# Are Journalists Reporting on the Highest-Potential Climate Solutions? Findings from a Survey of Environmental Journalists

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## Abstract

The most promising climate change solutions have yet to be widely implemented: Journalists are aptly positioned to ensure the implementation of the highest potential solutions is on the public's agenda. This article investigates environmental journalists' climate change solutions reporting practices and interests, with particular attention paid to negative emissions technologies (NETs), via a survey of Society of Environmental Journalists members (N = 592) conducted in 2020. A descriptive analysis demonstrated that environmental journalists are reporting on the highest impact solutions, being most interested in and likely to have reported on adaptation and resilience stories and renewable energy stories; over half were interested in and had recently reported on negative emissions solutions. Content analysis of participants' descriptions of their most recent negative emission story revealed: 1) many stories did not appear to be about negative emissions technologies per se; 2) participants were more interested in natural/biological rather than technological NETs; and 3) participants are particularly interested in reporting on the feasibility of NETs. While these results are promising, resources to support journalists in reporting about climate solutions may be helpful, particularly in navigating the nuances of negative emissions technologies.

*Keywords:* climate change communication, environmental journalism, climate change solutions, negative emissions technologies, content analysis

## Introduction

Climate change is arguably the most complex, pressing threat to public wellbeing in America and other nations. According to the Fourth National Climate Assessment (NCA4), the impacts of climate change are intensifying across the country and subsequently putting Americans' physical, social, and economic well-being at risk (USGCRP, 2017). The severity of climate impacts depends greatly on whether mitigation and adaptation actions are taken and which solutions are employed (USGCRP, 2017). There are several solutions that are often identified as having the highest potential to abate the worst effects of climate change (see Table 1). Of these, negative emissions technologies (NETs) are particularly important because analyses by the Intergovernmental Panel on Climate Change (IPCC) (2018) show that to limit global warming to 1.5°C—and therefore abate the worst of its impacts—NETs ought to be considered. NETs encompass a variety of existing technologies and practices that remove carbon from the atmosphere and put it into long-term storage (Institute for Carbon Removal Law and Policy, 2020; Morrow et al., 2018; National Academies of Science, Engineering, and Medicine, 2019).

Journalists work in a wide range of news media (e.g., print, broadcast, radio, etc.) and can therefore shape perceptions of climate change solutions (Maibach et al., 2020). However, despite its urgency, climate change is perceived to lack many of the properties that traditionally attract media attention and, as a result, is often underreported (Swain, 2015). Further, journalists and journalism play an important role in ensuring that relevant information about potential climate solutions are brought to the attention of the public and policymakers (Fahy & Nisbet, 2011; Gibson et al., 2016; Post, 2017). Because of this, it is important to understand current reporting on climate change solutions, including which potential solutions are currently being reported and which are likely to be reported in the future. Prior research has not investigated these topics in detail. This study seeks to fill this gap by examining the climate solutions reporting practices and

interests of environmental journalists—the group of journalists most likely to be reporting on climate change (Maibach et al., 2018). Additionally, because of the importance of NETs in achieving the Paris Agreement's target of limiting the increase of average global temperatures to 1.5°C above pre-industrial levels, we sought to further investigate which NETs stories were being reported and are likely to be reported in the near future (United Nations, 2015).

## Literature Review

### Journalists and Perceptions of Climate Change

Journalists bridge the gap between scientists, communicators, and stakeholders and the general public (Fahy & Nisbet, 2011; Post, 2017). As mediators, journalists and news managers make decisions about what and how to present information about climate change and related topics—it is in these decisions that journalists and news managers hold the power to influence public perceptions about climate change (Boykoff & Boykoff, 2007; Fahy & Nisbet, 2011; Hart, 2011; Myers et al., 2012; Post, 2017; Schmid-Petri et al., 2016). However, the process of information transmission is by no means linear (Swain, 2015).

Climate change journalism is often reactive: it is triggered by events—such as natural disasters or report releases—and can reflect or reinforce existing perceptions of climate change (Swain, 2015). Event-driven reporting may fail to take advantage of journalists' unique opportunities to influence public perceptions of climate change, including potential solutions (Swain, 2015).

Agenda-setting theory posits that what journalists choose to report on determines—in large part—what topics appear in the public view (Iyengar, 1990; McCombs & Shaw, 1972). News value theory posits that there are a multitude of considerations and news factors that play into whether or not a story is deemed newsworthy, including the presence of elite actors and the

level of conflict in a story (Schmid-Petri et al., 2016). Climate change has been systematically underreported in comparison to other topics of arguably less importance that have more "newsworthy" characteristics such as politics, the economy, sports, celebrities, and crime (Swain, 2015). Consequently, climate change has not been as prominently placed in the public eye (Swain, 2015). Because journalists and news managers have the power to decide what is considered newsworthy, news professionals are uniquely positioned to make decisions about not only what is included in the news but also how information is presented (Boykoff & Boykoff, 2007; Post, 2017; Schmid-Petri et al., 2016).

News framing refers to how journalists present a topic. More specifically, it "is the process of organizing and packaging information [that] involves selecting aspects of a perceived reality to make them more salient" (Swain, 2015, p. 5). By utilizing different frames in climate change stories, journalists can influence public perceptions of its impacts and solutions, an audience's motivation to act or become fatalistic towards it, and if and how an audience responds to it (Entman, 2007; Hart, 2011; Myers et al., 2012; Nisbet, 2009; Swain, 2015). Learning from agenda-setting theory, news value theory, and framing, the topics journalists report on and how they are presented matter for shaping public perceptions. This should not be ignored when working to bring climate change solutions into the public eye.

