Utilizing Twitter to Communicate Risk after a Natural Disaster

On October 10, 2018, Hurricane Michael, a powerful category five hurricane hit the Florida panhandle with windspeeds reaching 160 mph (Wamsley, 2019). Hurricane Michael grew to an immense and destructive size because of the warmer-than-average temperatures in the Gulf of Mexico, making it the third-strongest storm ever to make landfall in the U.S. (Gibbens, 2018). News coverage focused heavily on coastal communities; however, there was also damage to agricultural industries inland in Georgia and Florida (Mayo, 2018). The estimated total losses from Hurricane Michael in Florida alone were $1,481,843,193.58, which included reduced agricultural sales due to wind or flood induced product losses, decreased yields, spoiled product, and dead livestock (Florida Department of Agriculture and Consumer Services [FDACS], 2018). The hurricane also left more than 130,000 Florida residents without power and blew apart thousands of homes in the Florida panhandle (Panettieri, 2018).

After a natural disaster, like a hurricane, large amounts of standing water can remain. According to the Centers for Disease Control and Prevention (CDC, 2018c), standing water left after a natural disaster has the potential to spread infectious diseases, contain chemical hazards, or cause injuries. Floodwater mosquitoes can immediately hatch following a hurricane or natural disaster due to the excess water and generally do not spread diseases; yet, they can negatively affect recovery efforts, which is why local and state mosquito control often take precautions to control populations (CDC, 2018d). Two weeks to two months following a natural disaster, the types of mosquitoes that spread viruses may increase due to remaining standing water (CDC, 2018d). Caillouet, Michaels, Xiong, Foppa, and Wesson (2008) found a short-term increase of West Nile Virus (WNV) cases following Hurricane Katrina in 2005, likely due to the increased presence of mosquitoes. Because Florida has experienced mosquito-borne disease outbreaks in the past three years, they could be at risk for another outbreak after a natural disaster like a hurricane (CDC, 2018a). The Federal Emergency Management Agency's (FEMA, 2018) recommendation for "public safety agencies to be able to provide and maintain communications before, during, and after a disaster or emergency," (para. 1) and the history of mosquito-borne diseases in Florida (CDC, 2018a) indicated a need to communicate about mosquito control and vector-borne diseases after Hurricane Michael in the state of Florida.

Technology can aide disaster management by directly communicating early warning signs and hazards, and social media can specifically provide access to information quickly (CDC, 2014). Social media allows organizations to disseminate information, enable early warning systems, and coordinate relief-effort, during a disaster (CDC, 2014). In past natural disaster events, the Cooperative Extension Service has been called upon to help communities as a support agency to provide relief services (Telg et al., 2008). To better help Extension personnel communicate with communities in crisis, there is a need to understand best practices using social media to communicate about risk after a natural disaster. The purpose of this study was to explore how Twitter was used to communicate about mosquito control before and after Hurricane Michael.

Conceptual Framework

The conceptual framework for this study was guided by principles of crisis communication. A crisis can range from natural catastrophes, like earthquakes and floods, to orchestrated events like product tampering. Seeger (2007) developed a set of best practices when utilizing crisis communication. These practices included establishing communication policies, planning pre-event procedures, partnering with the public, listening to the public's concern, communicating

with honesty and openness, collaborating with credible sources, remaining accessible to the media, communicating with empathy, accepting uncertainty, and providing messages of self-efficacy. Many of the practices simply require organizations to analyze potential crises, identify necessary resources, and maintain constant, open communication with the public (Seeger, 2007).

The introduction of social media has helped organizations to quickly communicate about a crisis while simultaneously answering the concerns of their customers through two-way communication (Covello & Sandman, 2001). Users of social media place a great deal of trust in the information they gather from the sites (Marken, 2007), which makes social media a viable platform to communicate relevant crisis information. Organizations can utilize social media to directly communicate to followers with a more personal message (Prentice & Huffman, 2008) and keep stakeholders from turning to less credible sources for information in times of a crisis (Coombs, 2007).

Social Media Crisis Communication

Social media has been used for crisis communication with events that have impacted the public's safety and welfare, like the H1N1 flu outbreak (Fredberg, Palenchar, & Veil, 2013) and the 2010 earthquake in Haiti (Veil, Buehner, & Palenchar, 2011). Social media has been used during these types of events to both provide information and services to the community as well as education (Eckler, Worsowicz, & Rayburn, 2010). These platforms are also particularly helpful for crisis communication because they are the first platforms the public turns to when looking for information (Gil de Zuniga, Jung, & Valenzuela, 2012).

