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Assessing online opinions of wildlife through social media

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ABSTRACT

We present a technique to programmatically collect comments made about videos on YouTube, a popular social media website, and use content analysis to categorize and compare the frequency of comment types across videos and topics. For this article, we collected and categorized the comments of the 10 most viewed videos (in 2013) of three common North American mammals: the coyote (*Canis latrans*), Virginia opossum (*Didelphis virginiana*), and raccoon (*Procyon lotor*) to demonstrate the potential of the technique. Half of the categorized comments for coyote encouraged their lethal control while the most popular comments for raccoon and opossum described these species as "cute" (47% and 34%, respectively). Analyzing YouTube comments is a promising avenue of research, and given proper development, could represent a useful approach to assess public opinions toward wildlife expressed online.

KEYWORDS

content analysis; Internet; social media; urban wildlife; YouTube

Introduction

In the last two decades, the growth of information available online has altered the way people learn and relate to the world around them (Brundidge, 2010). Given the popularity and convenience of the Internet, it has become a primary source of public information. For example, nearly 60% of the U.S. population primarily uses the Internet when they want to learn about scientific issues (National Science Board, 2012). By virtue of providing that information, the various platforms on the Internet can influence public opinion (Fan, 2012). As changes in public opinion influence many aspects of the world around us including politics (Stimson, 2015), economics (Hester & Gibson, 2003), and the environment (Liordos, Kontsiotis, Anastasiadou, & Karavasias, 2017), it is increasingly important to assess information exchange and opinions expressed online (Brossard & Scheufele, 2013).

One such source of scientific information is user-generated content via online forums (i.e., social media). Online forums allow people to share ideas or content with others based on their own identities, ideologies, and interests (Boyd, Danah, & Ellison, 2007). Most importantly, social media has been shown to change the attitudes and behaviors of people (Diehl, Weeks, & Gil de Zúñiga, 2016). For example, social media can influence consumer habits (Goh, Heng, & Lin, 2013) and increase environmentally sustainable behaviors (Pearson, Tindle, Ferguson, Ryan, & Litchfield, 2016). A small but increasing number of studies have also begun to assess online information about and opinions toward the natural world as well. Such studies have demonstrated, for example, that Internet searches

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related to the environment have decreased through time (McCallum & Bury, 2013), have evaluated the attitudes of hunters and non-hunters (El Bizri, Morcatty, Lima, & Valsecchi, 2015), and have illustrated how Internet searches for bird species mimic their spatial distribution (Schuetz, Soykan, Distler, & Langham, 2015). Collectively, these studies illustrate the potential in researching the relationship between humans and the environment online and provide growing evidence that what is said and seen online influences public opinion (Diehl et al. 2016). As humans and the environment are incontrovertibly linked, so too then are the Internet and the environment.

We present a technique to programmatically collect comments made about videos on YouTube, one of the most popular social media websites in the world with nearly 1 billion active users each month (YouTube, 2016), and then use content analysis to categorize and compare the frequency of comment types across videos of different wildlife species. YouTube is a video-sharing website that allows and encourages users to upload, share, rate, and comment on user-generated content (Heckner & Wolff, 2009). We selected three widespread and common North American mammals: the coyote (*Canis latrans*), Virginia opossum (*Didelphis virginiana*, hereafter opossum), and raccoon (*Procyon lotor*). These species are ideal candidates to use as a demonstration because common species have a disproportionately large impact on ecosystem processes and are more likely to interact with people because they persist in human-dominated environments (Gaston, 2010). To understand what is said about these species on YouTube we asked two specific research questions: (a) what are the most commonly held opinions toward each species online as reported via comments on YouTube and (b) do the types of expressed opinions held toward coyotes, opossum, and raccoon differ?

