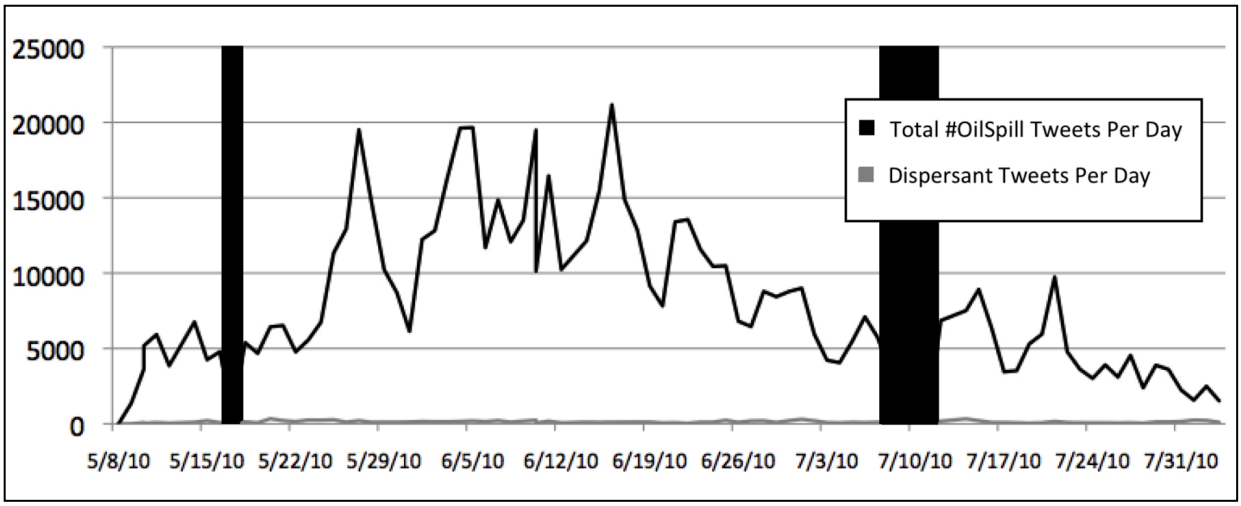

Figure 1. Tweet volume over time. [Black represents volume of #OilSpill tweets per day. Grey (small volume at the bottom) shows the volume for dispersant-related tweets.]