The social media platform, Twitter, has been identified as particularly helpful for communicating real-time information during a crisis. Twitter has more than 328 million followers and is one of the most popular platforms in the world (Forbes, 2017). Twitter allows users to post 240-character microblogs called tweets. These tweets are publicly available and allow for a rapid spread of information. Users can also include hashtags (#) to help people search and connect on specific topics of their interest (Su, Scheufele, Bell, Brossard, & Xenos, 2017). Additionally, Twitter users can share others' tweets through "retweets," which helps to share that post with additional sets of followers.

Researchers have explored the use of social media when communicating issues related to agricultural and natural resources. Wickstrom and Specht (2016) analyzed who was using Twitter to communicate about a water quality crisis in Ohio. The researchers concluded anti-agricultural activists were the most outspoken group during the crisis and recommended practitioners monitor not on only what is being said but who is leading the conversation on Twitter. Monitoring who is communicating on Twitter during a crisis could help practitioners identify authoritative figures in a community to engage in conversations about the issue (Wickstrom & Specht, 2016). Another study analyzed the use of Twitter to communicate during a time of drought in Nebraska (Wagler & Cannon, 2017). Researchers found the number of tweets related to the drought increased as time went on, and Twitter was used mostly as a news outlet to update followers on information related to the drought (Wagler & Cannon, 2017). However, Lachlan, Spence, Lin, Najarian, and Del Greco (2016) concluded emergency management agencies largely underutilized Twitter to communicate actionable information for Crisis and Emergency Risk Communication (CERC).

CDC Crisis Communication

The CERC guidelines from the CDC provided the framework for this study. The CDC has developed specific recommendations for crisis communication after a hurricane and related to the mosquito-borne disease zika. After a hurricane, communicators are encouraged to *Be First, Be Right, Be Credible, Express Empathy, Promote Action,* and *Show Respect* (CDC, 2018b). To *be first* meant to communicate about how to be prepared for an event before it occurred (e.g. communicate about generator safety prior to losing power). Being *right* meant fact-checking statements before sharing them, and to *be credible* meant to use scientific backing to facilitate public trust. *Expressing empathy* was defined as acknowledging the feelings of others and the challenges they were facing, while *promoting action* encouraged people to engage in meaningful activities, like helping neighbors. Finally, communicators were encouraged to *show respect* by listening to the needs of their community after a hurricane (CDC, 2018b).

The CDC has a similar set of CERC recommendations for zika risk communication. The first of which was to express *empathy* and acknowledge the concerns of the community (CDC, 2018e). The CDC (2018e) also recommended to raise *self-efficacy* beliefs by teaching people how to control the mosquito population by removing standing water that could be used as breeding grounds. *Credibility* was also important related to zika communication and communicators were encouraged to be open, honest, and utilize scientific information to back up claims. Because people seek information from a variety of sources, communicators were also encouraged to understand the role of the media during a time of crisis like a zika outbreak (CDC, 2018e).

The two CERC recommendations were adapted to help guide the analysis for this study (CDC, 2018be). Effective crisis communication related to mosquito control after a hurricane would need to be timely and appropriately utilize social media (CDC, 2018be). Additionally, messages related to the crisis would need to (1) be first, (2) be credible, (3) promote action, (4) encourage self-efficacy, and (5) express empathy (CDC, 2018be).

Purpose & Objectives

The purpose of this study was to explore how Twitter was used to communicate about mosquito control before and after Hurricane Michael. The objectives for this study were as follow:

1. Describe the number of tweets related to mosquito control two weeks before and two weeks after Hurricane Michael.
2. Describe who was tweeting about mosquito control during two weeks before and two weeks after Hurricane Michael.
3. Describe the most common hashtags used to describe mosquito control two weeks before and two weeks after Hurricane Michael.
4. Describe how mosquito control was communicated via Twitter two weeks before and two weeks after Hurricane Michael.

