KNIGHT SCIENCE JOURNALISM MIT

The State of Fact-Checking in Science Journalism

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1. EXECUTIVE SUMMARY

Journalism and science are both matters of fact. Journalists and scientists should follow rigorous methods and understand nuanced, complex information to reach their common goals: uncovering truths about the world and communicating these truths to others. This is doubly true for science journalists, who are tasked not only with delivering relevant stories to readers, but also decoding and translating dense, jargon-filled research.

As such, science journalists — like all journalists — should have formal processes in place to make sure their stories are accurate. One way to do this is editorial fact-checking, which we define as the process of verifying factual assertions in nonfiction writing. This includes, but is not limited to, double-checking basic facts, statistics, quotes, analogies, images, and descriptions. Editorial fact-checking is in-house quality control: it happens before a story publishes, and the work is done by the publication. While editorial fact-checking shares some features with political fact-checking, the terms aren't interchangeable. Political fact-checking is a watchdog endeavor that confirms public statements or publications —particularly those made by politicians or others in power. This report focuses on editorial fact-checking.

In the ideal case, the editorial fact-checker plays a separate role from the journalist or editor, although their methods and responsibilities may overlap. In other words, the fact-checker shouldn't be part of the team that pulled together the original story. The journalist and editor will have spent weeks or even months on a story and may be too close to the narrative, or have a skewed view of the quality or trustworthiness of a particular source. An outside eye will help bring some objectivity to the process.

In this report, we are using the definition of objectivity from "The Elements of Journalism," which said of the origin of the term in the industry: "Objectivity was not meant to suggest that journalists were without bias. To the contrary, precisely because journalists could never be objective, their methods had to be. In the recognition that everyone is biased, in other words, the news, like science, should flow from a process for reporting that is defensible, rigorous, and transparent — and this process is even more critical in a networked age."[1]

The fact-checker adds to this rigorous process, combing through a story or script line-by-line to check each fact against the source materials. In some cases, this may include re-interviewing people who appear in the story or digging up new sources. A formal fact check may be laborious and expensive. It has a long history of use at print magazines, although it is increasingly found at other outlets that produce long, complex stories, including digital magazines and longform podcasts. It can be a little painful — especially for the journalist whose work is under scrutiny. As Camille Carlisle, science editor at Sky & Telescope, tells her writers: "Think of it like a deep tissue massage — it'll hurt now, but it'll be great later."

Newspapers, digital news, and blogs usually follow a different system of verification. It isn't practical to spend time on a magazine-style fact check for breaking news or other fast-paced

stories. In these cases, the journalist is responsible for the facts. Still, these stories should go through layers of experienced editors, who challenge iffy claims or storylines and, when necessary, send the journalist to do more reporting. The traditional newspaper model also has copy editors, who do abbreviated fact checks on each story before publication, which may include checking basic facts such as spelling, statistics, and geographical details against written source materials.

However it's done, double-checking the facts before publication is vital. But, anecdotally, support for fact-checking has waned for years. Staff fact-checker jobs have shifted to freelance or disappeared entirely; legacy print publications don't always apply the same fact check requirements to their digital endeavors; fewer editors may read each story before it goes to print; and newspapers, including major publications such as The New York Times, have cut their copy desks.[2]

George Johnson, a science journalist and author who has been in the business for more than 35 years, compares the older editorial and fact-checking process to a series of nets. "It's always better to have as many extra layers as you can. If something slips through the first net it gets caught in the second or third or fourth." But now, he adds, "it's collapsed to one or two nets."

Despite these troubling hints, there has been little research on fact-checking in science journalism. Who fact checks? How? How many outlets have staff fact-checkers? Do outlets provide explicit training sessions and guidelines for journalists and fact-checkers? Are there formal expectations across the industry, or are most people just winging it? Do journalism programs — particularly those specializing in science — train their students to fact check? If so, what does that look like? And what resources might make fact-checking more robust?

This report attempts to answer these questions and more. Among the key findings:

— 34 percent of outlets assign fact-checking work to designated fact-checkers, 15 percent to copy editors, and the rest to a combination of the journalists and editors.

— Digital publications are slightly more likely to do a formal fact check than print publications (68 percent for digital and 66 percent for print).

— In both print and digital, publications often put more intensive fact-checking resources into long features compared to shorter news pieces.

— Around half of outlets do not fact check aggregated content.

— More than two-thirds of outlets with dedicated fact-checkers provide guidelines for their journalists on preparing for a fact check.

— Most outlets that hire independent fact-checkers do not provide specific training or guidelines on how to fact check.

— There is no clear consensus on sharing unpublished manuscripts or quotes with sources. Some outlets ban the practice, while others allow it.

— Fact-checking pay rates vary wildly. The average is between $27.76 and $34.27 per hour.

— Most fact-checkers do not have a science degree (87 percent).

These findings are based on extensive research, including 91 interviews and 301 survey responses from editors at outlets, journalists, fact-checkers, and professors or directors from journalism programs (for a breakdown of these numbers, see "Methods," below). We also collected data that could be used for a later, more detailed analysis, and have noted opportunities for this where appropriate. The responses in the surveys are each individual's view, and don't necessarily reflect the views or policies of the publications or programs as a whole. In fact, while most in the industry agree that fact-checking is vital to science journalism, there are real differences in opinion on what fact-checking is and how it should function.

Based on our findings, we recommend that outlets provide more robust guidelines for fact-checking, as well as processes for tracking corrections after publication. We also recommend more opportunities for training for both staff and freelance fact-checkers, editors, and journalists.

2. INTRODUCTION

The phrase "now more than ever" isn't new. It's popped up in literature from Keats to Cervantes, nineteenth-century political speeches from the Whigs, the lyrics of Robert Palmer, and the 1972 campaign slogan for Richard Nixon.[3] But ever since November 2016, the political climate in the United States has made the phrase particularly cliché, as it's regularly used to promote any number of causes — including journalism.[4]

It's tempting to apply the earnest rallying cry to the need for our report: Now more than ever, we need fact-checking in science journalism. After all, as of this writing, both science and journalism are in the political crosshairs. A scathing 2017 report from the Union of Concerned Scientists, which laid out how the Trump administration eroded scientific integrity at the federal level after just six months in power, stated: "Emerging patterns reveal tactics to diminish the crucial role of science in our democracy."[5] And the current White House regularly lobs threats to the press and calls verified journalism "fake news."[6]

But accuracy has always been important to science journalism. As Nsikan Akpan, science producer for PBS NewHour, put it: "Facts are our lifeblood." The current political climate, then, is just one of many reasons to examine fact-checking in the industry.

Other forces have, for years, eroded attention-to-detail and accuracy. To name several: The 24-hour news cycle — first on television and now online — has shifted from straight news to infotainment.[7] The internet has forced media to reinvent business models again and again, often incentivizing volume over quality, and journalists and outlets haven't always adapted well.[8] Algorithms on social media and in search engines have changed how and when readers see stories — and more recently, people who want to spread misinformation have exploited the algorithms for political and financial gain.[9] While some companies and academics suggest artificial intelligence fact-checking tools may help curb digital misinformation, the tech isn't yet savvy enough to make a difference.[10]

Meanwhile, there is no codified industry standard for fact-checking. While the basic principles remain the same from one publication to the next, the details vary in important ways.[11] For example, some outlets allow fact-checkers to read quotes verbatim to sources; at other outlets, this could get you fired. Some outlets prefer that fact-checkers use sources provided by the journalist, while others like their checkers to do original reporting. And so on. As for training, some outlets provide it; others just assume the checkers know what they're doing. And while journalism schools give a general ethical framework regarding accuracy and verification, they don't always lay out the specific process of fact-checking.

Between the lack of standards, the shift from print to digital, and funding woes, it's not surprising that we haven't formally explored the details of editorial fact-checking. But it's worth digging in. Now more than ever — er, okay, maybe not. How about: if not now, then when?

In the following report we assess the state of fact-checking in science journalism, although we hope our findings will also help guide other journalism specialties.

3. DEFINITIONS

3.1 Science journalism

Science journalism can be a nebulous term. For this project we define it broadly to include science, health, environment, energy, and general writing that touches on any of these topics in some way. In general, we did not include traditional tech journalism in the definition, since tech writing often falls under the rubric of business, rather than science. Caveat: Tech journalism that dives into, say, how artificial intelligence works, or the social or psychological effects of technology, would fall under our definition of science journalism.

3.2 Fact-checking

In this paper when we say fact-checking we mean editorial fact-checking unless otherwise noted. Editorial fact-checking is in-house quality control: it happens before a story publishes, and the work is done by the publication. This differs from political fact-checking, a watchdog endeavor that checks information after it has already published (or, in many cases, gone public

through a political speech or debate). Examples of groups that do political fact-checking include PolitiFact, FactCheck.org, and Snopes.

3.3 The magazine model

In the magazine model the fact-checker is not part of the team that does the original reporting or shaping for a story — the fact-checker is not the journalist, reporter, producer or editor. The fact-checker is usually also a different role from the copy editor; the latter is more concerned with style, grammar, and some light fact-checking, which includes spelling, names, titles, and dates. The fact-checker will go through every story line-by-line and check each claim against the journalist's source material. In some cases, the fact-checker may re-interview sources or find new sources to help double-check claims.

The magazine model may be found at print magazines, digital publications that publish long features, and longform podcasts.

3.4 The newspaper model

The newspaper model does not employ fact-checkers, per se. Instead, the accuracy of the story lies mostly with the journalist. Many newspaper journalists have their own systems for double-checking facts in their stories that may be similar to the magazine model — for example, checking the piece line-by-line and cross-referencing to original sources.

In the newspaper model all stories also go through editors, who push back on iffy claims and look for other holes in sourcing or logic. Rather than going line-by-line and checking all the facts, the editor is looking for potential problems. Finally, the story will go through the copy desk, where copy editors will check for style and grammar. At some publications, copy editors do an abbreviated fact check, confirming facts against written sources, although they don't typically re-interview people who appear in the story. The newspaper model may be found at newspapers, digital publications that publish blogs or short news pieces, and daily radio or television news shows.

4. METHODS

We identified four groups that may have knowledge — and different perspectives — about fact-checking in science journalism: editors at outlets that cover science, journalists, fact-checkers, and directors or professors at journalism programs. Of course, there is overlap among these groups; for the purposes of this report, we made clear distinctions for the ease of reporting and writing. We sought editors for their perspective on outlet policies and processes; journalists on the writer's perspective (both staff and freelance); fact-checkers for the view from the ground; and journalism schools for a sense of how new journalists receive fact-checking training and instruction. We collected data from each group through surveys and interviews. In total, we received 301 survey responses and conducted 91 interviews.

4.1 Surveys

We designed four surveys, one for each group (Appendix 1), and distributed through the survey management website SurveyMonkey.

4.1.a Testing and distributing

We tested the surveys internally using the SurveyMonkey preview tool.
For distribution, we used two approaches — one for outlets and journalism programs, and the other for journalists and fact-checkers. For the outlets and programs we complied master contact lists: 247 for outlets (Appendix 2) and 45 for programs (Appendix 3), and sent the survey by email. We did this because we only wanted one trackable and attributable response from each organization. It was beyond our resources to create a similar list of journalists and fact-checkers; we distributed these surveys through social media and personal networks.

4.1.b Compiling the master outlet list

We aimed for science magazines in print or online, science podcasts or radio programs, documentaries or other broadcast media programs, as well as general news outlets and daily newspapers that regularly publish science, health or environmental news. The outlets focused mainly on those based in the U.S., although 45 English-language media outlets from around the world were also included for comparison.

To make the list, we referenced AllYouCanRead.com's database of magazines and newspapers, Australian Science Writers' list of "Publications and outlets," Barnes & Noble's "Science & Nature magazines," Wikipedia's "List of science magazines," and various private lists provided by colleagues.

U.S.-based daily newspapers included in the outlet list were limited to the top 20 across Agility PR Solutions' and Cision's lists of top U.S. newspapers by circulation in 2017.

We included major English-language dailies from a few African, Asian, and European countries (for example, *The Express Tribune*, *Premium Times*, *South China Morning Post*, *The Guardian*). But we did not include wire services and outlets that rely heavily on these services for their science and health news (for example, *Associated Press (AP)*, *Agence France-Presse (AFP)*, *AllAfrica*, *HealthDay*, *Reuters*, *ABC News*, *CBS News*, *MSNBC*, *NBC News*, and *Yahoo News*).

We included general interest magazines in cases where they had regular science, health or environmental news coverage, or in cases where they had a dedicated science, health, or environment editor (for example, *Cosmopolitan*, *Family Circle*, *Men's Health*, *Men's Journal*, *Prevention*, *Women's Health*). But food magazines, hobbyist magazines,

hunting and fishing magazines, and wildlife conservation magazines were not included because these publications did not have a science vertical or focus (for example, *Field & Stream*, *Nuts & Volts*, *Saveur*).

We left out outlets affiliated with science societies, and institutes that could not be identified as editorially independent from their "About" pages or media kits (for example, *Natural History Magazine*, *APS news*, *Archaeology Magazine*, *Canadian Geographic*, *Earth Magazine*, *Eos*, *EuroScientist*, *Living Bird Magazine*, *MRS Bulletin*, *Proto Magazine*, *TCTMD*).

Outlets that had not updated online content in the past year were considered defunct and left off the list. (For example, *BBC Knowledge*, *Guru* Magazine).

Some outlets were listed under one umbrella company because they were run by the same editorial team. (For example, *Click, Ask, Muse* and *Dig Into History* were combined under the *Cricket Media* title). Other outlets were listed separately where it was clear that they were run by separate editorial teams and may have distinct fact-checking policies. (For example, *PBS Nature*, *PBS NewsHour*, *PBS NOVA*, and *PBS NOVA Next*, *Smithsonian* magazine and *Smithsonianmag.com*, *Vice* and *Vice News Tonight*). Further international outlets were included in the list based on recommendations from colleagues.

We found contact information for outlets based on the masthead and publicly available information. In most cases, the contact person was the science editor. In cases where there was no discernable science editor, we used one of the following: Editor-in-chief, managing editor, editorial director, executive editor, deputy editor, senior news editor, or research editor. To contact these editors, we found email address from the outlet websites, the editors' individual social media pages, personal interaction with the editors, or a web-based tool called RocketReach.

4.1.c Compiling the master program list

We prepared a list of graduate programs and fellowships in the U.S. that teach science, health or environmental journalism by referring to the Knight Science Journalism program's "Resources" site, the Society for Environmental Journalists' "Education" site, and recommendations from colleagues.

We then listed the program director's contact information for each graduate program based on information available on the program's website. We also included 16 undergraduate journalism programs in the U.S. in our list, based on USA Today's top 10 list from 2016 as well as the following: Northeastern University, Arizona State University, California State University, Northridge, Colorado State University, Cornell University, University of Illinois at Urbana-Champaign, Lehigh University, Marquette University, University of Nebraska-Lincoln, and Point Park University. Since most

undergraduate journalism programs did not have a specific science journalism track, we sent the fact-checking survey to the journalism school's dean, a faculty advisor, or a program coordinator.

4.1.d Monitoring

We monitored the surveys for responses throughout the length of the project. We tracked the responses on SurveyMonkey and created a collective GoogleDoc spreadsheet, which included who had responded, and we updated the spreadsheet at least twice a week for all four surveys. We sent reminders to respondents for the media outlets and journalism programs, some of which included direct links to the survey.