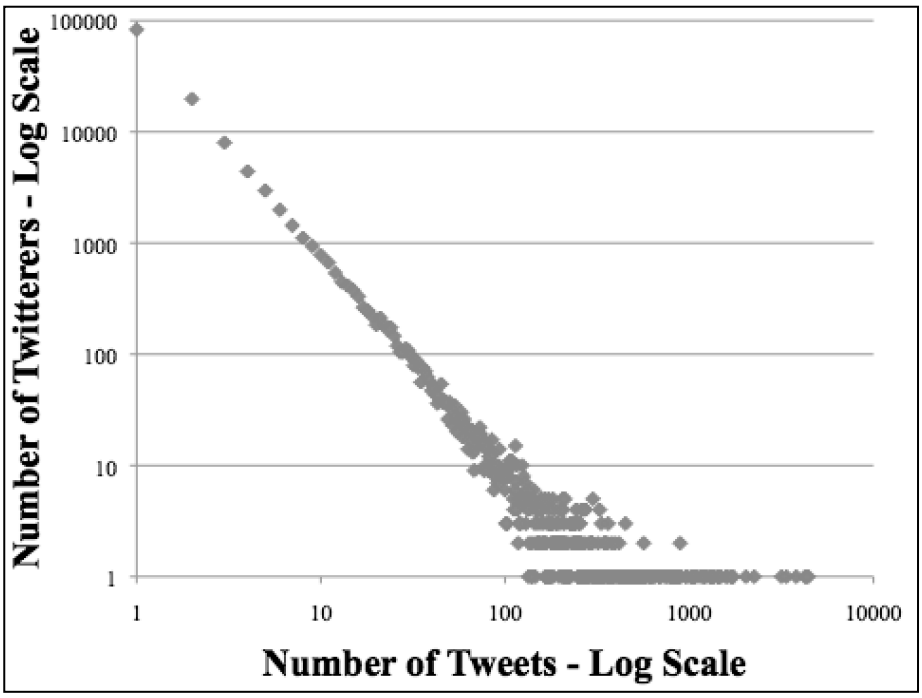

Figure 2. Tweet volume per Twitter user
Total #OilSpill Tweet Collection

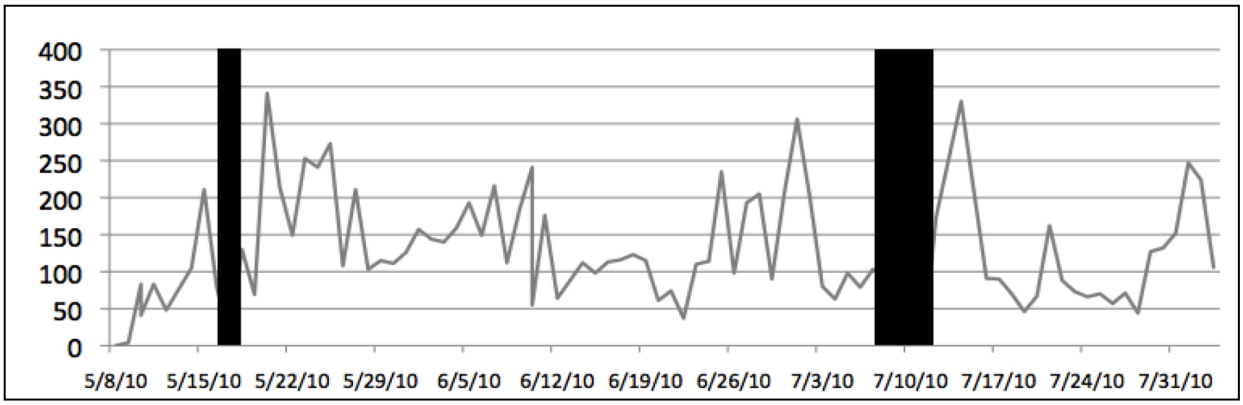

Figure 3. Volume of dispersant-related tweets over time.

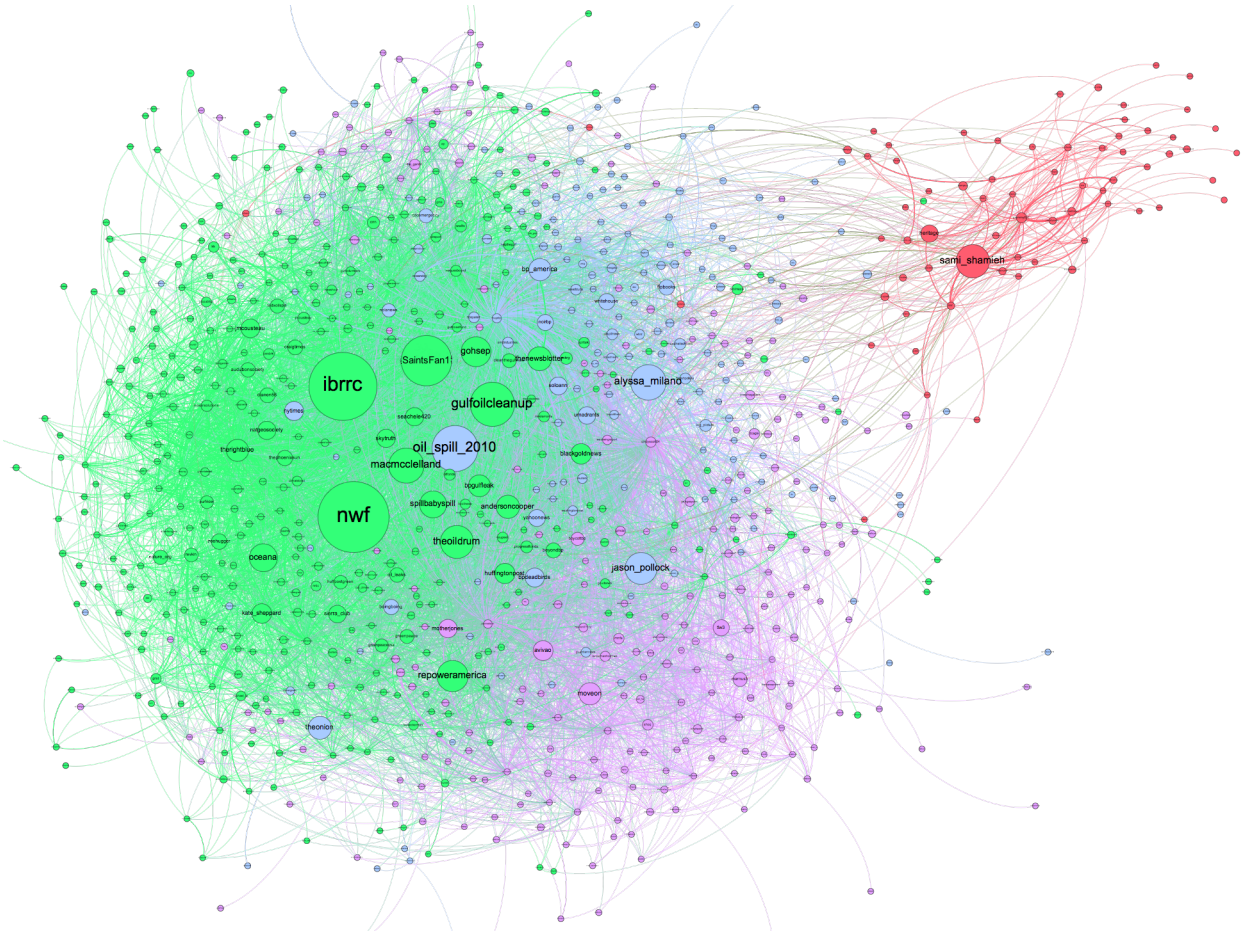

Figure 4. Network diagram from retweet connections.