Methods

A quantitative content analysis was used to fulfill the purpose of this study. Tweets related to mosquito control that were posted before and after Hurricane Michael were collected using the Sysomos Media Analytics Platform (MAP). Sysomos MAP allows researchers to collect detailed information related to online conversations based on Boolean searches. Additionally, Sysomos MAP can pinpoint user locations to help create more tailored analysis of online conversations.

The search query for this study was limited to two weeks before and two weeks after Hurricane Michael made landfall in Florida on October 10, 2018 (September 26, 2018 to October 24, 2018). Additionally, the tweets were limited to users in Florida to better understand how this crisis was communicated in the state predominately impacted by the hurricane. The Boolean search string was reviewed by a panel of experts with specializations in public opinion research, public health, and entomology to account for the variety of common mosquito control methods. The search query was as follows:

> ("mosquito" OR "mosquitoes") AND ("naled" OR "drain cover~2" OR "larvicide" OR "adulticide" OR "pesticide" OR "ultra low volume spraying" OR "aerial spraying" OR "truck spraying" OR "trucks spraying" OR "fogging" OR "repellent" OR "genetically modified mosquitoes" OR "control").

The search identified 285 mentions on Twitter meeting the search criteria. Irrelevant tweets were discarded to more accurately reflect the intent of the search. For example, Mosquito Control Districts in Florida were holding elections at the time of data collection. Tweets about the candidates for positions in the mosquito control districts were omitted. There were a total of 198 tweets (n = 198) that met the search criteria, including retweets. There were 143 unique tweets (n = 143) about mosquito control from Florida users during the time period of the search query (not counting retweets).

While Sysomos MAP allows users to easily retrieve and analyze social media data, it is not without its limitations. The platform can only access posts that are made public, which is why it is difficult to analyze other networking sites like Facebook or Instagram. However, Twitter is a public site that makes it easy for Sysomos MAP to analyze. When analyzing user demographics, Sysomos MAP is also limited to the information users provide in their profiles. For the current study, Sysomos MAP pulled tweets from users who disclosed their location as Florida, but researchers must assume this location is still accurate. Additionally, there is a chance other users in Florida were tweeting about mosquito control but did not include their location in their Twitter profile. This would limit who was included in the results. These limitations should be considered when interpreting the findings from this study.

All data were exported from Sysomos MAP to Microsoft Excel for analysis. Objective one presented the total number of tweets and how many tweets were posted each day during the time of data analysis. This reflects the concept of *timely* communication recommended from the conceptual model (CDC, 2018be). The leaderboard for users most frequently posting about mosquito control have been reported in objective two to help identify authoritative figures as recommended by Wickstrom and Specht (2016). How many people the top users follow and how many followers they have are reported in objective two. Additionally, the user bio has been included to help determine the type of source the user represented. The most used hashtags in the tweets have been presented in objective three. Objective four analyzed unique tweets only (retweets excluded) to code how original tweets followed the CDC's CERT recommendations. *A priori* coding was used to code for themes including *be first, promote action, self-efficacy, credibility, and empathy* (Kuzel, 1999). The definitions for these codes have been reported in Table 1.

Table 1
A Prior Codes Used to Analyze Mosquito Control Tweets

Code	*Definition*
Promote Action	Reader encouraged to help others related to mosquito control
Be First	Reader is warned about an upcoming mosquito control event
Self-efficacy	Reader is provided tips for how to protect themselves against mosquitoes
Credibility	Author established credibility through research or expertise
Empathy	Author expresses sympathy and understanding for the reader

Emergent themes were also included as part of analysis. These are discussed in greater detail in objective four. To help increase the reliability of the study, a code book was created and the codes were tested for inter-coder reliability. The primary researcher and a co-coder analyzed 10% of the tweets to help establish reliability (n = 15; Lombard, Snyder-Duch, & Bracken, 2005). The initial Krippendorff's alpha was .51, but after revision of the codebook, the co-coders had 100% reliability for the codes of interest. The tweets were also coded for if they discussed a hurricane or referenced a major "storm." The coders had a Krippendorff's alpha of 1.0 for this variable.

Findings

Objective One

Objective one determined how many times mosquito control was tweeted about in Florida during the time around Hurricane Michael. Between September 26, 2018 and October 24, 2018, there were a total of 198 mentions about mosquito control from Florida Twitter users. A timeline for the tweets can be found in Figure 1. Tweets related to mosquito control decreased in the time immediately preceding the landfall of Hurricane Michael but increased a few days after the Hurricane made impact on October 10, 2018.

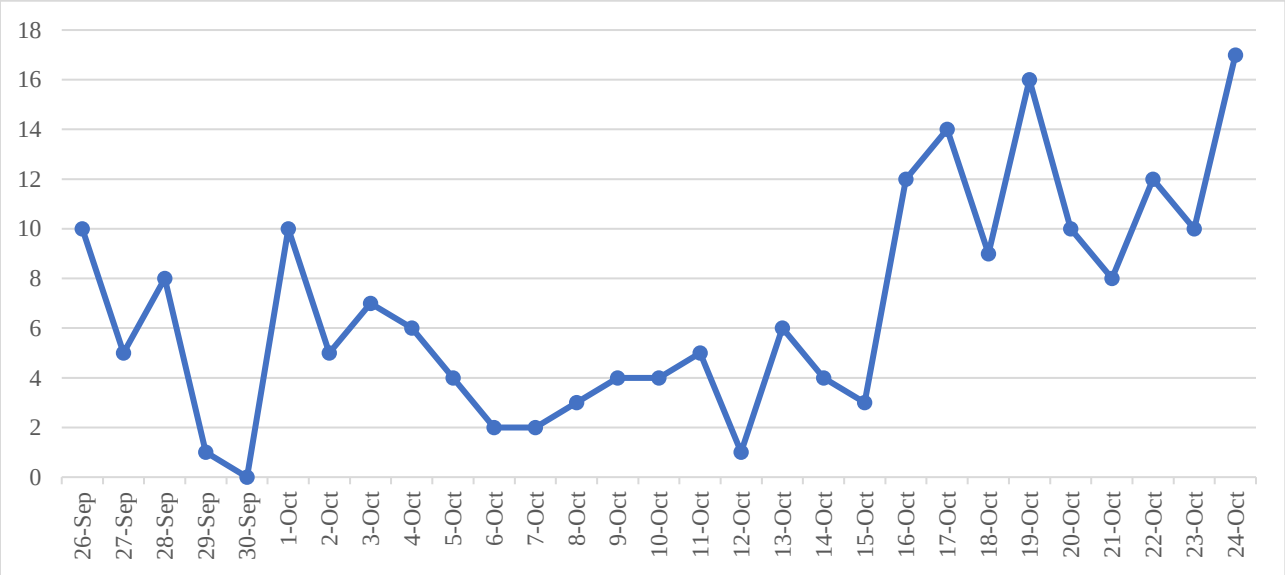

Figure 1. Timeline of mosquito control tweets in Florida between September 26, 2018 and October 24, 2018

Objective Two

The Twitter users with the most posts related to mosquito control during the time of Hurricane Michael have been presented in Table 2. The majority of these users were considered public support agencies and represented a mosquito control district. Volusia Emergency Management tweeted the most during the timeframe of this analysis with a total of 15 tweets. This Twitter account also has the largest following of all of the top users. Other top users included Florida Keys Mosquito Control, the Health & Wealth Network, and the Miami Dade County Mosquito Control District.

Table 2

Leaderboard for top users tweeting about mosquito control in Florida

Author ID	*Author Name*	*User Bio*	*Number of Tweets*	*Followers*	*Following*	*Category*
VCEmergencyInfo	Volusia EMER MGMT	This is the official Twitter account for Volusia County Emergency Management. This is NOT an emergency communication channel. Call 911 in an emergency!	15	7204	1106	Public Agency
FlKeysMosquito	FL Keys Mosquito	Florida Keys Mosquito Control is working to control mosquitoes in a manner that preserves the ecological integrity of our environment.	13	883	143	Public Agency
AM1470WWNN	Bob Morency	Welcome to the Health & Wealth Network! Listeners all over the world have the opportunity to interact with the nation's leading health and wealth professionals!	8	2192	1259	Public Agency
305Mosquito	305 Mosquito Control	Official account of the @MiamiDadeCounty #MosquitoControl Division. FB/IG: @305Mosquito #FighttheBite #DrainandCoverMiami #OurCounty #Mosquito #Miami #Wolbachia	8	1631	825	Public Agency