4.1.e Data collection and analysis

SurveyMonkey compiled the data generated for each survey. We downloaded the datasets for each survey in a .csv file and analyzed them using Microsoft Excel. Each survey collected data that represented a different part of the article writing and publishing process, so the data generated by each survey are not directly comparable.

We made graphs and sorted the data to analyze trends in statistically significant datasets. We analyzed only complete responses. This included 81 complete responses to the media outlets survey, 165 complete responses to the journalist survey, 35 complete responses to the fact-checker survey, and 22 complete responses to the journalism programs survey.

In certain surveys, respondents had the option of specifying "other" and then writing in an answer or description if they felt the provided categories were insufficient answers for the question asked. If respondents wrote in an option that was already encompassed by an existing answer choice, we redistributed the data to the appropriate category for analysis.

4.2 Interviews

We interviewed a subset of people from each of the four categories. Most interviewees also took the survey, but some opted to only do an interview. Some of the interviewees went off-the-record or on background.

We concentrated our interviews on outlets because when it comes to editorial standards — including fact-checking — they are the gatekeepers. We interviewed both freelance and staff journalists and fact-checkers in order to get their perspective on fact-checking, and to compare and contrast it to what the outlets said. And we interviewed people from the journalism programs in order to get a deeper sense of how they train new journalists.

5. RESULTS

5.1 Outlets

5.1.a Who fact checks?

We received 81 survey responses from editors at 79 outlets, and only included one survey from each outlet for the final tallies (survey respondents are bolded in Appendix 2). Respondents included editors from many levels of the publications, including but not limited to: Editor-in-chief, assistant managing editor, copy chief, research editor, senior editor, and associate editor. We conducted 52 interviews. The responses in the surveys and interviews are from representatives of the science sections and don't necessarily reflect the views or policies of the publications as a whole.

More than half of the respondents estimated that their science coverage makes up between 50 and 75 percent or more of their overall output (Figure 1). Most of the outlets are funded through advertising (30 percent), support from grants/endowments/foundations (23 percent), and subscriptions (22 percent) (Figure 2).

Figure 1: Percent science coverage

- >76 percent
- 1-15 percent
- 16-25 percent
- 26-50 percent
- 50-75 percent
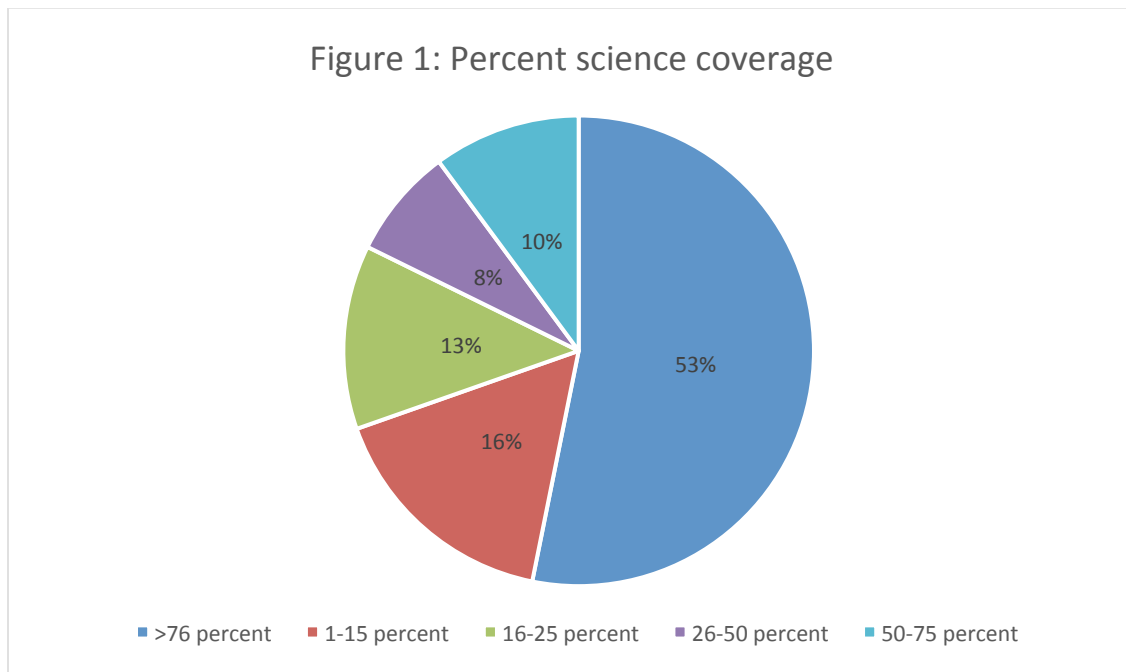
Figure 2: Funding sources

- Advertisements — 30%
- Subscriptions — 22%
- Organization Membership — 11%
- Grants/Endowment/Foundation-Based — 23%
- Other — 14%
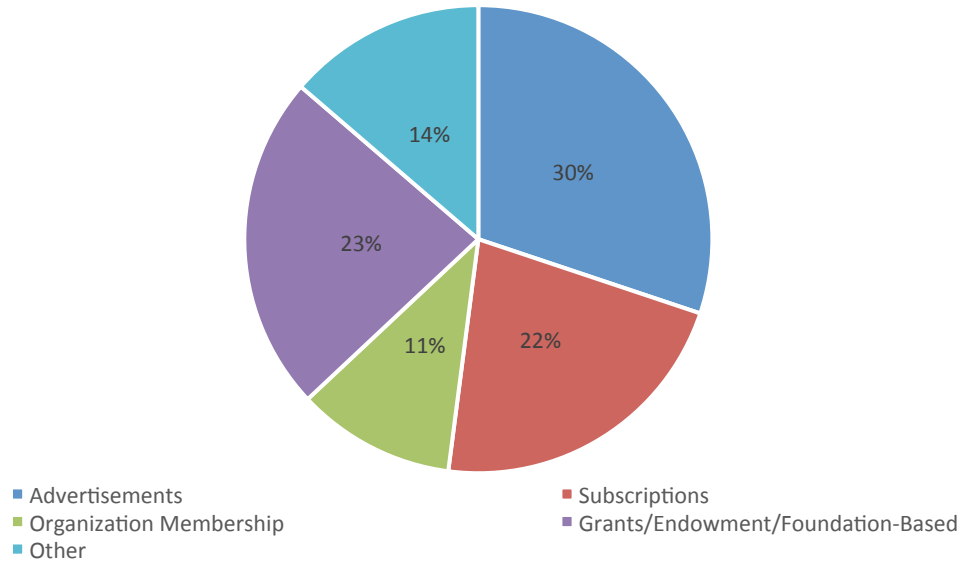
Fact-checking responsibilities fall to different people depending on the outlet, but only 34 percent give the work to fact-checkers specifically and only 15 percent to copy editors. Roughly half of outlets leave fact-checking to journalists, editors, or a combination (Figure 3). Circulation may play a role: In general, we found that outlets with large circulations or readerships/listeners put fact-checking on the writer.

Figure 3: Who is responsible for fact-checking?

- A combination of authors and editors — 9%
- Copy Editors — 15%
- Editors — 18%
- Fact-Checkers/Researchers — 34%
- Other — 4%
- Authors — 20%
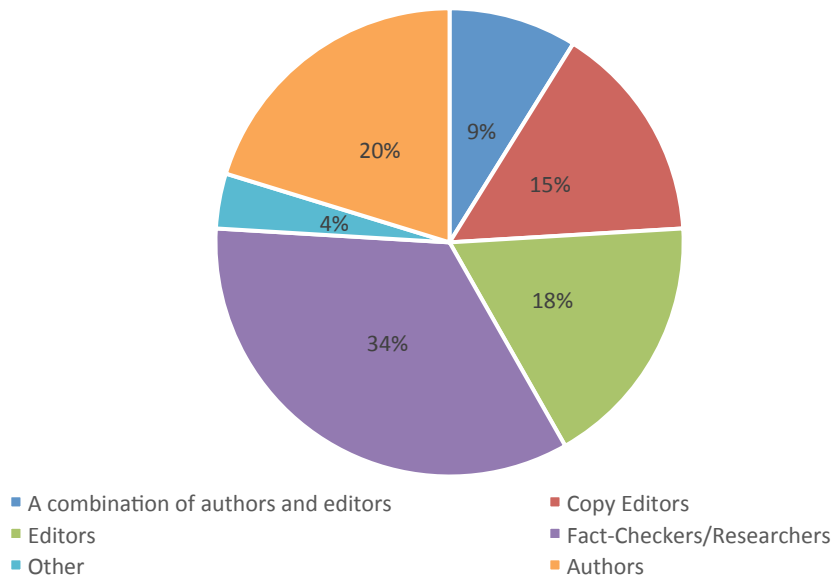
Our interviews showed a more nuanced distribution of fact-checking across science media, and particularly for digital publications. Individual editors reported that several outlets primarily use the magazine model, including Audubon's print magazine, Bay Nature's print magazine, bioGraphic, Consumer Reports' print magazine (as well as its newsletter and video scripts), Discover Magazine, Mosaic, Pacific Standard's print magazine, Popular Science's print magazine (aside from the product section, which follows the newspaper model), the print version of Sierra, the Smithsonian's print magazine, WIRED's print magazine, and scripts at the podcasts Radiolab and Science Vs.

Others primarily follow the newspaper model, although some are more rigorous than others. These include Ars Technica, Sky at Night Magazine, Chemical & Engineering News, Environmental Health Science publications The Daily Climate and Environmental Health News, Gizmodo, Nature Medicine, Newsweek (both print and online), NOVA Next, PBS NewsHour, Quartz, Retraction Watch, Science, Science News for Students, Vox (except features), and the Washington Post, as well as digital-only stories from Sierra, and Smithsonian. Many editors using the newspaper model described their approach as a "sniff test" or "gut check," where they would only fact check material if it didn't sound accurate based on their previous experience. Additionally, copy editors may do a light fact check and sometimes lawyers will vet a story.

The range of editorial oversight at publications that practice the newspaper model varies. Some have just one editor review each story before publication, and the quality varies from one editor to another — even in the same publication. In one interview, an editor mentioned that they fact check their section, but others do not, and it's noticeable: "Some articles that come out — I really cringe because I can tell they haven't been fact-checked." (This portion of the interview was anonymized, per the editor's request.)

Our surveys didn't capture a third approach, which we call the hybrid model. Here, the same outlet follows the newspaper model — often including an abbreviated fact check from a copy editor — for shorter items and the magazine model for more complex or legally-sensitive features. Outlets on the hybrid model include Hakai Magaine, JSTOR Daily, Mic, NPR (reserving more intense fact-checking for enterprise stories or longform podcasts), Quanta Magazine, SAPIENS, Spectrum, Undark (which also takes into account writer experience and if they've worked with the writer in the past), and Yale e360, as well as digital-only stories from Audubon, Pacific Standard, and WIRED.com.

Other outlets don't fall neatly into any of the above categories. FiveThirtyEight is on the newspaper model and has copy editors who do an abbreviated fact check, but the outlet also, uniquely, has a quantitative editor who works on an as-needed basis to double-check research findings and work with large datasets. The Last Word on Nothing is a collective of professional writers, and there isn't a strict set of editorial rules (although Ann Finkbeiner of LWON points out that all the writers are responsible for getting their facts right). Other outlets don't have dedicated fact-checkers, but say their editors do

line-by-line fact checks, including The Christian Science Monitor and Sky & Telescope (for features). Others, such as Aeon, are primarily written by experts; here, staff fact-checkers will do an abbreviated fact check.

Nearly all survey respondents and interviewees said that fact-checking is necessary for quality science journalism. But several added that they don't think it is necessary to follow the magazine model — a well-trained journalist and editorial staff, they said, should be able to get the facts right on their own.

Fans of the magazine model pointed out how often fact-checkers catch mistakes even from writers with years of experience. Pamela Weintraub, the psychology, neuroscience, and medical editor at Aeon, said that the classic magazine model achieves "a certain level of excellence" because of the extra eyes and perspectives — the writer, editor, top editor, copy editor, and fact-checker each bring a different point of view. "Every time you take one of those layers away," she added, "any time you take the process and make it sloppier and crush it down and make it a shorthand of itself — you're taking away from the overall excellence."

5.1.b Digital versus print

While it's tempting to suggest that formal fact-checking is more common to print media than digital media, our results suggest: it's complicated. Of the outlets in our survey, 66 percent of print publications and 68 percent of digital publications said they have formal fact-checking. Our interviews suggest that the divide is not so much between print and digital, but news and longform.

Still, the internet has certainly changed the perception of fact-checking, in part because "in the digital world, there's the idea that you can just update it quickly," said Tim De Chant, senior digital editor at NOVA and NOVA Next. "Fact-checking happens not in real time necessarily, but it can happen after publication. Whereas when we put something out on broadcast or print a magazine, that's kind of set in stone by comparison, and making changes after that point is extraordinarily expensive."

Even though editors would want to remove mistakes from all records, including printed ones, De Chant added, when it comes to digital corrections, "when you think about it from an archival issue, it's fixed."

Two other digital editors mentioned cultivating their comments section as a source for fact-checking. Rose Pastore, the science editor at Gizmodo, said commenters often get a shout-out in an editor's note if they — correctly — point out an error. And John Timmer, science editor at Ars Technica, said that his site's readers are often very knowledgeable about science and will catch mistakes or add nuance to a story that the reporter wasn't able to include in the original piece, although he also warned: "If you do not moderate your comments, they will turn into a cesspool."

But readers won't necessarily see every correction or read the comments. The idea that digital doesn't need to be fact-checked because it's easy to correct is "one of my great concerns," said Charles Whitaker, interim dean of Northwestern University's Medill School of Journalism, Media, Integrated Marketing Communications. "Digital really is permanent — if someone captures that screenshot, it's permanent. It's just there forever. Print is actually far more ephemeral when you think about it — that's lining the birdcage."

5.1.c Time and money

In our interviews, the most common reason for limiting or foregoing fact-checking was funding. While having extra sets of eyes on a story can help catch errors, "eyeballs cost money," said Roxanne Khamsi, the chief news editor at Nature Medicine. Other outlets, including The Daily Climate, Environmental Health News, and Retraction Watch, noted that even though they might eventually want to hire a fact-checker, the role would come after they found funding to hire other key positions.

Another common reason to limit formal fact-checking is time, particularly for digital publications and newspapers. But while this pressure is real, it isn't necessarily new. "The current economic drives in for-profit media creates competitiveness, and so it is built into your metabolism to be trigger happy with the publish button," said Tom Zeller Jr., editor-in-chief of Undark. "You just want to get it out there, to be first. And that's been true of newspapers too for a long time."

For these reasons, it makes sense that many publications are on the newspaper model or a hybrid model — particularly for news or blogs that are relatively easy to verify without the financial and time commitment required by a magazine-style fact check.

Other interviewees likened formal fact-checking to insurance — you don't always need it if the writers and editors are doing quality work. Still, letting it lapse can cause major problems, particularly for stories that may draw litigation. Despite that, some media companies want more proof that it'll help their bottom line. One editor, who asked for this quote to anonymous, described the experience of looking into hiring a full-time fact-checker: "Everybody on site agrees it would improve the quality of our material greatly. And the corporate attitude is simply: if we are going to give you money to hire someone new, we have to have a clearer indication of how it will make us more money. The difference made by incrementally-increased quality is hard to quantify and hard to justify financially."