**Journalists and Climate Change Solutions**

Given their powerful role as information disseminators, journalists can play a key part in raising awareness of known solutions to climate change. However, journalists' coverage of climate change solutions has been scant over the past few decades (Hart & Feldman, 2014; Swain, 2015). The 1980s marked a mitigation-focused period of climate change reporting (Swain, 2015). Since then, reporting on climate change has been inconsistent, and it was not until

2008 that climate change reporting shifted from primarily covering the science back to covering solutions (Swain, 2015). Even with this shift, and the growing coverage of climate change broadly, there is room for improvement in the current coverage of climate change solutions for several reasons. First, the impacts of climate change and potential solutions are rarely discussed in the same broadcast, meaning there is a disconnect between the effects of climate change and how to address those effects (Hart & Feldman, 2014). Further, when discussing impacts of climate change such as sea level rise and melting glaciers, television news broadcasts tend to feature an environment or ecosystem frame and highlight the negative impacts of climate change which—as noted above—can be demotivating (Swain, 2015). Similarly, solutions and actions are primarily discussed not in terms of their benefits but in terms of difficulties in their approval and implementation (Hart & Feldman, 2014). Given both the influence journalists can have on public perceptions of climate change solutions as well as current knowledge of their coverage, we sought to answer some fundamental questions about climate change solutions reporting:

> RQ1: What proportion of environmental journalists have recently reported on climate change solutions stories?
>
> RQ2: What proportion of environmental journalists are interested in reporting on climate change solutions?
>
> RQ3: Are environmental journalists reporting about higher potential climate change solutions more frequently than lower potential climate solutions?

**Climate Change Solutions with the Most Potential**

In order to answer RQ3, we ranked a range of possible climate change solutions based on their quantifiable potential to reduce the amount of greenhouse gases (GHGs) in Earth's atmosphere from greatest (1) to least (5) potential (Table 1, Column A). Solutions that cannot be quantified in such a way but are also essential for addressing climate change are presented in an unranked list (Table 1, Column B). Determining which solutions have the greatest potential is

contingent upon how one measures 'potential' and the context in which the solution is being considered. Further, solutions ought to be considered as a portfolio of synergistic options as there is no single path or approach that can solve climate change. However, research and reasoning tell us—in a general sense—which climate change solutions can be most impactful.

Solutions can be ranked based on their mitigation potential. According to the IPCC (2014b), mitigation refers to reducing "the sources or enhancing the sinks of greenhouse gases" (p. 4). The IPCC and other sources rank the following as having the largest potential to avert climate change in terms of their potential emission reductions ($CO_2$-eq(Gt)), from greatest to least: electricity; agriculture, forestry, and other land use (AFOLU); industry; transportation; and buildings (IPCC, 2014b; Project Drawdown, 2020; Wynes & Nicholas, 2017).

Following the reduction of emission sources, it is becoming increasingly clear that methods for drawing carbon dioxide out of the atmosphere will be necessary to avert the worst effects of climate change (IPCC, 2018; Project Drawdown, 2020). Negative emissions technologies, also referred to as carbon drawdown, capture a variety of technologies and practices that draw carbon out of ambient air and lock it away for decades, centuries, or possibly longer (Morrow et al., 2018; Institute for Carbon Removal Law and Policy, 2020). In a special report, the IPCC (2018) includes NETs in all of its pathways[1] for limiting the rise of global temperatures to 1.5°C above pre-industrial levels to avoid the worst effects of climate change (IPCC, 2018; United Nations, 2015). Further, Project Drawdown (2020) posits that enhancing land sinks (shifting agricultural practices, protecting and restoring land-based ecosystems, using degraded land, and addressing waste and diets) have the greatest potential to reduce greenhouse gas equivalent emissions in the atmosphere, followed by coastal and ocean sinks (protecting and

[1] Afforestation and bioenergy with carbon capture and storage (BECCS) are the carbon dioxide removal (CDR) options—or NETs—considered in the IPCC's models (IPCC, 2018).

restoring coastal and ocean-based ecosystems), and engineered sinks (human engineered methods for removing and storing carbon). The IPCC's (2018) and Project Drawdown's (2020) findings send a strong signal that NETs will need to be a component of our response to climate change and are therefore deserving of our attention as researchers, communicators, journalists, and practitioners. Yet, while NETs are clearly an essential step in climate mitigation efforts, there are no easy answers—each negative emissions option raises its own social and technical questions about feasibility, costs, and benefits. Consequentially, how researchers, practitioners, and journalists talk about NETs matters (Nisbet, 2019; Morrow et al., 2018).

To date, the literature examining journalists' understanding and reporting on NETs is sparse. Existing research has examined how journalists speak about and frame their conversations of geoengineering—an umbrella term that sometimes includes NETs along with other climate intervention strategies—in their reporting (Feldpausch-Parker, 2015; Luokkanen, Huttunen, & Hildén, 2014; Nerlich & Jaspal, 2012). While this work has been undoubtedly useful, researchers and practitioners who study NETs raise concern about journalists' portrayal of the nuances of these climate intervention strategies (Institute for Carbon Removal Law and Policy, 2019). Unpacking how journalists understand and write about NETs provides an entry point for guiding researchers and practitioners to help journalists make sense of NETs' complexity and accurately transferring that knowledge to the public, leading us to our fourth research question:

> RQ4: What negative emissions stories are environmental journalists reporting on and interested in reporting?

