



Royal Netherlands Academy of Arts and Sciences (KNAW) KONINKLIJKE NEDERLANDSE AKADEMIE VAN WETENSCHAPPEN

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Harvey, Jeffrey A.; van den Berg, Daphne; Ellers, Jacintha; Kampen, Remko; Crowther, Thomas W.; Roessingh, Peter; Verheggen, Bart; Nuijten, Rascha J. M.; Post, Eric; Lewandowsky, Stephan; Stirling, Ian; Balgopal, Meena; Amstrup, Steven C.; Mann, Michael E.

published in

BioScience

2018

DOI (link to publisher)

[10.1093/biosci/bix133](https://doi.org/10.1093/biosci/bix133)

document version

Publisher's PDF, also known as Version of record

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citation for published version (APA)

Harvey, J. A., van den Berg, D., Ellers, J., Kampen, R., Crowther, T. W., Roessingh, P., Verheggen, B., Nuijten, R. J. M., Post, E., Lewandowsky, S., Stirling, I., Balgopal, M., Amstrup, S. C., & Mann, M. E. (2018). Internet Blogs, Polar Bears, and Climate-Change Denial by Proxy. *BioScience*, 68(4), 281-287. Article bix133. <https://doi.org/10.1093/biosci/bix133>

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Internet Blogs, Polar Bears, and Climate-Change Denial by Proxy

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*Increasing surface temperatures, Arctic sea-ice loss, and other evidence of anthropogenic global warming (AGW) are acknowledged by every major scientific organization in the world. However, there is a wide gap between this broad scientific consensus and public opinion. Internet blogs have strongly contributed to this consensus gap by fomenting misunderstandings of AGW causes and consequences. Polar bears (*Ursus maritimus*) have become a “poster species” for AGW, making them a target of those denying AGW evidence. Here, focusing on Arctic sea ice and polar bears, we show that blogs that deny or downplay AGW disregard the overwhelming scientific evidence of Arctic sea-ice loss and polar bear vulnerability. By denying the impacts of AGW on polar bears, bloggers aim to cast doubt on other established ecological consequences of AGW, aggravating the consensus gap. To counter misinformation and reduce this gap, scientists should directly engage the public in the media and blogosphere.*

Keywords: advocacy, communication, contrarian, global warming, skeptic, social media

The US National Oceanic and Atmospheric Administration (NOAA) and National Aeronautics and Space Administration (NASA) both recently reported that 2016 was the warmest year on record (Potter et al. 2016), followed by 2015 and 2014. Currently, 2017 is on track to be the second warmest year after 2016. The vast majority of scientists agree that most of the warming since the Industrial Revolution is explained by rising atmospheric greenhouse gas (GHG) concentrations (Doran and Zimmerman 2009, Cook et al. 2013, Stenhouse et al. 2014, Carlton et al. 2015, Verheggen et al. 2015), that the frequency of extremely warm years will increase in a future of continually rising GHG levels, and that the harmful effects of anthropogenic global warming (AGW) on natural and managed ecosystems across the biosphere (Stocker et al. 2013) will escalate. However, much of the public remains unconvinced of the human influence on climate, as has been described by Working Groups 1 and 2 of the Intergovernmental Panel on Climate Change (IPCC), and believes scientists continue to debate AGW causes or even process (Lewandowsky et al. 2013). This chasm between public opinion and scientific agreement on AGW is now commonly referred to as the *consensus gap* (Lewandowsky et al. 2013). Several factors contribute to the consensus gap. For example, some media outlets consistently misrepresent our fundamental understanding of AGW. This may be partially because framing AGW as a “scientific

controversy,” with “opinions on both sides,” may be more profitable than differentiating unsubstantiated opinions of climate-change deniers from the broad and evidence-based “scientific consensus” (Oreskes and Conway 2011, Dunlap 2013, Lewandowsky et al. 2013). Also, the corporate media may not wish to overemphasize the significance of AGW if this conflicts with the interests of advertisers (Anderson 2009). Many elected politicians further confuse the public by denying—or expressing unwarranted skepticism about—AGW (Oreskes and Conway 2011).