Methods

Collecting and Analyzing Comments on Social Media

To identify relevant videos, we used the YouTube search feature and queried videos featuring each species using the search terms "coyote," "opossum," and "raccoon," filtering by the number of views. We only selected the top 10 most viewed videos for each species, as doing so provided roughly 50,000 comments to categorize across all species. After verifying that each video contained the target species, we accessed the mobile YouTube website and collected all comments made about each video by iteratively using Asynchronous JavaScript (AJAX) Language calls to retrieve 10 comments at a time (Nekaris, Campbell, Coggins, Rode, & Nijman, 2013). AJAX is a web development technique that can send or retrieve data from a website without interfering with the display or behavior of a webpage. On YouTube, AJAX effectively allows one to iteratively load and collect comments for a video. The mobile YouTube site was used because the comments had a formatting structure that was easier to access via AJAX calls but retained the same information as the desktop site. While most YouTube users only make one comment per video (Nekaris et al., 2013), some users may comment multiple times. To give individual users one "vote" per video so that one person is not overrepresented in the comments for a video, we only saved their first comment. At the time of our analysis, the mobile YouTube website would not correctly load for two videos because they had >20,000 comments. Because we could not guarantee a representative sample of the comments for these videos, we exempted

these two videos and collected comments from the next most viewed video so that there was a total of 10 videos per species.

Categorizing Videos and Comments

After viewing the top 10 most viewed videos for each species (following exemptions), we created five categories that covered the range of activities observed which included the target species (a) as a pet or in captivity, (b) as wild but actively being fed by humans, (c) coming into conflict with humans, (d) being hunted by humans, or (e) interacting with other wildlife species (Table 1). Videos were placed into one of these five categories based on their content with respect to the species of interest, and no video fit into more than one category. Comments in each video were also categorized based on their content. To ensure that these categories represented distinct attitudes we used categories defined by Kellert that describe contrasting attitudes toward wildlife which include: naturalistic, ecologistic, scientific, humanistic, moralistic, dominionistic, negativistic, esthetic, and utilitarian (Table 2; Kellert, 1984). While these attitudes were identified nearly four decades ago they are still relevant categories that describe opinions held toward wildlife today (George, Slagle, Wilson, Moeller, & Bruskotter, 2016). In our analysis, some attitudes described by Kellert (1984) were both rare and difficult to distinguish from a single comment

Table 1. Content categories in most viewed coyote, opossum, and raccoon videos on YouTube.

Video category	The target species in the video is…
As a pet or in captivity	either a pet or wild individual but in captivity
Actively feeding wildlife	wild and actively fed by people
Human–wildlife conflict	negatively interacting with people, their property, or their pets/livestock
Hunting	being hunted by people
Wildlife interactions	interacting with another wild species

Table 2. Kellert categories used in this analysis to assess online opinions toward coyote, opossum, and raccoon. Definitions of Kellert categories were taken from Kellert (1984), while comments were taken from different videos that were collected for this analysis.

Kellert category	Definition	Examples from YouTube comments
Naturalistic	Primary interest and affection for wildlife and the outdoors	"I love all coyotes"
Ecologistic	Primary concern for the environment as a system, for interrelationships between wildlife species and natural habitats	"Just like every animal…they are vital to keep this world working properly. These little dudes eat animals we class as 'pests' like rats, mice, bugs etc etc"
Scientific	Primary interest in the physical attributes and biological functioning of animals.	"Opossums are extremely resistant to zoonotic diseases."
Humanistic	Primary interest and strong affection for individual animals, principally pets.	"I wish I had that baby possum to raise. I love possums and I would love another baby possum to raise. They make lovely affectionate pets. The one I had was named Ziggy Piggy."
Moralistic	Primary concern for the right and wrong treatment of animals, with strong opposition to exploitation or cruelty toward animals.	"Why did u kill that?? it was a poor creature…"
Dominionistic	Primary interest in the mastery and control of animals, typically in sporting situations	"Destroy all coyote who ruin deer hunts"
Negativistic	Primary orientation on avoidance of animals due to indifference, dislike, or fear.	"If I ever saw a possum, I would freak the hell out!! Those things are gross and disgusting."

(utilitarian and esthetic). Due to this, we combined dominionistic and utilitarian attitudes into a single category and did the same with naturalistic and esthetic, and therefore used seven of the nine Kellert categories.

To decrease the number of irrelevant comments (e.g., job offers posted by "bots" or links to other YouTube pages), we programmatically searched the comments for 62 common keywords that represented these Kellert categories (Table 3). Keywords were selected by both (a) evaluating a random subset of 500 comments for each species across videos and choosing words that were attributable to a Kellert category and (b) using our professional opinion to include additional words related to the ecology, conservation, and management of these three species. We used approximate string matching with the *agrep* function in the R programming language to locate comments containing keywords and their variant spellings or misspellings (R Core Team, 2016).