Beyond mitigation and NETs, there are other essential solutions that make up the climate change response puzzle that cannot be quantified and ranked based on their emission reduction nor carbon drawdown potential (Table 1b). Adaptation, or the "process of adjustment to actual or

expected climate and its effects," encompasses a host of necessary climate change solutions (IPCC, 2014a).[2] Other climate intervention strategies, such as solar radiation management, are also under consideration. Finally, none of the solutions discussed thus far can be enacted without societal factors such as policy, education, and communication (National Council for Science and the Environment, 2009; Project Drawdown, 2020). While the nuances within and synergies between solutions must not be forgotten, Table 1 provides a benchmark for assessing how journalists are reporting on climate change solutions.

**Table 1**

*Potential of Climate Change Solutions to Limit or Reduce Atmospheric Greenhouse Gases*

| *A. Ranked* | *B. Unranked* |
|---|---|
| 1. Renewable energy | • Adaptation and resilience measures |
| 2. Sustainable food production and consumption | • Geoengineering solutions |
| 3. Sustainable cities and communities | • Public awareness and education |
| 4. Energy efficient homes and buildings | • Equity and empowerment |
| 5. Negative emissions or drawdown solutions | • Policy responses |

*Note:* The ranked solutions are listed in order of most (1) to least (5) GHG-reducing potential. The unranked solutions are deemed by experts to be important, but their GHG-reducing potential cannot be directly quantified.

## Methods

[2] Table SPM.1 in IPCC (2014a) presents a comprehensive list of approaches for managing the risk of climate change.

**Participants**

Data for this study were collected via an online census survey of the Society of Environmental Journalists (SEJ) members. The Society of Environmental Journalists (SEJ) is a North American membership association of professional journalists who are committed to enhancing public understanding of environmental issues.[3] This survey was conducted in support of the *Climate Matters in the Newsroom* project, a climate reporting resources program produced by George Mason University, Climate Central, Climate Communication, NASA, and NOAA. The survey was distributed to all 1,494 SEJ members via email on January 6th, 2020. The survey closed in early February with a response rate of 39.6% ($N = 592$) and a completion rate of 33.8% ($N = 505$).

Demographic (sex, age, race) and occupational (primary medium and position) descriptions of the survey participants can be found in Tables 1-5 in the Appendix. A topline description of their responses to all questions in the survey was previously reported in Maibach and colleagues (2020).

**Descriptive Analysis**

To answer RQs 1-3, SEJ members were asked about their experience with reporting on various climate change topics. If participants answered anything other than "None" to the question "Over the past 12 months, how many climate change-related stories have you reported?" they were asked: "Which, if any, of the following climate solutions stories have you reported on in the past 12 months?" Respondents were prompted to select "Yes" or "No" to the following climate change solutions: "Adaptation and resilience measures (e.g. habit preservation, wetland restoration, water quality maintenance, etc.)," "Renewable energy (e.g. wind, solar,

[3] More information about the Society of Environmental Journalists can be found at the following link: http://www.sej.org/about-sej.

etc.)," "Sustainable cities/communities (e.g. walking and biking friendly, green space[s], mass transport, etc.)," "Energy-efficient homes and buildings (e.g. insulation, energy efficient appliances, etc.)," "Sustainable food production and consumption (e.g. regenerative farms, plant-based diets, etc.)," "Negative emissions or drawdown solutions (e.g. reforestation, regenerative agriculture, carbon capture and sequestration, etc.)," "Geo-engineering solutions (e.g. solar radiation management, etc.)," "Policy responses (e.g. local climate initiatives, national carbon tax, global climate agreements, etc.)," "Public awareness and education (e.g. information campaigns, climate change [education] in schools, etc.)," "Equity and empowerment (e.g. education for girls, reducing poverty, etc.), and "Other (please specify)." If participants selected "Yes" to "Other (please specify)" they were offered a textbox to elaborate upon their selection. If participants selected "Yes" to "Negative emissions or drawdown solutions (e.g. reforestation, regenerative agriculture, carbon capture and sequestration, etc.)" they were prompted to provide an open-ended response to: "Please briefly describe your most recent negative emissions story."

Participants' interest in reporting on various climate change solutions was assessed by asking: "How interested are you in reporting on the following climate change solutions?" This list of climate change solutions was identical to those listed above, except the "Other" category did not provide a textbox to specify. Response options were "Not interested," "Slightly interested," "Moderately interested," and "Very interested." If participants responded "Very interested" or "Moderately interested" in reporting on "Negative emissions or drawdown solutions (e.g. reforestation, regenerative agriculture, carbon capture and sequestration, etc.)," they were presented with an open-ended question asking, "What kinds of negative emissions stories would you like to report?"

**Content Analysis**

To answer RQ4, a content analysis was used to examine participants' responses to the two open-ended survey questions. There were 178 responses to the question, "Please briefly describe your most recent negative emissions story." Each of these responses ranged from a few words to about two sentences in length. Responses were analyzed inductively for common themes, and a codebook was created based on these themes to assist in quantifying similar response types and sub-types. Coders then assigned a 0 for "no" and a 1 for "yes" to each response for each category and subcategory within the codebook. Three of the authors independently analyzed each of the responses. After the first round of coding, intercoder reliability was calculated for each category and subcategory in the codebook and the total codebook. Coders then discussed conceptualizations of each category and independently made edits to their coding. Intercoder reliability was calculated for a final time (Cohen's kappa = .83). Disagreements were then resolved through discussion.

Responses were coded according to 28 categories and subcategories. During the process of generating codes, it became clear that some responses were not directly related to negative emissions solutions; these responses were coded as *off-topic*. *Off-topic* responses were further categorized as follows: *confused* responses explicitly indicated confusion about the question; *climate change* responses referred to climate change in a general sense; *greenhouse gas emissions* responses mentioned greenhouse gas emissions in a general sense; *energy* responses mentioned fossil fuels and/or renewable energy; *NETs adjacent* responses conflated other climate change responses (such as cap and trade) with negative emissions; and *other* responses that did not fall into any prior categories.

Responses directly relevant to negative emissions were coded as *negative emissions* and, if applicable, coded as a particular negative emissions option: *direct air capture and carbon*

*capture and storage*, *biochar*, *bioenergy with carbon capture and storage*, *enhanced mineralization*, *soil sequestration*, *afforestation/reforestation*, *blue carbon*, and/or *other*. A sizable number of responses mentioned carbon capture storage and utilization, although none directly specified if the story was about carbon drawn from ambient air (negative emissions) or from an emission source (non-negative emission). Because of this ambiguity, we treated these responses not as a negative emissions option per se, but rather as a distinct *carbon capture* category, including subcategories *carbon capture and storage,* and *carbon capture and utilization, and carbon capture storage and utilization*, if applicable.

Negative emissions responses were also coded in terms of story type. Responses that mentioned a specific example of carbon removal were coded as *example*, including subcategories of *location* and *industry* to capture when the response mentioned specific states, regions, or nations and/or mentioned an industry or corporation of any kind, respectively. *Expert* was used to indicate responses that mentioned an expert, study, report or forum on negative emissions. *Explainer* captured responses that discussed reporting an informational piece on negative emissions (i.e., what are they? how do they work? etc.). Responses that mentioned the feasibility of researching, developing, and/or deploying negative emissions were coded as *feasibility*. *Advocate* captured responses that mentioned negative emissions are necessary to address climate change. *Policy* reflected responses that mentioned politics, policy, or regulations of negative emissions. *None* was used to indicate responses that explicitly state "none" or "n/a."

Further addressing RQ4, content analysis was also used to examine responses to the question, "What kinds of negative emissions stories would you like to report?" ($N = 331$). Each response ranged from a few words to a few sentences. Responses were analyzed inductively to update the existing codebook and best capture the emergent themes. The final codebook for the

previous question was revised to create the codebook for this question and resulted in a total of 32 categories and subcategories. For this question, we knew that some respondents mischaracterized NETs based on the responses from the previous question. This raised concern for the accuracy of coding these participants' responses to the second question, as the question wording assumed that participants would be able to characterize a NETs story they wished to write. We chose to take a conservative approach to this issue. First, we went through the responses to the first question and made note of the participant numbers that corresponded to responses that were coded as *off topic*. Second, we found and removed any responses to the second question that were given by participants who provided *off topic* responses to the first question. To further keep track of which respondents had previously provided an answer about NETs, we added a *Q49* code to reflect either 1 = the respondent answered Q49 ($n$ = 73) and has accurately characterized NETs or 0 = the respondent did not answer Q49 ($n$ = 146). As the researchers, this method gave us (1) confidence in the respondents' ability to accurately characterize NETs or (2) noted that the response should be considered with no assumptions about how the participant would characterize a NETs story.

*Vague* was added to the second codebook to signal if a response was too vague to ascertain if the respondent accurately characterized NETs. *All* captured respondents who simply said they are interested in 'all' or 'any' NETs stories. Natural/biological versus technological forms of NETs was a recurring theme that was reflected in the second codebook with codes for *natural* and *technological*. *Local* and *industry* codes were added to capture general interest in NETs projects in these two contexts. Lastly, three subcodes were added under *feasibility*: *cost*, *weighing* (addressing the benefits and drawbacks of different NETs options), and *policy*.

Three coders completed one round of coding with the second codebook. Intercoder reliability was calculated (Cohen's kappa = .78), and the coders collectively resolved all coding disagreements.

## Results

### Descriptive Analysis

Table 2 presents the proportion of climate solutions that had been reported on in the 12-month period prior to the survey (RQ1). Adaptation and resilience were the most reported on climate solutions (80.5%), followed by policy responses (78.8%) and renewable energy (67.2%). Geoengineering solutions (19.6%) were the least reported climate solution. Slightly more than half of participants reported on negative emissions and drawdown solutions (53.8%).

Table 2 also presents the proportion of climate solutions that participants are interested in reporting on (RQ2). Participants are most interested in reporting adaptation and resilience stories (70.8% are "very interested") followed by renewable energy (59.5%) and policy responses (56.6%). Participants are least interested in reporting geoengineering solutions (22.9%), with 15.9% saying they are "not at all interested" in reporting on it (the largest by a nearly 9-point margin). About half of participants (53.0%) are "very interested" in reporting in negative emissions and drawdown solutions. Regarding RQ3, Table 3 shows that there is a high degree of concordance between the most frequently reported stories and the ranking of its solutions potential (see Table 1a).

**Table 2**

*Valid Percentages of Reporting on Climate Solutions and Interest in Reporting on Climate Solutions*

| | Yes (%) | Not interested (%) | Slightly interested (%) | Moderately interested (%) | Very interested (%) |
|---|---|---|---|---|---|
| Adaptation and Resilience | 80.5 | 1.2 | 7.7 | 20.3 | 70.9 |
| Renewable Energy | 67.2 | 2.1 | 12.0 | 26.4 | 59.5 |
| Sustainable Cities/Communities | 58.0 | 4.1 | 15.1 | 27.1 | 53.7 |
| Energy Efficient Homes and Buildings | 44.0 | 7.0 | 21.9 | 33.8 | 37.3 |
| Sustainable Food Production and Consumption | 53.8 | 2.5 | 14.1 | 29.4 | 54.0 |
| Negative Emissions or Drawdown Solutions | 53.8 | 3.5 | 17.3 | 26.2 | 53.0 |
| Geoengineering Solutions | 19.7 | 15.9 | 30.1 | 31.1 | 22.9 |
| Policy Responses | 78.8 | 2.7 | 10.5 | 30.2 | 56.6 |
| Public Awareness and Education | 63.8 | 4.9 | 20.8 | 29.7 | 44.7 |
| Equity and Empowerment | 39.6 | 6.1 | 21.2 | 27.7 | 45.1 |

*Note*. Responses to the questions, "Which, if any, of the following climate solutions stories have you reported on in the past 12 months?" ($N = 592$) and "How interested are you in reporting on the following climate solutions?" ($N = 592$).

**Table 3**

*Potential of Climate Change Solutions Compared to Reporting Frequency*

| *Ranked List of Climate Change Solutions* | *Reporting on Climate Change Solutions* |
|---|---|
| 1. Renewable energy | 1. Renewable energy |
| 2. Sustainable food production and consumption | 2. Sustainable cities and communities |
| 3. Sustainable cities and communities | 3. Sustainable food production and consumption |
| 4. Energy efficient homes and buildings | 3. Negative emissions or drawdown solutions |
| 5. Negative emissions or drawdown solutions | 4. Energy efficient homes and buildings |

*Note:* See Table 3 for valid percentages of reporting on climate change solutions.

**Content Analysis**

Table 4 presents the results from the content analysis of the most recently reported negative emissions stories (RQ4). Notably, only 59.0% of respondents described a topic that is consistent with most definitions of negative emissions technologies (i.e., natural or technological methods that remove carbon from the atmosphere) (National Academies of Science, Engineering, and Medicine, 2019). Of negative emissions stories reported, the most common sub-topic was soil sequestration (35.6%), followed by afforestation/reforestation (20.6%). A sizable number of the stories focused on the related but distinct concept of carbon capture storage and utilization (15.2%). Many of the topics reported were unrelated to NETs per se (41.6%).

Table 5 presents the NETs story topics that participants would like to report. Slightly less than half of those story topics (47.1%) are negative emissions stories, with much higher rates of interest in reporting on natural (29.7%) than on technological (14.41%) negative emission solutions. Participants were particularly interested in reporting on the feasibility of NETs (16.2%). Nearly one-third (30.6%) of responses were too vague to interpret. Additionally, 18.3% of responses were unrelated to NETs per se.

**Table 4**

*Percentages of Past Reporting on Negative Emissions Technologies*

| | n | Total % | % Within Category |
|---|---|---|---|
| **Off Topic** | **74** | **41.6** | |
| Confused | 3 | 1.7 | 4.1 |
| Climate Change | 21 | 11.8 | 28.4 |
| GHG Emissions | 20 | 11.2 | 27.0 |
| Energy | 18 | 10.1 | 24.3 |
| NETs Adjacent | 10 | 5.6 | 13.5 |
| Other | 27 | 15.2 | 36.5 |
| **Negative Emissions** | **73** | **41.0** | |
| Direct Air Capture | 7 | 3.9 | 9.6 |
| BECCS* | 4 | 2.3 | 5.5 |
| Biochar | 2 | 1.1 | 2.7 |
| Enhanced Mineralization | 1 | 0.6 | 1.4 |
| Soil Sequestration | 26 | 14.6 | 35.6 |
| Afforestation/Reforestation | 15 | 8.4 | 20.6 |
| Blue Carbon | 5 | 2.8 | 6.9 |
| Other | 13 | 7.3 | 17.8 |
| **Carbon Capture Storage and Utilization** | **27** | **15.2** | |
| Carbon Capture | 16 | 9.0 | 59.2 |
| Carbon Capture and Storage | 8 | 4.5 | 29.6 |
| Carbon Capture and Utilization | 3 | 1.7 | 11.1 |
| **Example** | **32** | **18.0** | |
| Location | 24 | 13.5 | 75.0 |
| Industry | 9 | 5.1 | 28.1 |
| **Expert** | **16** | **9.0** | |
| **Explainer** | **9** | **5.1** | |
| **Feasibility** | **14** | **7.9** | |
| **Advocate** | **9** | **5.1** | |
| **Policy** | **5** | **2.8** | |

*Note*. Responses to the question, "Please briefly describe your most recent negative emissions story." $N = 178$. Four responses were not coded because the coders could not confidently decipher their meaning. *Bioenergy with carbon capture and storage.

**Table 5**

*Percentages of Intent to Report on Negative Emissions Technologies (all respondents)*

| | All Respondents | | | Answer to Previous | | | No Answer to Previous | | |
|---|---|---|---|---|---|---|---|---|---|
| | n | Total % | % Within Category | n | Total % | % Within Category | n | Total % | % Within Category |
| **Off Topic** | **42** | **18.3** | | **4** | **5.5** | | **38** | **26.0** | |
| Confused | 1 | 0.4 | 2.4 | 1 | 1.4 | 25.0 | 0 | 0 | 0 |
| Climate Change | 2 | 0.9 | 4.8 | 0 | 0 | 0 | 2 | 1.4 | 5.3 |
| GHG Emissions | 3 | 1.3 | 7.1 | 0 | 0 | 0 | 3 | 2.1 | 2.1 |
| Energy | 11 | 4.8 | 26.2 | 1 | 1.4 | 25.0 | 10 | 6.9 | 26.3 |
| NETs Adjacent | 28 | 12.2 | 66.7 | 0 | 0 | 0 | 6 | 4.1 | 15.8 |
| Other | 28 | 12.2 | 66.7 | 3 | 4.1 | 75.0 | 25 | 17.1 | 65.8 |
| **Negative Emissions** | **108** | **47.2** | | **58** | **79.5** | | **50** | **34.3** | |
| **Technological** | **33** | **14.4** | **30.6** | **28** | **38.4** | **48.3** | **5** | **3.4** | **10.0** |
| Direct Air Capture | 8 | 3.5 | 24.2 | 7 | 9.6 | 40.0 | 1 | 0.7 | 20.0 |
| BECCS* | 3 | 1.3 | 9.1 | 2 | 2.7 | 7.1 | 1 | 0.7 | 20.0 |
| Biochar | 1 | 0.4 | 3.0 | 1 | 1.4 | 3.6 | 0 | 0 | 0 |
| Enhanced Mineralization | 1 | 0.4 | 3.0 | 1 | 1.4 | 3.6 | 0 | 0 | 0 |
| **Natural** | **68** | **29.7** | **62.7** | **33** | **45.2** | **56.9** | **35** | **23.9** | **70.0** |
| Soil Sequestration | 29 | 12.7 | 42.7 | 15 | 20.6 | 45.5 | 14 | 9.6 | 40.0 |
| Afforestation/ Reforestation | 31 | 13.5 | 45.6 | 11 | 15.1 | 33.3 | 20 | 13.7 | 57.1 |
| Blue Carbon | 9 | 3.9 | 13.2 | 6 | 8.2 | 18.9 | 3 | 2.1 | 8.6 |
| **Other** | **23** | **10.0** | **33.8** | **11** | **15.1** | **33.3** | **12** | **8.2** | **34.3** |
| **Carbon Capture Storage and Utilization** | **17** | **7.4** | | **5** | **6.9** | | **12** | **8.2** | |
| Carbon Capture | 9 | 3.9 | 52.9 | 1 | 1.4 | 20.0 | 8 | 5.5 | 66.6 |
| Carbon Capture and Storage | 7 | 3.1 | 41.2 | 3 | 4.1 | 60.0 | 4 | 2.7 | 33.3 |
| Carbon Capture and Utilization | 1 | 0.4 | 5.9 | 1 | 1.4 | 20.0 | 0 | 0 | 0 |
| **Local** | **6** | **2.6** | | **3** | **4.1** | | **3** | **2.1** | |
| **Industry** | **7** | **3.1** | | **5** | **6.9** | | **2** | **1.4** | |
| **Research** | **15** | **6.6** | | **8** | **10.9** | | **7** | **4.8** | |
| **Feasibility** | **37** | **16.2** | | **28** | **38.4** | | **9** | **6.2** | |
| Cost | 9 | 3.9 | 24.3 | 6 | 8.2 | 21.4 | 3 | 2.1 | 33.3 |
| Weighing | 6 | 2.6 | 16.2 | 10 | 13.7 | 35.7 | 1 | 0.7 | 11.1 |
| Policy | 6 | 2.6 | 16.2 | 4 | 5.5 | 14.3 | 2 | 1.4 | 22.2 |
| **All** | **13** | **5.7** | | **7** | **9.6** | | **6** | **4.1** | |
| **Vague** | **70** | **30.6** | | **25** | **34.4** | | **45** | **30.8** | |

*Note*. Responses to the question, "What kinds of negative emissions stories would you like to report?" "All Respondents" ($N = 229$) refers to all participants who responded to this question. "Answer to Previous" ($n = 73$)

includes participants who answered both this question and the previous question. "No Answer to Previous" ($n$ = 146) includes only participants who answered the current question and not the previous question. *Bioenergy with carbon capture and storage.

## Discussion

Based on our analyses, several patterns emerged between the climate change solution stories that were reported on in the year prior to the survey and those that environmental journalists are interested in reporting. Based on Table 1 and the results listed in Table 2, environmental journalists are in fact reporting on the highest potential climate change solutions. However, there is a gap in the amount of reporting on each of these solutions, with the most reported on solution (adaptation and resilience) being reported approximately 60% more often than the least reported on solution (geoengineering). This influences how these solutions are represented to the public, potentially creating a false balance of the importance of each of these solutions particularly regarding the solutions that could not be ranked in Table 1. Significantly, environmental journalists are already reporting on the climate solutions that they are the most interested in: adaptation and resilience, policy responses, and renewable energy. This overlap between interest and reporting behavior indicates that journalists and news managers could expand their reporting to represent the full array of climate change solutions options. Journalists and news managers may be missing unique story opportunities by pigeon-holing the scope of their reporting in this way. Further, due to their role as information disseminators, journalistic depictions of a smaller scope of climate solutions may limit public perceptions of their current use and potential.

Just over half of participants reported on NETs stories and were interested in reporting on them in future stories. While this does not suggest an underreporting of NETs stories, it does

indicate that there is a desire among environmental journalists to report on the complexities and nuances of these solutions and room for researchers and practitioners to aid journalists in doing so.

Over half (56.2%) of environmental journalists answered the open-ended question about their most recent negative emissions story with a response that is consistent with how experts would define NETs; however, 41.6% of responses answered with responses that were seemingly inconsistent with how experts would define NETs (National Academies of Science, Engineering, and Medicine, 2019). An example of a response that appears to be inconsistent with how experts would define NETs is, "In regards to the IPCC, the need to reduce carbon emissions to net zero in the next decade." This response, while directly related to climate change solutions, does not explicitly mention drawing carbon out of the atmosphere and, therefore, could not confidently be identified as a NETs story by the three coders of this study. Beyond references to greenhouse gas emissions, several respondents made references to energy. As one participant stated, "Texas oil company commits to using all renewable energy in Texas." While renewable energies are key climate solutions, they are not by definition negative emissions solutions. Researchers, practitioners, journalists, and news managers should work together to ensure that NETs stories are being portrayed to the public both accurately and effectively, as such solutions are integral for addressing climate change (IPCC, 2018).

There are also useful findings regarding what and how journalists are reporting on NETs. Our research indicated that when journalists report on NETs they most often report on more natural/biological options such as soil sequestration and afforestation/reforestation. As an example of this, one participant stated, "We cover regenerative agriculture all the time; we've lately covered native prairie as a sequestration practice, how big food companies like General

Mills are trying to encourage regenerative ag, and more." The technological options—such as bioenergy with carbon capture and storage and direct air capture—received much less attention. In one example of a respondent interested in reporting on a technological option, the respondent highlighted the need for and feasibility of direct air capture, "The state of direct air capture technology and what's needed - technological development, policy implementation, funding - to launch DAC on large scale." The stronger interest among environmental journalists in reporting on natural/biological options as opposed to technological options is important to consider. Since the IPCC 1.5°C report includes both afforestation (a natural/biological option) *and* bioenergy with carbon capture and storage (a technological option) in its pathways to a 1.5°C world, it is very possible that both natural/biological and technological NETs will be necessary and deserving of attention from journalists (IPCC, 2018).

Further, responses often focused on only one type of NETs. This has implications for public perceptions of climate solutions, as it may lead them to believe climate change requires only one or two solutions instead of a broader suite of responses. Additionally, the relationship between various NETs options is also worthy of consideration given the complexity surrounding how these solutions either work together or compete with one another depending on the context in which they are employed. Therefore, when reporting on NETs, journalists and news managers should place these solutions into the broader societal context and stress that NETs represent only a portion of the range of climate change solutions that are necessary to address the issue and the relationship between each NETs option is highly nuanced.

In addition to what negative emissions options journalists report on, it is also revealing to understand how they are reporting on these climate change solutions. Environmental journalists package their reporting on negative emissions within examples of their actual or considered use.

They sometimes produce pieces that purely explain negative emissions, cite specific experts, or discuss the feasibility of negative emissions options. However, reporting on how negative emissions fit into the broader climate change policy could be increased. Researchers and practitioners should recognize the role journalists can play when shaping the public and decision-makers' views of these options and consider ways to best convey to journalists the feasibility of, synergies between, and policy needs of negative emissions technologies.

While few journalists have previously reported on the feasibility of NETs, reporting about feasibility is something that journalists are interested in reporting on in the future (16.16%). Here, feasibility refers to questions of research, development, deployment, scale, cost, timing, etc. of NETs options. Respondents specifically stated their interest in clarifying questions of cost (3.93%) in their reporting on negative emissions, as exemplified by one participant's response, "Funding sources for negative emissions R&D, who's pushing what and why, which approach has the most potential and whether it's the one being most funded/pursued or not and why." Environmental journalists are also interested in reporting on the benefits and drawbacks of NETs options generally and related to specific negative emissions options (2.62%). For example, one respondent stated, "The pros and cons of negative emissions," and another stated, "Assumptions about negative emissions in climate scenarios, modeling; feasibility of BECCS vs. reforestation, other 'natural climate solutions;' advances in direct air capture, other forms of negative emissions technologies." Journalists are also interested in comparing natural/biological NETs options to technological ones (e.g. "Differential reaction to 'natural' vs technological solutions. Debunking hype… .") and are notably more interested in reporting on natural/biological options (29.69%) than technological (14.41%) options. There is also interest in reporting on the feasibility of NETs as it relates to policy (5.68%) (e.g., "Will carbon capture

from ambient air work and what about the infrastructure to do it. Policy to spur new tech.”). These findings can help indicate what pieces of the complex the NETs portfolio (and their roles in addressing climate change) researchers and practitioners ought to focus on when communicating with journalists. Ultimately, our work indicates that environmental journalists are reporting on a broad suite of climate change solutions; however, there is much that can—and we argue *needs*—to be considered by researchers and practitioners to better translate the nuances of these solutions into the public eye for robust action toward climate change.