Climate-change denial and the Internet

Recent evidence shows that climate-change denial involves a growing labyrinthine network of corporations, conservative foundations, think tanks, and the mainstream media (Farrell 2016a, 2016b). Facebook, Twitter, and other social-media outlets also provide powerful voices in the battle for public opinion, and Internet blogs have become major conduits for disseminating various views on AGW (Nisbet and Kotcher 2009, Brulle et al. 2012, Dunlap 2013). A *blog* is a website that contains regularly updated online personal ideas, comments, and/or hyperlinks provided by the writer (Nisbet and Kotcher 2013). The Internet is open to public use, and individuals or organizations can set up blogs and promote their perspectives on virtually any topic, irrespective of their societal importance or validity. Many societally important

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doi:10.1093/biosci/bix133

Advance Access publication 21 November 2017

topics are discussed and debated on blogs, and some heavily visited blogs have strong effects on public opinion and even political decision-making (Oreskes and Conway 2011, Brulle et al. 2013, Dunlap 2013). *Watts Up With That* (WUWT), which consistently denies AGW and/or threats linked to it, is described as “perhaps the most visited climate website in the world,” with “more than two million unique views a month” (Pearce 2010). Other AGW-denying blogs, such as *Climate Depot* (CD) and *Junk Science* (JS), are not far behind. Many denier blogs exist and, because of cross-linking, form a large echo chamber, making them what one journalist described as “foot soldiers of AGW denial” (Renowden 2014). Despite the growing evidence in support of AGW, these blogs continue to aggressively deny the causes and/or the projected effects of AGW and to personally attack scientists who publish peer-reviewed research in the field with the aim of fomenting doubt to maintain the consensus gap.

Although science-based and science-denier blogs may draw on similar examples, they frame their claims differently. For example, scientific blogs provide context and associated evidence, whereas denier blogs often remove context or misinterpret examples. Frame analysis reveals how communicators present messages to audiences with the intention of influencing how the content is ultimately interpreted (Nisbet 2014). The same frame can be presented in both negative and positive ways, depending on the types of evidence and claims that a writer or speaker makes (Balgopal et al. 2017). Although frame analysis sometimes focuses on the dynamic process through which ideas are developed (Vliegthart and van Zoonen 2011), the examination of blogs requires a focus on the written communication strategies used (Druckman 2001). Most importantly, any topic can be framed in exactly the way a communicator desires if it is not presented objectively, honestly, and with context.

Climate-change denial by proxy: Using hot topics as “keystone dominoes”

A growing body of scientific research reports the wide array of negative effects of AGW on biodiversity (Walther et al. 2002, Parmesan 2006), with the Arctic being particularly affected (Post et al. 2009, 2013). Given that the implications of AGW pervade almost all aspects of ecology (Parmesan 2006) and society (Karl et al. 2009), deniers often focus their attention on observations that, when taken out of context, they can frame in a way that appears to contradict or downplay the severity of climate impacts. Another strategy is to selectively attack prominent lines of research providing compelling evidence of AGW. Mann and colleagues’ (1998) “hockey-stick” graph (see also Mann 2012), in which temperature reconstructions have been made over the past millennium, is a prime example of the latter. Polar bears (*Ursus maritimus*) are also a prominent focus of blogs in the debate over AGW and its biological effects. Because polar bears depend on a habitat that literally melts as temperatures rise, these animals are iconic symbols of the negative effects of AGW (Manzo 2010). At the same time, many denier blogs

pay little or no attention to the volumes of physical evidence for AGW and the empirical biological and ecological evidence of its effects (Nisbet 2014). Because this evidence is so overwhelming, it would be virtually impossible to debunk; the main strategy of denier blogs is therefore to focus on topics that are showy and in which it is therefore easy to generate public interest. These topics are used as “proxies” for AGW in general; in other words, they represent *keystone dominoes* that are strategically placed in front of many hundreds of others, each representing a separate line of evidence for AGW. By appearing to knock over the keystone domino, audiences targeted by the communication may assume all other dominoes are toppled in a form of “dismissal by association.” Proponents of creationism and intelligent design use the same strategy: Instead of providing scientific evidence in favor of their opinions, they instead focus selectively on certain lines of evidence for evolution and attempt to cast doubt on them (Nisbet 2009). They then use this as an argument to support their own views, even if these have no conceptual or empirical support.

