November 2022

Measuring the Impact of Science Journalism

The Pulitzer Center's *Connected Coastlines* Initiative

Final Report

The USC Norman Lear Center
Media Impact Project

TABLE OF CONTENTS

■ EXECUTIVE SUMMARY

INTRODUCTION

In the U.S., we are facing crises across domains of journalism, science, and public health. Supporting public access and engagement with trustworthy information in these domains is more important than ever before. Despite the urgency, there are few evidence-based resources on how to accomplish this. Unsurprisingly, there are multiple calls for more guidance toward more effective science journalism.

It is in this context that the Howard Hughes Medical Institute (HHMI) partnered with the USC Norman Lear Center's Media Impact Project to map the state of knowledge in the field of science journalism, analyze key investments, and develop an evidence-based framework to help practitioners and funders of science journalism achieve impact at scale. To explore investments in science journalism, the focal point of the study was the Pulitzer Center on Crisis Reporting's *Connected Coastlines* (*CC*) initiative (funded by HHMI), which supported dozens of reporting projects covering the impacts of climate change on U.S. coastlines.

METHODS

To address these aims, we carried out mixed-methods research in two phases:

1 **FORMATIVE RESEARCH** including roundtables and interviews with journalists and experts, and an extensive literature review charting trends, practices, and impact analyses in science journalism over the last ten years, culminating in the identification of "best practices" for maximizing the impact of science journalism.

2 **SUMMATIVE RESEARCH** examining the uptake of these best practices by *CC* stories and their reach and engagement on Twitter. Building on this work, we conducted deep dive analyses of two *CC* stories in key regions. These analyses explored all available metrics, characteristics of relevant Twitter conversations, life cycles of the two stories, and trends in policy and news discourses in their respective regions.

KEY FINDINGS

Multiple research efforts showed inroads that the *CC* initiative made in the related organizations, journalists, and communities.

- Research revealed **challenges and opportunities** for the growing field of science journalism and informed a catalog of best practices aimed at impact on **two levels**.
  - ○ **Best practices for the *science journalism field*** include diversifying newsrooms, and providing capacity-building and learning opportunities. These opportunities can support journalists' abilities to tell powerful stories.

- ○ **Best practices for *story design*** include rendering science coverage local, personal, and readable. Many impactful science stories also show where most of the evidence comes from and use images strategically.
- ● ***CC* stories that employed *story design* best practices, such as readability and personalization, had greater audience reach and engagement on Twitter.** In tandem, interviewed experts tied identified practices, such as making stories more personal and understandable, to stories' traction.
  - ○ One *CC* story that used all of the story design best practices garnered more than 170,000 page views and reached up to 768,812 people on Twitter—numbers about four times larger than the median story in the initiative.
- ● **CC projects sought and realized various kinds of impact.** In addition to wide readership, authors reached diverse audiences. Similarly, media outlets saw improvements in their organizations, staffing, and partnerships due to the initiative.
  - ○ For example, a regional journalism development director indicated that their company went from one to seven full-time environmental reporters as a result of the public interest in environmental issues, demonstrated with the *CC* initiative.
- ● Region-focused analyses, centering climate journalism in the Carolinas and the Great Lakes, revealed **changing journalistic and cultural landscapes**.
  - ○ The term "climate change," once controversial, is becoming more accepted. The growing acceptance follows evident effects of climate change and more frequent climate talk in the news and in policy conversations.
  - ○ Twenty percent of the tweets discussing *CC* stories on regional environmental issues used language supporting the concept of man-made climate change, as opposed to simply reporting the factual news (43%), using neutral language about climate change (35%) or using language negating the concept of man-made climate change (less than 1%).

RECOMMENDATIONS

These insights gleaned from our analyses lead to recommendations for strategic investment in science journalism. These include:

- ● **Continue to fund regional science and climate journalism projects**, as audience interest in climate change grows.

- ● **Develop systems for tracking diverse forms of impact**, including organizational growth and reaching high-priority audiences.

- ● **Support the use of social media tools in science journalism projects** to more effectively deliver messages to target audiences and track their spread.

- ● **Prioritize diversity in storytellers and coverage** to increase audience engagement and enrich the ecosystem of science journalism.

- ● **Continue to invest in research investigating best practices**, including how these best practices operate in different contexts and with different audiences.

■ INTRODUCTION

1. Howard Hughes Medical Institute. www.hhmi.org

2. Howard Hughes Medical Institute. Undergraduate and graduate programs. www.hhmi.org/science-education/programs

3. Howard Hughes Medical Institute. (2018, February 27). The Associated Press and Howard Hughes Medical Institute expand collaboration to bolster health and science coverage. www.hhmi.org/news/the-associated-press-and-howard-hughes-medical-institute-expand-collaboration-to-bolster-health

4. *The Atlantic*. Life up close. www.theatlantic.com/projects/life-up-close

5. Howard Hughes Medical Institute. *Tangled Bank Studios*. www.tangledbankstudios.org

6. Pulitzer Center. pulitzercenter.org

Science journalism—like the broader enterprise of journalism—is facing new and complex challenges. Newspapers are closing and shedding jobs, and new profit models focus on consolidation and online platforms. Journalism is under partisan attack, with well-developed stories being labeled "fake news" and journalists branded as "enemies of the people." At the same time, the crises of COVID-19 and climate change have pushed the need for scientific literacy to the forefront, making science journalism as critical as ever.

Within larger changes in the journalism ecosystem, the key players in the science journalism field have also shifted. With the decline of local news organizations, Big Tech companies like Google and Facebook, government agencies like the National Science Foundation, journalism-focused philanthropy and nonprofit news organizations have stepped in. Some of these brought multi-million dollar investments to newsrooms to support the provision of accurate information while combating COVID-19 and climate change misinformation.

HOWARD HUGHES MEDICAL INSTITUTE

The Howard Hughes Medical Institute (HHMI) is a science philanthropy organization whose mission is to advance basic biomedical research and science education for the benefit of humanity.[1] It is the largest private biomedical research institution in the nation. As part of its science education[2] grantmaking, HHMI has developed a number of media partnerships—including with the Associated Press (AP) health and science desks[3] and *The Atlantic*'s "Life Up Close" series[4]—to support high-quality science journalism. It views these partnerships with media outlets as a mechanism to deepen coverage of science and elevate science literacy, thereby nurturing an appreciation for science and scientific thinking in the general public.

HHMI's investments in science journalism supplement its original media productions through Tangled Bank Studios.[5] Whereas films produced by Tangled Bank Studios largely appeal to audiences who already have an abiding interest in science, the science journalism partnerships reach a broader swath of the public.

PULITZER CENTER & *THE CONNECTED COASTLINE INITATIVE*

The **Pulitzer Center for Crisis Reporting**[6] supports journalists' efforts to raise public awareness of underreported issues in local media markets and across

7. Pulitzer Center. *Connected Coastlines*. pulitzercenter.org/connected-coastlines

the globe. The Pulitzer Center's grants and fellowships support in-depth, high-impact reporting by a consortium of news organizations and individual journalists, both freelance and on-staff. Their efforts also feature educational programs and public outreach.

With support from HHMI and other funders, in 2019 the Pulitzer Center launched *Connected Coastlines* (*CC*), a nationwide climate reporting initiative focused on all U.S. coasts.[7] The initiative is building a consortium of newsrooms and independent journalists to bring climate science to local audiences with a focus on the local effects of climate change.

PROJECT OVERVIEW

HHMI engaged the USC Norman Lear Center's Media Impact Project (MIP) on an evaluation project with the ultimate goal of enabling more data-driven grantmaking by HHMI and other science journalism funders. This research project had two broad aims:

1 **Formative Research:** Identifying evidence-based best practices—"what works"—for maximizing the impact of science journalism.

2 **Summative Research:** Capturing "what worked" in HHMI's investments in local and regional climate change coverage through *CC*.

Through its *Connected Coastlines* initative, the Pulitzer Center supports reporting projects on climate change issues on every coastline in the United States.

Image courtesy of Pulitzer Center

FORMATIVE RESEARCH
IDENTIFYING WHAT WORKS IN SCIENCE JOURNALISM

METHODOLOGY

The overarching goal of the formative phase of this project was to identify trends and challenges facing the field of science journalism, along with evidence-based "best practices" to overcome these challenges and generate societal impact.

Roundtables: At the outset of this research project, HHMI convened two roundtables with climate scientists, *CC* journalists and editors, members of Tangled Bank Studios and The Pulitzer Center, and communication experts to identify some of the current challenges and opportunities in climate change reporting.[8] We used these roundtables to gather preliminary data on best practices for communicating science to a general audience. Participants also discussed the impact of HHMI's funding on climate change journalism as a whole.

Semi-structured interviews: We interviewed sixteen science journalists and editors (including those supported by HHMI) and five experts in climate/science communication to understand gaps, challenges, opportunities, and needs in the field of science journalism, and climate change coverage more specifically.

Landscape analysis: We conducted a review of academic publications and gray literature to provide an overview of the role of science journalism and key trends and challenges, culminating in the identification of ten emerging "best practices" for generating social impact through science journalism.

'What Works' taxonomy: Drawing upon the ten identified best practices, we developed a taxonomy as an organizing framework within which to begin operationalizing the best practices for further analysis.

9. Trench, B. (2008). How the Internet changed science journalism. In M. W. Bauer & M. Bucchi (Eds.), *Journalism, science and society* (pp. 145-154). Routledge. http://doras.dcu.ie/3628/1/ internet_science_journalism.pdf

10. Fahy, D., & Nisbet, M. C. (2011). The science journalist online: Shifting roles and emerging practices. *Journalism*, 12(7), 778-793. https://doi.org/10.1177/1464884911412697

11. Roundtables were conducted in April 2021 and in-depth interviews with journalists and science communication experts were conducted in September and October 2021. See Appendix A for a full list of roundtable and interview participants.