5.1.d Aggregated content

According to our survey, 39 percent of outlets publish aggregated content (Figure 4). About half do not fact check this content, while an additional 19 percent only do an abbreviated fact check (Figure 5).

Figure 4: Does your outlet aggregate?

- ■ Yes ■ No

39%

61%

Figure 5: Fact-checking aggregated stories

30%

19%

51%

- ■ We fact-check everything in detail
- ■ We double check basic facts like names, dates, locations, etc.
- ■ We do not fact-check aggregated content
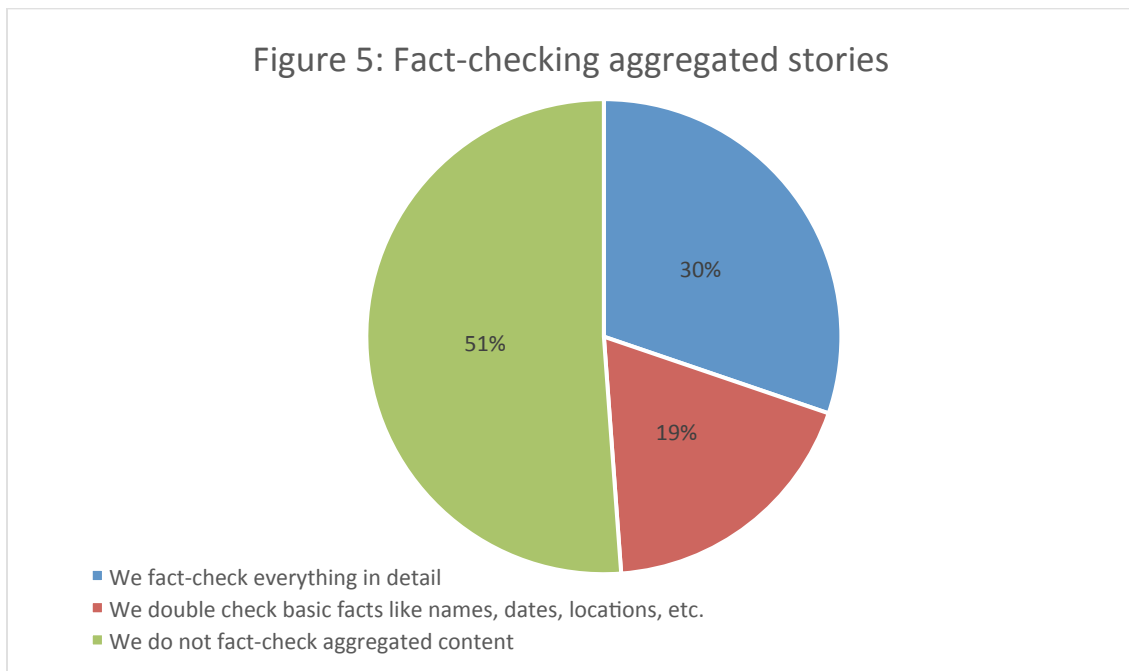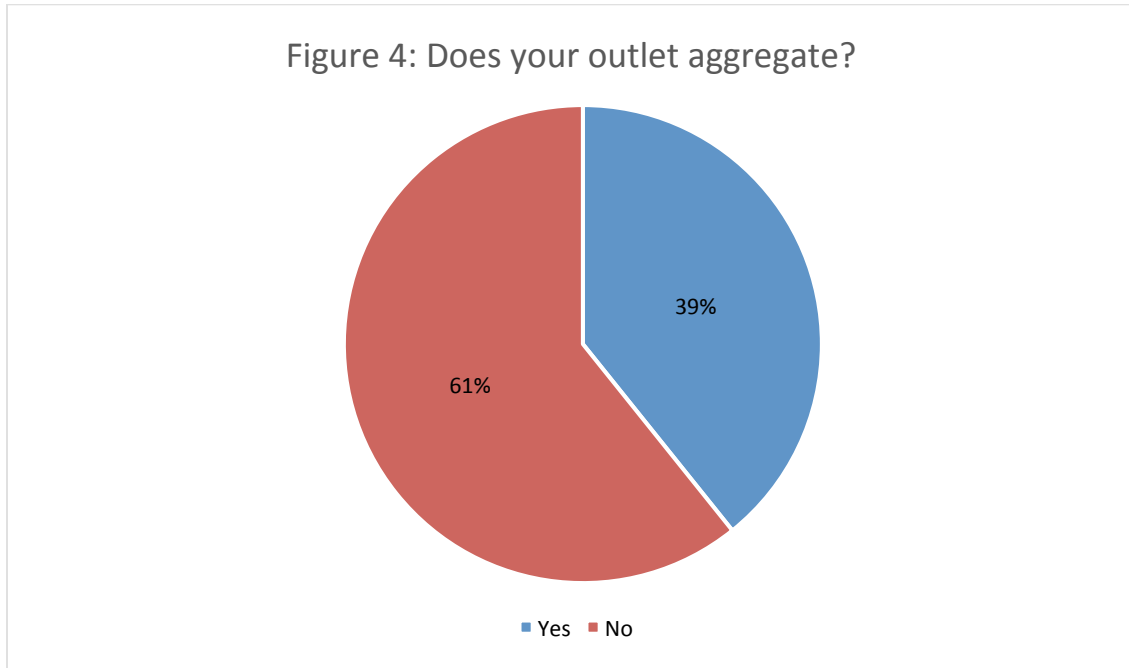
While aggregation is relatively popular, at least one publication in our interviews decided to forgo it entirely. The push for aggregated content — driven by the push for clicks — doesn't always pay off. "We yielded to the pressure to chase page views for a long time," said Noelle Swan, the science, technology, and environment editor at The Christian Science Monitor. "At a certain point we realized it was not working as well as we thought, and we were not as proud of the product we were putting out because we had diverged from the original mission of the paper." Since then, The Christian Science Monitor moved to a subscription model.

5.1.e Corrections

All outlets said they handle corrections in a similar way: By publishing a correction as quickly as possible. For print corrections, most said they run a note in the letters-to-the-editor pages in the next available issue. For digital corrections, most said they correct the error in the text of the story and add a note at the bottom describing the original error and the change. Particularly egregious errors may have a note at the top of the story. And for podcasts and online radio clips, it is common to update the audio and include a note on the website.

Most outlets do not run correction notes for a typo unless the typo introduces a factual error — including misspelled names. But editors at some outlets reported making minor corrections to minor errors like name misspellings or an incorrect date without a note. One outlet noted doing this for stories that have been live for only a short period of time (i.e., under an hour).

A few editors said they have internal processes to track corrections, including at Mic, Newsweek, and Vox, while others keep a public list, including NPR and Slate.

Still, it's possible corrections don't always happen as the outlets report, as there is no way to be sure without a full audit. One journalist in our interview recalled instances where their stories had factual errors and their editors made blind corrections — i.e., corrected the story without adding a note. And although there isn't much hard data on corrections, one 2007 study on 10 daily newspapers found that 97 percent of errors went uncorrected.[12]

5.1.f Guidelines for journalists and fact-checkers

More than two-thirds of the outlets with dedicated fact-checkers — i.e., someone other than the journalist or editor — provide guidelines for their writers on how to prepare stories and back-up materials for a fact check (Figure 6). At outlets without dedicated fact-checkers about a third provide such guidelines (Figure 7).

Figure 6: Do outlets with dedicated fact-checkers give written fact-checking guidelines to writers?

32%

68%

■ Yes ■ No
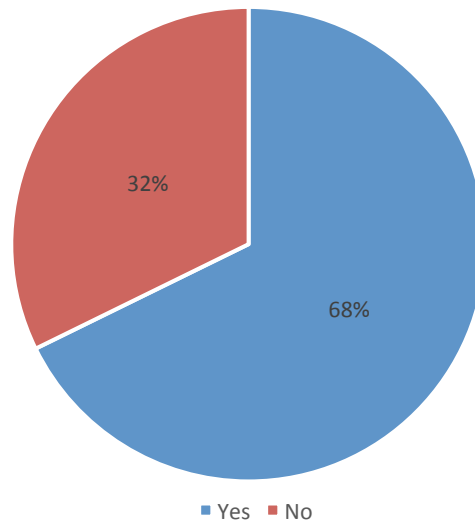
Figure 7: Do outlets without dedicated fact-checkers give written fact-checking guidelines to writers?

35%

65%

■ Yes ■ No
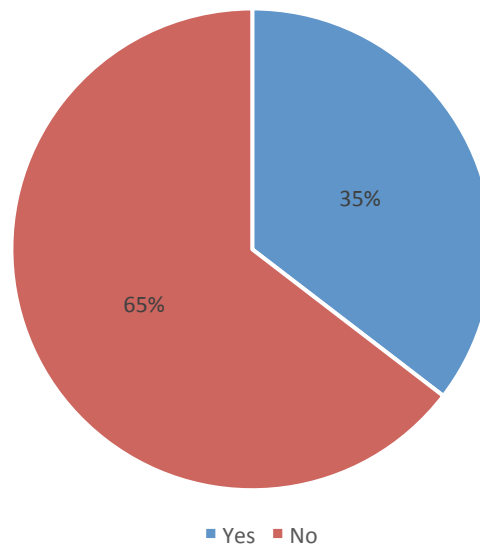
In all about half of the outlets communicate guidelines formally (35 percent in a document or email and 14 percent in the contract). Through our surveys, we received examples of fact-checking guidelines for writers and fact-checkers from 29 outlets. The details vary, but in general the guidelines lay out expectations on annotating stories for fact-checkers (i.e., marking which facts came from which sources) and providing primary sources and contacts as well as interview transcripts. Many of the guidelines also explain how to vet sources. At least two gave estimates on how many hours it should

take to check stories: bioGraphic suggested between eight and 12 hours, and Discover Magazine had targets for a range of story lengths, from three to four hours for a short 235-word item up to 25 hours for a 3,100-word feature.

In follow-up interviews, at least nine editors said that despite their fact-checking guidelines, the quality of preparation varies greatly from one journalist to another.

Interestingly, of the outlets that use fact-checkers, many do not provide written guidelines (Figure 8) or training (Figure 9). It isn't clear whether this is an oversight or the outlets generally hire experienced fact-checkers and assume the checkers don't need or want training. It's also possible that some outlets prefer not to have written guidelines for legal reasons. One editor, who asked to be anonymous, doesn't use guidelines in part because legal counsel suggested that if an outlet has written guidelines and then deviates from those guidelines, it could be more difficult to defend against a lawsuit.[13]

Figure 8: Do outlets provide guidelines for fact-checkers?

39%

61%

■ No ■ Yes
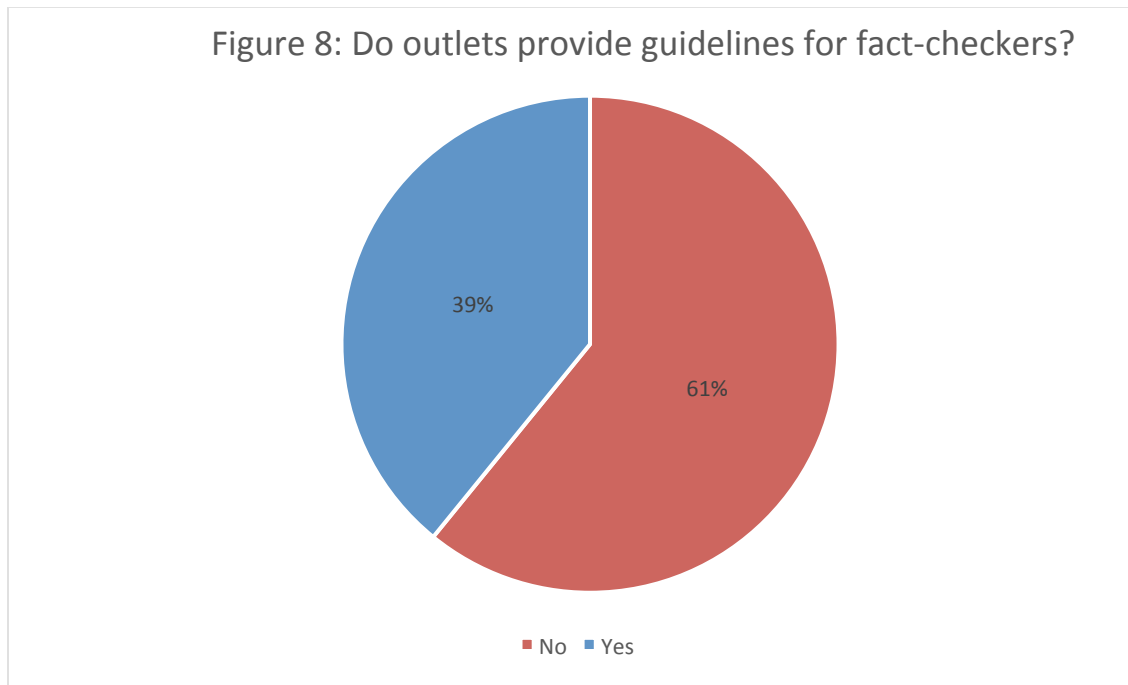
Figure 9: Do oulets train fact-checkers?

43% 57%

■ No ■ Yes
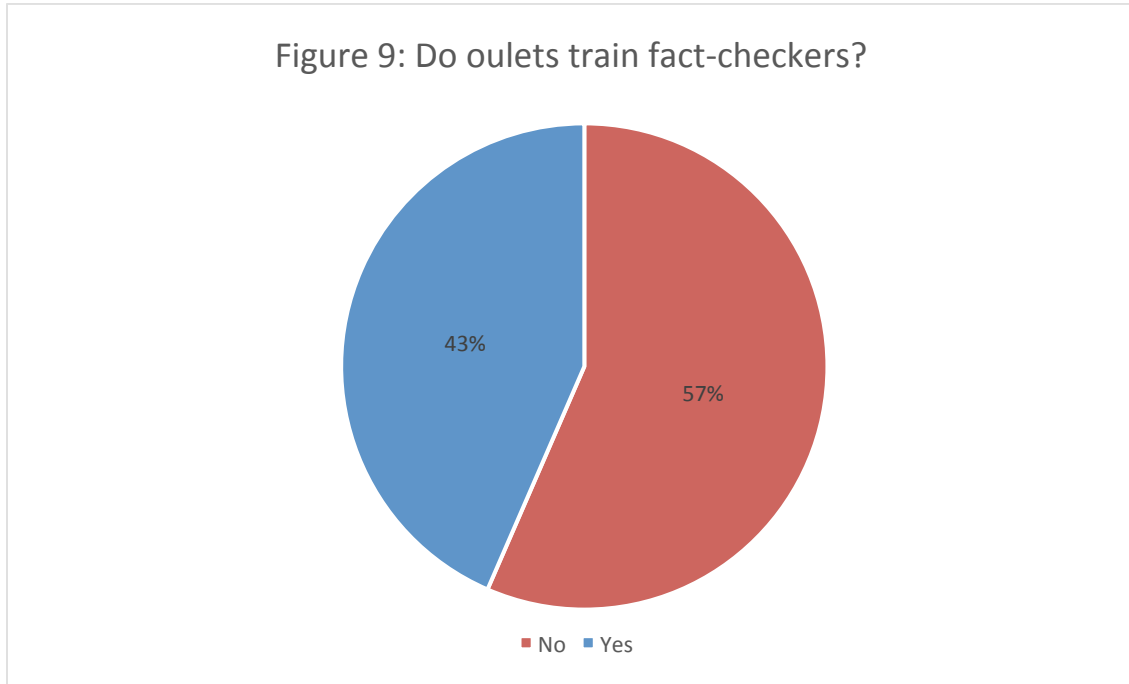
According to our interviews and surveys, at least two outlets provide checklists for their journalists, which the journalists are supposed to go through before they publish each story. This can help prepare for a fact check or, for publications on the newspaper model, this gives a more formal process to the journalist in checking their own work. At Newsweek, the checklists remind web writers to double-check basic facts including spelling, affiliations, dates, and geography. Quartz has a similar checklist for journalists reporting on a scientific study. The checklist runs through key points such as looking at the broader scientific literature on the same topic and understanding the statistics.

5.1.g Sharing unpublished materials with sources

From our interviews, 19 editors said they don't allow anyone to share unpublished materials — whether an entire story or a short excerpt — with sources during a fact check. These include editors at Aeon, Audubon, Bay Nature, bioGraphic, FiveThirtyEight, Mic, Nature Medicine, NPR (except when there are questions about the content or more caution is needed), Pacific Standard, PBS NewsHour, Popular Science, Quanta Magazine (other than Q&As that have been edited and condensed), Quartz, Science News for Students, Slate, Spectrum, Undark, and one other outlet that asked their interviews to be on background. Many were adamantly against the practice.

Two outlets said it wasn't forbidden, but discouraged: JSTOR Daily and SAPIENS. Four said they allow sources to review materials, including excerpts or entire stories, but noted that sources can only change facts and not style choices: Sky at Night Magazine, Sky & Telescope, Vox, and one that gave responses on background.

Others take a hybrid approach. These outlets don't typically allow sources to review full, unpublished manuscripts. But some allow for short excerpts or specific language, particularly for technical material, including The Christian Science Monitor, Discover Magazine, Ensia, Environmental Health Science publications The Daily Climate and Environmental Health News, Gizmodo, Hakai Magazine, Newsweek, NOVA Next, Science, Science Vs, Sierra, Smithsonian, the Washington Post, and Yale e360 (only allowed for writers), and one that gave responses on background. Mosaic only allows excerpts to go out if there is a legal issue with right-to-reply or on the advice of a lawyer. And at WIRED, fact-checkers may read from short sections of a story over the phone if context is necessary to confirm a fact or a summary will alter the overall meaning.

Some outlets share quotes, although they don't give permission to alter anything other than factual errors — for example, if the source misspoke. These outlets include Ars Technica, The Christian Science Monitor, Environmental Health Science publications The Daily Climate and Environmental Health News, Radiolab (scripts but not audio), Retraction Watch, Science Vs (scripts but not audio), the Washington Post, and one that gave responses on background.

Only about half of the editors said they give explicit instructions to their journalists or fact-checkers that outline the policies on sharing unpublished material with sources.

It's a hodgepodge of rules and opinions, to be sure. And the effects of the individual policies extend beyond individual outlets, said Corinne Iozzio, deputy editor at Popular Science, which has a strict policy against quote approval or sharing quotes. The inconsistency "creates tension with sources who have dealt with other publications and have been given quote approval," she said. "The concessions that other people make cost us quality in some instances, where we aren't able to talk to someone because of something that someone at another publication has done. It's like everyone else threw us on this slippery slope that we didn't even step onto."

5.1.h Finding, training, and paying fact-checkers

According to the outlet survey more than half (54 percent) of the people who fact check are staff (Figure 10).

Figure 10: Freelance or staff fact-checkers?

- Freelance 46%
- Staff 54%
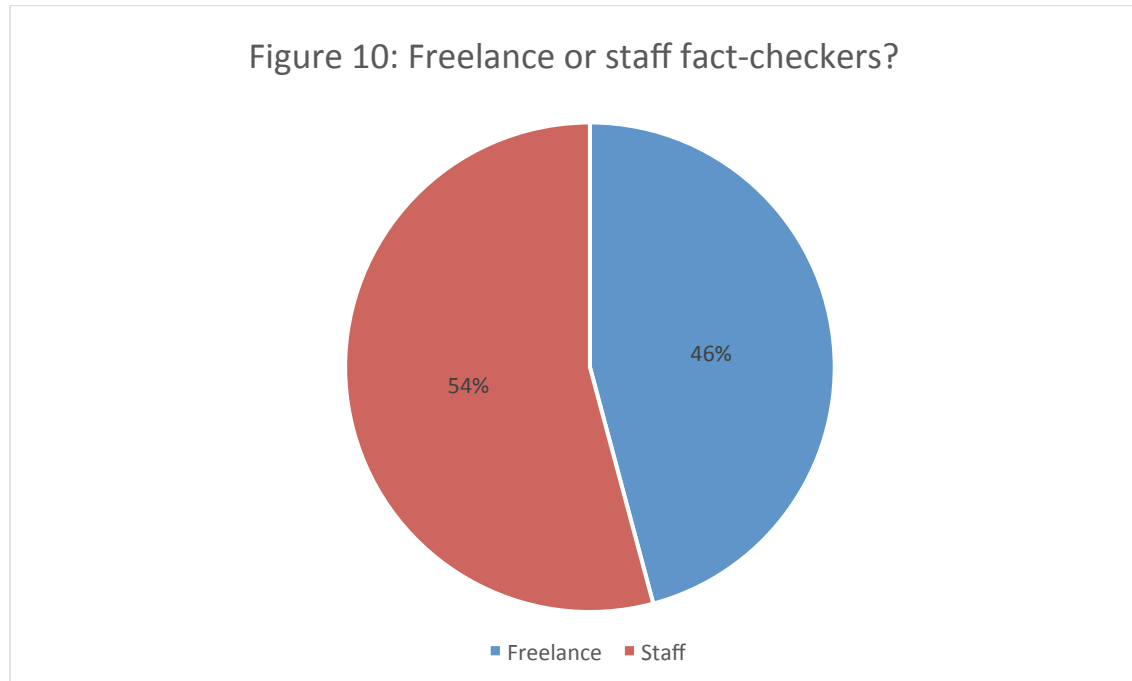
But our interviews and additional survey data suggest a more complicated picture. In our interviews, the majority of the outlets said their fact-checkers are freelance. And in another question in our survey that explored fact-checker employment, outlets included both fact-checkers and "staff or interns who take on fact-checking duties" in their staff versus freelance tallies.

From our interviews, it also appears that most freelance fact-checkers work remotely. While this may provide flexibility for the checkers, it can make the job more difficult, said Iozzio of Popular Science: "It's a harder job when you aren't there, just because of how much more communicative you have to be when you can't just walk over and talk to someone."

Most outlets say they find fact-checkers through personal networks or word-of-mouth. Many outlets also said they rely on the fact-checkers' existing expertise. These practices suggest that newcomers may find it difficult to land fact-checking gigs. While the interviews suggest that most outlets prefer to hire people with fact-checking experience, most do not require a science or science journalism background (Figure 11).

Figure 11: Are fact-checkers required to have a background in science and/or science journalism?

42%

58%

■ No ■ Yes
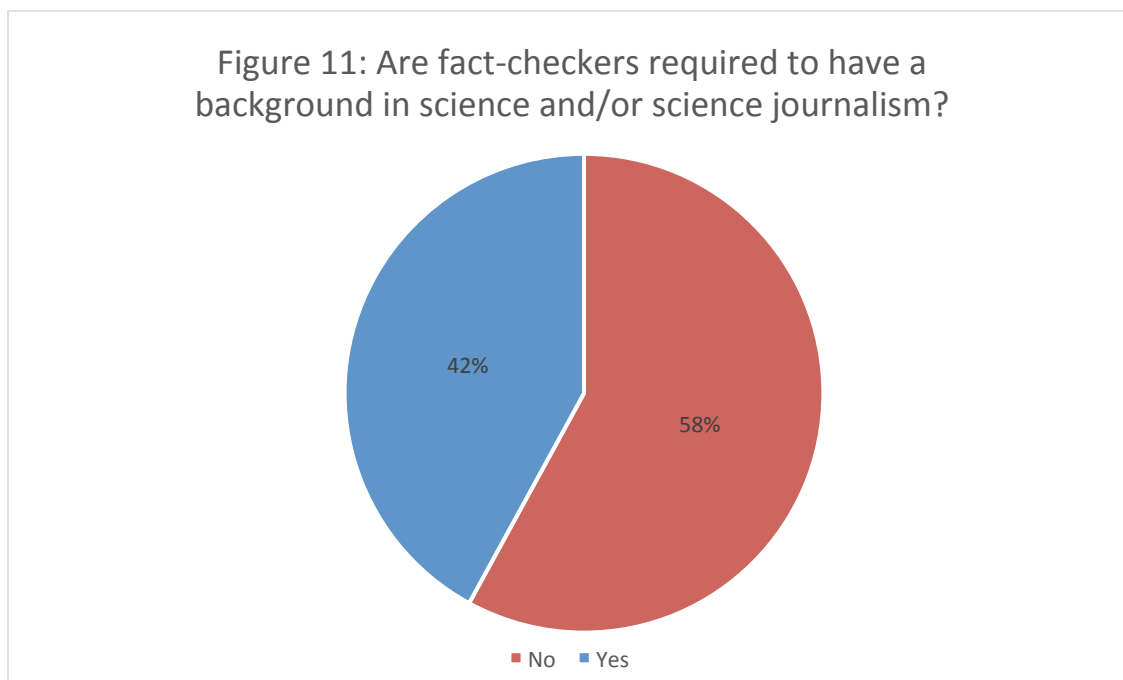
And then there's the pay, which, based on our follow-up interviews, is all over the place. Of the 16 editors who answered questions regarding pay, the rates range from $15 to $50 an hour. Some pay on a project-basis or regular monthly flat fees, which makes the hourly rate difficult to gauge. Of the hourly rates reported, the average was $27.76 and the median $27.20. Several outlets reported the highest rates go to fact-checkers with more experience or specific expertise. (For more on freelance rates, see the "Fact-checkers" section below.)

5.1.i The limits of fact-checking

Fact-checking isn't a panacea for producing quality journalism. It can help, certainly, but only if it's done well and made a respected and integral part of the process. Take, for example, *Rolling Stone*, which, like most national print magazines, has a fact-checking process.[14] Still, the fact check didn't save it from the infamous story "A Rape on Campus," which was ultimately retracted and cost the magazine millions of dollars in defamation lawsuits.[15]

In our interviews, some editors noted specific issues that can arise in fact-checking science journalism. For example, if fact-checkers only check a story against the sources a journalist provides, and don't dig deeper into the literature, they may miss mistakes or scientist bias. "It's so easy to find anything to support any conclusion," said Katie Palmer, a senior editor at WIRED. "I would hope for fact-checkers and writers to have a better sense of how to read a study, how to interpret how reliable a study is, how to search the rest of the scientific literature to understand if this is a single anomaly or a

reinforcement of decades of other research. Avoiding the 'here is my citation!' and just stopping there."

Ivan Oransky, co-founder of Retraction Watch, agreed. It is "not sufficient to just say 'we did the fact-checking, everything in this is all right,'" he said. A good fact-checker should dig in to find what's missing from a story, he added, but sometimes people in the industry give themselves "soft expectations, and we sort of say, well, we've done enough for now."

In our interviews, not all editors agreed that fact-checking is the most crucial issue in journalism right now. One editor, who asked to remain anonymous, said: "I'm not really an idealist about fact-checking being super important in this political moment — I don't really take a rose-colored view of fact-checking. I just think it's a crucial way in which magazines can help prevent themselves from getting sued. If anything worries me about the state of journalism right now it's lawsuit shopping and the propensity of sources to go to lawsuits as their primary method of recourse."

5.1.j Fact-checking wish list

In our survey, we asked outlets to rank which of the following would help make their fact-checking more robust: Annual grants to hire fact-checkers, templates for fact-checking instructions for writers/journalists, template for a fact-checking handbook, free in-person workshops, fact-checking interns, or online training programs. They also had the option to select "none of the above, our fact-checking doesn't need improvement." The respondents also had the opportunity to write in their own suggestions.

Virtually all respondents ranked "doesn't need improvement" lowest, suggesting a desire for fact-checking tools and resources. As for the other categories, the responses were all over the place, although choices that involved more time and funding — such as grants for hiring fact-checkers or interns — were popular.

From the interviews, at least 20 outlets would like to hire fact-checkers, while a handful of others wished for more copy editors. Other suggestions included: training; an online database to find fact-checkers; an industry standard or verification system to show which outlets fact check; new editing software that tracks fact-checking annotations and corrections more cleanly than Microsoft Word or Google Docs; more fact-checkers with science backgrounds; and a cooperative that could provide fact-checking either on a subscription or per-project basis (one editor who mentioned the cooperative, De Chant from NOVA and NOVA Next, suggested it could also offer other services beyond fact-checking).

5.2 Journalists

A total of 165 journalists responded to the survey, and we did 10 interviews. Because outlets are the gatekeepers for fact-checking policies, the journalist surveys and interviews focused mainly on the interactions journalists have with outlets regarding fact-checking. (It should be noted that many freelance journalists also pick up freelance fact-checking jobs and vice-versa.)

Most of the journalists in the surveys and interviews said fact-checking was important for quality science journalism, although several had the same caveat that we saw with the outlet data: It isn't absolutely necessary to have a magazine-model fact check if the journalists and editors are doing a thorough and careful job.

5.2.a Guidelines from outlets

Only two-thirds of the survey respondents have ever received guidelines on how to prepare stories for a fact-checker (Figure 12) and half have received these guidelines in a formal document. Several interviewees said they had never written for a publication that does a formal fact check.

Figure 12: Have journalists received fact-checking guidlines from outlets?

34%

66%

■ Yes   ■ No
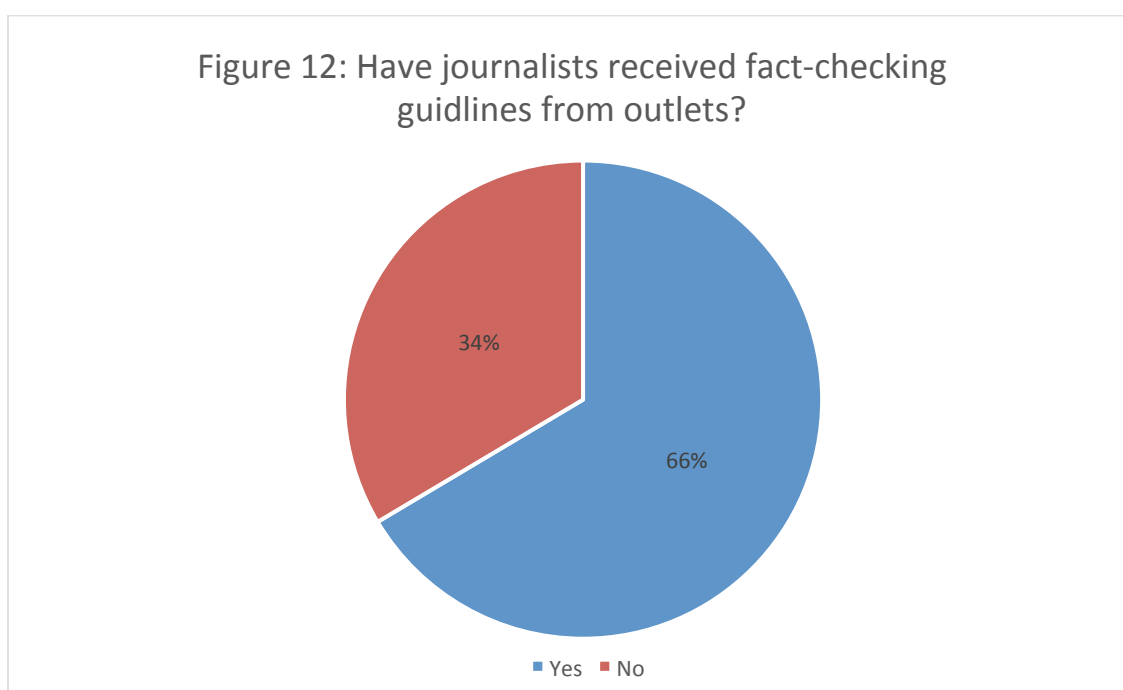
5.2.b Sharing unpublished material with sources

For the most part, the journalists in our interviews said they do not show unpublished manuscripts or excerpts to sources, although some occasionally paraphrase or describe a section of a story over the phone to double-check their work. Whether the journalists received explicit guidelines from outlets was mixed: some said they've seen written

rules, while others said either their editors haven't directly addressed it or they don't recall one way or the other.