Arctic ice extent and polar bears are proxies for AGW denial

On the basis of the bulk of empirical research, polar bears are officially classified as Vulnerable by the International Union for Conservation of Nature (IUCN; 2017) and threatened under the US Endangered Species Act (Cooley et al. 2016). This status has received considerable attention, given their cultural significance and charismatic nature (Stirling and Derocher 2012). Because they can reliably catch their main prey, seals (Stirling and Derocher 2012, Rode et al. 2015), only from the surface of the sea ice, the ongoing decline in the seasonal extent and thickness of their sea-ice habitat (Amstrup et al. 2010, Snape and Forster 2014, Ding et al. 2017) is the most important threat to polar bears’ long-term survival. Although the effects of warming on some polar-bear subpopulations are not yet documented and other subpopulations are apparently still faring well, the fundamental relationship between polar-bear welfare and sea-ice availability is well established, and unmitigated AGW assures that all polar bears ultimately will be negatively affected. Indeed, credible estimates suggest that the entire Arctic may be ice-free during summer within several decades (Snape and Forster 2014, Stroeve and Notz 2015, Notz and Stroeve 2017), a process that, as has been suggested by both theoretical and empirical evidence, will drastically reduce polar-bear populations across their range (Amstrup et al. 2010, Stirling and Derocher 2012, Atwood et al. 2016, Regehr et al. 2016).

To characterize how blogs and related online sources frame the topic of AGW, we identified a total of 90 blogs covering climate-change topics that mentioned both polar bears and sea ice. We found that none of the blogs or online sources expressed views with respect to AGW that were truly in the middle; they fell quite easily into two camps, as was evidenced by the preambles in their descriptors.

As natural and social scientists, we grounded our study in Nisbet's (2014) typology of frames used by science policy-makers and journalists and provide full context and statistical analysis with objective interpretation. We conducted a content analysis to categorize how blogs presented evidence of or opinions on AGW to explain the current and future effects of AGW on Arctic ice extent and polar-bear status (Braun and Clarke 2006). On the basis of statements regarding the current and future status of Arctic sea-ice extent and polar-bear populations, we entered keywords, including *global warming*, *climate change*, *polar bear*, and *Arctic ice*, into Google's search engine. From the blogs, we identified common positions on Arctic ice extent (1–3) and polar-bear status (4–6) and methodically coded each entry's stated positions from the 90 blogs using a constant comparative approach, ensuring that no additional codes were required (Kolb 2012). Each blog was coded for stated positions on these two topics (Arctic ice extent and polar-bear status). The six codes identified were the following: (1) sea-ice extent is on average declining rapidly in the Arctic; (2) sea-ice extent is decreasing only marginally, is not decreasing significantly, or is currently recovering in the Arctic; (3) changes in sea-ice extent in the Arctic are due to natural variability, and it is impossible to predict future conditions; (4) polar bears are threatened with extinction by present and future AGW; (5) polar bears are not threatened with extinction by present and future AGW; and (6) polar bears will adapt to any future changes in Arctic ice extent whether because of AGW or natural variability. We also collected every peer-reviewed scientific paper that we could find that investigated both polar bears and sea ice in our search process (92 papers) and scored their positions for the same six statements. The scores for both blogs and papers were analyzed, and a principle component analysis was used to visualize their relations.

