#GARWEEK: Insights from a Social Media Outreach Campaign about Alligator Gar in Oklahoma

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Abstract: Alligator gar (*Atractosteus spatula*) populations have declined throughout much of their range, and one of the reasons for the decline is misconceptions by fisheries managers and the general public. In recent years, directed research and renewed interest by anglers has increased appreciation of alligator gar, but fisheries managers still lack an understanding of how the general public perceives this species. Using social media, managers can characterize the public's sentiment towards alligator gar and identify misconceptions. Biologists and the social media specialist with the Oklahoma Department of Wildlife Conservation joined Texas Parks and Wildlife in their social media campaign, #GARWEEK, to educate the public about alligator gar and gain a better understanding of the public's opinion of alligator gar in Oklahoma. Five posts were made to a variety of social media platforms with Facebook being the most heavily used. Social media analytics and sentiment analysis were used to evaluate the public's perception of alligator gar. Overall, the sentiment expressed by the public was positive indicating a major shift in public perception towards alligator gar. However, misconceptions relating to alligator gar and management remain, though these may be overcome via communication efforts that include social media. In time, this will lead to a better understanding by the public of alligator gar and the role of alligator gar in the environment and more effective management.

Introduction

Historically, alligator gar (*Atractosteus spatula*) has been viewed through a lens of hostility, criticism, and distaste (Scarnecchia 1992). The negative public perception towards gar originates from their toothy, threatening appearance and the misconception that gars prey primarily on sportfish. These sentiments resulted in the targeted removal of gar from aquatic systems by recreational anglers (Scarnecchia 1992; Garcia de Leon et al. 2001; O'Connell et al. 2017). Historically, many state natural resources agencies have directed efforts to eradicate gar with the motivation of promoting sportfish population growth (Scarnecchia 1992;

Binion et al. 2015; David et al. 2018). Local reductions in population abundance caused by targeted removal and harvest, coupled with habitat alteration and loss, has resulted in the extirpation of alligator gar from most of their historic range (Buckmeier et al. 2016; Kluender at al. 2016; David et al. 2018). The American Fisheries Society's Endangered Species Committee currently recognizes the alligator gar as "vulnerable" because of range reduction and over-exploitation (Jelks et al. 2008).

In recent years, however, the perception of alligator gar has apparently shifted in a positive direction. An increase in directed research and renewed interest by recreational anglers has led to an increased appreciation of alligator gar among fisheries biologists and anglers (David et al. 2018). Despite unregulated harvest of the species historically (DiBenedetto 2009, Smith et al. 2018), recent management efforts have recognized the commercial and recreational value of alligator gar by regulating harvest, promoting sustainable harvest, and reintroducing the species in portions of its former range (Buckmeier et al. 2016, Smith et al. 2018). Compared to other members of Lepisosteidae, alligator gar presently garners the most attention from recreational anglers because of their potential to reach "trophy" sizes (≥ 2438 mm total length; Buckmeier et al. 2016, Smith et al. 2018).

Even with increasing interest from biologist and anglers towards alligator gar, managers lack an understanding of how the general public currently perceives alligator gar. Management and conservation actions, and the research that informs such efforts, are often directed toward species that are charismatic or well-known by the public (Reimer et al. 2013). Would the public support restoration projects or management efforts directed at conserving alligator gar populations? This question is a complex one that has yet to be addressed. Alligator gar have been traditionally viewed as an unfavorable species, but how have perceptions of alligator gar among the general public changed as more research, management, and angling effort is directed towards the species?

Prior to widespread adoption of social media, communication among recreational anglers occurred primarily through word of mouth when they would gather to discuss fishing at local coffee shops, baits shops, boat ramps or access areas (Claussen et al. 2013; Kopaska and Fox 2013; Midway and Cooney 2013; Taylor and Sammons 2019). Therefore, researchers often used creel surveys, phone surveys, or questionnaires to gauge the attitudes and opinions of constituents about a given management topic. Within the last decade, however, social media platforms have provided anglers the ability to exchange information in real time via the internet (Martin et al. 2012; Kopaska and Fox 2013). In response, biologists have adopted social media platforms to improve public outreach of management and conservation topics (Claussen et al. 2013; Kopaska and Fox 2013; Midway and Cooney 2013; Taylor and Sammons 2019). Social media outreach efforts can result in quantifiable increases in public perception; for example, Reimer et al. (2013) found that providing the public with facts about the rarity, uniqueness, habitat, and local importance resulted in an increased positive perception of the eastern hellbender (*Cryptobranchus alleganiensis alleganiensis*) a rare, but uncharismatic, aquatic giant salamander that has been killed intentionally by humans in the past. Furthermore, analyzing the public's comments made on social media outreach posts via "opinion mining" could help managers characterize the public's sentiment towards a given topic (Palomino et al. 2016).