But one journalist in our interviews wondered whether the industry should rethink this practice, particularly with shrinking fact-checking budgets. "It's probably time to renew the conversation about when it is appropriate to share copy with sources and so on," said Richard Harris, a science correspondent at NPR, who stressed he was sharing his own opinion and not his employers. "There is that strong tradition in journalism to not show copy before it's been published. But I think there are certainly some circumstances in science journalism where you could argue — especially with things that aren't controversial — that [sharing] could improve fact-checking."

5.2.c Fact-checking wish list

From the interviews, several journalists said they would like to have more dedicated fact-checkers or copy editors on their teams, and one wished for more training. Though some thought they weren't the best use of resources in every circumstance. "To be honest, I'm not sure how much a 300-word blogger needs a fact-checker as much as a fact-checking system," said Ryan Mandelbaum, science writer at Gizmodo. "It'd be cool to get a fact-checker for features, exclusives — things that aren't timely that I need to file two hours later."

Mandelbaum also suggested that digital reporters should work with a fact-checking checklist and perhaps sign an honor code that acknowledged a commitment to accuracy.

And one journalist wished more colleagues would be more careful when they don't have the luxury of a fact-checker. "It would be great if everyone just did their own fact-checking," said Rachel Nuwer, a freelance journalist. "I've read pieces by people I know personally and respect, and I know they are in a hurry when they do these things, but I see errors introduced. It just kind of annoys me because we are just perpetuating these falsehoods."

5.3 Fact-checkers

A total of 35 fact-checkers responded to the survey, and we did 16 interviews. Of those who responded to the survey, most were freelance rather than staff (Figure 13) and most do not have science degrees (Figure 14). (It should be noted that many freelance fact-checkers also pick up freelance reporting jobs and vice-versa.)

Figure 13: Types of fact-checkers

- Dedicated Staff Fact-Checker
- Freelance Fact-Checker
- Staff or Intern with Fact-Checking Duties
- Other
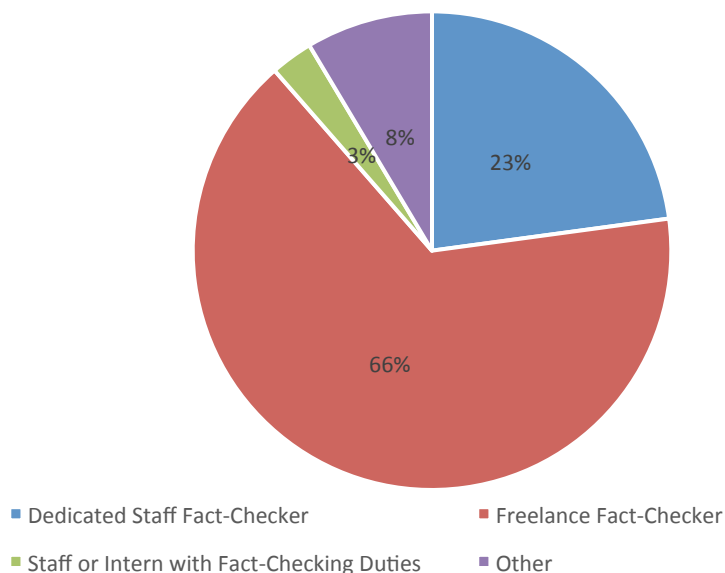
Figure 14: Do fact-checkers have a science degree?

- Yes
- No
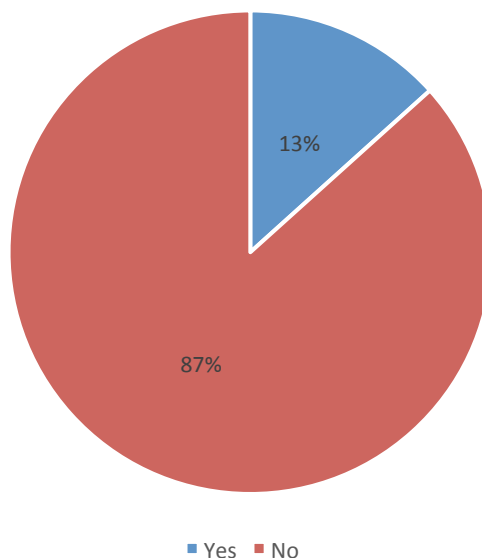
5.3.a Guidelines from outlets

In the survey, most fact-checkers (83 percent) said they have received guidelines from outlets on how to fact check (Figure 15). This doesn't line up with the results from our outlet survey, which suggested that only 39 percent of outlets provide such guidelines (Figures 8). We may have inadvertently surveyed more fact-checkers who work at the outlets that do provide these resources. Sixty percent of the fact-checkers said they

received training at work (Figure 16), which more or less aligns with the results from the outlet surveys (57 percent, Figure 9).

Figure 15: Have fact-checkers received fact-checking guidelines and policies from outlets?

- Yes
- No

17%

83%
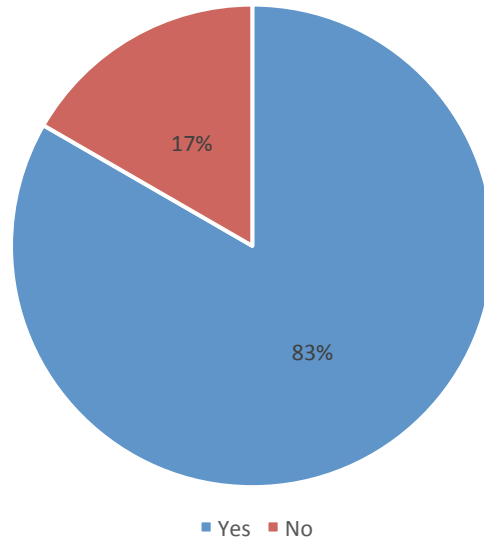
Sixty percent of the survey respondents received their training at work (Figure 16).

Figure 16: Where Fact-Checkers Get Training

7%
3%
30%
0%
60%

- A publication I worked for provided my training
- Professional fact-checking course (e.g. Poynter Fact-Checking Certificate)
- Self-taught
- My journalism/writing program taught fact-checking
- Other
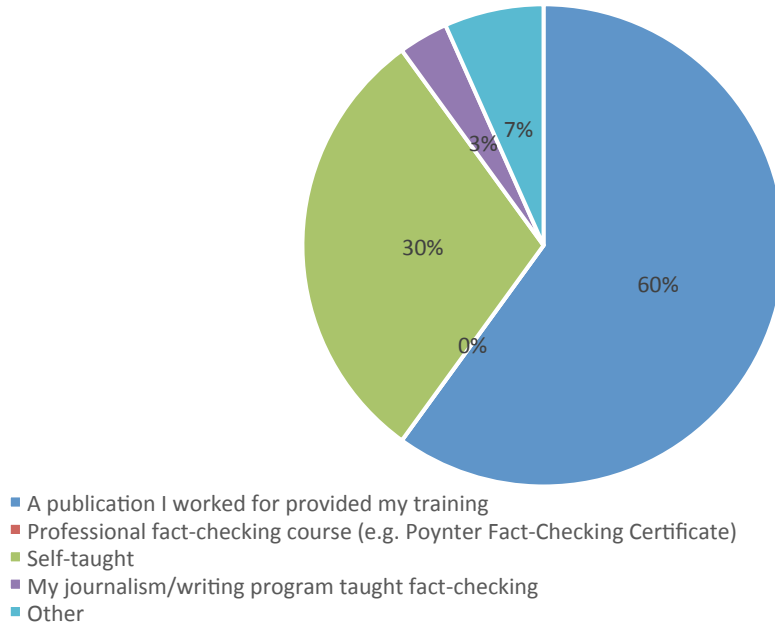
5.3.b Finding work and getting paid

According to our survey, more than two-thirds of fact-checkers find work through professional networks or word-of-mouth; the rest get assignments through staff jobs (Figure 17). None of the survey respondents said they find work through public job posts or advertisements, although two interviewees mentioned Mediabistro as a resource.

Figure 17: How do fact-checkers find assignments?

33%

67%

■ I am assigned fact-checking assignments as a dedicated staff fact-checker or as a staff member who fact-checks
■ Professional networks/Word-of-mouth
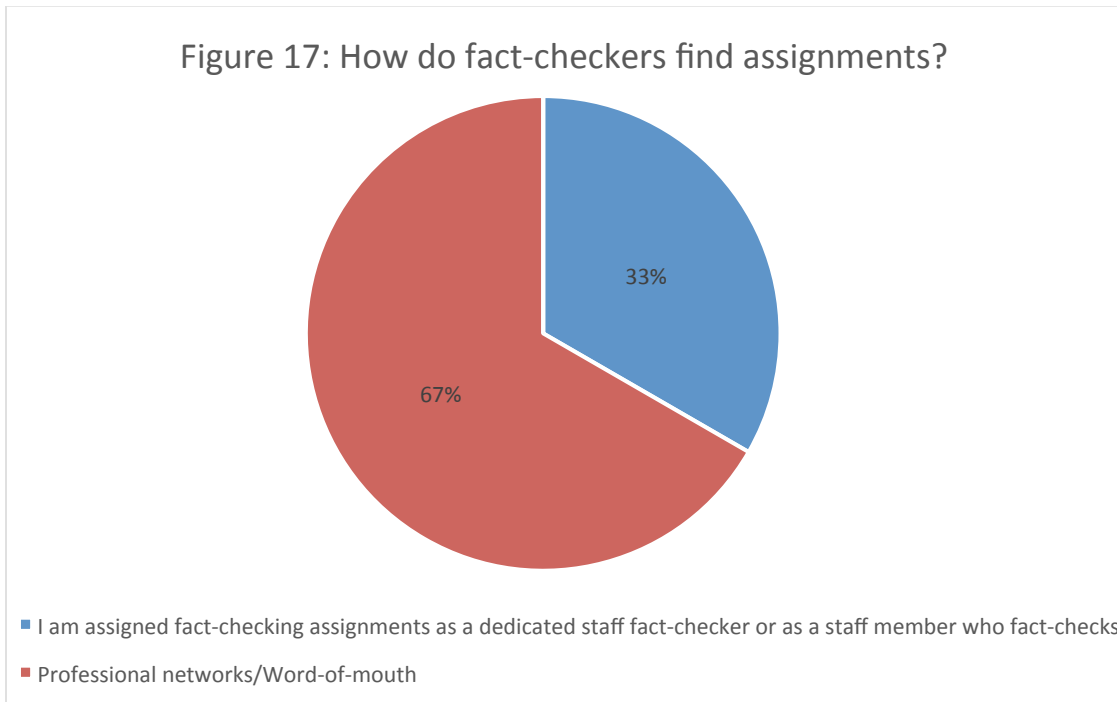
Again, hiring trends suggest a bias against newcomers who are interested in working as a fact-checker. "It's hard to get your foot in the door if it's all about word-of-mouth," said Michelle Harris, a freelance fact-checker who works for Radiolab, Science Vs, National Geographic, and more. But word-of-mouth, she added, has "definitely been my experience."

As for pay, the fact-checkers in our interviews reported higher rates than the outlets. We may have inadvertently selected fact-checkers who have more experience or specific expertise, since many outlets said they pay more in these cases. Our fact-checkers said their pay ranges from $19.28 to $75 an hour, with an average of $34.27 and median of $30.

One fact-checker noted at least two outlets she has worked for put an hourly cap on a story. Depending on the complexity, this could either decrease the fact-checker's rate if the work would normally have taken more time, or affect the quality of the fact-checking. Publications may have good intentions but "they need to pool more financial resources into not having a rushed process with fact-checking and also pay fact-checkers

a fair wage," said Wudan Yan, a freelance journalist and fact-checker for Discover Magazine, Knowable, Quanta Magazine, Spectrum, and others. "A lot of the places I write for — their writing rates are significantly higher than the fact-checking rates, and to me it shows that the fact-checking process is literally being devalued."

5.3.c Sharing unpublished materials with sources

In our interviews, most fact-checkers said they are not allowed to share excerpts or full manuscripts with sources. Heidi Schultz, a National Geographic Magazine fact-checker said it would actually better to be able to share materials (according to two interviews, fact-checkers used to be allowed to share text with sources at NatGeo, although that is no longer the policy).

"I would like to go back to being able to send out quotes over e-mail as well as sections of text without having to paraphrase them," said Schultz. Not sharing materials, she added, "can result in an answer that doesn't get to the question you really want answered, can lead to misunderstandings, and can make people defensive because we're not being transparent. I have experienced people becoming defensive or mistrustful on more than one occasion, and I believe our not revealing the wording we intend to use caused problems where there wouldn't have been any, or at least fewer, had I been allowed to show the person what we intend to say."

5.3.d Fact-checking wish list

In our survey, we asked fact-checkers what would make their fact-checking more robust and provided a list for them to rank: A template for fact-checking instructions for writers/journalists, a template for a fact-checking handbook, free in-person workshops, fact-checking internships, or online training programs. They also had the option to select "none of the above, the current fact-checking procedures I've experienced don't need improvement " and to write in their own suggestions.

As with the outlet and journalist data, the responses were all over the place. The most popular option was a template for fact-checking instructions for writers/journalists. From our interviews, several fact-checkers also expressed interest in an online database to find jobs, share rates, find information on liabilities, and ask other general questions.

Many of the interviewees also want the industry to have a better understanding of what fact-checking is — and to invest in it financially. "I think writers sometimes misinterpret the process of fact-checking as though the checker or magazine doesn't trust them," said Andrea Powell, a research editor at WIRED. "It's actually the opposite: the magazine is trying to have your back in advance so no one comes after you for your story. I wish more journalists started out as a fact-checker, because it makes you a better reporter."

As for money: "I think it is foolish that a lot of places tend to cut copy and fact-checking first — they look at it as an easy way to get money out of the budget," said Erika Villani, a freelance fact-checker who has worked for publications including Popular Science and Discover Magazine. "But I think it really trickles down to the quality of what you're producing."

Brad Scriber, Deputy Research Director at National Geographic magazine, said it'd be nice to have "a sign from the industry that this function is valuable and worth preserving and paying for."

"A lot of what we do is prevent bad things from happening," he added. "It's like lowering your insurance policy — a somewhat painless cost-cutting measure, until you have a disaster you need insurance for."

Other comments suggested that having a remote workforce in fact-checking can be a drawback. "There is value to having in-office fact-checking," said Alyssa Favreau, a freelancer who fact checks at Discover Magazine, Reader's digest, and Air Canada enRoute. "It wouldn't be a bad thing to have more of an in-person relationship with the editors, particularly when we are dealing with sensitive information."

5.4 Journalism programs

A total of 22 programs responded to the survey, and we did 14 interviews representing 11 schools (survey respondents are bolded in Appendix 3). Most respondents were from programs that cover science (Figure 18) and about two-thirds offer graduate degrees (Figure 19).

Figure 18: Programs that cover science

9%

91%

■ Yes ■ No

Figure 19: Program type

A one-year Master's program (on-campus) — 29%
A one-and-a-half year Master's program (on-campus) — 8%
A two-year Master's program (on-campus) — 25%
Undergraduate — 13%
Online/Low-Residency — 8%
Other — 17%
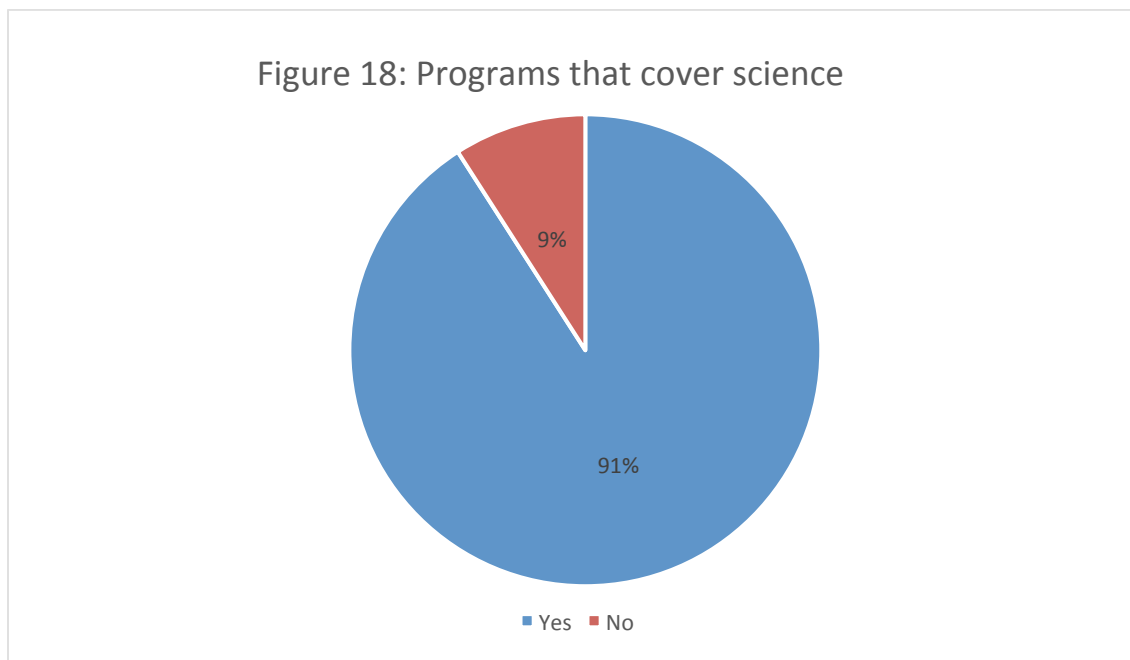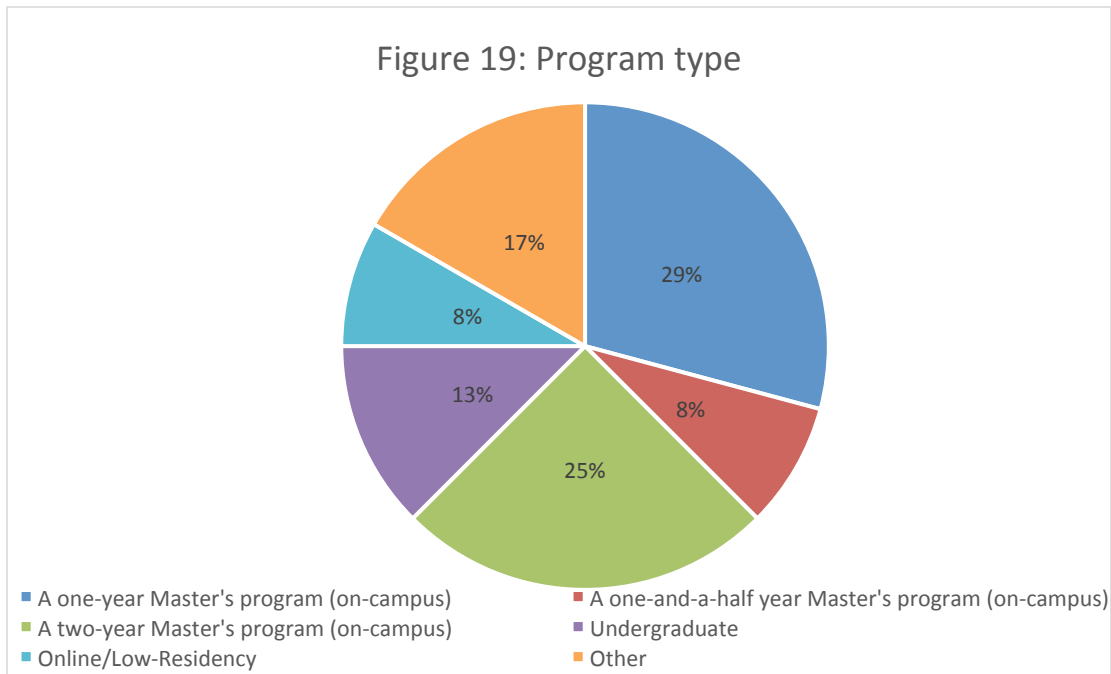
From the survey, more than three-quarters of the programs said their curriculum covers fact-checking (Figure 20). Our interviews suggest a more nuanced picture. Four programs said that while they do not explicitly teach the magazine model of fact-checking, the concept of verification is integrated into their classes. These include programs at the University of California, Berkeley, Johns Hopkins University, the University of North Carolina at Chapel Hill, and New York University (although NYU recently added an online fact-checking module for all journalism students).

Figure 20: Does the curriculum cover fact-checking?

Yes — 77%
No — 23%
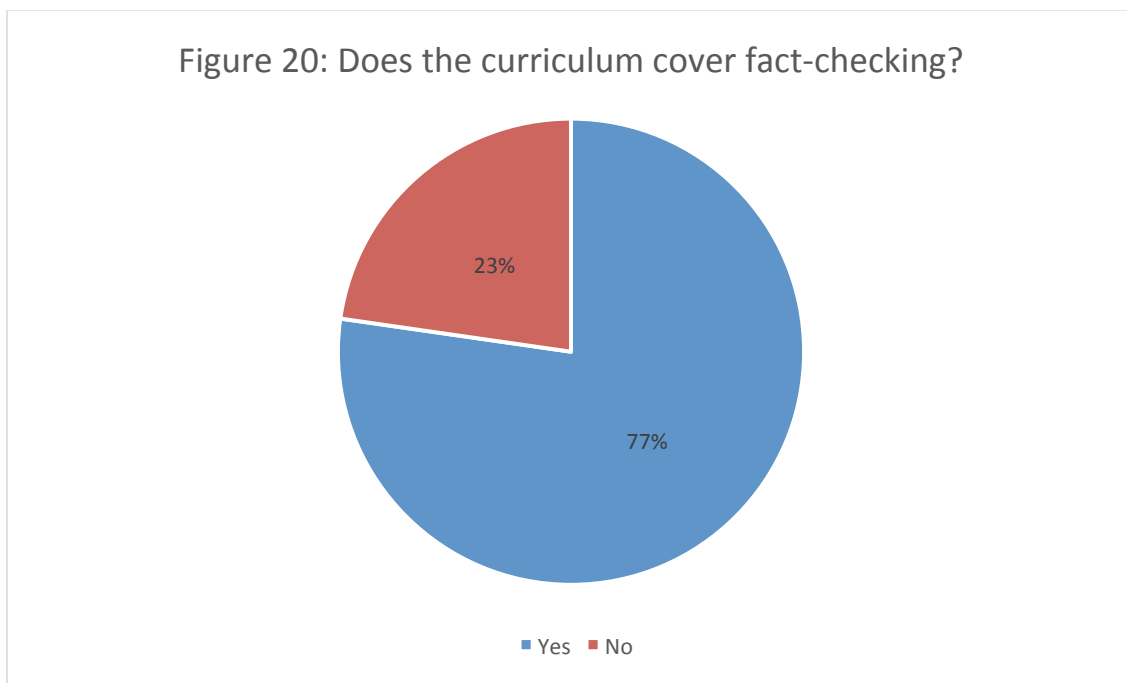
According to Dan Fagin, the director of NYU's Science, Health, and Environmental Reporting Program, it doesn't make sense to dedicate too much class time to magazine-style fact-checking because it isn't a common job in the industry. Rather, it's more important to instill a culture of verification. "In the real world of journalism as it exists now," he said, "we have to get reporters and editors to do that work because most places are not going to have the luxury of hiring fact-checkers."

Some people at the programs said they discuss independent fact-checking in class, mostly to prepare students who may eventually write for magazines. These include programs at the University of California, Berkeley and Texas A&M University. Others explicitly teach the magazine model through assignments, exercises, or drills. These include journalism programs at the City University of New York, the University of Missouri, the University of Arizona, Stanford University, and Northwestern.

And the Graduate Program in Science Writing at MIT changes the approach from year to year depending on the students' backgrounds and needs, said Seth Mnookin, the program's director. In some years, coursework includes fact-checking drills and assignments, while in others there is only a brief overview of how fact-checking works at a magazine.

Several of the interviewees acknowledged that their students might not always work with a fact-checker — or get a fact-checking job. Still, two argued that is worth teaching fact-checking as a stand-alone skill. Fact-checkers "are like a shrinking population," said Barbara Gray, chief librarian and associate professor at the CUNY Graduate School of Journalism. Still, she added, "rather than keeping [fact-checking skills] close to the vest, we have to teach journalists how to do this themselves."

Patti Wolter, an associate professor at Medill, agreed. "In some ways, some of the nit-pickiness of the magazine fact check seems like overkill. But I think when you are teaching it to students, it is almost a better way of emphasizing accuracy because it makes them understand that every little bit counts in this very explicit way," she said. She tells her students: "I'm going to teach you this strict black-and-white version of fact-checking and ethics, and you're going to get out in the world and it's going to be nothing but gray. But I want you to have my voice in the back of your head so you know when someone is deviating, and so you have your own metric for how you are going to pull your stories together."

6. RECOMMENDATIONS

6.1 Outlets

Fact-checking is essential to journalism. The magazine model is an excellent way to ensure a high-quality story. But it isn't realistic to apply the magazine model to every single story at every single outlet. So what can the industry do to make fact-checking more robust?

For outlets — both print and digital — we recommend applying the magazine model at least to enterprise reporting, long narrative features, and any other complex or high-stakes journalism. In these cases, the publication is already investing a lot of time and money, and a thorough fact check will help make sure that investment is sound.

For shorter, less complex stories or breaking news, the newspaper model can work very well. But we are concerned at the ways in which editorial safety nets are disappearing at some outlets. Every story should have at least one experienced editor reading it before publication, if not two or more, and every story would benefit from a copy editor to check both style and basic facts. We recognize that many outlets have cut or curbed copy editing for financial reasons, but this unfortunate move will inevitably lead to more mistakes. Even minor errors can erode readers' trust.

Many of the outlets we spoke with do not have formal processes in place to help catch errors before they print — or to track corrections. We recommend that all outlets have a cohesive system, which may include written instructions on how to fact check, instructions for writers on how to prepare for a fact check, internal checklists for journalists who don't have the luxury of working with a dedicated fact-checker or copy editor, and tracking systems for corrections and to ensure writers are following the checklists. Of course, outlets should have their lawyer review these materials (see Endnote 13).

We also recommend regular training and refresher courses for longtime staff and new hires alike. For outlets with staff fact-checkers and/or copy editors, staff could run the sessions. For outlets without fact-checkers and/or copy editors, we recommend periodic training sessions with outside experts. Outlets should make sure to include freelancers in relevant training sessions.

6.2 Funders

One of the goals of this report was to figure out which fact-checking resources outlets, journalists, and fact-checkers want, if any. The responses from our surveys and interviews were mixed, so no single approach will fill all needs. Still, we noticed some themes. Based on these we recommend five approaches, which could be done separately or in concert:

1- Create templates of instructions, checklists, and guidelines, as well as training materials such as online modules, to distribute to outlets on request. Outlets could modify these materials as needed.

2- Craft a fact-checking code that outlines the principles of editorial fact-checking and verification, which could function somewhat like the Society of Professional Journalist's Code of Ethics or the political fact-checking code from the International Fact-Checking Network at Poynter. Outlets could publicly acknowledge that they follow the fact-checking code and also use it as a reference.

3- Build a website dedicated to fact-checking, which could house the key documents described in suggestions 1 and 2 above; lay out a code of ethics and best practices; provide a job database; provide a detailed database of fact-checkers and researchers who are available for hire; and host a private forum for fact-checkers to ask one another questions about work.

4- Create a fact-checking fellowship program. Both fact-checkers and outlets would apply to receive a fellowship or fellow, respectively. The fellows would receive training materials and/or sessions through the program and would act as fact-checkers at their respective outlets. Because it can take time to become part of a team, we recommend the fellowships last 6 months to one year.

5- Create a fact-checking cooperative. Outlets that can't afford to hire full-time fact-checkers and other key staff would be members of the cooperative, which would help arrange for fact-checkers and copy editors on either a subscription or per-project basis.

7. FUTURE RESEARCH

No report related to science or science journalism would be complete without the words: more research is needed. There are several questions we didn't address, and some data we did not analyze. Here are a few possible next steps:

1- We only looked at outlets that publish in English. Further research might extend our work to science publications in other languages.

2- We collected guidelines for journalists or fact-checkers from 27 outlets, but did not have the resources to code and formally analyze these guidelines. Further research could dig into these guidelines and see how fact-checking expectations compare and contrast across outlets.

3- The cost, feasibility, and liability for some of our recommendations are unclear. For example, it should be relatively easy to prepare and distribute basic checklists, guidelines, and training materials. Fact-checking fellowships and a website are more involved. A cooperative that provides fact-checking services might be too expensive to be practical, or may not be an attractive option for outlets that are hesitant to trust a third-party with sensitive stories. Such a cooperative could also open participants to liabilities. Further research could assess the costs and benefits of specific recommendations in this report.

8. ABOUT THE REPORT

The Knight Science Journalism Program at MIT produced this report through an unrestricted grant from the Gordon and Betty Moore Foundation. Deborah Blum oversaw the project and Bettina Urcuioli provided administrative support. Brooke Borel managed the team, conducted the outlet interviews and some journalist interviews, and wrote the bulk of the report. Knuvl Sheikh prepared the contact lists for the outlets and journalism programs, conducted the remaining journalist interviews, and wrote part of the "Methods" section. Fatima Husain created and managed the surveys, analyzed and prepared the data, and wrote the rest of "Methods." Ashley Junger conducted all the fact-checker interviews. Erin Biba fact-checked.

9. ABOUT THE AUTHORS

Brooke Borel is a journalist and author. She has written on everything from artificial intelligence to the seedy world of cannabis pesticides to the history of fake news, and her work has appeared in Popular Science, The Guardian, The Atlantic, BuzzFeed News, FiveThirtyEight, Scientific American, and Undark magazine, among others. She is a contributing editor at Popular Science and an editor-at-large at Undark. Both the Alicia Patterson Foundation and the Alfred P. Sloan Foundation have supported her work. She teaches writing workshops at New York University. Her books are "Infested: How the Bed Bug Infiltrated Our Bedrooms and Took Over the World" and "The Chicago Guide to Fact-Checking," which Library Journal named one of the best reference titles of 2016.

Knvul Sheikh is a freelance science journalist based in New York. She writes about psychology, personalized medicine, technology, and culture. She has served as the web editor for Genome magazine and her byline has appeared in publications such as The Atlantic, Live Science, National Geographic, Popular Science, Scholastic, Scientific American, and Vice. She's a graduate of NYU's Science, Health, and Environmental Reporting Program and has a B.S. in molecular biology from the University of California, San Diego. In a previous life, she grew hippocampal brain cells in a lab in Singapore to test how epigenetic factors affect memories. She also once won an award for the best science project in a regional Intel Science Olympiad in Pakistan. Now, she is most happy when reporting on the genomic revolution, the weird brain circuitry behind why we behave the way we do, trends in nutrition science, and the occasional offshore wind farm.

Fatima Husain is a science writer from West Des Moines, Iowa. She is a current student in the MIT Graduate Program in Science Writing in Cambridge, Massachusetts and mainly writes about earth, environmental, atmospheric, and planetary sciences. She attended Brown University in Providence, Rhode Island, where she earned an Sc.B. with Honors in Geology-Chemistry and performed Arctic paleoclimate research for three years. She has published her recent work in PBS NOVA Next, MIT News, The College Hill Independent, and in various other print and online media outlets.

Ashley Junger grew up in Chesterfield, Missouri, where she developed a love for reading and exploring her environment. As an undergraduate at DePauw University, she pursued both of these passions, double-majoring in Biology and English Literature. She found that science writing combined her favorite parts of these two subjects, and decided to build her science communication skills in MIT's Graduate Program in Science Writing. While at MIT, Junger worked at Undark as a fact-checker. She now looks forward to graduating the program in the fall, and building her science writing career. Her stories have been featured in The DePauw, A Midwestern Review, oceanus magazine, and NOVA Next.

Erin Biba is a science journalist and semi-retired fact-checker. After graduating from Medill's Graduate School of Journalism, she spent seven years as a fact-checker at WIRED (the print edition), where she followed the magazine model, fact-checking stories about science, technology, and entertainment. While there she corrected errors about thorium nuclear reactors, the size of LL Cool J's boombox, and the fact that cows actually release the majority of methane through burps and not farts (a fact that no one seems to ever get right and the near-constant repetition of factually inaccurate farting has haunted her ever since). After leaving fact-checking, Biba went to on use the skills she learned on the job to fact check her own work as a reporter. Currently she writes about climate change, field science, ecology, clean energy, and the environment, as well as human health and technology. In addition to the pages of WIRED her work has appeared in Scientific American, BBC, Newsweek, Popular Science, Popular Mechanics, The Atlantic, The Daily Beast and California Sunday. Her tweets dispelling myths about fact checking and how it works have appeared on Twitter as well as in Undark and The Guardian. She does not believe in showing sources any part of a story prior to publication.

Pulitzer Prize winner Deborah Blum is director of the Knight Science Journalism Program at MIT and publisher of its award-winning science magazine, Undark. She is the author of five books; her sixth, "The Poison Squad," will be published by Penguin Press in September. Prior to joining MIT, she was the Helen Firstbrook Franklin Professor of Journalism at the University of Wisconsin-Madison. She worked as a newspaper science writer for twenty years, winning the Pulitzer in 1992 for a series on primate research, which she turned into a book, "The Monkey Wars" (Oxford, 1994). Her other books include "The Poisoner's Handbook" (Penguin Press, 2010), "Ghost Hunters" (Penguin Press, 2006) "Love at Goon Park" (Perseus, 2002), and "Sex on the Brain" (Viking, 1997). She is also co-editor of two editions of "A Field Guide for Science Writers," published by Oxford University Press, and translated into numerous other languages. In addition, she has written for publications including The New York Times, WIRED, Time, The Wall Street Journals, Discover, Mother Jones, The Guardian and The Boston Globe. Blum is a past president of the National Association of Science Writers, a fellow of the American Association for the Advancement of Science, and a lifetime associate of the National Academy of Sciences. She lives in Boston in a 1910 house (the era of her latest book), along with her husband, a fellow journalist, and a rescue lab named Bongo.

APPENDIX 1
Fact-checking Survey: Outlets (starred questions denote required responses)

*Publication Name

* Location of Publication Headquarters (City, State, Country)

* Your Current Location (City, State, Country)

* Your Name

* Your Role

- Editor-in-Chief
- Deputy Editor
- Executive Editor
- Managing Editor
- Copy Editor
- Research Editor
- Researcher
- Fact-checker
- Other (please specify)

* Is your publication:

- Primarily science-focused
- General interest with some science stories
- Our publication does not cover science

* Please estimate your circulation numbers/reach.

* Please estimate and rank how your audience most frequently accesses your publication (1 corresponds to most frequently accessed in this format; 4 corresponds to least frequently accessed in this format):

- Print
- Digital
- Video
- Audio

* Which category best describes your publication's main focus?

- Lifestyle/Entertainment/General Interest
- General Science
- Specialized Science
- Newspaper

* Which of the following funding sources supports your publication?

- Advertisements
- Subscriptions
- Grants
- Organization Membership
- Other (please specify)

How much of your coverage includes science?

- 1-15 percent
- 16-25 percent
- 26-50 percent
- 50-75 percent
- > 76 percent

* What science topics do you cover (check all that apply)?

- Health/medicine
- Planetary Science
- Chemistry Defense
- Biology
- Ecology/Environmental Science
- Physics
- Engineering
- Earth Science
- Climate Science
- Computer Science/Robotics/Technology
- Other (please specify)

* Does your outlet aggregate stories from other outlets?

- Yes
- No

If you aggregate stories from other outlets, what is your policy for fact-checking these stories?

- We fact check everything in detail
- We double check basic facts like names, dates, locations, etc.

- We do not fact check aggregated content

* Who most commonly fact checks at your publication (here, fact-checking means that you have dedicated staff or freelancers — other than the writer or editor — who fact check your stories)?

- Interns
- Fact-checkers/Researchers
- Research Editor
- Copy Editors
- Other (please specify)
- Editors

- The author of the piece is responsible for fact-checking
- We do not fact check

* If you have fact-checkers, are they (select the option that is the most common):

- Staff
- Freelance
- Other (please specify

* How many fact-checkers do you employ?

- # of dedicated fact-checkers
- # of staff or interns who take on fact-checking duties
- # of freelancers who provide fact-checking services

* What is the most common way that you find your fact-checkers?

- Job postings (please list sites used)
- Professional networks (please list networks used)
- Internship programs
- Other (please describe)

* Do you have written guidelines for your staff/freelance fact-checkers?

- Yes
- No

* For your science journalism pieces, do you require your fact-checkers to have a science background and/or science journalism experience?

- Yes
- No

* Why or why not?

* Do your fact-checkers receive training?

- Yes
- No

* What training do you provide your fact-checkers (describe all that apply)?

- Staff training
- Books (please list)
- Articles (please list)
- Websites (please list)
- Handouts (please list)
- Other (please describe)

* Do you provide your staff and freelance journalists/writers with instructions on preparing their stories for a fact-checker?

- Yes
- No

If possible, please upload your journalist/writer fact-checking instructions/guidelines here:

* How do you communicate fact-checking policies to your writers?

- In the contract
- In a standard email or document, sent to all writers
- Nothing formal; as it comes up
- We do not provide freelance journalists/writers with instructions regarding fact-checking
- Other (please specify)

* Do you think fact-checking is important to journalism?
- Yes
- No

* Why or why not?

* Which of the following would help make your outlet's fact-checking more robust (rate on a scale from most to least likely)? Assume that these services would be free to you, funded by a foundation or professional organization:

- Online training programs
- Fact-checking interns
- Free in-person workshops
- Template for a fact-checking handbook
- Template for fact-checking instructions for writers/journalists
- Annual grants to hire fact-checkers
- None of the above — our fact-checking doesn't need improvement

What would make your outlet's fact-checking more robust that's not listed above?

May we contact you for an interview for our report? If so, please include your name and preferred contact information.

Fact-checking Survey: Journalists/Writers (starred questions denote required responses)

* 1. Your Name

* 2. Your Current Location (City, State, Country)

* 3. Please list the publications in which your writing has most frequently appeared:

* 4. Are you a:

- Staff Journalist/Writer
- Freelance Journalist/Writer
- Other (please specify)

* 5. Do you write about science?

- Yes
- No

* 6. Which category best describes your writing? (General interest refers to general interest writing with a little bit of science - the other choices refer to general or specialized science beats)

- General Interest - Newspaper
- General Interest - Magazine
- General Interest - Website
- General Interest - Audio
- General Interest - Video
- General Science - Newspaper
- General Science - Magazine
- General Science - Website
- General Science - Audio
- General Science - Video
- Specialized Science - Newspaper
- Specialized Science - Magazine
- Specialized Science - Website
- Specialized Science - Audio
- Specialized Science - Video

* 7. What science topics do you cover (check all that apply)?

- Health/medicine
- Planetary Science
- Chemistry Defense
- Biology
- Ecology/Environmental Science
- Physics
- Engineering
- Earth Science
- Climate Science

- Computer Science/Robotics/Technology
- Other (please specify)

*8. Have any publications you've written for provided you with instructions on preparing your stories for a fact-checker?

- Yes
- No

In questions 9 through 13, your responses are anonymous. We may pull quotes and information from the materials you upload, but we will not disclose that the materials came from you. Uploading any documents is entirely optional.

9. If yes, please list the publications here:

* 10. How have you received fact-checking instructions/policies? In the contract

- In a standard email or document with an editor
- Nothing formal; as it comes up
- I have not received fact-checking instructions before
- Other (please specify)

11. 1st publication: If possible, please upload the fact-checking instructions/guidelines you received here:

12. 2nd publication: If possible, please upload the fact-checking instructions/guidelines you received here:

13. 3rd publication: If possible, please upload the fact-checking instructions/guidelines you received here:

* 14. Do you think fact-checking is important for journalism?

- Yes
- No

* 15. Why or why not?

16. May we contact you for an interview for our report? If so, please include your name and preferred contact information:

Fact-checking Survey: Fact-checkers (starred questions denote required responses)

* 1. Your Name

* 2. Your Current Location (City, State, Country)

* 3. How long have you been a fact-checker (please estimate)?

* 4. Are you a:

Dedicated Staff Fact-checker

Freelance Fact-checker

Staff or Intern with Fact-checking Duties

Other (please specify)

* 5. Do you fact check science journalism/writing?

- Yes
- No

* 6. Which category best describes the type of writing you fact check? (General interest refers to general interest writing with a little bit of science - the other choices refer to general or specialized science beats

- General Interest - Newspaper
- General Interest - Magazine
- General Interest - Website
- General Interest - Audio
- General Interest - Video
- General Science - Newspaper
- General Science - Magazine
- General Science - Website
- General Science - Audio
- General Science - Video
- Specialized Science - Newspaper
- Specialized Science - Magazine
- Specialized Science - Website
- Specialized Science - Audio
- Specialized Science - Video

* 7. What science topics have you fact-checked (check all that apply)?

- Health/medicine
- Planetary Science
- Chemistry Defense
- Biology
- Ecology/Environmental Science
- Physics
- Engineering

- Earth Science
- Climate Science
- Computer Science/Robotics/Technology
- Other (please specify)

* 8. Do you have a science degree?

- Yes
- No

In questions 9 through 16, your responses are anonymous. We may pull quotes and information from the materials you upload, but we will not disclose that the materials came from you. Uploading any documents is entirely optional.

* 9. Have any publications you've fact-checked for provided you with instructions on their specific fact- checking policies and procedures?

- Yes
- No

10. If yes, please list the publications here:

* 11. How have you received fact-checking instructions/policies?

- In the contract
- In a standard email or document, sent to all writers
- Nothing formal; as it comes up
- We do not provide freelance journalists/writers with instructions regarding fact-checking
- Other (please specify)

12. 1st publication: If possible, please upload the fact-checking instructions/guidelines you received here:

13. 2nd publication: If possible, please upload the fact-checking instructions/guidelines you received here:

14. 3rd publication: If possible, please upload the fact-checking instructions/guidelines you received here:

15. 4th publication: If possible, please upload the fact-checking instructions/guidelines you received here:

16. 5th publication: If possible, please upload the fact-checking instructions/guidelines you received here:

* 17. How did you receive your fact-checking training?

- A publication I worked for provided my training
- A professional fact-checking course (e.g. Poynter Fact-checking Certificate)
- Self-taught
- My journalism/writing program taught fact-checking
- Other (please specify)

18. Please describe your fact-checking training in a few sentences.

* 19. How do you most commonly find your fact-checking assignments?

- I am assigned fact-checking assignments as a dedicated staff fact-checker or as a staff member who fact checks
- Professional networks/Word-of-mouth
- Job postings/advertisements
- Other (please specify)

20. If you are a freelance fact-checker, please list the networks, postings, and programs you use to find fact-checking assignments.

* 21. Do you think fact-checking is important for journalism?

- Yes
- No

* 22. Why or why not?

* 23. Which of the following would help make your fact-checking more robust (rate on a scale of most to least likely)? Assume that these services would be free to you, funded by a foundation or professional organization:

- Online training programs
- Fact-checking internship
- Free in-person workshops
- Template for a fact-checking handbook
- Template for fact-checking instructions for writers/journalists
- None of the above — the current fact-checking procedures I've experienced don't need improvement

24. What would make your fact-checking more robust that's not listed above?

May we contact you for an interview for our report? If so, please include your full name and preferred contact information below.

25. Your Name (First, Last)

26. Preferred contact address (Email, Phone, etc.)

Fact-checking Survey: Journalism/Writing Programs (starred questions denote required responses)

* 1. Journalism/Writing Program Name

* 2. Your Current Location (City, State, Country)

* 3. Are you a:

- Program Director
- Program Faculty
- Adjunct Faculty
- Other (please specify)

*4. Does your program cover science journalism/writing?

- Yes
- No

* 5. How old is your program?

* 6. How many students are enrolled in the program each year (on average)?

* 7. How many students have graduated from your program? If you don't know the exact number, please estimate.

* 8. Is your program:

- A one-year Master's program (on-campus)
- A one-and-a-half year Master's program (on-campus)
- A two-year Master's program (on-campus)
- An online Master's program
- A certificate program
- Other (please specify)

* 9. Does your program curriculum cover fact-checking?

- Yes
- No

* 10. Why or why not?

11. If your program provides fact-checking training/guidance, please describe how this training/guidance is disseminated:

12. If your program includes written fact-checking instructions or guidelines, please upload them here:

* 13. In which publications does student/fellow work appear during or after program completion?

* 14. Do you think fact-checking is important to journalism?

- ● Yes
- ● No

* 15. Why or why not?

16. May we contact you for an interview for our report? If so, please include your name and preferred contact information:

APPENDIX 2: List of outlets that received survey (Bolded names responded)

1	AARP The Magazine
2	Adelaide Advertiser (Australia)
3	**Aeon**
4	AIR (Association of Independents in Radio)
5	**All About Space (U.K.)**
6	**American Scientist**
7	Anthropocene Magazine
8	Ark Media
9	**Ars Technica**
10	Asian Geographic (Singapore)
11	**Asian Scientist (Singapore)**
12	Astronomy Magazine
13	Atavist Magazine
14	Atlantic
15	Atlas Obscura
16	**Audubon**
17	Australian Geographic (Australia)
18	Australian Science (Australia)
19	Australia's Science Channel (Australia)
20	Axios
21	**Bay Nature Magazine**
22	BBC - Earth
23	BBC - Future
24	BBC Focus magazine (UK)
25	BBC News
26	**BBC Sky at Night magazine (UK)**
27	**bioGraphic**
28	BioPharm Insight
29	Bloomberg Businessweek magazine
30	Bloomberg Technology magazine
31	Boston Globe
32	Brain World
33	**Bright Magazine (Kenya)**
34	**Business Insider**

35	**Buzzfeed**
36	Chemical & Engineering News
37	Chicago Tribune
38	**Christian Science Monitor**
39	City Lab
40	**Climate Central**
41	CNBC
42	CNN
43	**Consumer Reports**
44	Cosmopolitan
45	**Cosmos (Australia)**
46	Costco Connection
47	**Cricket Media - Click/ Ask/ Muse/ Dig Into History**
48	Current Archaeology (UK)
49	Current World Archaeology (UK)
50	Daily Beast
51	Daily Climate
52	Dallas Morning News
53	**Denver Post**
54	Deutsche Welle (Germany)
55	**Discover Magazine**
56	Diversity In STEAM magazine
57	Double Helix (Australia)
58	Dream 2047 (India)
59	**E360**
60	Earth Island Journal
61	Earth Sky
62	Earth Touch News (South Africa)
63	Earther
64	East Bay Times
65	Economist
66	Endpoints News
67	**Ensia**
68	**Environmental Health News**
69	EuroScientist (France)
70	Everyday Health
71	**Express Tribune (Pakistan)**
72	Family Circle Magazine

73	Fast Company
74	FierceMarkets - FierceBiotech/ FiercePharma
75	Financial Times
76	**FiveThirtyEight**
77	Food & Environment Reporting Network (FERN)
78	Forbes
79	Fortune
80	Frontline Genomics (UK)
81	Frontline Medical News
82	**Futurism**
83	**Genome magazine**
84	Genome Web
85	**Geographical (UK)**
86	Glamour
87	**Gizmodo**
88	Grist
89	Guardian (Australia)
90	Guardian (UK)
91	Guardian (US)
92	**Hakai Magazine**
93	Harper's Magazine
94	HBCU Research magazine
95	Health
96	Healthline
97	**High Country News**
98	Houston Chronicle
99	How It Works (UK)
100	iD (Ideas & Discoveries) magazine
101	IEEE Spectrum
102	IHS Chemical Week
103	Inc.
104	Inside Science
105	InsideClimateNews
106	**Inverse**
107	Jigsaw Productions
108	**JSTOR Daily**
109	**Kaiser Health News**
110	**Knowable Magazine**

111	Korea Exposé
112	**Labiotech (Germany)**
113	Laboratory News (UK)
114	**Last Word on Nothing**
115	**Lateral (Australia)**
116	Live Science
117	Los Angeles Magazine
118	Los Angeles Times
119	Managed Care
120	Mashable
121	McMahon Publishing
122	Medical Daily
123	Medical News Today
124	MedPage Today
125	**Medscape**
126	Men's Health
127	Men's Journal
128	**Mental Floss**
129	Mercury News
130	**Mic**
131	Michael J. Hennessy Associates - Cure Magazine/ MD Mag/ Onc Live/ Rare Disease Report/ Specialty Pharmacy Times
132	MIT Technology Review
133	**Modern Farmer**
134	**Modern Healthcare**
135	Modern Notion
136	**Mongabay**
137	**Mosaic (UK)**
138	Mother Jones
139	Motherboard
140	Ms. Fit Magazine
141	N + 1
142	National Geographic
143	**Nature**
144	**Nature Medicine**
145	Nautilus
146	NBC News MACH
147	**New Scientist**
148	**New York Magazine**

149	New York Times
150	New Yorker
151	Newsday
152	**Newsweek**
153	NPR News
154	NPR - All Tech Considered
155	NPR - The Salt
156	NPR - Shots
157	NPR - Science
158	NPR - Science
159	O, The Oprah Magazine
160	Observer
161	onEarth
162	OPB - Oregon Field Guide
163	Orion Magazine
164	Outside Magazine
165	**Pacific Standard**
166	PBS - Nature
167	**PBS - News Hour**
168	**PBS - NOVA Next**
169	**PBS - NOVA**
170	Permaculture Magazine (UK)
171	Philadelphia Inquirer
172	PNAS Front Matter
173	Politico
174	Popular Mechanics
175	**Popular Science**
176	Premium Times (Nigeria)
177	Prevention
178	ProPublica
179	Psychology Today
180	Public Radio International (PRI) - Living On Earth
181	Public Radio International (PRI) - The Takeaway
182	Public Radio International (PRI) - The World
183	**Quanta**
184	**Quartz**
185	Quest Magazine (South Africa)
186	R&D Magazine

187	**Radiolab**
188	Refinery 29
189	**Retraction Watch**
190	**Reveal**
191	Room, The Space Journal (Austria)
192	Rural Health Quarterly
193	Safari Magazine (India)
194	Salon
195	San Francisco Chronicle
196	**SAPIENS**
197	**Scholastic - Science World/ Super Science/ Math/ DynaMath**
198	**Science**
199	Science Friday
200	**Science News**
201	Science News for Students
202	Science Reporter (India)
203	**Science Vs**
204	Scientific American
205	Seattle Times
206	Seeker
207	SELF
208	**Sierra Magazine**
209	SciDev.net (UK)
210	**Science Alert (Australia)**
211	Science Spy (Singapore)
212	**Sky And Telescope**
213	Sky News (Canada)
214	**Slate**
215	**Smithsonian**
216	Smithsonian.com
217	South China Morning Post (Hong Kong)
218	Space.com
219	**Spectrum**
220	**STAT**
221	Sydney Morning Herald
222	**Symmetry Magazine**
223	Tampa Bay Times
224	Tech Times

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225	Technologist (Switzerland)
226	**Technology Times (Pakistan)**
227	The California Sunday Magazine
228	The Caravan (India)
229	**The Conversation**
230	The Outline
231	The Quint - Fit (India)
232	The Scientist
233	Tonic
234	U.S. News & World Report
235	**Undark**
236	USA Today
237	Verge
238	Vice
239	Vice News Tonight
240	**Vox**
241	Wall Street Journal
242	**Washington Post**
243	WebMD
244	WIRED UK
245	**WIRED US**
246	Women's Health
247	Yes! Magazine

APPENDIX 3: List of journalism programs that received survey (Bolded names responded)

1	Arizona State University
2	**Boston University - Science and Medical Journalism Program**
3	California State University, Northridge
4	Colorado State University
5	**Columbia University - Journalism M.A. Program, Science Concentration**
6	Columbia University - Journalism M.S. Program
7	Cornell University
8	Emerson College
9	**George Washington University**
10	Indiana University - Joint Degree in Journalism and Environmental Science
11	**Johns Hopkins - Graduate Certificate in Science Writing**
12	**Johns Hopkins - M.A. in Science Writing**
13	Lehigh University - Science and Environmental Writing Program
14	Marquette University
15	**Massachusetts Institute of Technology - Graduate Program in Science Writing**
16	**Massachusetts Institute of Technology - Knight Science Journalism Program**
17	**Michigan State University - M.A. Program in Journalism with Environmental Option**
18	**New York University - Science, Health & Environmental Reporting Program**
19	Northeastern University
20	Northern Arizona University - Journalism M.A. with Minor in Environmental Communication
21	**Northwestern University - Graduate Journalism Program, Health, Environment and Science Specialization**
22	**Point Park University - Environmental Journalism**
23	**Stanford University - Journalism M.S. Program**
24	Stony Brook University - Journalism M.S. Program
25	Syracuse University
26	**Texas A&M University - Science & Technology Journalism**
27	**The City University of New York (CUNY) - Health & Science Reporting**
28	**University of Arizona - Science Journalism Program**
29	**University of California, Berkeley - Science & Technology Journalism**
30	**University of California, Santa Cruz - Science Communication Program**
31	University of Colorado, Boulder - Ted Scripps Environmental Journalism Fellowships
32	**University of Florida - MAMC: Science/Health Communication**

33	**University of Georgia - Health & Medical Journalism Program**
34	**University of Illinois at Urbana-Champaign - Agricultural Communications Program**
35	University of Maryland
36	University of Maryland - Science Communication
37	**University of Missouri, Columbia - Science, Health & Environmental Journalism**
38	University of Montana - Environmental Science and Natural Resource Journalism
39	University of Nebraska-Lincoln
40	**University of North Carolina at Chapel Hill - Science and Medical Journalism Program**
41	**University of Southern California - Annenberg Health Journalism Fellowships**
42	University of Tennessee - Science Communication Program
43	University of Texas, Austin
44	University of Wisconsin, Madison - Life Sciences Communication
45	University of Wisconsin, Madison - Professional M.A. Track with a specialty in science, health and technology reporting

ENDNOTES

[1] Bill Kovach and Tom Rosenstiel, *The Elements of Journalism: What Newspeople Should Know and the Public Should Expect* (New York: Three Rivers Press, 2014), page 10.

[2] Brooke Borel, *The Chicago Guide to Fact-checking* (Chicago: The University of Chicago Press, 2016); American Society of News Editors, https://www.asne.org/content.asp?contentid=131 (ASNE stopped tracking job categories in the 2015, in part because the categories were shifting. Per personal email exchange between Brooke Borel and Adam Maksl); Sydney Ember, "Times Staff Members Protest Cuts and Changes to News Operation," *The New York Times* https://www.nytimes.com/2017/06/29/business/media/new-york-times-staff-members-protest-cuts.html

[3] John Keats, "Ode to a Nightingale," John Keats, the Poetry Foundation, accessed May 7, 2018 https://www.poetryfoundation.org/poems/44479/ode-to-a-nightingale; Miguel de Cervantes , *Don Quixote* (New York: Penguin Classics, Revised Ed edition, 2003); "Latest Intelligence: By Telegraph to the New-York Daily Times. Massachusetts Whig Convention at Worcester — Nomination for Governor," New York Times, October 3, 1855; Robert Palmer, "More Than Ever," © Warner/Chappell Music, Inc. 1988; Robert Nedelkoff, "Now More Than Ever," Richard Nixon Foundation, August 7, 2011, https://www.nixonfoundation.org/2011/08/now-more-than-ever/

[4] Alex Caton, "Now, More Than Ever, 'Now More Than Ever' Needs to Go," *The Washington Post*, March 15, 2017, https://www.washingtonpost.com/posteverything/wp/2017/03/15/now-more-than-ever-now-more-than-ever-needs-to-go/?noredirect=on&utm_term=.acd1f8673197; Claire Fallon, "'Now More Than Ever' And the Distracting Urgency of Our Words," *Huffington Post*, Updated November 8, 2017, https://www.huffingtonpost.com/entry/now-more-than-ever-and-the-distracting-urgency-of-our-words_us_5a01db50e4b066c2c03a6c9f; The Editors of n+1, "Now Less Than Never," Spring 2017, https://nplusonemag.com/issue-28/the-intellectual-situation/now-less-than-never/

[5] Jacob Carter et al, "Sidelining Science Since Day One," Union of Concerned Scientists, 2017, https://www.ucsusa.org/sites/default/files/attach/2017/07/sidelining-science-es-ucs-7-20-2017.pdf

[6] Joel Simon, "Assessing Trump's Press Freedom Record, One Year On," *Columbia Journalism Review*, January 19, 2018, https://www.cjr.org/analysis/trump-press-freedom.php; Kelsey Sutton, "After Threats to CNN, Freedom Groups Say Trump's Cries of 'Fake News' Endanger Journalists," *Mic*, January 23, 2018 https://mic.com/articles/187566/after-threats-to-cnn-press-freedom-groups-say-trumps-cries-of-fake-news-endanger-journalists#.HCPkGa1iH

[7] Neil Postman, *Amusing Ourselves to Death: Public Discourse in the Age of Show Business*, (New York: Penguin Books, 2005)

[8] Bob Franklin, "The Future of Journalism," *Journalism Studies* 15:5 481-499 (2012); Michael Barthel, "5 key takeaways about the State of the News Media in 2016," Pew Research Center, 2016, http://www.pewresearch.org/fact-tank/2016/06/15/state-of-the-news-media-2016-key-takeaways/

[9] Nick Wingfield, Mike Isaac, and Katie Benner, "Google and Facebook Take Aim at Fake News Sites," *The New York Times*, November 14, 2016, https://www.nytimes.com/2016/11/15/technology/google-will-ban-websites-that-host-fake-news-from-using-its-ad-service.html; Sam Levin, "Facebook and Google promote politicized fake news about Las Vegas shooter," *The Guardian*, October 2, 2017, https://www.theguardian.com/us-news/2017/oct/02/las-vegas-shooting-facebook-google-fake-news-shooter; Heather Timmons, "Google executives are floating a plan to fight fake news on Facebook and Twitter," *Quartz*, February 8, 2018, https://qz.com/1195872/google-facebook-twitter-fake-news-chrome/; Tim Bradshaw and Anna Nicolaou, "Facebook and Google executives clash over 'fake news,'" *Financial Times*, March 22, 2018, https://www.ft.com/content/3929bb2c-2de9-11e8-9b4b-bc4b9f08f381

[10] Brooke Borel, "Can AI solve the internet's fake news problem? A fact-checker investigates," *Popular Science*, March 20, 2018, https://www.popsci.com/can-artificial-intelligence-solve-internets-fake-news-problem

[11] Borel, *The Chicago Guide to Fact-checking*

[12] Scott R. Maier, "Tip of the Iceberg: Published Corrections Represent Two percent of Factual Errors in Newspapers," Newspaper Division, Association for Education in Journalism and Mass Communication, Washington, D.C. (August 2007)

[13] There may be legal precedent for avoiding fact-checking guidelines, although it would likely apply to all fact-checking processes, and not only those that are written down. In *Masson v. New Yorker Magazine, Inc.* No. 89-1799, an appeals court suggested that because the *New Yorker* had a fact-checking process, it opened the publication to greater scrutiny than if it had no such process.

[14] Borel, *The Chicago Guide to Fact-checking*

[15] Sheila Coronel et al, "'A Rape On Campus' What Went Wrong?" *The Columbia University Graduate School of Journalism*, April 5, 2015, https://www.rollingstone.com/culture/features/a-rape-on-campus-what-went-wrong-20150405; Sydney Ember, "Rolling Stone to Pay $1.65 Million to Fraternity Over Discredited Rape Story," *The New York Times*, June 13, 2017, https://www.nytimes.com/2017/06/13/business/media/rape-uva-rolling-stone-frat.html; Matthew Haag, "Rolling Stone Settles Lawsuit Over Debunked Campus Rape Article," *The New York Times,* April 11, 2017, https://www.nytimes.com/2017/04/11/business/media/rolling-stone-university-virginia-rape-story-settlement.html