Science-based and -denier blogs take completely different positions on Arctic ice extent and polar-bear status

We found a clear separation between the 45 science-based blogs and the 45 science-denier blogs. The two groups took diametrically opposite positions on the “scientific uncertainty” frame—specifically regarding the threats posed by AGW to polar bears and their Arctic-ice habitat. Scientific blogs provided convincing evidence that AGW poses a threat to both, whereas most denier blogs did not (figure 1). Science-based blogs overwhelmingly used the frame of established scientific certainties and supported arguments with the published literature affirming that warming is rapidly reducing seasonal Arctic sea-ice extent and threatening the mid- to longer-term survival of polar bears, whereas those written by deniers did not (figure 2). Science-denier blogs instead focused on the remaining uncertainties regarding the effects of AGW on Arctic ice extent, suggesting that those uncertainties cast doubt on the present and future demographic trends of polar bears.

Approximately 80% of the denier blogs cited here referred to one particular denier blog, *Polar Bear Science*, by Susan Crockford, as their primary source of discussion and debate on the status of polar bears. Notably, as of this writing, Crockford has neither conducted any original research nor published any articles in the peer-reviewed literature on the effects of sea ice on the population dynamics of polar bears. However, she has published notes and “briefings” through a conservative think tank, the Global Warming Policy Foundation (GWPF), and is described by them as “an expert on polar bear evolution.” Similarly, the Heartland Institute, another conservative think tank that downplays AGW, describes her as “one of the world's foremost experts on polar bears.” Prominent among blogs giving Crockford's blog disproportionate attention are WUWT and CD, suggesting that her blog reaches a large audience.

The GWPF articles by Crockford claim that contrary to available scientific and empirical evidence, polar bears will easily adapt to any changes that Arctic ecosystems may experience in coming decades (Crockford 2014, 2015). Crockford's blog frequently extracts partial research outcomes and portrays them as contrary to the documented effects of AGW on sea ice or polar bears—supporting a “scientific uncertainty” frame. For example, when alleging sea ice recovered after 2012, Crockford downplayed the contribution of sea-ice loss to polar-bear population declines in the Beaufort Sea. Similarly, in GWPF reports and on her blog, Crockford vigorously criticizes, without supporting evidence, the findings of several leading researchers who have studied polar bears in the field for decades. In this manner, her blogs highlight a second frame, “public accountability of science,” evidenced by her claims that scientists overstate their findings. For example, Crockford recently called the findings of a new peer-reviewed and vetted paper by USGS scientists (Durner et al. 2017) “bogus,” “lame,” and “dangerous.” (Crockford 2017). Rhetorical devices to evoke fear and other emotions, such as implying that the public is under threat from deceitful scientists, are common tactics employed by science-denier groups (Barry et al. 2008).

A primary approach of Crockford's and other denier blogs is to frame uncertainty by focusing on the present and to question the accuracy of future predictions—implying that the rapid loss of Arctic ice recorded over the past 40 years induced by AGW cannot serve as a guide to future conditions. This contrasts with the scientific consensus that polar bears will ultimately disappear if Arctic sea-ice declines continue unabated (Amstrup et al. 2010). Despite the roughly linear relationship between observed sea-ice decline and global mean temperature (Amstrup et al. 2010), biological responses are often nonlinear. As in other ecosystems, when critical thresholds in habitat availability are passed, tipping points occur, and species dependent on that habitat suddenly experience sharp declines (Dai et al. 2012). Moreover, habitat loss is not always immediately followed by abundance declines of species dependent on that habitat.