PestControlBuzz	Westfall's	Westfall's offers a wide variety of Pest Control and Lawn Care programs and services in Bradenton, Lakewood Ranch, and Sarasota, Florida.	5	21	34	Pest Control
myescambia	My Escambia	Official Twitter Site for Escambia County, Florida - for promoting the news, programs and services of our county. Any emails are subject to public records law.	5	6971	49	Public Agency
Andrew73taylor	Andrew Taylor	System Engineer	5	27	98	Citizen
PascoMosquito	Pasco Mosquito	Our mission is to protect the health and well-being of citizens in Pasco County through the prevention and control of mosquitoes and mosquito-borne diseases.	3	410	377	Public Agency
MyDistrict1	Escambia District 1	News and events of interest to residents of Escambia County, FL Commission District 1, represented by Comm. Jeff Bergosh.	3	770	9	Public Agency
woofeous	Eli_Brody	Official Twitter Acc't / Patriot / MAGA / Pro Military / Pro Life / Pro Fiscal Restraint / Pro Police / Taking Nothing For Granted / Never Surrendering To Left	2	4191	2499	Citizen

Objective Three

The most commonly used hashtags related to mosquito control were analyzed in objective three (Table 3). The most commonly used hashtag was #mosquito (*n* = 19) followed by #mosquitocontrol (*n* = 15). #HurricaneMichael was only found in three of the tweets and was not considered to be a top hashtag.

Table 3

Top Hashtags Used in Tweets About Mosquito Control in Florida

Rank	*Hashtag*	*Mentions*
1	mosquito	19
2	mosquitocontrol	15
3	getthembeforetheyfly	9
4	mosquitoes	9
5	fkmcd	9

Note: fkmcd stands for "Florida Keys Mosquito Control District."

Objective Four

Unique tweets (retweets excluded) from two weeks before and after Hurricane Michael were analyzed for objective four (*n* = 143). These tweets were coded based on the CDC's conceptual framework to communicate risks related to hurricanes and mosquito-borne diseases (CDC, 2018be): *be first, self-efficacy, promote action, self-efficacy, credible*, and *empathy*. Additional themes emerged during coding and included *sales* (selling or promoting a specific mosquito control product), *threat* (threats related to mosquitoes), and *challenges* (challenges with mosquito control). The findings have been reported in Table 4. The most commonly identified theme was to *be first* (44.8%, *n* = 64). These tweets focused on informing followers some type of mosquito control was about to happen in the community. *Self-efficacy* was the second most identified theme (20.3%, *n* = 29) – followers were provided tips for how to limit the impacts of mosquitoes in their lives. The third most common theme was *sales,* with a little more than 10% (*n* = 18) of authors promoting or trying to sell a mosquito-control product. The rest of the themes appeared less than 10% of the time. The theme of empathy appeared zero times in tweets related to mosquito control in Florida before and after Hurricane Michael. It should also be noted that only 15 tweets specifically mentioned a hurricane or storm.

Table 4

Summary of Tweets About Mosquito Control in Florida

Code	*f*	*%*	*Example*
Be First	64	44.8	Mosquito Control is spraying after sunset in the Edgewater area, weather permitting. https://t.co/8vLtqJNgle
Self-efficacy	29	20.3	It's not uncommon to see mosquitoes after a major #emergency like a #flood. You can take steps to help control mosquitoes in and around your home to prevent mosquito bites. https://t.co/SDHkNxrWiQ

Sales	18	12.6	No more mosquitoes bugging me thanks to @earthkind natural repellent. Learn more in my full review I wrote for @socialnature, and get 20% OFF to try it out for yourself! #GotItFree https://t.co/kH7IDEtvOv
Promote Action	11	7.7	@WJHG_TV I know here in Calhoun we are in need of sunscreen, sunburn lotion/creams/ointments, and mosquito repellent and I'm sure Bay county could use some also. Walking everywhere and sleeping with the doors and windows open to stay cool has it's perils. Thanks for all you do ❤️
Credible	11	7.7	Great presentations this morning given by Dr. Dan Hahn of @UF and Dr. David Hoel of Lee County Mosquito Control District. #MosquitoControl #MosquitoEducation #SIT #SterileInsectTechnology https://t.co/0XG7y5WymL
Threat	8	5.6	Malaria, West Nile Virus, dengue, yellow fever, and Zika are just a few reasons to have one of the best Mosquito Control agencies in the world located right here in Lee County. Granted,... https://t.co/5GE4Ghfspi
Challenges	2	1.4	@VCEmergencyInfo @NewsDaytonaBch "Mosquito Spraying"!!! Challenge with mosquito control is making sure all those areas of standing water have a soapy layer on top surface of water to deter mosquitos from multiplying instead of building up their chemical tolerance. https://t.co/J1XcxIWGcP
Empathy	0	0	N/A

The most retweeted posts have been reported in Table 5. Three out of the five most retweeted posts were identified as using a theme of *warning*. The other two tweets *promoted action* to help a community and *self-efficacy*.

Table 5

Most Retweeted Tweets About Mosquito Control in Florida

Number of Retweets	Retweet	Theme
4	RT @myescambia: The Escambia County Mosquito Control Division has filed a "Notice of Intent" to proceed with fogging missions on Tuesday, Oct. 16 in Commission District 1. Mission hours vary, but typically occur in the evening hours from…	Be First
3	RT @amsuprak: Hey #Earpers! I just wanted to reach out again and ask for some #EarperSupport for our neighbors to our east here in the Florida Panhandle. We need donations to take the many many people affected by Hurricane Michael. Currently they're in dire need of mosquito repellent... 1/3	Promote Action
3	RT @MayorGimenez: Peak mosquito season may have passed, but we still deal with the the threat of mosquito bites and the potentially serious diseases they may carry. Check out #OurCounty's mosquito control tips for autumn. https://t.co/HQVHkAeHb3 https://t.co/GLodkwfNyW	Self-efficacy
3	RT @myescambia: Mosquito Control is fogging in the Beulah, Ensley and Molino areas tonight. ☑ To make a request for service or to have an area listed as a no spray zone, please 📞 call 850-937-2188 or use the Ask	Be First
3	RT @myescambia: Mosquito Control is fogging in the Millview area tonight. ☑ To make a request for service or to have an area listed as a no spray zone, please 📞 call 850-937-2188 or use the Ask MyEscambia app 📣 https	Be First

Discussion

The purpose of this study was to understand how Twitter was used to communicate about mosquito control before and after Hurricane Michael. The findings from this research provide valuable insight for both researchers and practitioners for using social media to communicate during a crisis. Overall, Florida Twitter users followed CDC's (2018ed) recommendations for communicating risks and crisis. The tweets were posted in a timely matter and a sharp increase in tweets per day were noted after October 10, 2018 when Hurricane Michael made landfall. These tweets began to increase about one week after the hurricane. Communication about mosquito control during the first week following the hurricane was likely limited due to loss of electricity and more immediately pressing matters, like access to shelter, electricity, and clean water (Panettieri, 2018). However, mosquitoes are expected to breed in standing waters during the first two weeks after a hurricane (CDC, 2018b), so this timeframe for mosquito control communication would be appropriate.

Objective two explored who was tweeting the most about mosquito control before and after Hurricane Michael. Users posting the most about this topic were from public agencies and

represented emergency response agencies or mosquito control districts. Lachlan et al. (2016) had concluded emergency management agencies largely underutilized social media to communicate in a crisis. While this still may be true considering there were only 198 mentions on Twitter in a 28-day period, these agencies were posting the most about mosquito control out of all users involved in the conversation. Interestingly, three of the top four users came from Volusia County Emergency Management, Florida Key Mosquito Control District, and 305 Mosquito Control District (Miami). All of these districts fell outside of the track of the hurricane or were on an opposite coast of Florida from where Michael made impact (Florida Department of Transportation [FDOT], 2019; Panettieri, 2018). The only county on the Twitter user board that was directly impacted by Hurricane Michael was Escambia County (FDOT, 2019; Panettieri, 2018). Counties directly hit by the hurricane may have had more critical information to communicate about aside from mosquito control, including clean water and electricity. Notably absent from the leaderboard was a representative from the Cooperative Extension System. There is an opportunity for Extension personnel to be involved in these conversations related to mosquito control after a hurricane. Additionally, there may be an opportunity to help communicate about control efforts in the counties most effected by a disaster if the counties themselves are unable to focus on every part of disaster relief efforts.

Hashtags associated with mosquito control were reported for objective three. Common hashtags included #mosquito and #mosquitocontrol. These hashtags allow users to easily search for and follow tweets of interest (Su et al., 2017). People specifically searching for information related to mosquito control would likely find these posts, but people trying to find general information related to how to prepare for the hurricane or what to do after the hurricane would have trouble finding these posts, especially since #HurricaneMichael was only found in three tweets.

Objective four analyzed tweets based on the CDC's CERC recommendations. The *Be First* theme was the most prevalently used related to tweets warning followers that mosquito control, like aerial spray or truck fogging, was about to occur. Additionally, about one-fifth of the tweets promoted *self-efficacy* and encouraged readers to user repellent or drain standing water. Themes also emerged during the coding process that did not align with the a priori codes. The most common of these themes was *sales* – companies were using Twitter to sell mosquito control products. Additionally, *empathy* was not identified in any of the tweets. Tweets about mosquito control before and after Hurricane Michael somewhat followed the CDC's recommendations, but there were opportunities to express empathy and increase perceived self-efficacy, promote action, and establish credibility. The most retweeted tweets had to do with sharing information first, which aligned with prior research (Wagler & Cannon, 2017). However, tweets promoting action to help communities affected by the hurricane and self-efficacy related to mosquito control also appeared to resonate with readers, which was indicated by them being retweeted.

Interestingly, only 15 of the total tweets appeared to directly reference a hurricane or a major storm. Even though the research was limited to users in the state impacted by the hurricane and during the two weeks before and after Hurricane Michael, the conversations may not necessarily reflect mosquito control communication in response to the hurricane. Regardless, the conversations related to mosquito control appeared to mostly follow the CDC's (2018be) recommendations for crisis and risk communication, but there is an apparent need to increase the amount of communication about the topic to ensure information is shared in a timely and relevant manner.

Recommendations

Extension professionals and communicators should consider this information when creating emergency/risk communication in the wake of a natural disaster. While there was an increase in Twitter mentions related to mosquito control after the hurricane, Extension and other support agencies should communicate preventative measures related to mosquito control prior to hurricanes as well. Additionally, Extension counties/districts should proactively communicate about mosquito control efforts to help remove some of the burden from local emergency management agencies impacted by the storm. In cases like Hurricane Michael, where affected counties were left without power (Panettieri, 2018), state Extension should assist in risk communication until local authorities are able to consistently engage the public again. Extension could also use social media analysis to determine key influencers to collaborate with when communicating about mosquito control (Wickstrom & Specht, 2016).

Including common hashtags like #mosquito or #mosquitcontrol could also help people find information about mosquito control. Additionally, a hashtag related to specific crisis, like #HurricaneMichael, could also help expose people affected by the disaster to mosquito control information who were not necessarily searching for that information. Helping authority figures and support agencies understand the role of media when communicating crisis could also help to increase the effectiveness of risk communication efforts on social media.

When developing tweets related to mosquito control, users should not only focus on being first to communicate about mosquito control events. They should also encourage self-efficacy by providing ways citizens can protect themselves from mosquitoes. Additionally, users should express empathy for their followers to help gain trust from the community and promote action by offering ways in which people can help others with mosquito control. Crafting tweets in these ways will help increase two-way engagement with those impacted by disaster and keep followers from turning to less credible sources for information (Coombs, 2007).

This research is limited to the programmatic capabilities of Sysomos MAP and not all Florida users were necessarily included in the study. Additionally, only tweets that met the search criteria were analyzed for this study. Additional tweets related to mosquito control may exist that fell outside of the search parameters. General searches related to mosquitoes or mosquito-borne diseases may have provided additionally information related to Twitter conversations about mosquito control after a natural disaster.

Future research should include qualitative interviews with authority figures in counties impacted by a natural disaster to understand how they prioritize what to communicate about leading up to and following a crisis. Interview questions could also determine how these individuals' prioritized communicating mosquito control after Hurricane Michael and what role they believed social media served in their crisis communication. Surveys could also be used to determine how those impacted by a natural disaster, like a hurricane, search for information immediately following the event to determine if Twitter would still be the most appropriate channel for this type of communication. Additionally, future research should include expanding the timeframe for collecting data to more than just two weeks before and after a natural disaster. An increased timeframe allows for a more in-depth evaluation of the Twitter conversations. This research should be replicated with other natural disasters to help determine best practices for using social media to communicate during times of crisis.

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