Because modern anglers now rely heavily on social media to obtain information about fishing (Martin et al. 2014) and social media platforms provide an instant path of communication where constituents can exchange information (Claussen et al. 2013; Midway and Cooney 2013; Martin et al. 2014), the Oklahoma Department of Wildlife Conservation (ODWC) has been using social media platforms to educate the general public about the state's natural resources and the science that informs resource management. The ODWC joined the Texas Parks and Wildlife Department's (TPWD) #GARWEEK campaign to inform followers about alligator gar and to gain

a better understanding of the public's perception of alligator gar in Oklahoma. Biologists and social media specialists with ODWC crafted outreach-oriented #GARWEEK posts about the conservation and management of alligator gar in Oklahoma with the following objectives: 1) to increase ODWC's target audience and impact on its social media pages on Facebook, Twitter and Instagram; and 2) to quantify the public's sentiment towards these messages about alligator gar via "opinion mining" of comments made on these social media posts. Results gleaned from this study can be used to improve the breadth and impact of future social media outreach efforts related to alligator gar, while also providing an important baseline for public sentiment towards alligator gar that can be monitored over time.

Methods

Social media outreach posts were made by ODWC biologists and social media specialists during a 5-day period designated as "Gar Week" from June 11 to 16, 2018. A total of 5 posts were created, each consisting of informative text about alligator gar and at least one original video or photograph intending to garner more engagement among followers (Osborne-Gowey 2014; Taylor and Sammons 2019). Post #1 consisted of a 1-minute video clip that featured a large alligator gar and texts that detailed their large size, diet of primarily scavenging on non-game fishes, and status as a Species of Special Concern in Oklahoma (Figure 1). Post #2 featured a photograph of the snouts of an alligator gar, a hybrid alligator
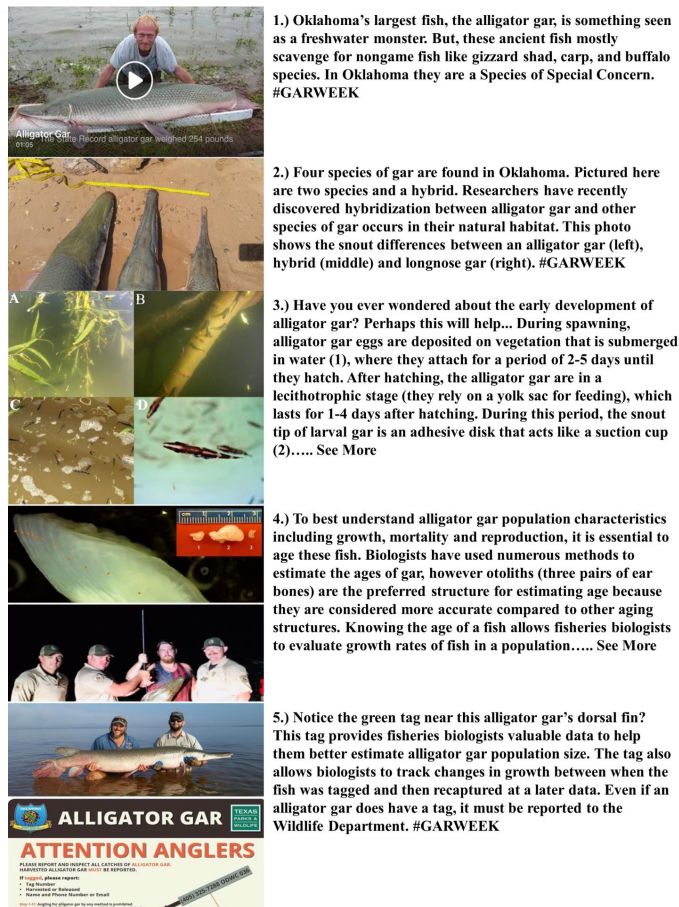

Figure 1. #GARWEEK posts shared on ODWC's Facebook, Twitter, and Instagram pages in ascending order (1 - 5). Due to Twitter's character limits, Post #3 was separated into four tweets (3a, b, c, and d). A single post (#2) was made to Instagram.

gar x longnose gar, and a longnose gar, along with text describing hybridization among the four gar species native to Oklahoma. Post #3 highlighted alligator gar development along with photographs of sac fry and free-swimming fingerlings. Post #4 illustrated how age can be estimated from harvested alligator gar otoliths, and how that information can provide insights into the environmental conditions that favor reproduction. Finally, Post #5 showed a photograph of a tagged alligator gar and explained how reporting tagged fish helps ODWC to estimate population size.

These #GARWEEK posts were shared on ODWC's Facebook, Twitter, and Instagram pages. One post was made each day of "Gar Week" on Facebook. Because of Twitter's character limits, Post #3 was separated into four tweets (3a, b, c, and d) on Twitter, therefore, Twitter's posts included Post #'s 1, 2, 3a, 3b, 3c, 3d, 4 and 5. A single post (#2) was made to Instagram. Across all three platforms, each post included the hashtag #GARWEEK, which allowed social media users to follow this specific topic (Palomino et al. 2016). In addition to ODWC's posts, concurrent #GARWEEK social media posts were made by TPWD and several other scientists active in alligator gar research; however, analysis of those posts are beyond the scope of this study.

Each social media platform provided different metrics towards quantifying the reach and engagement of #GARWEEK posts. Facebook provided numbers of likes, shares, reach, impressions, and engagement for Facebook (Table 1; Facebook 2019). Twitter utilized a similar metrics to Facebook with retweets, impressions, engagement, and engagement rate (Table 1; Twitter 2019). Instagram reported hearts, comments, and collections (Table 1; Instagram 2019). Because of differences in audience, engagement metrics, and algorithms used to display content to users across platforms, we calculated platform-specific measures of reach and engagement for #GARWEEK posts. We used analytics tools available to administrators of Facebook and Twitter accounts to download data for the #GARWEEK posts that had accumulated over a nine-day window (June 11-19), and manually compiled data from Instagram. To quantify how #GARWEEK posts performed relative to other posts on each platform, we calculated the percent increase of these metrics as compared to a 30-day average for posts made by ODWC (calculated from the 30 days of data on each platform prior to the first #GARWEEK post). Facebook, Twitter, and Instagram averages encompass a timeline from 5/13/2019 – 6/8/2019. The number of posts varied between medial forum ranging from 13 - 25 (Table 2, 3, 4). Percent increase was calculated by (Gar Week mean – previous 30-day's mean = increase), then (increase / previous 30-day's mean) x 100 = percent increase.

Table 1. Descriptions of each metric used to quantify increases of ODWC's target audience and reach on its social media pages.

Media forum	Metric	Description
Facebook	Engagement	Performing actions on your page (post clicks, likes, shares and comments).
	Impressions	The number of times a post from your page is displayed.
	Reach	The number of people who visited or saw your page or one of your posts in a news feed.
	Comments	A follower submits a comment to a post on your page.
	Likes	A feature that allows followers to show their support for specific posts, comments, and statuses.
	Shares	A follower shares a post with their Facebook friends, possibly adding commentary.
Twitter	Engagement	Total number of times a user interacted with a Tweet (retweets, replies, follows, likes, or hashtags).
	Engagement Rate	Is the percentage of users who saw a tweet and engaged with it.
	Impressions	The number of times a tweet shows up in somebody's timeline.
	Comments	A user submits a comment to a tweet.
	Likes	A user showing appreciation for a tweet.
	Retweets	Re-posting (sharing) of a Tweet.
Instagram	Collections	Allows you to save the post into a private collection, where it can be accessed at any time.
	Comments	A submits a comment to a post on your page.
	Hearts	Liking any picture posted or showing interested in a post

Table 2. #GARWEEK Facebook post analytics compared to previous 30-day analytics.

Facebook	Number of posts	Engagement	Impressions	Reach	Comments	Likes	Shares
Mean 30 Day Comparison	25	1,457	28,560	19,662	44	242	102
https://www.facebook.com/wildlifedepartment/videos/1847811505268453/	1	3,612	55,723	40,553	255	622	235
https://www.facebook.com/wildlifedepartment/posts/1849254468457490	1	65,996	670,961	418,266	2,941	6,907	2,941
https://www.facebook.com/wildlifedepartment/posts/1850462848336652	1	1,796	23,747	17,171	43	235	49
https://www.facebook.com/wildlifedepartment/posts/1851506881565582	1	1,943	25,911	17,115	11	123	26
https://www.facebook.com/wildlifedepartment/posts/1852878341428436	1	2,811	32,894	21,059	32	219	137
Mean of Gar Week Posts	5	15,232	161,847	102,833	656	1,621	678
% Increase		945	260	423	1,397	570	565

Table3. #GARWEEK Twitter post analytics compared to previous 30-day analytics.

Twitter	Number of posts	Engagements	Engagement rates	Impressions	Comments	Likes	Retweets
Mean 30 Day Comparison	14	30	0.016	1,827	0.07	4	1
https://twitter.com/OKWildlifeDept/status/1006309913428156416	1	152	0.047	3,262	0	30	10
https://twitter.com/OKWildlifeDept/status/1006680110953529352	1	951	0.106	8,977	5	70	31
https://twitter.com/OKWildlifeDept/status/1006978571984830466	1	87	0.026	3,299	1	13	1
https://twitter.com/OKWildlifeDept/status/1006978575755595776	1	148	0.059	2,511	1	6	1
https://twitter.com/OKWildlifeDept/status/1006978578721005568	1	64	0.032	1,978	1	6	1
https://twitter.com/OKWildlifeDept/status/1006978582147629059	1	43	0.029	1,481	1	12	5
https://twitter.com/OKWildlifeDept/status/1007633186317389824	1	536	0.068	7,935	1	59	24
Mean of gar week posts	7	283	0.052	4,206	1.43	28	10
% Increase		848	226	130	1,902	684	668

Table 4. #GARWEEK Instagran post analytics compared to previous 30-day analytics.

Instagram	Number of posts	Collections	Comment	Heart
Mean 30 Day Comparison	13	3	2	172
https://www.instagram.com/p/Bj7_HH_HxZ4/	1	24	22	419
% Increase		845	853	143

We then conducted sentiment analysis, "opinion mining," of public comments to the #GARWEEK Facebook posts at two relevant data resolutions using the R programming language (v.3.5.1; R Core Team 2019). First, we conducted an analysis of overall sentiment by pooling all comments and posts. We used the *tidytext* (v. 0.2.0; Silge and Robinson 2016) and *dplyr* (v. 0.8.0.1; Wickham et al. 2019) packages to tokenize individual words and assign them to a positive or negative sentiment based on the "Bing" lexicon (Silge and Robinson 2016). The overall sentiment of the entire dataset of tokenized words was then calculated as the sum of positive words minus the sum of negative words. We created a word cloud to compare the most frequently used words associated with positive versus negative sentiments using the *wordcloud* package (v. 2.6; Fellows 2018).

Second, we conducted a comment-level analysis to compare the sentiments of comments among #GARWEEK Facebook posts. We tokenized words within each comment, calculated the sentiment of each comment based on its tokenized words compared to the "Bing" lexicon, and then compared these comment-level sentiments among posts. For each post, we calculated the mean, standard deviation, minimum, and maximum of the comment-level sentiments. We visualized differences in mean sentiment among posts with a boxplot created with the *ggplot2* package (v. 3.0.0; Wickham 2016), and we performed pairwise t-tests to identify significant differences in mean sentiment among posts at $P \leq 0.05$, with a Bonferroni adjustment to control for Type I rates across multiple tests.

Results

In terms of engagement on social media, the #GARWEEK posts were successful across all three platforms. On Facebook, #GARWEEK posts saw a 456% increase in reach, 260% increase in impressions, 945% increase in engaged users and an impressive 1,397% increase in comments (Table 2). Likes and

shares had a similar percent increase. In fact, all five posts were among the Facebook page's top one-third best performing posts for the year. Post #2 was ODWC's second best performing post of the year, reaching 418,266 people and receiving 2,941 shares, 6,907 likes and 1,693 comments (Table 2).

Twitter posts about #GARWEEK saw similar success, with an 848% increase in engagement, 226% engagement rate. Comments had the highest increase among the three media platforms at 1,902% (Table 3). Likes and retweets experienced similar percent increases as seen on Facebook. Also, like Facebook Post #2 was the second-best performing tweet of the year (Table 3). While only one post (#2) was made to Instagram, it too was highly successful with 143% increase in hearts and 853% increases in comments (Table 4). This post was ranked 4 out of 104 public posts with #GARWEEK on Instagram. Compared to the previous 30-day's

Figure 2. Word cloud illustrating the most frequently used words in comments of #GARWEEK Facebook posts. Frequency is indicated by font size, sentiment is indicated by font color (positive is grey, negative is black).

posts, collections had an 845% increase (Table 4).

The overall sentiment of comments made on the five #GARWEEK Facebook posts was positive (+54), with 263 positive and 209 negative words identified in the overall pool. Some of the most frequently used positive words were "like," "good," "right," and "well," whereas frequently used negative words included "kill," "attack," "freak," "scary," and "crazy" (Figure 2). For the comment-level analysis, the number of comments with a sentiment score varied from $\underline{n} = 4$ for Post #5 to $\underline{n} = 218$ for Post #2 (Table 5). Mean sentiment of the comments among the five Facebook posts ranged from 0.00 (i.e., neutral) for Post #1 to 1.27 (i.e., slightly positive) for Post #4 (Figure 3). The most negative comment-level sentiment (-3) was recorded for Post #1, whereas the most positive sentiment (+6) was recorded for Post #4. Pairwise t-tests identified two statistically significant differences between Post #'s 1 and 4 and between Post #'s 2 and 4 (both with $P = 0.02$); however, Post #4's relatively low sample size ($n = 15$), coupled with a potential outlier of the single highest sentiment score (+6) observed, may have influenced these test results.

Discussion

Our reflective look at #GARWEEK revealed that ODWC's social media outreach posts about alligator gar were widely popular and increased ODWC's audience and engagement in all three social media platforms evaluated. All five posts during gar week were well received by followers with many of the posts ranking in the top third of all posts for the year. Specifically, post #2 ranked as one of the top posts of the year across all ODWC social media forums. Furthermore, the overall sentiment of comments made on the five Facebook posts during Gar Week were positive (+54). Going into Gar Week, ODWC was unsure of the general public's sentiment towards alligator gar, so it is promising that most Oklahoma constituent's sentiments were positive.

Positive sentiments could mean a major

Table 5. Comment-level sentiment measures for #GARWEEK Facebook posts.   Post numbers relate to information in Figure 1. Sample size reflects the count of comments with a sentiment scored.

Post	Mean	SD	Min	Max	n
1	0.00	1.41	-3	4	44
2	0.14	1.32	-4	4	218
3	0.50	1.22	-1	2	8
4	1.27	1.57	-1	6	15
5	0.25	0.83	-1	1	4

shift in public perception towards alligator gar. Historic perceptions towards alligator gar were likely driven by their menacing exterior (shielded with large ganoid scales and rows of sharp teeth), combined with the belief that they negatively impacted more appealing species. In general, humans treat animals that they find most attractive with the greatest respect (Estren 2012). However, the public's perception towards wildlife species once viewed as ominous or unattractive appears to be changing.   For example, George et al. (2016) found a positive increase in public attitudes toward coyotes, wolves, vultures, sharks, bats, and rats from 1978 to 2014. Further, social media was used to clarify misconceptions towards hellbenders that resulted in improved perception towards this species and garnered support for their conservation in Indiana, Missouri, and North Carolina (Reimer et al. 2013, Mullendore et
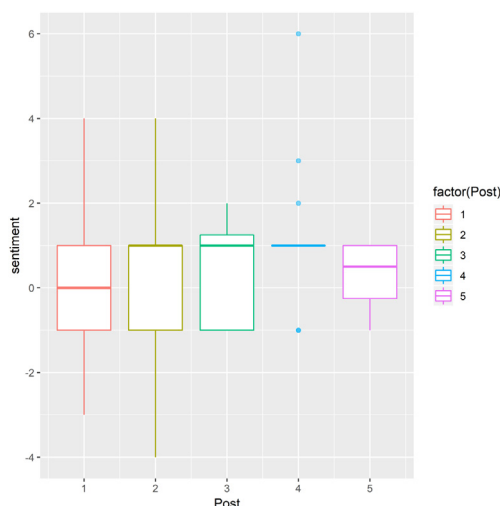

Figure 3. Boxplot of comment-level sentiment as compared across five #GARWEEK Facebook posts.

al. 2014, Perry-Hill et al. 2014, Williams et al. 2019). Our results suggest that page followers were overall receptive of conservation-oriented messages about alligator gar in Oklahoma, suggesting that continuing directed outreach efforts could instill an improved perception of the species to a broader audience.

The ability to utilize open-source statistical packages, instead of subjective sentiment ratings in this study, establishes a repeatable workflow that can be used to objectively quantify sentiment and monitor trends over time. Despite these positive aspects of word-level sentiment analysis, the methodology is not perfect and some results should be interpreted with caution. For example, a post like "The killing of alligator gar is disgusting" would have an overall negative sentiment of -2 based on the tokenized words "killing" and "disgusting." However, the overall context of this comment suggests the individual may be receptive to management and conservation actions that limit the mortality or harvest of alligator gar. "Deep learning" text analysis methods attempt to identify keywords, concepts, sentiment, and subject-action-object relationships (Turian 2013; IBM 2019). These deep learning tools, like AlchemyAPI and IBM Watson, are business-oriented, typically require a subscription, and necessitate additional coding language expertise beyond open-access coding (e.g., the R language). Therefore, we suggest that social media page managers and biologists also apply their own understanding of posted topics when they review social media interactions, understanding that some degree of subjectivity may be necessary to best evaluate the overall attitude and sentiment of each comment.

While the overall sentiments were positive and agreed with ODWC's message, glimpses of historical negative perspectives towards alligator gar did surface. The topics of bowfishing or killing alligator gar were "hot button" issues that sparked vulgar language (as evidenced in the word cloud), and revealed differing opinions among interest groups – particularly, differences arose between those that favored killing gar and those that promoted a complete moratorium on the harvest of alligator gar. Bow anglers are a

dedicated constituency that participate only in this fishing activity (Bennet et al. 2015), which may explain some of the passionate comments observed in this study. Future ODWC alligator gar social media outreach campaigns could promote a balance between the importance of gars in aquatic ecosystems, while also highlighting that sustainable harvest provides sporting opportunities without increasing the conservation risk of the overall population.

A potential bias associated with the study is a lack of understanding of the users that follow the various ODWC social media pages. It can be assumed if an individual is following the ODWC social media forums they are involved, or interested, in hunting, fishing or other outdoor activities. Outdoor enthusiasts may be more informed about alligator gar, which may have biased the sentiment related to alligator gar in a more positive direction than would be observed among the general public. Further, followers of ODWC pages may also be more prone to follow other resource agency pages. If so, this could make them more educated on natural resource topics in general, this may result in differing perceptions of alligator gar than the general public.

Future research should be directed towards surveying social media followers to understand some of their background information including, their age, education level, residency, outdoor hobbies (ex. fishing, hunting, nature watching), overall interests, and views on natural resources in Oklahoma. Having this background information for different social media audiences may provide resource agencies with insight into what is driving the various perspectives towards natural resource topics on their social media pages. Further, this information can be used to direct specific outreach campaigns designed to clarify misconceptions about natural resource topics that a particular audience may have. Although we are confident in our findings, it is possible that sentiments towards alligator gar (negative or positive) are a reflection of how some members of the public feel towards the agency (ODWC), agency personnel, or outdoor activities. Further research is needed to tease

this potential bias out of future social media evaluations.

This study was a first step at trying to understand public attitudes towards a unique, but misunderstood species, in Oklahoma. While most comments were positive, misconceptions towards alligator gar remain with some page followers. For example, the perception that all gar are alligator gar results in a lack of understanding why alligator gar are a species concern in Oklahoma. To remedy this misconception, future outreach efforts could be directed towards educating the public on gar species diversity.

A much more difficult topic to navigate and address in the future is the "hot button" issue of bowfishing for alligator gar. A subjective look at the comments suggests that many followers do not understand why bowfishing or other angler harvest is allowed if the alligator gar is a Species of Special Concern in Oklahoma. ODWC may slowly work towards changing this perception towards harvesting alligator gar by working with bowfishing groups to limit distasteful photographs, irresponsible dumping of harvested fish, and other posts that put bowfishing in a bad light.

In conclusion, #GARWEEK achieved its objectives and goals, and utilizing the hashtag propelled our message beyond ODWC's typical social media audience. This campaign not only allowed ODWC to educate and inform a larger audience, it also allowed us to better understand the public's perception towards alligator gar and other gar species. The information gained in this study suggests that future posts should highlight Oklahoma's gar diversity, the importance of alligator gar in aquatic environments, ongoing gar research, and regulations. Perhaps the most important topic to address is the angler's role in alligator gar conservation and research. Continued engagement of constituents will become increasingly critical as management biologists continue to learn more about gar species and consider implementation of conservation strategies.

Acknowledgments

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