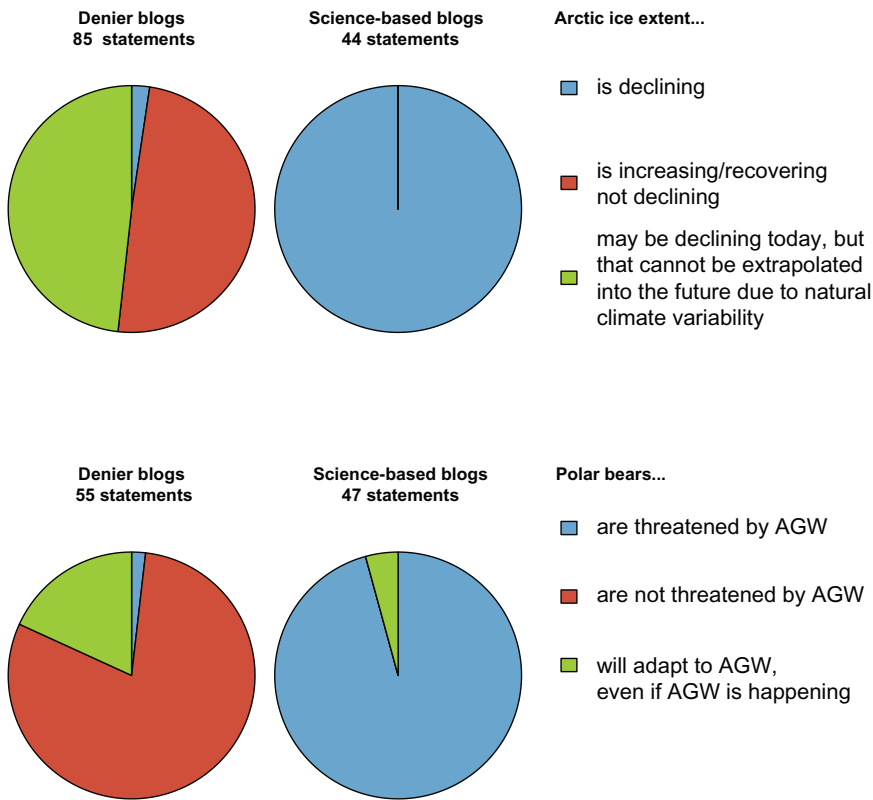


Figure 1. Pie charts showing the percentage of 45 science-based and 45 denier blogs expressing opinions on the effects of AGW on Arctic ice extent and, in turn, on polar bears. “Statements” refers to the cumulative number of hits for each of the three statements about Arctic ice extent and polar-bear status for the blogs included in this study. The blogs were color-coded using a cluster analysis (Manhattan distances and Ward’s clustering) that yielded two large clusters.

Instead, the phenomenon of “extinction debt” can create temporal gaps between the two processes (Kuussaari et al. 2009). These important aspects, vital to our understanding of future prospects for species in shrinking habitats, including polar bears, are ignored by Crockford’s and other AGW-denying blogs.

Denier blogs that downplay the threats of AGW to Arctic ice and polar bears rely heavily on arguments that it has been warmer in the past, that temperature and seasonal ice extent vary naturally over time, and that it is therefore difficult or even impossible to predict what will happen in the future. This framing ignores the fact that scientists agree that natural short-term fluctuations in weather and climate will persist along with secular trends of global warming and declining ice. Also, previous global-warming events were a part of natural cycles of warming and cooling driven by orbital factors. Summer sea ice did not disappear entirely during past interglacial periods (Stein et al. 2017), as it ultimately will with unabated GHG rise. And even if dramatically reduced, ice extent always recovered when warm interglacial periods were followed by waning insolation and cooling temperatures. Current global warming, in contrast, is driven by rising GHG concentrations, is

occurring despite reduced insolation, and cannot be reversed without mitigating GHG rise (Brigham-Grette 2009, Tzedakis et al. 2012, Barnhart et al. 2013, Stocker et al. 2013). Moreover, sea-ice habitat reductions during past interglacial periods occurred over millennia (rather than over the decadal scales that accompany AGW), giving the bears more time to adjust their behavior and distribution. Bears today also face multiple additional threats, including chemical bioaccumulation, on-the-ground habitat manipulation, and human harvesting, factors that were absent during past warming episodes (Stirling and Derocher 2012). Because current warming cannot be reversed without human action (Stocker et al. 2013), the prognosis for polar bears and other Arctic biota without GHG mitigation is bleak (Stirling and Derocher 2012, