Who Gives a Whoop?

An Analysis of Conservation Messages on Twitter

by

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Abstract

Whooping Cranes' (*Grus americana*) historic range ran from the Arctic Coast to Central Mexico and throughout much of the mid-west to the eastern shores of the United States. By the winter of 1941, approximately 16 Whooping Cranes remained. Historic population declines resulted from habitat destruction, shootings, and displacement by human activities. Through enhanced protection and management, the Whooping Crane population has grown, but still faces many challenges. Developed by a Canada-United States Recovery team, the stated goal of the Recovery Plan for the Whooping Crane is to be able to delist the Whooping Crane as an endangered species after the establishment of multiple self-sustaining Whooping Crane populations in North America. The Recovery Plan identifies five actions that must be taken to establish delisting criteria, one of which is to establish and maintain an outreach program. Little research examines the scope and effectiveness of social media for conservation outreach. This thesis is an examination of conversations on Twitter regarding Whooping Cranes. The thesis provides insight into the sources of messages, what the content of those messages are, and which messages seem to have the most impact. This understanding provides a first step toward developing a comprehensive social media outreach strategy.

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List of Abbreviations

ABC	American Bird Conservancy
AWBP	Aransas-Wood Buffalo Population
CWS	Canadian Wildlife Service
DYK	Did you know?
EMP	Eastern Migratory Population
ESA	Endangered Species Act
FNMP	Florida Non-Migratory Population
IBA	Important Bird and Biodiversity Area
ICF	International Crane Foundation
LNMP	Louisiana Non-Migratory Population
NGO	Non-Government Organization
NWR	National Wildlife Refuge
PWRC	Patuxent Wildlife Research Center
SMLC	Social Media Listening Center
US	United States
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

An Analysis of Conservation Messages on Twitter

Introduction

The goal of the International Recovery Plan for the Whooping Crane (2007) is to be able to remove the species from the list of endangered species after the establishment of multiple self-sustaining Whooping Crane populations in North America. In order to establish delisting criteria, the Recovery Plan identifies five actions that must be taken: (1) Continue to build the Aransas-Wood Buffalo population (AWBP) and manage its habitat to minimize the probability that a catastrophic event will eradicate this population; (2) attain a breeder pair and productivity goals at four captive facilities in the U.S. and one in Canada to produce birds required for reintroductions.; (3) establish two additional self-sustaining wild populations, continue research to identify appropriate reintroduction sites, improve reintroduction techniques, and protect and manage habitat for reintroduced populations; (4) continue to use genetic information and advances to conserve flock genetics and determine effective population size; (5) maintain an outreach program. This thesis seeks to establish how social media can help achieve this fifth goal: maintaining and expanding current outreach, particularly through multimedia viewing as a form of education. Specifically, our work examines the role of Twitter as a form of social media in conservation outreach. However, little research examines the effectiveness of social media for conservation outreach. This thesis helps remedy this oversight by examining who uses Twitter and how they employ it to communicate about Whooping Crane conservation. This thesis provides insight into the sources of messaging information, what the content of those messages are, and which messages seem to have the most impact. This understanding provides a first step toward developing a comprehensive social media outreach strategy.

Whooping Crane Recovery

Whooping Cranes' (*Grus americana*) historic range ran from the Arctic Coast to Central Mexico and throughout much of the mid-west to the eastern shores of the United States. Much of the reduction of the historic range is due to the loss of wetland habitat across North America. Historic population declines resulted from habitat destruction, shooting, and displacement by human activity (Trick, Smith, Stehn, & Walker, 2001). By the winter of 1941, only 15 Whooping Cranes remained in North America, the only continent on which they are found (Urbanek & Lewis, 2015). Through enhanced protection and management, the Whooping Crane population has grown, but still faces many challenges. Current threats include the limited genetics of the population, loss and degradation of migratory stopover habitat, construction of new power lines, degradation of coastal ecosystems, and the threat of chemical spills in Texas (Canadian Wildlife Service & U.S. Fish & Wildlife Service, 2005). Numerous captive breeding programs, reintroduction, and recovery efforts have helped the species to rebound to 750 individuals in 2017 (International Crane Foundation, 2018). There are now two wild migratory populations of Whooping Cranes. The AWBP migrates between the Aransas National Wildlife Refuge in in the state of Texas and the Wood Buffalo National Park in Alberta, Canada. An eastern migratory population (EMP) migrates from Wisconsin to Florida (CWS & USFWS, 2005). Both Louisiana and Florida have non-migratory populations (LNMP and FNMP). Whooping Cranes currently inhabit both wild and captive environments. In sum, while progress has been made, there remains much work to do.

Some of that ongoing work includes several laws and government-authored conservation plans in both Canada and the United States (U.S.) drafted to manage the species. The current International Recovery Plan for the Whooping Crane was finalized in 2006 and published the following year (CWS & USFWS, 2007). A Canada-United States Recovery team consisting of

five representatives from both countries authored the plan. Executors of the plan include, but are not limited to, Aransas National Wildlife Refuge (ANWR) in Texas and Wood Buffalo National Park in Alberta. In 1991, an international agreement known as the *Memorandum of Understanding on the Conservation of the Whooping Crane* outlined the cooperative recovery actions of Canada and the U.S., and continues to be updated at 5-year intervals. Additionally, several key pieces of legislation require conservation actions. In the United States, the Whooping Crane was listed as "threatened with extinction" in 1967 and as endangered in 1970 – both listings were grandfathered into the Endangered Species Act of 1973. In Canada, the Whooping Crane was designated as endangered in 1978 by the Committee on the States of Endangered Wildlife in Canada and was listed under the Species at Risk Act in 2003. Critical habitat was designated in the U.S. in 1978 and in 2003 in Canada.

Social Media

Wildlife photography has been a key reason for recent increases in wildlife watching activity and equipment expenditures (U.S. Department of the Interior, U.S. Fish and Wildlife Service, U.S. Department of Commerce, & U.S. Census Bureau, 2016). Between 2011 and 2016, the USFWS National Survey reported that photography around the home was the participation category that increased the most. Some social media platforms which may contribute to the growth of wildlife watching include videography and photography-based ones such as Flickr, Instagram, and YouTube. Flickr has been used to predict visitation rates at nature tourism sites around the world and it was found that an annual spike in photographing activity in the Black Rock Desert correlated with the time of the three-week Burning Man Festival that takes place each year (Wood 2016). This research demonstrates a direct connection between social media activity and participation in an annual special event or festival. Our research seeks to illustrate a

similar link; one which connects social media activity to participation in wildlife recreation, specifically birdwatching.

The activity and interactions of the eBird Facebook page provides an excellent example for federal wildlife agencies and non-government organizations as they seek to promote conservation messages through social media. Launched in 2002 by the Cornell University Laboratory of Ornithology, eBird is an online database of bird observations. The managers of eBird have successfully utilized the social media platform of Facebook to encourage participation in birdwatching. Their motivational posts (i.e. those that encourage birdwatchers to post images of birds spotted) have directly influenced high user engagement on the eBird Facebook page (Cardoso, 2016).

The effective usage of social media to communicate conservation efforts can help to grow a targeted audience. To build a social media audience, The Black Bass Conservation Committee focused their outreach efforts on their Facebook page. Through techniques including thematic day-of-the-week postings, the Committee increased their Facebook audience by over 500 individuals in the span of four years (Taylor & Sammons, 2019).

Understanding human-nature interactions is critical to finding conservation solutions (Bennett et al., 2017). Effective outreach can improve public support for policy, improve compliance with regulations, reduce poaching, and help foster pro-conservation behaviors (Jacobson, 2010). While many outreach materials simply provide factual data (Varner, 2014), a more targeted approach in content and source may be appropriate (Lessard et al. 2018, 2020). Digital conservation is a term used to describe a new research area of conservation science that uses social media and big data sets to investigate conservation issues (Toivonen et al., 2019; DiMinn et al., 2015). Nature 2.0 is another moniker given to the phenomenon of social media

applications that let people share, co-create, rate, like, link, and actively modify or co-produce nature and conservation information (Buscher ,2014). The recognition that there are not simply readers that consume information has significant implications and complications for conservation organizations seeking to relay information and messages, build communities, and influence behavior. Social media offers opportunities to engage readers like never-before, but also enables the spread of imprecise or incorrect information and the possibility of messages going off-target into other tangential or even non-sequitur discussion.

Studying social media provides a new source for understanding debates about conservation and discussions online (DiMinn et al., 2015). It can be used to monitor public reactions to conservation events and news, spatial analysis of behavior, content analysis of discussion and/or discussion photo combinations, and biodiversity monitoring of real-world species observations (Toivonen et al., 2019; DiMinn et al., 2015). Nah and Saxton (2012) outlined what drives conservation group's adoption and use of social media with a focus on organization strategy, capacity, governance, and environment. A number of opportunities and challenges for conservation science to use social media data have been identified (DiMinn et al., 2015). Several authors have assessed how scientists can communicate their studies through the popular press and social media (Parsons et al., 2013; Papworth et al., 2015). Papworth et al. (2015) found that the academic journals where the research was published and articles on charismatic megafauna with photos were more popular on Facebook and Twitter. Crowd sourcing data collection for citizen science (Tulloch et al., 2013), conservation marketing (Roberge, 2014), species monitoring (Barve, 2014), and communication (Papworth et al., 2015) are some of the potential applications while self-selecting users, geographic bias, large amount of noise in the data (not relevant), and ethical concerns regarding anonymity of users are some of

the challenges (DiMinn et al., 2015). In this evolving area of study, methodological overviews and best practices are still being developed (Toivonen et al., 2019).

A few studies have examined social media and wildlife conservation relevant to our project. Wu et al. (2018) examined WeChat, China's largest social networking platform, to identify the factors that impact the popularity of wildlife related articles and public awareness. They examined the publisher type, titles, picture counts, and content to identify attitudes and emotions from online comments. Publishers were divided into six groups and content was inductively into meaning units or themes. The authors found that traditional publishers and media companies had higher readership, that the number of pictures increased readership, long text had the opposite effect, and emotion invoking messages (Wu et al., 2018). They also found that there was confusion regarding conservation knowledge and very few articles mentioned human impact. Sorian-Redondo et al. (2017) studied public interest in flagship species in conservation projects in the U.K. The authors used Google Trends to study internet search queries over time related to reintroduction of the red kite (*Milvus milvus*) and then Google Analytics to understand user behavior within a website about the reintroduction of the Eurasian cranes (*Grus grus*), The Great Crane Project. The authors were able to identify temporal and spatial trends of interest related to conservation actions and information regarding the red kite. They were also able to assess the media release impact on public interest in Eurasian cranes by monitoring the specific website for use levels, which parts of the websites they viewed, view time, and location of the viewer. They found that the Google Analytics assessment was more fine-tuned for specific public engagement activities whereas the Google Trends was more useful for larger impact media releases (Sorian-Redondo et al., 2017). Two other studies used social media to assess species conservation. Roberge (2014) explored which type species draw

attention on twitter. Their analysis of attention given to mammal and bird species from the U.S. Endangered Species list (ESA) indicated that users tweet more about mammals than birds and that larger species garnered more tweets. Directly relevant to this study is that they found the two most frequently tweeted birds were the Sandhill Crane (*Grus canadensis*), Whooping Crane (*G. americana*) (Roberg, 2014). Hausmann et al. (2019) used international geolocated Flickr and Twitter data that corresponded with Important Bird and Biodiversity Areas (IBAs) to ass which areas were more popular, the relationship between popularity and geographical data, and to identify sites that were under high pressure from visitors. They were able to identify the sites that had the most use and that were associated with high visitation that might warrant management considerations (Hausmann et al., 2019).

Effective outreach is critical to bring attention to the conservation of endangered species (Brewer, 2002). Successful outreach can improve public support for conservation actions, facilitate pro-conservation behavior, reduce poaching and even influence policy (Jacobson 2010). Research on social media usage in the field of natural resources is relatively new and still developing. What has been demonstrated is that social media has impacts on participation in wildlife-related recreation (Callaghan et al., 2018; Wood, 2016). Other social media research in natural resources has been aimed at managers and agencies, demonstrating how they can create active social media profiles for increased interactions with their audiences (Taylor & Sammons, 2019). Despite the trending interest in research involving online discussions, little research has been done on social media discussions as they pertain to an endangered species and its potential to inform conservation. Further research has been called for in regard to communication on endangered species through other types of social media platforms (Wu et al., 2017).

Our study adds a targeted approach to examine online discourse, or communications and themes, involving Whooping Crane conservation on Twitter. We seek to identify the speakers/authors of the tweets, the content is they are tweeting, and the public engagement by author and by topic to assess impact of the outreach messaging. This research will answer the following questions:

1) What is being said about Whooping Crane conservation on Twitter?

2) What are the conservation implications that arise from the content of online conversations about Whooping Crane conservation?

3) What types of users are influencing the discussion of Whooping Crane conservation?

Methodology

This thesis begins by documenting the prevalence and efficacy of social media in a dataset captured from over 150 million sources of social media conversations. The Social Media Listening Center (SMLC) at Clemson University, an interdisciplinary research laboratory and teaching facility that works as a small network operations center, provided our data. The Center uses SalesForce Social Studio (formerly Radian6) as a platform to listen, discover, measure and engage in conversations across the Web. The Social Studio summary dashboard provides a graphic display of social media content to convey sentiment, share of voice, trend information, geo-location data, and much more. This technology allows for a triangular approach to pooling data as the sources of social media conversations vary in type, user demographics, and user activity (Orne and Bell, 2015). Among other social media-related projects at Clemson University, this technology has been applied to examine online conversations about college sports (Sanderson and Gramlich, 2015). Researchers were able to identify what words people

were using to describe college sports, patterns and conversations about different sports, and why differences exist around women's and men's college sports (Clemson University).

For this research, the SMLC collected social media communications of non-government organizations, government organizations, educational institutions, and members of the public between the years 2016 and 2019 as these communications referenced Whooping Crane conservation. Key words and phrases were used to pull this data (see Table 1). While there are a number of platforms used to communicate about Whooping Crane conservation, this thesis analyzes only Twitter data. Twitter provides the most intensive data, as it is a micro-blogging platform where Tweets from any individual user, or tweeter, can be viewed online and are automatically shared with the users who have subscribed to the tweeter's Twitter feed (followers). Tweeters may have enormous an enormous following: currently, the most widely subscribed to Twitter account belongs to former U.S. president Barack Obama who has 122 million followers (Friend or Follow, 2020). Tweets that users find of interest can be "liked" as well as "retweeted," or reposted on their own Twitter feed. Twitter is accessible online and through its smartphone application, is free to users, and disseminates tweets almost instantaneously.

Table 1: Keywords and Phrases

Keywords and Phrases					
icf	wcf19	international crane foundation	sarus	shoot	illegal
whoopingcrane	texas	aransas national wildlife	blue	poachers	conserve
festival of cranes	endangered	Whooping Crane	sandhill cranes		saving
aransas	portaransas	wheeler national wildlife	sandhill	poach	protect
endangeredspecies	savingcranes	whoopcranefest	crime	shooting	protection
crane	wheeler	whoopingcranefestival	shot		save

whoopitup	alabama	endangered species	poaching		conservation

The SMLC dataset included 1135 tweets that included Whooping Cranes and any of the keyword phrases listed in Table. These tweets were proximate between March 29, 2016 and April 29, 2019, around the time of two Whooping Crane festivals: The Whooping Crane Festival in Port Aransas, Texas and the Festival of Cranes at Wheeler National Wildlife Refuge in Decatur, Alabama. We anticipated that there might be extra social media activity around those festivals, especially as they are known to be advertised and discussed on social media. The SMLC provided the data in Excel sheets, one for each year 2016-2019. The Excel sheets contained social media activity across multiple platforms and the columns described aspects of the textual data with the headlines including date, content, media platform, region, language, and sentiment. SMLC approaches sentiment in accordance with Salesforce Social Studio technology: negative, positive, or neutral. At least one previous study by the SMLC has noted discrepancies in the sentiment analysis of Social Studio and have used alternative methods, such as online textual analysis via Aylien software, to identify sentiment associated with online text (Pratt et al., 2019).

Data Analysis

Tweets were separated from the other textual data pulled from other social media platforms such as forum websites, Facebook, and blogs. Analysis began with open coding, also known as induction, allowing the text to inform the selection of more general themes (Orne & Bell, 2015). These general themes informed a “codebook,” or set of thematic categories used to analyze the textual data.

In Excel, one column contained the text of the tweet. In addition to text, some tweets also included URL's. These could represent either an attached photograph, other graphic (a screen capture or an event flyer), an external link, or an internal link. Internal link would describe a link that led to another page in Twitter – perhaps a tweet by another user. External links lead to webpages beyond Twitter, like a news article for example. These webpage links were examined as they added context to the tweets that they were shared within. Retweets were not disregarded as they are unique to individual users on Twitter. Each tweet had its own unique URL, unless it was a duplicate, in which case it was disregarded. Tweets with URLs that were inaccessible were also disregarded. Our analysis sought to go beyond the textual data displayed in Excel in order to capture each tweet its entirety, from textual characters to attached images and links. Each tweet was examined to identify content and type of author. Author types were used to generally describe the Twitter user that composed the tweet. Content was defined as the subject of the tweet, or what was being discussed. If the content of the tweet was enhanced by the addition of photography, videography, or links, that was also noted in this category.

Author Types

We identified 8 different author (or Twitter user) types: corporate, educational, international, government, media, non-government organization (NGO), unique individual, and other (see Table 2). Corporate defined any account representing a company, from a small business, to a large corporation. Examples include the Disney Corporation, oil and gas corporations, and powerline companies. Educational accounts were those that represented educational institutions or organizations such as museums, universities, and grade schools. International was used to describe any account that was obviously describing experiences outside of the United States (Pratt et al., 2019). Examples of international accounts included World

Wildlife Fund Zambia and any accounts with tweets translated from an international language. Government accounts were those representing some official government organization or entity. Some examples are U.S. Fish and Wildlife Service (USFWS) accounts and the U.S. Geological Survey (USGS). Media described any account associated with media publication or station. Examples of media accounts included radio stations, news stations, magazines, newsletters, and research publication journals. Twitter accounts of non-government organizations included those associated with the International Crane Foundation and the Audubon Society. Unique individuals described those accounts that were associated with unique members of the public. Author types identified as other described those not clearly identifiable and not belonging to one of the other categories, such as aggregators.

Tweet Content

The contents of each tweet generally reflected the search conducted by the SMLC at Clemson University: each tweet mentioned Whooping Cranes in some way, with most tweets mentioning the conservation of the species and/or a poaching incident. Additional columns were placed in the Excel file for author type, content and features. The additional content column featured the general subject of discussion. To provide specificity, an adjacent column was added to list the features that enhanced or shaped the general subject of discussion. For example, if a tweet mentioned a poaching incident, the subject of "poaching" was then complemented by the location of the incident, such as Texas, Louisiana, or Indiana. Additional features included links and photos.

A modified Excel sheet of 994 usable tweets was uploaded to NVivo. NVivo allows you to import spreadsheets, organize that data by coding it to identify themes and trends, and then analyze and visualize that data to answer complex questions about it. In an effort to protect the

identities of Twitter users, especially unique individuals, the Author column was removed from the dataset. Additional irrelevant columns were also removed to leave publish date, author type, content, followers, retweets, likes, and features. In NVivo, we developed a codebook by using the emergent themes and trends found during the first phases of analysis. Each tweet was reexamined by its unique URL. Both author types and tweet contents (subject and additional features such as photos and links) were used as codes in NVivo.

Results

Tweets could be characterized as primarily being written by unique individuals as they tweet about Whooping Cranes. The most common speaker types were unique individuals (55 percent of tweets), followed by media outlets (16 percent), and NGOs (15 percent). The URLs within the text of each example tweet indicate attached media (photography and video) and/or a link.

Author Type

The large majority of online commentary is generated by unique individuals tweeting about bird sightings and sharing news articles about poaching and conservation. Of the 550 tweets tweeted by unique individuals, 166 (30.2 percent) were coded for poaching, 48 (8.72 percent) for politics, and 334 (60.72 percent) for conservation. Table 4 displays content by author type in more detail. The second largest speaker group, the media, shared similar information. One notable user from 2017 was a university researcher who tweeted over 70 times about Whooping Cranes and their conservation to help raise funds for his research. A plausible explanation is that these tweets help researchers, NGOs, and other managers promote their projects to the public and potential funders.

Table 2: Tweets per Author Type

Author Type	Number of Tweets
Unique Individual	550
Media	162
NGO	145
Educational	52
Other	48
Government	20
Corporate	15
International	3

Tweet Content

Generally speaking, the contents of each tweet reflected the key word search conducted by the SMLC at Clemson University. Table 3 quantifies and lists the content codes used in NVivo. The codes reflect what type of content, or context, was added to tweets about Whooping Cranes.

Table 3: Tweets by Content

Content	Number of Tweets
Whooping Cranes	972
Link	781
Conservation	582
Photography	428
Poaching	339
Indiana	236
ESA or Endangered Species	138
Special Event	122
Canada	100
Louisiana	88
Politics	57
Wood Buffalo National Park	56
Texas	54
Other Species	50
Fact	49
Art	41
Zoo	40
Videography	31

Patuxent WRC	29
Sandhill Cranes	19
Agriculture	12
Hunting	9
Port Aransas	9
International Crane Foundation	8
Humor/joke	5
Aransas NWR	4
Other	45

Conservation

Twitter users often celebrated achievements and awards for Whooping Crane conservation and shared its history, usually with reference to factual information such as how few Whooping Cranes remained before conservation efforts began. In 2016, two of the facilities where captive breeding populations are held, the Calgary Zoo and the San Antonio Zoo, accepted awards for their longtime involvement in Whooping Crane conservation. That same year, Wood Buffalo National Park in Canada celebrated its 50th year in Whooping Crane conservation. It should be noted that some links shared via Twitter, like stories of Whooping Crane conservation achievements, automatically add text to a tweet. Not all text in a tweet is personalized by the user.

Examples of tweets regarding conservation by different authors include:

Unique individual: *"Parks Canada celebrates 50 years of Whooping Crane Conservation - https://t.co/CWtlKjbqbC"*

@ParksCanada/ Government: "*A record-breaking 63 Whooping Crane chicks were counted in #WoodBuffaloNP in 2017! Making #conservation history in @spectacularNWT https://t.co/njw9sk6LGP*

@CalgaryHerald/ Media: "*Calgary Zoo honoured for Whooping Crane conservation efforts https://t.co/Ps8rE93Rfy #yyc https://t.co/6euYfMpXo1"*

@SanAntonioZoo/Educational: *"Did you know that San Antonio Zoo is home to one of the best Whooping Crane conservation programs in the world? We even received an award! Can we get a WHOOP WHOOP? #SAZOO #SanAntonioZoo #WhoopingCrane #AZA https://t.co/bwRwhAxPOA"*

Photography

Photography was a major motivation for tweets with over 43 percent containing a photography theme. Tweets that were coded for photography were either tweets that contained photos or tweets that mentioned photography but did not include any photos. The most engaging tweets for each year included something that users could view in the form of photography or videography.

In 2017, a tweet by the International Crane Foundation (ICF) that featured a photo of a Whooping Crane received the most retweets for the year with 159 retweets. This tweet may also have been popular due to its subject matter:

> *Please retweet! $6,500 #reward offered for info leading to arrest & conviction for #Indiana #WhoopingCrane shooting: https://t.co/FINshwYenJ https://t.co/Curcbnic0u*

Poaching

The most discussed poaching events were those that occurred in the state of Indiana. Poaching incidents in Texas and Louisiana were also mentioned, but not as frequently. The ICF

has been tracking Whooping Crane poaching incidents. Between 2009 and 2019, five Whooping Cranes were killed in Indiana (International Crane Foundation 2018).

Examples of tweets regarding poaching by different authors include:

Media: *"Conservation officers say a Whooping Crane scientists were tracking was found shot dead in west-central Indiana. https://t.co/X7aO7OXiaN"*

Media: *"#Wishtv Conservation officers investigating after Whooping Crane killed in Greene County. Read Blog: https://t.co/weyu41WIln"*

@USFWSMidwest/ Government: *"An #endangered Whooping Crane was shot in #Indiana. Concerned citizens can make the difference. If you have any tips, please let us know. https://t.co/I2XOMIkCbb"*

Unique individual: *"People are dumb. https://t.co/5DVIjwnaeC"*

Unique individual: *"AGAIN!?! This is the 5th Whooping Crane shot in IN SINCE 2009. #birds https://t.co/DSsjz1m0iQ"*

Places

Although location data provided by the SMLC was limited to as specific as country of origin, subject matter and usernames aided in the identification of where a tweet was tweeted or where something like a poaching incident or conservation achievement had occurred. The most notable places were Texas, Canada, Louisiana, and Indiana. The location with the most mentions was the state of Indiana, with 236 tweets (24 percent). Most of these tweets discussed poaching incidents that occurred in the state. Canada follows with 100 tweets (10 percent), Louisiana with 88 tweets (9 percent), and Texas with 54 tweets (5 percent).

Media: *Conservation officers say a whooping crane scientists were tracking was found shot dead in west-central Indiana. https://t.co/X7aO7OXiaN*

Media: Back from the brink: *Calgary Zoo wins conservation award for whooping crane initiative https://t.co/zTrJu9toUY #yyc https://t.co/oD2uogwGbU*

Unique Individual: *First Wild #WhoopingCrane Hatches In Louisiana Since WWII https://t.co/770Ps6rMDK #conservation #wildlife #crane https://t.co/VftrxYhlxL*

Government/ @CanCGDallas: *We're in #PortAransas today at @WhoopCraneFest! Rhona Kindoop is here from Wood Buffalo National Park in Alberta to talk about the whooping crane's migration between Texas and Canada and the important efforts to protect this species. #WCF19 https://t.co/Gp9Z5yZNLl*

Endangered Species

A small percentage of tweets (14 percent) explicitly mentioned endangered species and the Endangered Species Act. The subject of endangered species was popular among unique individuals as 49 percent of tweets in this content category were written by unique individuals. Some examples of these tweets include the following:

Unique Individual: *Canada' s stamp program has grown into a rich and creative celebration of the lives of Canadians, our achievements, and the natural beauty of our country. Our #BirdsofCanada stamp series highlights our magnificent winged creatures & the need for continued conservation efforts.*

Unique Individual: *@SenateGOP @SenateDems @HouseGOP @HouseDems PLEASE no not destroy the Endangered Species Act! We all need to protect every specie on that list. Please act responsibly & vote AGAINST repeal.*

Unique Individual: *For #EndangeredSpeciesDay, I'd like to highlight one of the most charismatic migratory birds that stop over in Great Plains #playawetlands in the Central Flyway. This year I had the immense pleasure of seeing my first #WhoopingCrane flying over the Platte River in Nebraska. https://t.co/wJs2aNYOeA*

Facts

Factual tweets (5 percent of all tweets) were those that contained facts about Whooping Cranes or other species. Facts were typically relative to species biology, habitat, and endangered status. Some examples of factual tweets include the following:

Government/ @USACE_SWD: *The whooping crane is one of the most endangered bird species in the world and is commonly seen as America's symbol of conservation. Standing 5 feet tall with a wing span of 7 feet, it is the largest bird in North America. https://t.co/4VZIiiPhGu*

Government/@ParksCanadaVan: *#DYK the Wooping Crane can be up to 1.5m tall! That makes them about the same height as @DannyDeVito! The Whooping Crane is an endangered species because of urbanisation in their habitat. You can help protect them by supporting and visiting #WoodBuffaloNP Š— where they live! https://t.co/UrZj1DLh8u*

Educational/@CalgaryZoo: *It's #WorldWetlandDay! DYK that 3 of the our conservation species depend on wetlands? Can you guess which 3? It's Leopard frogs, whooping cranes & sitatunga! While the leopard frog & whooping crane may have been easy to guess, the sitatunga is a species of antelope from Ghana! https://t.co/cRy74TZnWh*

Other species

Less than 6 percent of all tweets mentioned other species along with Whooping Cranes. These species included other endangered species and species that occupy the same wetland habitat as Whooping Cranes, like Sandhill Cranes. Examples of these tweets include:

Educational/ @CalgaryZoo: *How do animals move to new homes? Shipments are another way we participate in world conservation, ensuring the populations of critical species grow. In 2017, we had 40 shipments, from lemurs & chameleons, to fertile whooping crane eggs! #conservationconversation https://t.co/6P8adNKVt0*

Unique Individual: *Can you tell which bird is the #WhoopingCrane in this group of #SandhillCranes? #IGiveAWhoop @savingcranes #conservation #Wisconsin https://t.co/bNJ6osuAMt*

NGO/ @WCAudubon: *Federally-listed #KirtlandsWarbler #LeastTern #PipingPlover #RufaRedKnot #WhoopingCrane are threatened, endangered, proposed, or candidate species' by @USFWS #Midwest IL IN IA MI MN MO OH WI Here are some simple ways to help protect birds https://t.co/edNzWsnfjZ https://t.co/AZ8fpKqZKT*

Politics of Conservation

Twitter users reflected the growing partisan divide in America under the Trump Regime. According to a survey conducted by the Pew Research Center, the majority of Twitter users tend to be under the age of 50 (73 percent) and 36 percent of Twitter users identify as Democrats or lean towards the Democratic Party (2019). As Patuxent Wildlife Research Center (PWRC) was sending its last Whooping Cranes to other facilities, talk of the program changed from one of blaming the republican Trump administration in 2017 to one of a conservation victory in 2018. Still, there were some tweets that showed that the public viewed conservation as a priority for

any political administration. Users tweeted links to their followers to sign online petitions that called upon the republican Trump administration and the democratic Obama administration to protect endangered species and wildlife. A small amount of Twitter users directly tagged (or mentioned) their local representatives in similar action tweets. Tweets that contained political connotations made up 6 percent of all tweets most of them (84 percent) were composed by unique individuals.

A number of example conservation tweets from different audiences are below:

@BirdLifeEurope/NGO: *"The fight never ends! After saving the EU's #NatureAlert Birds & Habitats Directives, we now turn to support our American partners @audubonsociety as they fight against Trump's plan to try to pull the same nature destroying trick in th US"*

Unique Individual: *"Tell the Obama administration: Help save the Whooping Crane and Protect Wyoming's public lands! https://t.co/3R3gZSyUEz"*

Unique Individual: *"Stop trump, ACT ON THEIR BEHALF- National Wildlife Federation Action Fund - Protect Whooping Crane Habitat from Taxpayer-Funded Destruction https://t.co/BWG8gddH1T"*

Unique Individual: *"Trump cut the Whooping Crane captive breeding program to save money so I guess we can just say bye to that species"*

Unique Individual: *"In yet another #Trumpski attack on bedrock environmental laws that have been working successfully for decades to preserve and protect our health and environment, the Endangered Species Act is under fire from the administration. Let's see, Bald eagle on the menu?"*

ABCBirds/NGO: *"Good news for whoopers: @USGS Patuxent Wildlife Research Center Whooping Crane breeding program is ending, but Smithsonian @NationalZoo & Conservation Biology Institute will continue the efforts. Read more along w other notable #bird #conservation #news: https://t.co/qYpjkI3Dd2 https://t.co/aDgRSUuX7B"*

Table 4: Tweet Content by Author Type

	Author Types								
Content	**Total**	**Unique Individual**	**Media**	**NGO**	**Educational**	**Government**	**Corporate**	**International**	**Other**
Whooping Cranes	972	538	162	139	50	18	14	3	48
Link	781	419	157	112	34	17	5	2	34
Conservation	582	334	37	98	49	13	12	2	34
Photography	428	218	64	77	32	10	9	1	18
Poaching	339	166	126	30	1	6	1	1	8
Indiana	236	110	93	18	1	4	1		9
ESA or Endangered Species	138	68	37	19	2	3	1		8
Special Event	122	43	11	34	17	2	7	1	7
Canada	100	41	17	11	12	5	2		12
Louisiana	88	43	25	15	2	2		1	
Politics	57	48		4	2				3
Wood Buffalo National Park	56	21	6	6	8	6			9
Texas	54	27	6	11	7	2	1		
Other Species	50	30	3	9	2	1	2	1	2
Fact	49	23	3	11	3	5	1		3
Art	41	25	1	10	1		2		2
Zoo	40	16	8	4	6		3		3
Videography	31	18	2	5	5	1			
Patuxent WRC	29	22	1	4	2				
Sandhill Cranes	19	12	1	3	1		1		1
Agriculture	12	11		1					
Hunting	9	6	2	1					
Port Aransas	9	3	1	3	1	1			
International Crane Foundation	8	5		2	1				
Humor/joke	5	5							
Aransas NWR	4	2		1		1			
Other	45	33		6					6

Follower Engagement

In addition to the type of content, we were interested in the impact of different authors. Similarly, we were interested in how much the different categories of content may have on impact. We have defined follower engagement on Twitter by the number of likes and the number of retweets. Reach, or number of followers, is used to assess potential engagement of followers, but is not always reflected in total likes and retweets. The tables below display how different types of authors engaged their followers on Twitter. Specifically, the tables order the tweets with the most likes and the most retweets for each year, along with the content of those tweets. Likes and retweets are a direct reflection of how a tweet engages those who see it – followers. Although the tweets described in the following tables could be coded for multiple types of content, only the most prominent content is noted in the tables. In general, most of the tweets below included photos of whooping cranes.

Table 5: Follower Engagement - Likes

2016				
Top 3	**Likes**	**Followers**	**Author Type**	**Content**
1	34	2653	Unique Individual	Conservation
2	32	94318	NGO	Politics
3	25	4969	Educational	Conservation
2017				
Top 3	**Likes**	**Followers**	**Author Type**	**Content**
1	149	172161	Government	Conservation
2	79	5474	NGO	Poaching
3	64	25310	Media	Conservation
2018				
Top 3	**Likes**	**Followers**	**Author Type**	**Content**
1	208	22374	Other	Fact
2	174	423656	Educational	Fact
3	63	349086	Educational	Conservation
2019				
Top 3	**Likes**	**Followers**	**Author Type**	**Content**
1	290	150954	NGO	Conservation

2	163	3238	Unique Individual	Photography
3	52	22222	NGO	Conservation

Table 6: Follower Engagement - Retweets

2016				
Top 3	**Retweets**	**Followers**	**Author Type**	**Content**
1	42	94318	NGO	Politics
2	12	4949	Unique Individual	Poaching
3	12	2653	NGO	Conservation
2017				
Top 3	**Retweets**	**Followers**	**Author Type**	**Content**
1	159	5474	NGO	Poaching
2	54	41053	NGO	Poaching
3	40	172161	Government	Conservation
2018				
Top 3	**Retweets**	**Followers**	**Author Type**	**Content**
1	65	423656	Educational	Fact
2	29	22374	Other	Fact
3	20	57233	NGO	Conservation
2019				
Top 3	**Retweets**	**Followers**	**Author Type**	**Content**
1	122	19142	NGO	Politics
2	16	4978	NGO	Conservation
3	11	485	Unique Individual	Conservation

Follower Engagement of the ICF

The online communication efforts of the ICF are of particular interest. Their follower engagement between March 29, 2016 and April 29, 2019 is presented in Table 7. The number of followers reflects the number of users who possibly saw the tweet. The number of updates is the number of times the ICF tweeted in the year. The likes and retweets reflect overall engagement for the year. The ICF received a steady increase in followers (average increase of 20 percent)

over this time period. It should be noted that only one tweet by the ICF relative to Whooping Cranes was extracted and analyzed for the year 2018, along with three for 2019, thirteen in 2017, and 24 in 2016. The tweet with the highest number of retweets and likes over all four years was one calling for followers to share any information that would lead to a conviction for the shooting death of a Whooping Crane in 2017.

ICF: *"Please retweet! $6,500 #reward offered for info leading to arrest & conviction for #Indiana #WhoopingCrane shooting: https://t.co/FINshwYenJ https://t.co/Curcbnic0u"*

Table 7: ICF Follower Engagement

ICF Follower Engagement						
Year	**Followers**	**Updates**	**Average Likes**	**Most Likes**	**Average Retweets**	**Most Retweets**
2016	5312	2130	12	19	5	12
2017	6011	2702	17	79	20	159
2018	6401	3240	17	17	19	19
2019	6672	3757	11	14	3	6

Follower Engagement of the USFWS

Tweets from two accounts associated with the U.S. Fish and Wildlife Service were collected: *@USFWSSouthwest* and *@USFWSMidwest*. Both accounts are associated with regional sectors of the USFWS. In total, three tweets were extracted from these accounts in our designated time period. No tweets were extracted for the years 2016 and 2019, while one was extracted for 2018, and two for 2019. The table below presents the highest recorded value for the number of updates, followers, likes, and retweets for each year.

Table 8: USFWS Follower Engagement

USFWS Follower Engagement				
Year	**Updates**	**Followers**	**Likes**	**Retweets**

2017	8409	10485	15	12
2018	2256	5234	4	0

Discussion

Most research on online discussion on Twitter have focused especially on politics, in addition to climate change, sports, and transportation (Anderson and Huntington, 2017; Pratt et al., 2019; Sanderson and Gramlich, 2015; Yan et al., 2019). The focus points of this body of research have been public sentiment, the content or subject of conversations, online activity or interactions, and broad themes to describe conversation patterns and trends. Some other studies have focused on another social media platform: Facebook. One such study (Cardoso, 2016) examined and compared the impact of certain Facebook page posts by three nature-based organizations: eBird, Anacosta Watershed Society, and Aspen Center for Environmental Services. Impact was defined by follower activity the potential of engagement in environmental projects. The study identified four types of Facebook posts: motivational, invitational, informational, and investigational. It was concluded that the degree to which page posts fall into the motivational category - with incentives, prizes, rewards, and expressions of appreciation - impacted follower engagement the most. Although this study was not focusing on Twitter discussions, it is relevant to this research in that it examines the engagement trends of organizations like the International Crane Foundation on a social media platform and provides a strategy for online engagement of followers.

We found that most users of Twitter are unique individuals and were surprised to find that they discussed Whooping Cranes much more frequently than government agencies and non-government organizations did. In the beginning of this research, our users of focus were the U.S.

Fish and Wildlife Service and the International Crane Foundation. Agencies and organizations in Canada also became Twitter users of interest. Over half of all tweets about Whooping Cranes (55 percent) came from unique individuals compared to 15 percent from NGO's and 2 percent from government agencies. The topic of poaching and was mostly discussed by unique individuals, and likely due to this group being the majority author type. However, government agencies usually reported poaching incidents, followed by media outlets and then members of the public (i.e. unique individuals).

Although most unique individuals did not typically have as high numbers in engagement categories (followers and retweets) as NGOs and educational institutions, there were a couple of notable users whose Twitter usernames came up frequently in the data. One user looked to be university researcher who had tweeted over 70 times about his Whooping Crane conservation research in an effort to gain funding for it. Another user was a guide and possibly boater who lead Whooping Crane tours. His tweets featured tips, sightings, and photography.

The most common themes discussed involving whooping cranes were conservation (59 percent of all tweets), photography (43 percent), and poaching (34 percent). Not all sightings shared on Twitter were accompanied with photos as some Twitter user lamented missed photo opportunities for a species as charismatic and rare as the Whooping Crane. Unique individuals may have talked the most about the conservation of the Whooping Crane (57 percent), but they obtained conservation stories and news from other author types: NGOs (16 percent), educational institutions (8 percent), and media outlets (6 percent). In comparison to the amount of conservation tweets by unique individuals, such tweets by other author types is fairly low. However, unique individuals retweeted and shared links to conservation news stories that were initially shared by NGOs, educational institutions, and media outlets.

The mission of the ICF is to conserve all 15 crane species around the world and the habitats on which they depend by providing knowledge, leadership, and inspiration to engage people in resolving threats to cranes and their diverse landscapes. Twitter conversations about the Whooping Cranes tell us that members of the public are angered by the threat of poaching and poaching incidents and are generally aware of conservation efforts to delist the Whooping Crane from the endangered species list. What is also apparent is that members of the public tend to miss the nuances and details of certain conservation happenings. For instance, sentiment around the announcement of the end of the Patuxent WRC Whooping Crane breeding program was one of anger and sadness. Twitter users blamed the Trump administration for defunding the program and assumed that efforts to save the species would be severely weakened. Since PWRC ended its breeding program, six other facilities have been conducting their own active breeding programs: the Smithsonian Conservation Biology Institute in Front Royal, Virginia; the White Oak Wildlife Conservation Center in Yulee, Florida; the International Crane Foundation in Baraboo, Wisconsin; the Dallas Zoo in Texas; the Freeport-McMoRan Audubon Species Survival Center in New Orleans, Louisiana; and the Calgary Zoo in Canada. The initial frustration expressed by members of the public could be due to lacking details about where the PWRC Whooping Cranes would go and the known or assumed conflicting interests of the Trump Administration. Users often referenced the administration's apathy towards science-based conservation and land management.

Conclusion

We found that conversations on Twitter regarding Whooping Cranes were primarily facilitated by unique individuals and that sharing links was common. Also, the media, NGOs, and educational groups were key contributors, but to a lesser extent. We found that conservation,

poaching, photography, and their status as an endangered species were the most common topics discussed regarding whooping cranes, but there were a range of other topics identified as well. The most liked and most retweeted tweets were those that included photos of Whooping Cranes and mentioned conservation efforts or poaching incidents. These most popular tweets were composed by NGOs and educational institutions. Examination of patterns of authors and content that has been discussed on Twitter and their impact (as measured by followers and retweets) can help the ICF and the USFWS to design strategies for their own to facilitate effective outreach and communications strategies consistent with the Recovery Plan. A suggestion for state agencies, the USFWS, and the ICF would be to have more collaboration on Twitter, especially as all of these groups have the same goal for the Whooping Crane in having the species delisted.

Public outreach is effective in terms of fostering engagement and inspiration. Users tweeted links to petitions to save the Whooping Crane and other endangered species, shared their photos and sightings of Whooping Cranes with their followers, and tweeted their responses to poaching incidents. Twitter is one sources that can be used to help create an engaged and educated public to enhance the conservation of Whooping Cranes. This research can serve as an introduction to Twitter analysis for communication and outreach efforts for other species as well.

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