## Limitations and Future Research

There are several limitations that need to be discussed. Primarily, the skip logic for the survey did not display some questions as intended. If participants selected "Moderately interested" or "Very interested" in reporting on "Negative emissions of drawdown solutions (e.g., reforestation, regenerative agriculture, carbon capture and sequestration, etc.)” for "How interested are you in reporting on the following climate solutions?" then, the survey should have displayed, "What kind of negative emissions stories would you like to report?" However, the follow-up question was displayed for participants who were very or moderately interested in reporting on "Adaptation and resilience measures (e.g., habitat preservation, wetland restoration, water quality maintenance, etc.)" rather than for responses to the statement about negative emissions. In order to address this, the responses of participants who responded to the follow-up question and who did not respond that they were very nor moderately interested in negative emissions were removed from the analyses. This remedied the issue by retaining responses that were originally intended to be captured by the survey while also eliminating those that were given due to the error in display logic.

As with any qualitative methods, there exists some level of subjectivity with the writing of a codebook. In particular, we as researchers are all deeply ingrained in the field of climate change communication and negative emissions and carbon removal and therefore may conceptualize carbon removal and climate change differently than participants. This was mitigated by explicit definitions of the terms used in the codebook. Further, we wrote the survey questions with our broader research questions in mind. As such, we were looking for particular things when developing our codebook. Because the open-ended responses were short-answer and because we intentionally did not provide participants with a definition of negative emissions in order to fully assess their understanding of the term, there were occasional instances where we struggled to interpret the meaning of the participant's answer. In these instances, the responses were flagged for further evaluation or thrown out entirely in order to ensure that the results reflected what we were trying to capture with the codebook.

An additional concern regarding the integrity of the open-response data arose during the development of the second codebook, as was referenced in the methods section of this paper. Upon coding some responses as *off topic* in the open-ended question on current reporting, we wanted to ensure that we could accurately capture the meaning of the responses to the second open-ended question about interest in future reporting on negative emissions. Our resolution to this problem, as described in the methods section, resulted in dropping some responses from the analysis and marking others in order to ensure no assumptions were made about how respondents would characterize a NETs story. While it is always challenging to remove data from a study, we felt this was necessary to most accurately portray the nuances of environmental journalists' interest in reporting on NETs. Given these challenges, a larger sample size would have been beneficial. Additionally, a future study may consider conducting an in-depth qualitative study on

journalists' interest in reporting on NETs so the researcher can be present to clarify any questions or concerns the participant has about what is being asked of them.

Another limitation to consider is that the survey was specific to members of the Society of Environmental Journalists, and therefore the results of this study cannot be generalized to the broader population of journalists in the United States. Future studies should use a larger, more diverse sample of journalists in order to produce results that are more generalizable. Additionally, the descriptive analysis portion of study looked only at the percentages of interest in reporting on different climate change solutions topics. While this is useful to begin understanding levels of interest in climate change solution stories, future research should seek to expand on this portion of the study and use more in-depth quantitative and qualitative methods to do so.

## Conclusion

Climate change is impacting the world now and will continue to do so in the future if action is not taken. This is a global issue requiring global solutions. Implementing solutions with the highest potential is nothing short of necessary, and journalists will continue to play a key role in this process by reporting on these solutions. Our study indicates that, at present, this is being done to a degree. However, there is always room for improvement and growth of climate change solutions reporting. In particular, augmenting journalists' reporting of negative emissions technologies and pairing it with increased reporting on the solutions that are known to be most effective is a crucial path forward in our fight against climate change. It is our hope that the findings of this study can help guide journalists, news managers, researchers, and practitioners work together to broaden the scope of climate change solutions that are visible in the public eye.

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# Appendix I

**Table 1**

*Age*

| | N | Valid % |
|---|---|---|
| 18-29 years | 109 | 29.6 |
| 30-44 years | 151 | 41.0 |
| 45-59 years | 101 | 27.5 |
| 60+ years | 7 | 1.9 |

*Note.* $N = 592$.

**Table 2**

*Race*

| | N | Valid % |
|---|---|---|
| Non-White | 44 | 9.2 |
| White | 432 | 90.8 |

*Note.* $N = 592$.

**Table 3**

*Gender*

| | N | Valid % |
|---|---|---|
| Male | 206 | 41.8 |
| Female | 274 | 55.6 |
| Not Applicable | 13 | 2.6 |

*Note.* $N = 592$.

**Table 4**

*Primary Medium*

| | N | Valid % |
|---|---|---|
| Radio Broadcast | 26 | 8.6 |
| Television Broadcast | 14 | 4.6 |
| Newspaper [Print] | 52 | 17.2 |
| Newspaper [Online] | 52 | 17.2 |
| Magazine [Print] | 45 | 14.9 |
| Magazine [Online] | 58 | 19.2 |
| Solely Digital Publication | 32 | 10.6 |
| Digital/Social/Online [Affiliated with a Radio or TV Station or Group] | 11 | 3.6 |
| Podcast | 7 | 2.3 |
| Social Media (please specify) | 5 | 1.7 |

*Note.* $N = 592$.

**Table 5**

*Position*

| | N | Valid % |
|---|---|---|
| General Reporter (salaried) | 45 | 9.2 |
| Beat Reporter (salaried) | 108 | 22.0 |
| News Director (salaried) | 23 | 4.7 |
| Producer (salaried) | 12 | 2.4 |
| Freelance | 213 | 43.3 |
| Management (in a news organization) | 50 | 10.2 |
| Salaried elsewhere (i.e., not a news organization) | 19 | 3.9 |
| Student | 4 | 0.8 |
| Retired | 16 | 3.3 |
| Unemployed | 2 | 0.4 |

*Note.* $N = 592$.

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