We categorized each of the comments selected through this process except for comments that were not specifically related to the target species. For example, the comment "it's so cute" would not be categorized as humanistic if there were multiple species present in the video whereas "that raccoon is so cute" would be categorized as humanistic for a raccoon video even if multiple species were present. Comments could also be placed into multiple categories if they covered varying topics. The comment "opossum are the only marsupial native to North America, can play dead, and are commonly found in urban environments" would fit into the "scientific" and "ecologistic" categories because the comment focuses on the species' biology (being a marsupial that can play "dead") and its ecology (found in urban environments). The accuracy of statements made in a comment was not considered when assigning them to Kellert categories, only the user's apparent intent. After classifying all comments selected by our search criteria the frequency of each Kellert category was calculated for each video.

Analysis of Comments

We fit a Bayesian multinomial model to these data for each species to estimate the most likely opinions held toward coyote, opossum, and raccoon. Our posterior distribution for the j videos, k species, and i Kellert categories is:

Table 3. Keywords associated to the seven Kellert categories. Although some of these keywords may appear to be related to a single category (e.g., the keyword 'hunt' is likely related to the dominionistic Kellert category), the way that it is used within a comment could drastically alter how it is categorized. Thus, these keywords are only organized alphabetically.

adorable	earth	hunt	scare
aggressive	eat	hurt	scum
attack	ecology	kill	service
baby	ecosystem	learn	shoot
beautiful	environment	love	shot
beauty	f*ck	mange	stupid
behavior	fear	maul	suffer
bite	feed	meat	threat
blood	food	no	trap
conflict	free	order	ugly
cruel	fur	pet	want
cute	fuzzy	PETA	welfare
danger	gross	predator	wild
dangerous	gun	prey	
dead	habitat	rabies	
disease	hate	scabies	

$$[\theta|\mathrm{N}] \propto \prod_{j=1}^{10}\prod_{k=1}^{3}\mathrm{Multinomial}\left(\mathrm{N}_{j,k}|\theta_{1,j,k}\ldots\theta_{I,j,k}\right)\mathrm{Dirichlet}\left(\theta_{1,j,k}\ldots\theta_{I,j,k}|a_{1,j,k}\ldots a_{I,j,k}\right)$$

where $\theta_{i,j,k}$ is the estimated proportion of comments for each category per video per species and $N_{j,k}$ is the number of comments in each category per video per species. We used a vague Dirichlet prior centered on a uniform multinomial distribution by setting all alpha values ($a_{1,j,k}$ … $a_{I,j,k}$) to 1/7 (~0.14) for the seven Kellert categories which assumes an equal prior probability for all Kellert categories in a video. Given this specification, our model estimates the probability each Kellert category would be observed in a comment per species per video. To compare the most common types of comments made about each species; however, it may be of greater interest to calculate the global proportion of each comment type over all videos for each species. Following Gelman et al. (2014), we calculate these values with the posterior simulations and the known values of $N_{j,k}/N_k$:

$$\theta_{i,k} = \sum_{10}^{j=1}\frac{\mathrm{N}_{j,k}}{\mathrm{N}_k}\theta_{i,j,k}$$

where $\theta_{i,j,k}$ and $N_{j,k}$ are the same as above, N_k is the total number of comments attributable to a Kellert category, and $\theta_{i,k}$ is the proportion of comments made in the ith category for the kth species. We used JAGS version 4.0.0 (Plummer, 2003) to fit this model with version 3.2.3 of R (R Core Team, 2016). Following a 20,000-step adaptation and a 20,000-step burn-in, the posterior distribution was sampled 60,000 times. To ensure model convergence we calculated Gelman–Rubin diagnostics, ensured they were <1.10, and visually inspected the conditional posteriors for proper mixing (Gelman et al., 2014).

Results

The average number of views for the videos we assessed was 1.7 million for coyote (min = 993,597, max = 2,684,086), 1.0 million for opossum (min = 530,513, max = 3,062,951), and 1.8 million for raccoon (min = 844,524, max = 2,958,914). The 10 most viewed coyote, opossum, and raccoon videos were, respectively, seen >16 million, 9 million, and 17 million times. For coyote, 80% of the top viewed videos were of humans hunting coyotes and 20% depicted aggressive behavior and competitive interactions between coyotes and wolves. Conversely, 70% of the most popular opossum videos were of pet or wild opossum in captivity and 30% depicted human-opossum conflict (e.g., a wild opossum entering a house that had to then be removed by a homeowner). Finally, 50% of raccoon videos depicted human-raccoon conflict (e.g., raccoons stealing food from domestic pets that are fed outside), 40% featured pet or wild individuals in captivity, and 10% included people actively feeding wild raccoons.

After duplicate comments from the same individual were omitted, 19,298, 13,636, and 19,748 comments were collected from coyote, opossum, and raccoon videos, respectively, on October 31, 2013. Filtering by keyword left us with 10,532, 5,058, and 7,772 comments for coyote, opossum, and raccoon, of which 19%, 55%, and 24% were assignable to a Kellert category, respectively.

The coyote multinomial model estimated that dominionistic opinions were the most commonly held opinion in coyote comments (49%, 95% CI = 47–52) and were 2.31 times (95% CI = 2.22–2.39) more likely than ecologistic opinions, the second most common category (Figure 1). Moralistic opinions were almost as common as ecologistic (Figure 1). Humanistic opinions were the rarest for coyotes (1%, 95% CI = 0–2; Figure 1).

Humanistic opinions were the most commonly held in opossum video comments (47%, 95% CI = 45–48; Figure 1), followed by negativistic (19%, 95% CI = 17–20). Naturalistic opinions were the third most common and accounted for 12% of categorized comments (95% CI = 11–14). Like opossum, humanistic opinions were estimated to be the most frequent Kellert category observed for raccoon and accounted for 34% (95% CI = 32–37) of comments in videos (Figure 1).

Between species, coyote had 4.87 (95% CI = 4.14–5.63) times more comments that signified dominionistic opinions than opossum and raccoon (Figure 1). For all species,

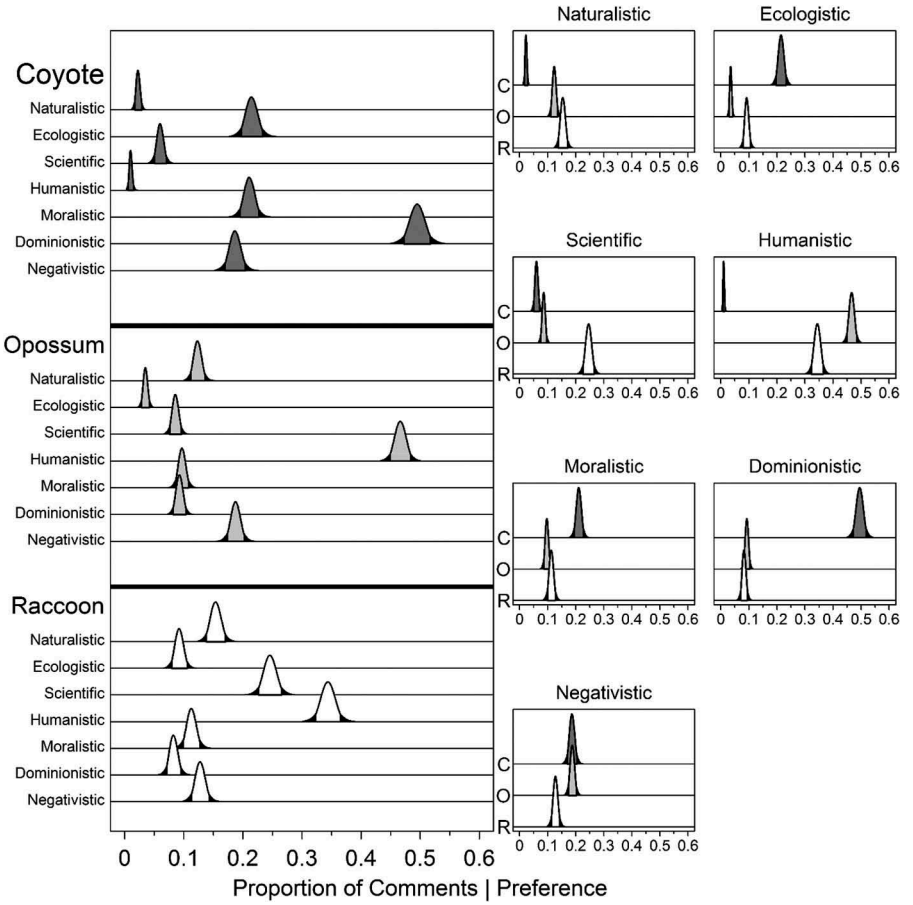

Figure 1. The estimated proportion of comments that were assigned to Kellert categories from the 10 most viewed coyote (C), opossum (O), and raccoon (R) videos on YouTube. The left panel of the figure illustrates how attitudes differ within a species, while the right panels show how species vary across attitudes. The area inside the black tails of each proportion represents the 95% credible interval per species per attitude.

humanistic, dominionistic, and negativistic opinions were the most common categories across all videos and species and, respectively, accounted for 24% (95% CI = 23–25), 20% (95% CI = 19–21), and 15% (95% CI = 14–16) of comments for the coyote, opossum, and raccoon. Across all videos and species, naturalistic, ecologistic, and scientific opinions were the rarest Kellert categories and, respectively, accounted for 9% (95% CI = 8–10), 10% (95% CI = 9–11), and 11% (95% CI = 10–13) of all comments for the coyote, opossum, and raccoon.

Discussion

Based on comments from YouTube videos, Internet users held more dominionistic opinions toward coyotes, but more humanistic opinions toward opossum and raccoons in the 10 videos viewed per species. Naturalistic, ecologistic, and scientific opinions were the least common opinions overall. As this technique can be used to identify common trends or opinions about species online it may be applicable to wildlife management professionals, especially as one goal of U.S. wildlife agencies today is to educate the public and foster an understanding of wildlife and the environment (Adams & Lindsey, 2010). Our results show the potential of using online resources to estimate human opinions toward wildlife online and allow researchers to tap into a vast wealth of data previously unexplored.

However, there are limitations that should be considered, and which suggest future areas of potential research. Similar to other online studies, the trends observed are not a true random sample of the population, but are based on a specific sample of Internet users. As other survey based research has found that demographics (e.g., age, gender, highest level of education gained) may influence a person's perceptions toward wildlife (Gamborg & Jensen, 2016), it would be useful to link our own analysis to the demographic data of commenters. However, YouTube only allows owners of a given video to download demographic data. Further analyses could either (a) request permission from video owners to collect the associated demographic data or (b) have a random sample of individuals view the same videos, offer comments on them, and collect their demographic data. The multinomial model described here could be extended for both approaches so that the probability that each category occurs is made a function of demographic data via the multinomial logit-link (Gelman et al., 2014). Such a process would allow for a linear predictor to be generated for each comment category so that it could be made a function of covariates. Either analysis could then estimate how representative YouTube comments are of the opinions of a larger population and thereby help bridge the gap between social media and other research on opinions toward wildlife.

There did appear to be correlation between the content of a video and the comments made. For example, 80% of the top viewed coyote videos depicted hunting, and almost half of the comments made about coyote were dominionistic (Figure 1). For raccoon and opossum, 55% of videos were of pets or wild individuals in captivity, and most comments made were humanistic. In this analysis, we selected the most viewed videos, which likely represent popular and/or common interest in the species, and therefore did not choose videos based on their content. To control for the influence that video content may have on comments made, future research could locate videos for a given species that cover a multitude of topics to determine if comments made apply generally to the species, or are

in specific response to the context. For example, our results would be more robust for the coyote if dominionistic comments were made across videos that varied in content, instead of the 10 most seen videos of this species which primarily depicted hunting.

In conclusion, we have presented a technique that can be used to collect and categorize comments on YouTube. While we applied Kellert's categories to these videos, any classification scheme could be used depending on the hypothesis tested. Likewise, instead of manually classifying comments, sentiment analysis could be used to computationally identify and categorize the polarity (e.g., positive, negative, neutral) of comments made (e.g., Fan, 2012). Thus, sentiment analysis may be a useful, albeit more general, metric for the analysis of large numbers of comments. Regardless, analyzing the comments made in YouTube videos, given proper development and careful selection of videos, could represent a useful approach to assess public opinions toward wildlife and nature expressed online.

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