12. Fahy, D., & Nisbet, M. C. (2011). The science journalist online: Shifting roles and emerging practices. *Journalism*, 12(7), 778-793. https://doi.org/10.1177/1464884911412697

Thoreson, B. (2018, December 10). Public-powered journalism in practice. *Medium*. https://medium.com/we-are-hearken/public-powered-journalism-in-practice-79ea463eec0d

13. König, L., & Breves, P. (2021). Providing health information via Twitter: Professional background and message style influence source trustworthiness, message credibility and behavioral intentions. *Journal of Science Communication*, 20(4), A04. https://doi.org/10.22323/2.20040204

14. Fahy, D., & Nisbet, M. C. (2011). The science journalist online: Shifting roles and emerging practices. *Journalism*, 12(7), 778-793. https://doi.org/10.1177/1464884911412697

15. Russell, C. (2010). Covering controversial science: Improving reporting on science and public policy. In D. Kennedy & G. Overholser (Eds.), *Science and the media* (pp. 13-43). American Academy of Arts & Sciences. https://www.amacad.org/publication/science-and-media/section/5

16. Olsen, R. K., Kalsnes, B., & Barland, J. (2021). Do small streams make a big river? Detailing the diversification of revenue streams in newspapers' transition to digital journalism businesses. *Digital Journalism*, 1-22. https://doi.org/10.1080/21670811.2021.1973905

Pickard, V. (2014). The great evasion: Confronting market failure in American media policy. *Critical Studies in Media Communication*, 31(2), 153-159. https://doi.org/10.1080/15295036.2014.919404

TRENDS AND CHALLENGES

Historically, science journalists have held a privileged position in society, as gatekeepers who determine what scientific information deserves coverage.[9] Science journalism has traditionally followed *the information deficit model*—a one-way communication model where information flows from experts to public audiences to increase knowledge and understanding.[10] In roundtables and interviews conducted with journalists and science experts, this practice was still commonplace in the industry, with several science journalists acknowledging their role as "informing audiences" or "raising awareness" of science issues.[11]

The popularization of **social media** has compelled some science journalists to move away from this one-way communication model to more of a cyclical feedback loop that relies on reporters engaging directly with audiences and employing multimedia strategies.[12] Many scientists are bypassing journalists altogether, sharing health- and science-based information with the public directly via social media platforms like Twitter.[13]

As news organizations defund science coverage, the gap is being filled by **public relations efforts** at museums, universities, and other private outlets, creating an overreliance in the industry on press releases.[14] General-assignment reporters cover science topics as often as dedicated science writers do, but often lack training to understand and communicate complex science and technology issues.[15]

As one interviewed journalist noted, many local newspapers "*don't have the funding or the staff, so everything is just kind of written off of press releases. There's no enterprise reporting.*"

> **[Many local newspapers] don't have the funding or the staff, so everything is just kind of written off of press releases. There's no enterprise reporting.**

At the economic level, journalism's funding model has moved away from traditional print advertising sales and toward **subscription-based models**.[16] The emphasis on profitability has led to an increase in national coverage at the expense of local issues and a focus on consumer health and fitness trends (also known as "news you can use") over in-depth coverage that requires greater in-

17. Russell, C. (2010). Covering controversial science: Improving reporting on science and public policy. In D. Kennedy & G. Overholser (Eds.), *Science and the media* (pp. 13-43). American Academy of Arts & Sciences. https://www.amacad.org/publication/science-and-media/section/5

Sumner, P., Vivian-Griffiths, S., Boivin, J., Williams, A., Bott, L., Adams, R., Venetis, C. A., Whelan, L., Hughes, B., & Chambers, C. D. (2016). Exaggerations and caveats in press releases and health-related science news. *Plos One*, 11(12), e0168217. https://doi.org/10.1371/journal.pone.0168217

18. Thomas, K. (2021, March 17). 24-hour news, information cycle gradually changes industry. *The Daily Beacon*. https://www.utdailybeacon.com/city_news/24-hour-news-information-cycle-gradually-changes-industry/article_dea5d932-86d8-11eb-8c6f-bb280c60c276.html

19. Motta, M., Sylvester, S., Callaghan, T., & Lunz-Trujillo, K. (2021). Encouraging COVID-19 vaccine uptake through effective health communication. *Frontiers in Political Science*, 3, 1. https://doi.org/10.3389/fpos.2021.630133

20. Guenther, L., & Weber, A. (2019). Science, journalism, and the language of (un) certainty: A review of science journalists' use of language in reports on science. In D. R. Gruber & L. C. Olman (eds.), *The Routledge handbook of language and science* (pp. 47-59). Routledge. https://doi.org/10.4324/9781351207836-5

21. Brüggemann, M., & Engesser, S. (2017). Beyond false balance: How interpretive journalism shapes media coverage of climate change. *Global Environmental Change*, 42, 58-67. https://doi.org/10.1016/j.gloenvcha.2016.11.004

22. Grieco, E. (2018, November 2). Newsroom employees are less diverse than U.S. workers overall. Pew Research Center. https://www.pewresearch.org/fact-tank/2018/11/02/newsroom-employees-are-less-diverse-than-u-s-workers-overall

Sanza, C., Borowiec, B. G., Secko, D., Qaiser, F., Ferreira, F. A., MacGregor, H., Bramadat-Willcock, M. & Nazemi, P. (2019, February 26). Why we see hope for the future of science journalism. *The Conversation*. https://theconversation.com/why-we-see-hope-for-the-future-of-science-journalism-111244

vestment of time and resources.[17] The 24-hour breaking news cycle leads to shorter pieces and faster production timelines and puts pressure on news organizations to release information that may not be thoroughly vetted.[18] The breaking news cycle presents challenges for climate change reporting.

As one interviewee commented, "[C]limate change is nebulous, massive, and extends over lots of different topics, [so] it's hard to cover that if your news framework is breaking news, single events, and noteworthy instances that are deviating from the norm. Climate change is our norm, so it goes against this breaking news paradigm."

Science issues—like COVID-19 and climate change—are increasingly at the center of politicized coverage, with conservative-leaning outlets more likely to spread **misinformation** about both topics.[19] The reality of scientific uncertainty is frequently at odds with journalism's need for clear-cut information and recommendations.[20] Exacerbating the problem is false-balance reporting that highlights "both sides" of an issue rather than underscoring views backed by scientific consensus.[21] Journalists who participated in the in-depth interviews largely agreed that they were seeing less of this false-balance phenomenon in reporting. One interviewee indicated that "*climate science denial and the false balance of having to include climate denier voices...is all but gone from mainstream news coverage.*"

> *[C]limate change is nebulous, massive, and extends over lots of different topics, [so] it's hard to cover that if your news framework is breaking news, single events, and noteworthy instances that are deviating from the norm. Climate change is our norm, so it goes against this breaking news paradigm.*

Despite gaining ground in news discourse, science journalism continues to face challenges in the newsroom, with one significant challenge being the lack of racial and gender diversity in newsroom staff and on science and technology beats.[22]

Each of these trends presents **challenges and opportunities** for science journalists and organizations that support the enterprise.

23. Motta, M., Sylvester, S., Callaghan, T., & Lunz-Trujillo, K. (2021). Encouraging COVID-19 vaccine uptake through effective health communication. *Frontiers in Political Science* 3, 1. https://doi.org/10.3389/fpos.2021.6301

BEST PRACTICES AND THE WHAT WORKS TAXONOMY

Based on insights gleaned from roundtables and interviews with journalists and experts, along with empirical evidence gathered primarily from the framing literature, we propose a set of ten **best practices for maximizing the impact of science journalism** in the current information ecosystem.

1 **Replace scientific jargon with metaphors.** Refraining from overly complex terminology in favor of concise metaphors can increase understanding of climate change. As one climate communication expert highlighted, metaphors used by science journalists serve as a *"valuable tool [for building] powerful bridges"* between scientists and the public.

2 **Use images strategically.** A photograph or infographic can increase reader interest and attention. According to an interviewee, it was *"pervasive images of polar bears on ice that captured our attention and made us care [about climate change]."*

3 **Bring science close to home.** Make scientific findings relevant to the specific local communities. A local news reporter discussed the value of localizing issues to empower communities and build their understanding of climate solutions: *"Where we can make a difference and empower people is by honing in on small solutions on the community level, or even the state level. It brings it down into a bite-sized chunk [because] we're not talking about glaciers melting on a global scale."*

4 **Connect science to health outcomes.** Health framing is one of the best methods to motivate behavior change, especially among conservative and moderate audiences. As one roundtable participant and journalist noted, *"people really want to know how this changing climate is going to affect them personally, and there's nothing more personal than health."* A recent study also found the use of health frames increased participants' intentions to vaccinate, more so than highlighting the economic costs (e.g., shutdowns) associated with non-vaccination.[23]

5 **Humanize coverage with personal stories.** The use of stories of someone's lived experience can facilitate reader engagement. One science reporter highlighted how science stories with a personal element attract larger audiences: *"A story where people learn about the background, where they connect in a personal way with somebody's passion or personality—those stories tend to do well."*

Measuring the Impact of Science Journalism

6 **Balance personal stories with systemic causes and solutions.** Individualistic "hero stories" can backfire by framing climate change as a problem to be solved at the individual level. Reporters should not "*create this cult of the hero,*" as one journalist put it, instead focusing on how social change as well as social destruction comes from systems, institutions and organizations.

7 **Avoid sensationalism.** Exaggerated science coverage can backfire and lead readers to feel disappointed when overhyped science or technology does not live up to expectations. A roundtable participant cautioned against sensationalized science headlines, urging caution instead: "*So much diligence and care in articles can get sideswiped by a clickbait tagline.*"

8 **Use weight-of-evidence reporting to counter false balance.** Weight-of-evidence reporting asks journalists to identify where the bulk of scientific evidence resides, which can help address issues of scientific uncertainty. A science communication expert observed that journalists are dedicating less time and space in their reporting to scientifically invalid viewpoints: "*I see less classic both sides-ism in which you leave it to the reader to decide what the stronger argument is…At a certain point, they may make mention of opposition, but it's not like there's this alternative valid point of view.*"
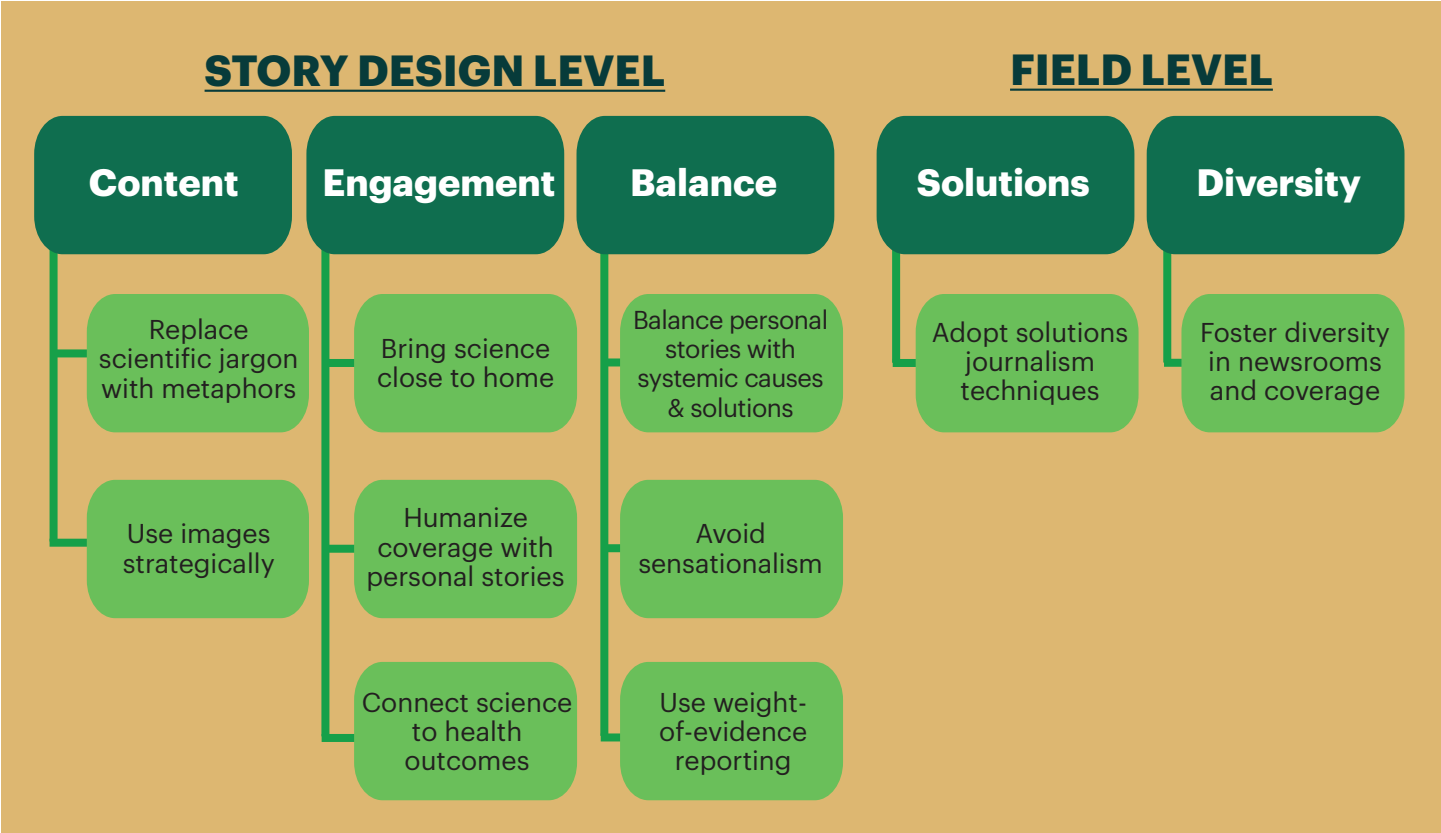
9 **Adopt solutions journalism techniques.** Solutions Journalism (SJ) focuses on the how-tos of problem solving, and can be useful in engaging audiences who feel overwhelmed, pessimistic, or defeatist about daunting topics. It typically manifests as investigative or explanatory journalism, which includes descriptions of efforts to address problems. SJ positions problems as mysteries to be solved, effectively heightening the potential narrative engagement in the story. One roundtable participant characterized SJ as a form of "*accountability journalism [because] describing a solution that has been implemented in one place allows readers to go back to their own elected officials and ask about specific, proven policy solutions.*"

10 **Foster diversity in newsrooms and coverage.** Diversity needs to be a priority in all aspects of reporting, including subjects, sources and newsroom staff. Diversifying newsrooms can improve access to and understanding of how science topics impact underserved communities. An interviewed journalist emphasized the importance of sharing climate change information with the communities most at risk: "*Right now there's a lot of inequities baked into the climate change issue, and if you don't cover those, then all these great technological advances may not get to the right people, or enough people, or a privileged few people.*"

These ten best practices informed a taxonomy of "what works" for achieving impact through science journalism. Informed by published research and expert guidance, the practices are context-specific and oriented toward different types of impact—including infrastructural impact in the newsroom, field-wide impact in journalism, individual impact on readers, and impact at the level of audiences and publics. **The kind of impact a project is aiming for will inform both the interpretation and operationalization of the best practices.** Similarly, project aims will affect which practices are most applicable and what they look like on the ground.

Figure 1: The What Works Taxonomy

STORY DESIGN LEVEL

Content	Engagement	Balance
Replace scientific jargon with metaphors	Bring science close to home	Balance personal stories with systemic causes & solutions
Use images strategically	Humanize coverage with personal stories	Avoid sensationalism
	Connect science to health outcomes	Use weight-of-evidence reporting

FIELD LEVEL

Solutions	Diversity
Adopt solutions journalism techniques	Foster diversity in newsrooms and coverage

SUMMATIVE RESEARCH
CAPTURING WHAT WORKED FOR *CONNECTED COASTLINES*

ALL CONNECTED COASTLINES STORIES

METHODOLOGY[24]

For the entire set of *CC* stories published between September 2019 and March 2022, we conducted a series of analyses:

TWITTER METRICS

Using the Twitter API, we collected all tweets that mentioned either story title or story URL as of March 31, 2022. We then cataloged the reach, impressions, organic impressions, and composite engagement associated with 142 *CC* stories within 25 projects.[25]

Reach:	The total number of people who may have seen tweets that mention the *CC* story title or URL. It is calculated by summing the number of followers of each Twitter account that published *CC*-related tweet(s).
Total Impressions:	Total Impressions: The total number of times Twitter users may have seen tweets that mention the CC story title or link. It is calculated by summing the number of relevant tweets published by each Twitter account multiplied by the account's number of followers.
Organic Impressions:	The total number of times Twitter users may have seen tweets that mention the CC story title or URL, excluding impressions associated with tweets from the accounts of the outlet that published the story.[26]
Composite Engagement:	The total number of times Twitter users liked, commented on, or reshared tweets that mention or link to the CC story.

24. We examined the metrics currently collected by the Pulitzer Center and recommended approaches to enhance their tracking procedures. These findings are not included in this report.

25. See Appendix B for the full list of stories.

26. Reshares of any type of tweets published by *CC* story outlets are included as part of the organic impressions.

USE OF BEST PRACTICES IN *CC* STORIES

Based on the **What Works Taxonomy** developed in the formative research phase, we devised a content analysis codebook to examine use of the ten best practices in 137 *CC* stories.[27] A student intern was trained to apply the codebook, and 20% of the sample was double-coded for inter-rater reliability.[28]

RELATIONSHIPS BETWEEN USE OF BEST PRACTICES AND TWITTER METRICS

We examined the relationships between the presence of nineteen story features and Twitter metrics (organic impressions and composite engagement) across 132 stories.[29]

To control for the potential confounding effects of news outlets with high social media presence influencing our analysis of Twitter impressions and engagement, we excluded four stories published by the *New York Times*, an outlier with thirteen times more Twitter followers than the second-ranked outlet, *Scientific American*.

We then split the remaining stories into two sub-groups based on the outlet's number of Twitter followers and analyzed the relationships between story features and Twitter metrics both overall and separately within the two groups:

- Small number of Twitter followers (less than median 54,825): N = 75 *CC* stories

- Large number of Twitter followers (more than median 54,825): N = 57 *CC* stories

KEY FINDINGS

TWITTER METRICS

Over 2.5 years, approximately 18,500 tweets about *CC* stories may have been seen by 374 million Twitter users, who may have seen them 918 million times, and engaged with them 36,000 times. Excluding tweets by the outlets in which the stories were published, the "organic" tweets may have been seen 258 million times, accounting for 30% of total impressions.

The table below shows the total across all *CC* stories and the maximum (highest observed) value for each Twitter metric. To illustrate their range and distribution, we also include the 25th, 50th (median), 75th, and 95th percentiles for each Twitter metric. Discrepancies between the maximum and the 95th percentile are due largely to a few outlier stories that include common phrases in their story titles (e.g. "After the Flood"), which increases the volume of irrelevant data among the tweets retrieved. As a result, the 95th percentiles serve as a more accurate estimate of the maximum values.

Table 1. Summary of Twitter metrics for 142 *CC* stories.

Summary	Total	25th Percentile	50th Percentile (Median)	75th Percentile	95th Percentile	Max
Reach♦	373,732,367	53,132	149,112	404,372	4,943,551	175,000,000
Impressions❖	918,112,049	64,266	168,181	602,695	14,314,633	506,000,000
Organic Impressions	257,900,419	34,313	127,506	392,659	4,905,968	67,582,496
Count of Tweets	18,494	9	21	56	553	4,466
Likes	24,100	8	21	65	605	6,122
Comments	2,118	0	2	7	49	385
Reshares	9,963	4	9	31	319	2,441
Composite Engagement (Likes + Comments + Reshares)	36,181	13	35	95	1,064	8,948

♦**Reach:** Potential # of Twitter users to whom the tweet was reached
❖**Impressions**: Potential # of times the Tweets that mention story title or story URL were seen by Twitter users

Notes:
Decimals are rounded up to the nearest whole number.
Discrepancy between the maxes and the 95th percentiles is mainly due to a few outlier stories that use generic words in their story titles (e.g. After the Flood), which increase the volume of noise data among the tweets retrieved.

USE OF BEST PRACTICES IN *CC* STORIES

Overall, the authors of *CC* stories followed best practices applicable to their projects. For instance, stories made generous use of helpful visuals and used age-appropriate language for their audience. Moreover, the majority of stories defined scientific jargon when it appeared, used headlines that accurately captured the story, and included a personal story—all in line with identified best practices.

Results of the content analysis of *CC* stories were more mixed when it came to best practices that are topic-dependent: for example, connecting science and climate narratives to health problems. For example, a short piece about local economic resilience in Michigan wouldn't have the scope to also include health implications. Importantly, the application of best practices depends on the context of the work and the particular goals of the journalistic endeavor. The *CC* stories utilized identified best practices as follows:[30]

1   **Replace scientific jargon with metaphors:** No stories included undefined jargon,** but fewer than 5% explained scientific concepts using metaphors.*[31] On average, stories were written at a 10th-grade reading level which is within the recommended range of reading level in journalism; 70% of stories were at or below a 10th-grade reading level.[32]

2   **Use images strategically:** A substantial proportion of stories included engaging images; 36% included an infographic or data visualization and 57% included a photograph of an interview subject.

3   **Bring science close to home:** 70% of stories were published in the same state as the subject matter and 16% were published in adjacent states.

4   **Connect science to health outcomes:** 18% of stories discussed a health issue, and most of these (84%) linked this health issue to climate change.

5   **Humanize coverage with personal stories:** 61% of stories included a personal anecdote.

6   **Balance personal stories with systemic causes and solutions:** There was a high ratio of systemic solutions* (62%) to individual solutions (29%) mentioned in the stories.

Measuring the Impact of Science Journalism

7 **Avoid sensationalism:** There were no sensationalized "clickbait" headlines; 98% of stories had "very accurate" headlines.** However, only a small percentage communicated something about a scientific study's degree of certainty.*[33]

8 **Use weight-of-evidence reporting to counter false balance:** Fewer than 10% of stories offered competing perspectives on why something was happening* and none in the sample offered evidence for competing claims.* This finding is consistent with the assessments of our key informants who see "both sides-ism" as a waning influence in climate journalism.

9 **Adopt solutions journalism techniques:** There was relatively little use of solutions journalism techniques. Less than a quarter of stories presented results or indications of progress, linked to a solution,* while fewer than 10% offered specific "how-to" details for how to implement a solution.*

10 **Foster diversity in newsrooms and coverage:** There is considerable room for improvement in terms of diversity. Just 39% of stories had at least one woman author (compared to 65% with at least one man author) and only 23% had at least one person of color (POC) author. About a third of stories (34%) included a photograph of a POC. Only 8% made reference to indigenous knowledge.

RELATIONSHIP BETWEEN USE OF BEST PRACTICES AND TWITTER METRICS

Several of the identified best practices were associated with greater Twitter traction in terms of organic impressions or composite engagement.

Across all stories:

- Stories that included a *personal anecdote* or *data visualization*, addressed a *subject in a neighboring state*, or were *authored by at least one person of color* generated greater engagement and impressions.

- Stories that connected any *health issues to climate change* received more impressions.

In addition, for the 57 stories in outlets with a large number of Twitter followers:

- Those with *photos of interview subjects* generated greater engagement.

33. Communicating about scientific certainty and uncertainty can combat sensationalism by making readers less likely to overgeneralize scientific findings. We did not measure how many stories cited a scientific study; our focus was on citing scientific studies and communicating about the degree of certainty.

34. Lough, K., & McIntyre, K. (2021). A systematic review of constructive and solutions journalism research. Journalism 0(0), https://doi.org/10.1177/14648849211044559

For the 75 stories in outlets with a relatively small number of Twitter followers:

- Those that *mentioned health problems* or had at least one *female author* had greater engagement and impressions.

INTEGRATED FINDINGS

Stories that incorporated **best practices** oriented toward generating audiences' interest (e.g., strategic use of images and the inclusion of personal stories) were associated with higher social media impressions and engagement. Combining content analysis and Twitter analysis, we find that the use of particular best practices in *CC* stories is associated with more discussion on Twitter, which may reflect more discussion in the public sphere.

- The majority of *CC* stories incorporated story-relevant **personal anecdotes**, and these stories tended to have greater engagement and impressions on Twitter than those that did not include a personal anecdote. This suggests stories about climate are more engaging when illustrated through personal stories.

- The 16% of stories that addressed a **subject in an adjacent U.S. state** had greater engagement and impressions than those that focused on issues in a distant region or only the state of the publication. This suggests that reporters who write stories about topics nearby could increase their Twitter audience.

- The 23% of stories **written by at least one POC reporter** had higher engagement and impressions on Twitter, as did the 53% of stories published by outlets with low social media presence that had at least one woman author. This suggests that a more diverse reporting staff can produce stories with wider appeal.

- Stories with **data visualizations** (e.g., infographics) had greater engagement and impressions than those without images. As research shows, audiences are more eager to learn about science when text is accompanied by informative visuals.

- The stories that **connected health issues to climate change** had significantly more impressions on Twitter, suggesting broad interest in reporting that connects the dots between personal concerns and large-scale issues.

- There is a growing body of research on the benefits of **solutions journalism**.[34] Few articles employed the devices of solutions journalism that we measured, and there was no correlation between those devices and Twitter engagement. This suggests a need for more research on the uses and benefits of solutions journalism.

DEEP DIVE INTO TWO *CONNECTED COASTLINES* STORIES

METHODOLOGY

STORY SELECTION

35. Link to the Institute for Nonprofit News (INN) project page: https://inn.org/inn-collaborations/from-rust-to-resilience; link to the "From Rust to Resilience" story in the original publishing source: http://edge.ensia.com/from-rust-to-resilience-great-lakes-climate-change

36. The story was originally published on October 20, 2020 and updated on October 24, 2020. Our Twitter research used the latter date as a benchmark for collecting the data two-week before and after the story's release. Link to the "Flesh-Eating Bacteria" story in original publishing source: https://www.newsobserver.com/news/politics-government/article246018110.html

In consultation with HHMI, we identified two high-priority *CC* regions—the Great Lakes and Carolinas—for in-depth qualitative analysis. Within each region, we selected one story based upon factors like unique keywords in the headline and text, shareable images in the publication source, high reach and engagement on social media, and anecdotal evidence from the formative phase regarding the popularity of the stories. For instance, the Pulitzer Center and roundtable participants mentioned the two selected stories as having effectively garnered attention and reactions online.

Image courtesy of Pulitzer Center

STORY 1

Great Lakes region: "From Rust to Resilience" in *Ensia*, by Kari Lydersen (April 20, 2020, *Climate Change and Great Lakes Cities* project and part of the *From Rust to Resilience* project with the Institute for Nonprofit News).[35]

This story provides an overview of local environmentalism and economics in the Great Lakes region. It outlines particular environmental challenges and economic opportunities that residents are experiencing in the region with a focus on resilience in the face of the climate crisis.

Image courtesy of Pulitzer Center

STORY 2

Carolinas region: "A Flesh-Eating Bacteria Lurking in the Ocean is Killing People in the Carolinas" in *The News & Observer*, by Sammy Fretwell (October 20, 2020, *Beyond the Beach* project).[36]

This article tells the story of Vibrio, a deadly microorganism that has infested coastal waters near the Carolinas. Linked to warming waters and rising sea levels, Vibrio outbreaks have sickened hundreds of Carolinas residents. The story incorporates interviews with scientists and members of one victim's family.

To examine the regional journalistic and cultural impact of *CC* reporting, we conducted a series of qualitative analyses of these two stories and their respective regions.

QUALITATIVE TWITTER ANALYSIS[37]

We scraped a total of 14,010 tweets mentioning keywords associated with the two stories from the period two weeks before to two weeks after each story's publication. We then filtered the data to include only the most relevant search terms. We performed *amplifier*, *thematic*, and *sentiment analyses* on the final (filtered) sample (N = 2,271 tweets; "From Rust to Resilience": N = 909; "Flesh-Eating Bacteria'': N = 1,362). For the *temporal analysis*, we report results based on the full dataset (N = 14,010).[38]

- **Temporal analysis:** We examined trends in the volume of Twitter conversations in the period from from two weeks before to two weeks after each story's publication. For the "From Rust to Resilience" story, we calculated the reach and impressions of a unique hashtag (#RusttoResilience) during this analysis period.

- **Amplifier analysis:** We identified the Twitter accounts that amplified relevant conversations and generated more than 100,000 impressions (top two percentile).

- **Thematic analysis:** We identified the ten most frequently used words and phrases in the sample in the two weeks following each story's publication. We removed the stop words (e.g., "the", "is", "and") and counted the frequencies of the words that were semantically different.

- **Sentiment analysis:**
  ○ *Machine learning* (ML): We developed a ML sentiment model to classify tweets into one of four categories regarding the *belief in man-made climate change*:
    ▪ *News:* The message links to factual news about climate change.
    ▪ *Pro:* The message supports the belief in man-made climate change.
    ▪ *Anti:* The message is against the belief in man-made climate change.
    ▪ *Neutral:* The message neither supports (Pro) nor refutes (Anti) the belief in man-made climate change and does not link to news (News).
  ○ *Human coding refinement of ML model:* Two human coders analyzed 20% of tweets from the filtered dataset to classify tweets into the same four categories regarding the *belief in man-made climate change*. This classification was used to refine the ML sentiment model, which was then reapplied to the final filtered dataset.
  ○ *Additional human coding:* In addition to refining the sentiment model regarding belief in man-made climate change, human coders analyzed 20% of tweets to determine: (1) whether the tweets discussed climate change; (2) sentiment regarding *the effects of climate change* (positive, neutral, negative, unclear); (3) whether the author indicated any emo-

39. See Appendix E for a list of analytics, methods, and data sources used in the case studies.

40. LexisNexis. https://www.lexisnexis.com/en-us/home.page

41. Environmental and Natural Resources State Tracking Bill Database. https://www.ncsl.org/research/environment-and-natural-resources/environment-and-natural-resources-state-bill-tracking-database.aspx

tions about climate change effects (e.g., frustration, fear, inspiration, relief, etc.); and (4) whether the author indicated any behavioral reactions (e.g., sharing information with others, calling for action).

CASE STUDIES[39]

We used a multi-level approach to examine region-level and story-level impact:

- **Region-level:** We conducted keyword searches of news (using the Lexis-Nexis news database[40]) and legislation (using the National Conference of State Legislatures database[41]).

  - To analyze trends in news databases, we captured stories mentioning the key terms "climate change" and "Great Lakes" together for the first region and stories mentioning the terms "climate change" and "Carolina" for the other region. The time period for this analysis was March 19, 2019 to July 19, 2022 (six months before the first *CC* story to six months after the last story in our overall sample).

  - To analyze trends in regional policy, we searched texts of bills introduced in all states relevant to the stories in our case studies for climate and environmental protections language for the last ten years.

- **Story-level:** We examined story metrics (including data provided by Pulitzer, authors, editors, online reach data, sources linking to or citing the story, social media impressions), conducted interviews with key informants connected to each story, and examined uptake of best practices in the content analysis compared to key informant descriptions of story impact.

KEY FINDINGS

QUALITATIVE TWITTER ANALYSIS

Temporal analysis

For both stories, Twitter conversations started increasing on the day the story was published. This implies that the two stories and key words related to their content received attention from the Twitter users almost immediately after their online publication. Compared to the "From Rust to Resilience" story, the "Flesh-Eating Bacteria" story received short-lived attention.

- On the day the "Flesh-Eating Bacteria" story was released, the volume of relevant Twitter conversations increased by approximately 15 times, from 28 tweets on October 19, 2020 to 421 tweets on October 20, 2020, which was the peak of that trend.

Figure 2. Trends in the Volume of Twitter Conversations: "Flesh-Eating Bacteria" story (N = 2,347).
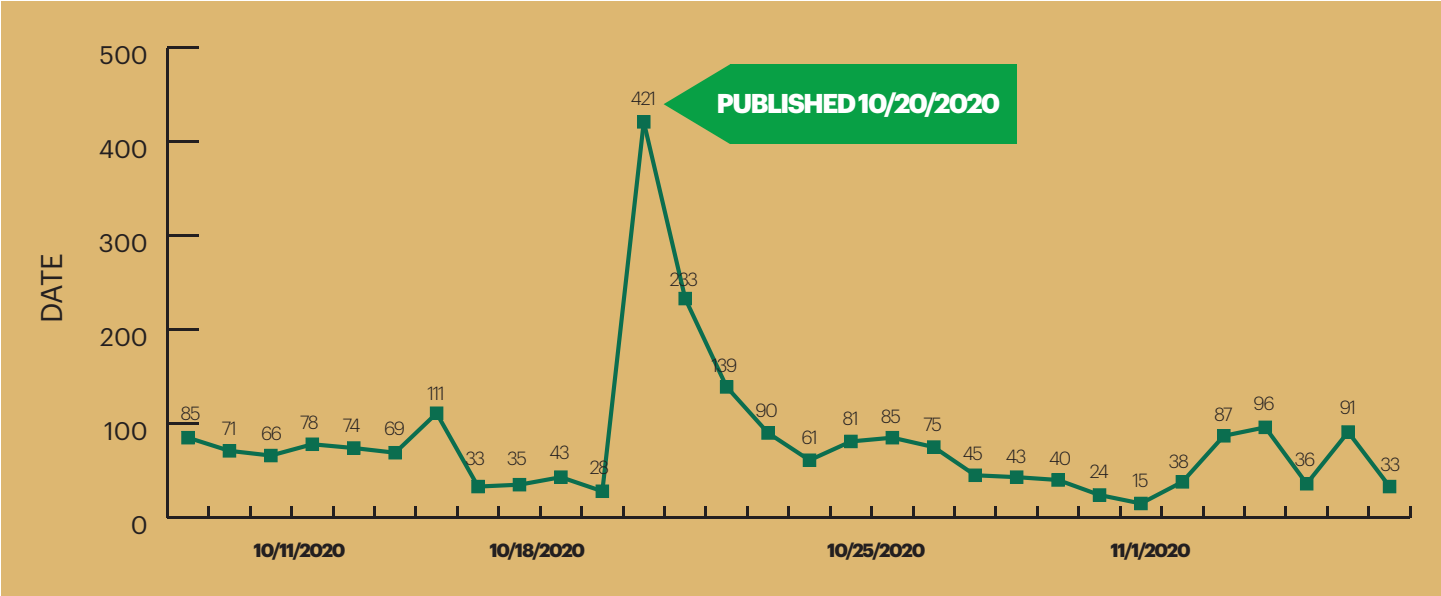
- On the day "From Rust to Resilience" story was released, the volume of relevant Twitter conversations increased by about 8 times, from 175 tweets on April 19, 2020 to 1,422 tweets on April 22, peaking within two days after publication.
  - ○ "From Rust to Resilience" had a unique hashtag (#RusttoResilience), which was used for online promotion alongside two other hashtags (#GreatLakes, #CCNow).
  - ○ Two weeks after the story's publication, 500,000 Twitter users (reach) may have seen the #RusttoResilience hashtag 2.5 million times (impressions). That means the hashtag #RusttoResilience alone had higher impressions than the tweets that mention the "From Rust to Resilience" story title or URL (approximately 1.9 million).

Figure 3. Trends in the Volume of Twitter Conversations: "From Rust to Resilience" story (N = 11,663).
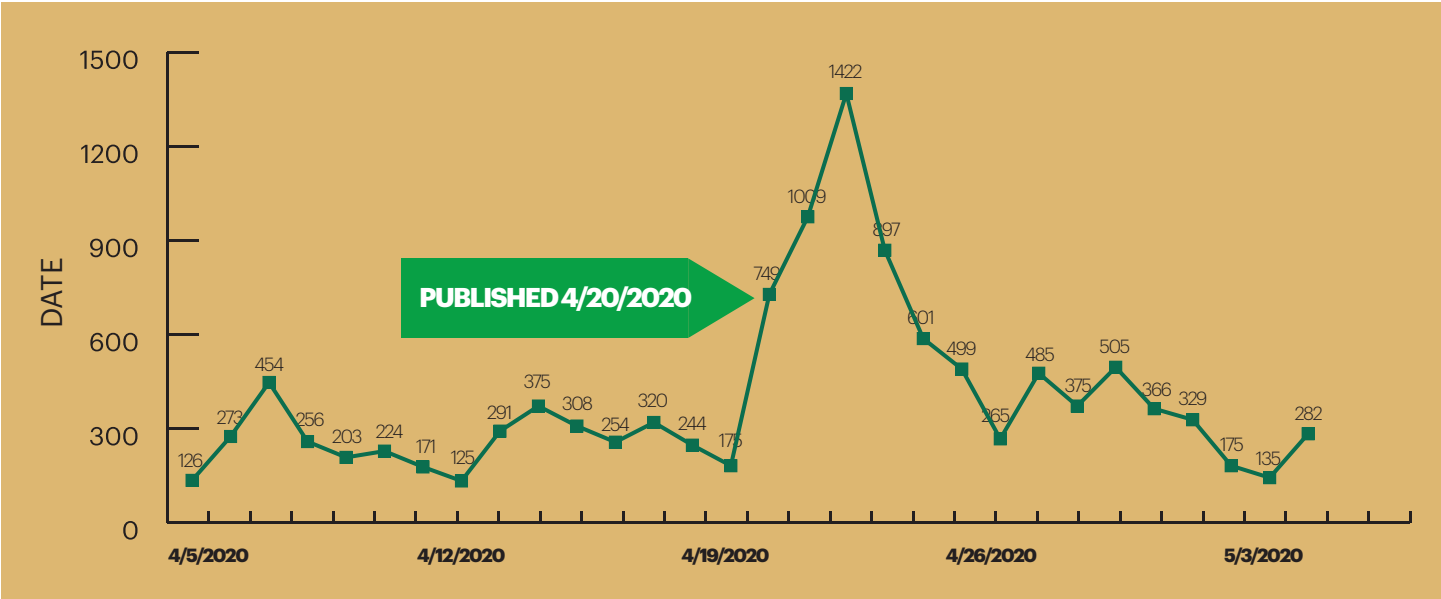
Amplifier analysis

Accounts that amplified or promoted the stories were key to increasing Twitter impressions and engagement. Amplifiers both published original tweets and regularly reshared tweets related to each story. Multiple local and national news outlets cross-promoted tweets related to the two *CC* stories.

● **Twelve amplifiers** for the **"From Rust to Resilience" story** generated more than 100,000 impressions. These amplifiers included Twitter accounts of local and regional news outlets, nonprofit news organizations, a Twitter bot, and an individual Twitter user.

● **Fourteen amplifiers** for the **"Flesh-Eating Bacteria" story** generated more than 100,000 impressions. These amplifiers included Twitter accounts of local and tech-focused news sources, nonprofit news organizations, university programs related to climate change and public health, and individual Twitter users.

Thematic analysis

For both stories, the most frequently used words in the two weeks after publication indexed key concepts from the stories, indicating that platform users were engaging with the content substantively. This was also true for national outlets that republished the story, such as the Center for Public Integrity in the case of the "Flesh Eating Bacteria" story.

For the **"From Rust to Resilience"** story:

● The ten most frequently mentioned words and phrases were: "climate change", "great lakes", "duluth", "ccnow", "zebra mussels", "ensiamedia", "challenges", "refuge", "rust-toresilience", and "INN" (Institute for Nonprofit News).

● Some of the Twitter conversations were associated with a related story that was part of the same INN collaborative reporting project: "In the 'climate refuge' city of Duluth, a fight brews over the hometown utility."

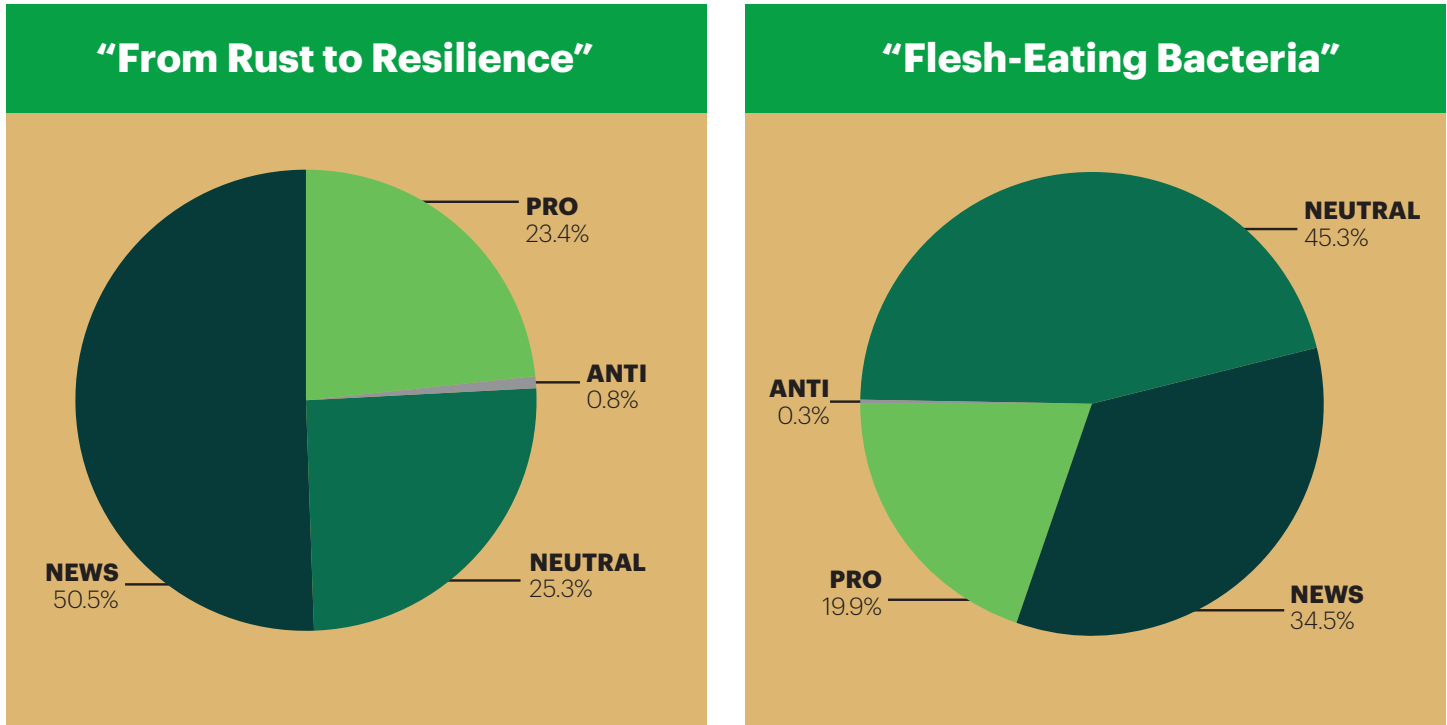For the **"Flesh-Eating Bacteria"** story:

● The ten most frequently-mentioned words and phrases were: "vibrio", "climate", "carolina", "fischeri", "bacteria", "coast", "deadly", "cholerae", "flesheating", "bacterium".

Sentiment analysis

The ML-based sentiment analysis (refined with human coding) classified about 20% of the tweets related to the two *CC* stories as Pro (supportive of the **belief in man-made climate change**). Less than 1% were Anti (opposed).

● For the **"From Rust to Resilience" story**, half of the tweets were classified as News related to climate change.

● For the **"Flesh-Eating Bacteria" story**, a large proportion (45%) of tweets were classified as Neutral — neither supportive nor opposed to the belief in man-made climate change.

Figure 4. Classification of sentiment toward the belief in man-made climate change in the refined machine learning model.

"From Rust to Resilience"
PRO 23.4%
ANTI 0.8%
NEUTRAL 25.3%
NEWS 50.5%

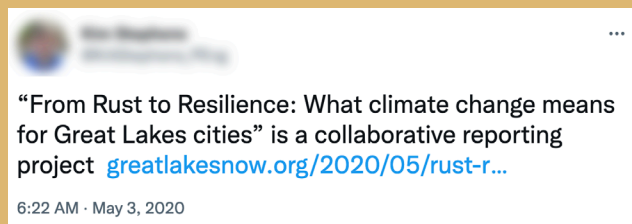| "Flesh-Eating Bacteria" |
|---|
| NEUTRAL 45.3% |
| ANTI 0.3% |
| NEWS 34.5% |
| PRO 19.9% |

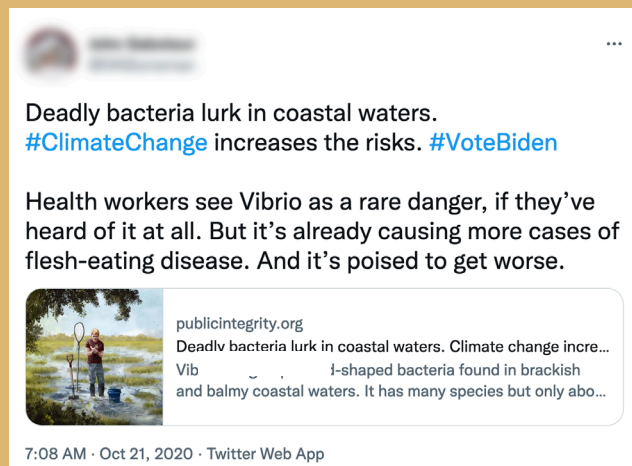Additional qualitative insights drawn from the human coding (N = 399) include:

- Forty-two percent of human-coded tweets discussed climate change. Of these, 40% had negative sentiment about the ***effects of climate change***. The majority (60%) had neutral sentiment. None had positive sentiment.

- Eight percent addressed Twitter users' **emotional reactions** to the content of the two *CC* stories. Of these, 50% were coded as negative (e.g., angry, frustrated, disgusted, afraid, concerned, disappointed, shocked) and 43% were coded as positive (e.g., excited, inspired, interested, hopeful, funny, joyful, happy, pleased). Seven percent were coded as neutral.

- The majority (76%) of human-coded tweets captured Twitter users' **behavioral responses** to the content of the two *CC* stories. Most of these (84%) shared information with other users by including a link to the story or other relevant information. Approximately 11% of Twitter users actively engaged with others by prompting them to read *CC* stories, asking questions, or exchanging opinions with others. Five percent called for action, suggesting what individuals or institutions "should" or "should not" do.

Figure 5. Examples of Twitter users' behavioral responses.

EXAMPLE 1: A Twitter user sharing the link to a story.

> "From Rust to Resilience: What climate change means for Great Lakes cities" is a collaborative reporting project greatlakesnow.org/2020/05/rust-r…
>
> 6:22 AM · May 3, 2020

EXAMPLE 2: A Twitter user sharing the link to the story and calling for an action (e.g., #VoteBiden).

> Deadly bacteria lurk in coastal waters. #ClimateChange increases the risks. #VoteBiden
>
> Health workers see Vibrio as a rare danger, if they've heard of it at all. But it's already causing more cases of flesh-eating disease. And it's poised to get worse.
>
> publicintegrity.org
> Deadly bacteria lurk in coastal waters. Climate change incre…
> Vib   -shaped bacteria found in brackish and balmy coastal waters. It has many species but only abo…
>
> 7:08 AM · Oct 21, 2020 · Twitter Web App

EXAMPLE 3: A Twitter user prompting other users to check our their activities

> Replying to @jackfrostqueen_
>
> please check us out and see how we help in the fight against the zebra mussels, and do NO harm to the aquatic environment.
>
> 06oblo.com
> Invasive Mussel Defense
> Made in   527758
>
> thedockdisk.com
> The Dock Disk – Invasi   – Solving Your Zebra and Quagga Mu…
> The Dock Disk - Repel Zebra and Quagga Mussels
>
> 9:50 PM · Apr 23, 2020 · Twitter Web App

EXAMPLE 4: A Twitter user sharing the link to the story and prompting others to read it.

> Come for the important, superbly told story about climate change in the Great Lakes region. Stay for the flying carp GIF. buff.ly/2VM8xcC @ensiamedia
>
> 6:31 PM · Apr 25, 2020 · Buffer

EXAMPLE 5: A Twitter user engaging with other users by asking for their opinions.

> · Apr 18, 2020
>
> Update: I'm working on a project discussing invasive species in North America and I would love to hear your thoughts on some species I should write about, let me know and it might end up in there! @pinkrocktopus heard some of my material and she loves it. #sciencetwitter
>
> OKAY, JUST LET ME KNOW
>
> 162   23   175
>
> Replying to @sciencewi   ktopus
>
> Zebra mussels!
>
> 1:49 PM · Apr 21, 2020 · Twitter for iPhone

CASE STUDIES

Region-level analysis: Journalism Landscape

Both regions had an increase in news stories mentioning key terms from March 19, 2019 to July 19, 2022:

● In the Great Lakes region, there was a nearly four-fold increase in news stories mentioning the key terms "climate change" and "Great Lakes" together, from 677 to 3220. This increase suggests a rise in regional news coverage incorporating the concept of climate change.

● In the Carolinas region, there was a three-fold increase in news stories mentioning key terms "climate change" and "Carolina" together — from 2,701 to 8,550.

Figure 6. Aggregate numbers of news hits mentioning 'Great Lakes' and 'climate change' together (left) and 'Carolina' and 'climate change' together (right) in the time period from 6 months before the first story in our sample to 6 months after the last story in our sample.
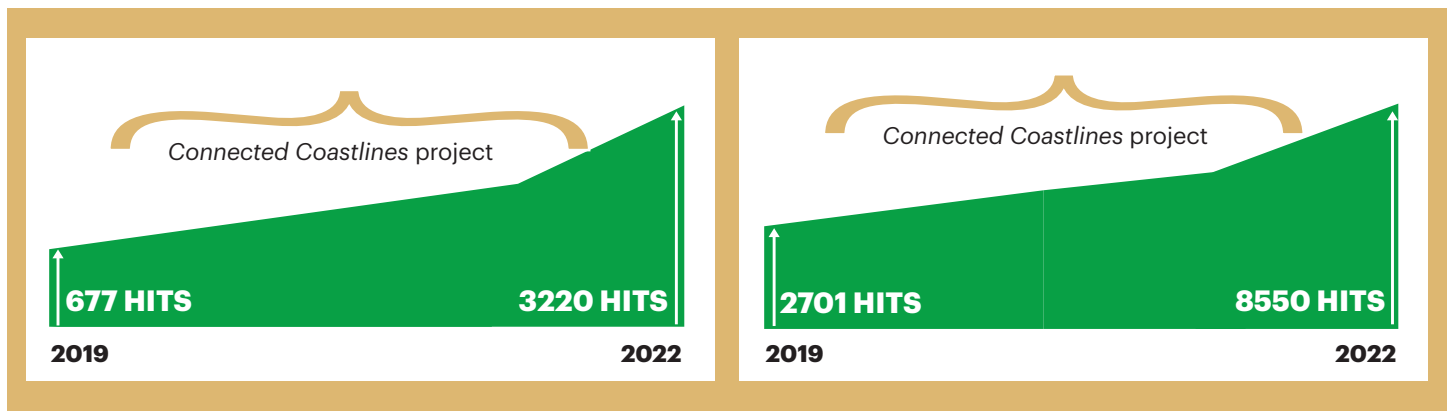
● Unique key terms from the Great Lakes story—"climate," "ecological recovery," and "great lakes"—were mentioned together in the news more frequently in the year after the publication of the story (342 keywords) than in the year before (243 keywords), suggesting that key words and messages from the Great Lakes story were spreading.

Figure 7.

Aggregate numbers of news hits mentioning key terms and phrases of "Great Lakes", "ecological recovery" and "climate," one year prior to the publication of the Great Lakes story and one year after.

Great Lakes Story
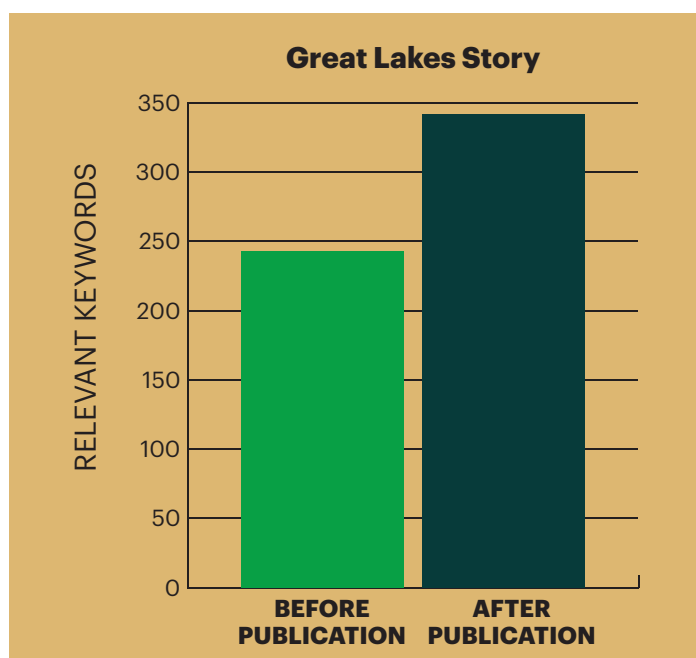
Region-level analysis: Legislation landscape

- In both regions, there was an aggregate increase in introduced environment-related legislation during the period 2013 to 2022. However, this increase had marginal statistical significance, and there was no increase within the *CC* project period from 2019 to 2022.

Figure 8. Environment-related legislation introduced in the Great Lakes and Carolinas regions, 2013-2022.
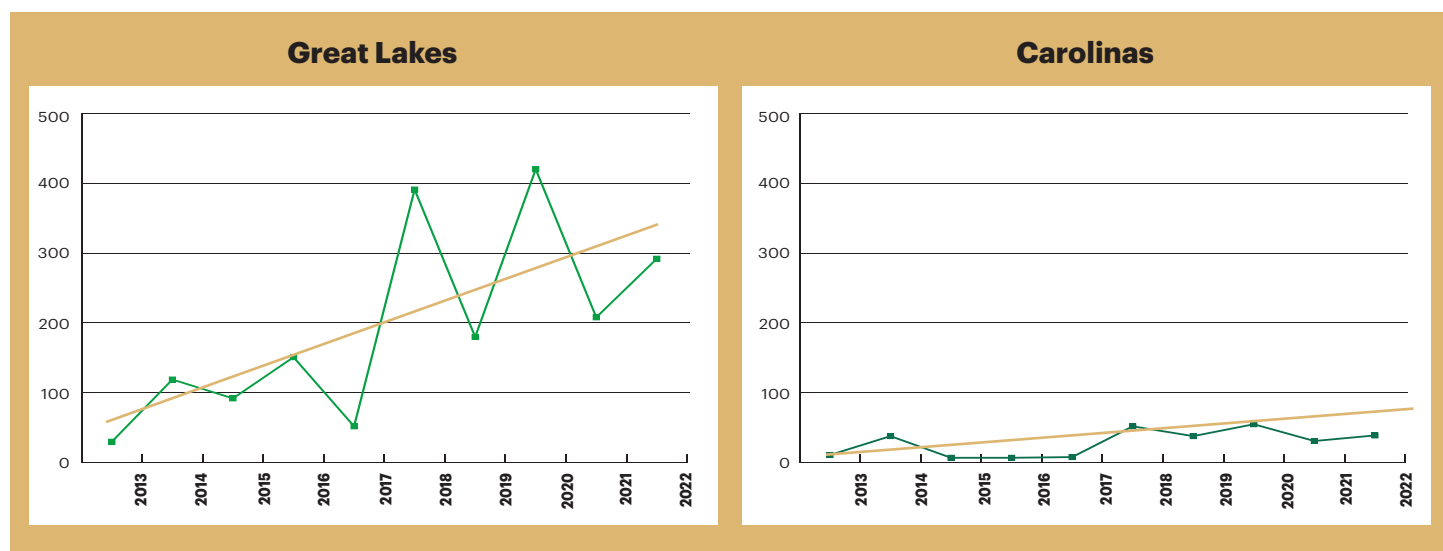
Story-level analysis: The "Flesh-Eating Bacteria" story

The "Flesh-Eating Bacteria" story was extensively read in both of the Carolinas, but also spread nationally and internationally. For example, it was picked up by *Mother Jones*, based in San Francisco and *The Daily Mail*, based in the UK.

- The story had 170,000 lifetime page views as of August 2022, of which 150,000 were in the first month of publication. This is approximately 20 times as many page views as the median *CC* story.

- Its estimated Twitter reach of 768,812 was four times higher than the median *CC* story. Interviews with the publishing company director and the story author revealed that this story was broadly shared on multiple social media platforms.

- The story was extensively quoted in eight outlets and recirculated by 19 outlets. It won the Thomas L. Stokes Award for Best Energy and Environment Reporting and the South Carolina Press Association Award.

Key informants noted various indicators of impact beyond story metrics:

- The story author indicated he received multiple emails thanking him for bringing visibility to the issue, especially from members of the local community and scientists.

> " *[T]here was no reluctance to connect the trend of storms getting wetter to climate change. The argument is over.*

- The story editor noted changes in public sentiment, including climate change becoming "settled science" in the region, due to journalistic efforts and environmental impacts like flooding events. The editor talked about changes in climate and environmental reporting in the Carolinas over the last five years: *"In coverage of the Matthew and Florence hurricanes, there was no reluctance to connect the trend of storms getting wetter to climate change. The argument is over... Even newspapers in red states are talking about climate change. You cannot deny climate change when your ankles are deep in water."*

- The regional journalism development director explicitly tied the *CC* project to increased capacity and staffing, due to demonstrated public interest in climate and environmental issues. The company grew from one reporter covering environmental issues to seven full-time nationwide reporters during the *CC* project timeframe. As he explained: *"There's a clear line between Beyond the Beach and work that was done here. We did not really have climate change reporters until 2021... And at this point, we have seven climate reporters at McClatchy that are funded through the company and through various initiatives... I think a lot of it has to do with the success of that series, and what it showed about the interest in this space."*

- Key informants attributed the story's power to its attention-grabbing topic and headline, the inclusion of in-depth interviews with scientists and affected individuals, and visuals that helped to place the issue in context.

- They independently highlighted the same set of **eight best practices** that our content analysis identified in the story, with a focus on bringing science close to home, personal stories, and using images strategically.

Story-level analysis: The "From Rust to Resilience" story

"From Rust to Resilience" had greater Twitter reach, but fewer page views than the Carolinas story.

- The story had an estimated 11,000 lifetime page views as of August 2022, which is about average for *CC* articles. It had an additional 1,573 views on the local Great Lakes Now TV show website.

- At nearly 2 million, its estimated Twitter impressions (based on the number of tweets that mention the story title or story URL) were 11 times higher than the median *CC* story. The story's reach was about 959,535, almost six times the median story reach. This social media traction is likely related to the fact that the unique hashtag associated with the story (e.g., #rusttoresilience) was used for all ten stories published as part of the INN-led collaborative reporting project.

- The story was extensively quoted in five outlets and recirculated by ten, including PBS and Detroit Public Television. It won the Great Lakes Leadership Award.

Key informants highlighted the importance of using multimedia and framing climate change in local, economic, and concrete terms to generate impact.

- Key informants also noted the value of placing climate and science information on television, where it is more likely to reach audiences who might not otherwise seek out that information.

- Informants independently mentioned the same set of six best practices that our content analysis identified in the story, with a focus on bringing science close to home and adopting solutions journalism techniques. The story's author noted that they strategically highlighted local economic benefits to reach audiences across the ideological spectrum: *"We used a strategy of trying to depoliticize the debate, and to focus more on economics and freedom of choice. I think that that strategy has been effective and can be effective, especially in the Great Lakes region."*

Story-level analysis: Both Stories

Analyses from both regions and stories showed a trend toward acceptance of "climate change" as a term.

- Two of the key informants spoke about the misconception that covering climate is controversial, pointing out that this controversy is dissipating with each passing day.

- Another key informant explained that although climate-related issues are covered

ubiquitously, newsrooms in more conservative areas rely on using language that describes the effects of climate change, such as flooding and heatwaves, as opposed to the term "climate change."

The editor in charge of the "Flesh-Eating Bacteria" story put it this way: "*Every story about disasters or public works can be connected to climate change, but it's not called that. However, reporters and editors are now more willing to connect the dots.*"

Both articles strategically framed and timed stories to reach across ideological aisles and find new and more diverse audiences.

- Authors reported incorporating facts connected to the local economic opportunities to generate bipartisan interest in stories about science and climate.
- Project managers sought out partnerships with TV stations and school curriculum designers to reach a wider audience and ensure greater engagement and impact for their messaging.

Across the two stories, we saw generative organization-level impact of the *CC* project.

- Interviewees mentioned expanding personnel for climate and science reporting projects, and developing collaborations and leads for future stories.

- At least four of our informants reported leveraging the success of the *CC* project for more staffing and professional opportunities, including projects that ended up in outlets like the *New York Times*.

> *Usually impact is much more subtle. You're talking about changing hearts and minds or planting a seed in someone's brain that takes off and grows into something big.*

Informants demonstrated the complexity in measuring journalistic impact.

- The specific term "impact" was related to readership and audience response for many informants.

- They decried the timing of the project, as the stories were published around the time that coverage of COVID-19 swept the world, saturated most media, and canceled in-person publicity events, reducing the capability to meet audience members, gather feedback, and create community.

- Editors and directors spoke about each outlet adding one voice to the cultural milieu, considering impact as synergistic. When discussing the direct line between science reporting and regional policy, the Director of INN explained: "*Usually impact is much more subtle. You're talking about changing hearts and minds or planting a seed in someone's brain that takes off and grows into something big.*"

Measuring the Impact of Science Journalism

INTEGRATED FINDINGS

- **Local journalistic and policy landscapes** in both of the studied regions demonstrated increasing awareness and acceptance of the climate crisis. This is consistent with our finding that less than 1% of tweets related to our two studied stories were opposed to the consensus of man-made climate change. The case studies and Twitter findings alike show that public sentiment and interest in climate issues have increased in the time frame of the *CC* initiative.

- We saw an uptick in the public appetite for learning about climate related issues. As the local impacts of the climate crisis become more extreme and more evident, with catastrophic weather events on every coastline in the U.S., **the discussion in the public sphere has become more sober**. Relatedly, we found that 40% of tweets that discussed climate change effects in relation to *CC* stories had negative sentiment and none had positive sentiment.

- Key informants tied the *CC* project to learning about **new topics, technologies, and strategies**. For instance, Twitter analyses underscored the importance of social media knowhow and partnerships in amplifying stories' social media reach. Planning and implementing effective social media strategies played a large role in impactful dissemination. For example, the From Rust to Resilience project's use of a unique hashtag dramatically increased the reach, impressions, and engagement of the story, along with others in this project.

- Key informants' opinions regarding impactful strategies used in the two stories were fully aligned with the **best practices** identified in those stories by content analyses. As they described the stories' life spans, caliber, and impacts, they emphasized best practices such as bringing science close to home, humanizing coverage with personal stories, and using images strategically.

- Both *CC* stories in our case study had **effects on infrastructure, network-building, and organizational capacity**—outcomes which are not evident in the currently available metrics. At the same time, informants expressed the need for tools to **capture social impact more holistically**.
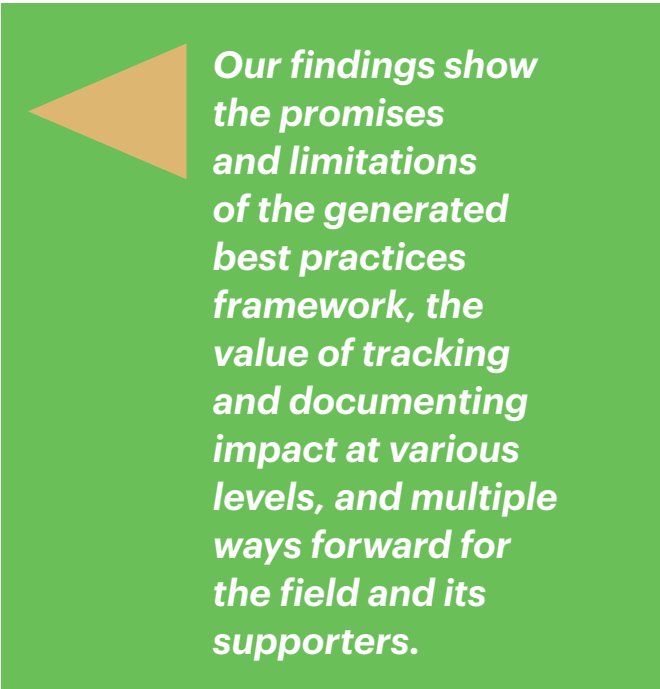
CONCLUSION & RECOMMENDATIONS

The summative phase of this project illuminates the diverse processes and impacts of the *Connected Coastlines* initiative. Implications drawn from these findings help lay the groundwork for effective science journalism.

First, we charted the landscape of science and climate journalism to distill a catalog of evidence-based best practices in science journalism. Using this best practices framework, we saw that most studied *CC* stories incorporated story-level best practices, such as bringing science close to home, incorporating personal anecdotes, and using images strategically. Stories using these practices had higher reach and engagement on Twitter, and key informants highlighted their impact as well. These findings demonstrate the importance of continuing to refine and investigate features and practices associated with impact in the field of science journalism.

Employing a broader lens, region-focused analyses revealed an increasing trend in the use of environmental and climate-focused language in news and policies, along with growing audience appetites for climate change stories in places historically less invested in climate change discourse. *CC* project stakeholders sought to capitalize on this interest and create stories that engaged more communities. Reaching wider and more diverse audiences was facilitated by several factors, including story framing, partnerships, and dissemination. To reach broader publics, journalists relied on foregrounding regional issues, evident effects of climate change, personal stories, and top-of-mind topics like local economics. Also impactful was leveraging strategic partnerships with entities like TV stations. Finally, Twitter analyses showed the power of using unique hashtags, shareable images, and amplification to enhance reach and dissemination.

Our findings show the promises and limitations of the generated best practices framework, the value of tracking and documenting impact at various levels, and multiple ways forward for the field and its supporters.

Overall, the social impact of the *CC* project took multiple forms, often uncaptured by existing metrics and data tracking systems. A key finding was the impact of the initiative on organizations in terms of staffing, capacity-building, know-how, partnerships, and

networks. Similarly, *CC* projects informed and inspired other impactful journalism projects, illustrating the power of building capacity and networks. Interviewees pointed to positive reader reception and possible uptake by policymakers, but did not have existing tools to capture these impacts. Some of the social media and database mining tools documented in this report could serve as models to capture more diffuse and diverse examples of science journalism's impact.

Taken together, these findings illustrate the inroads made by science and climate journalism. Using the *CC* initiative as a case study, we applied what's known about impactful science journalism to glean insights for stakeholders and the field more generally. Our findings show the promises and limitations of the generated best practices framework, the value of tracking and documenting impact at various levels, and multiple ways forward for the field and its supporters.

RECOMMENDATIONS FOR PRACTITIONERS AND FUNDERS

1 **Continue to fund regional science and climate journalism projects.** As audience interest in environmental and climate stories continues to grow, locally-framed stories are likely to lead to wider reach and greater engagement with the content. This is especially true when salient issues and personal anecdotes are incorporated.

2 **Develop systems for tracking diverse forms of impact.** Effective science and climate communication initiatives have complex processes and multifaceted impacts that could be captured in multiple ways. In addition to measuring story features and their impact on audiences' knowledge, attitudes, and behavior, measure organizational capacity building, learning, and network expansion.

3 **Support the use of social media tools in science journalism projects.** Such tools facilitate delivery of messages to audiences and make it easier to track their spread. Generating and using unique hashtags consistently — for an article, series, or project — builds a brand identity and helps with both amplification and tracking.

4 **Prioritize diversity in storytellers and coverage.** Voices from communities historically-excluded from journalism help elevate the field, increase audience engagement, and position science and climate issues in ways that may have been previously erased. Through mechanisms such as fellowship programs, funders can increase the diversity of the voices telling science stories and enrich the ecosystem of science journalism.

5 **Continue to invest in research investigating best practices.** The best practices framework we developed serves as a starting point for future research on science journalism initiatives beyond *CC*. Projects in this field have different aims and audiences, necessitating different strategies. More work is needed to understand how these best practices operate in different contexts and with different audiences, as well as the types of social impact they promote.

ACKNOWLEDGEMENTS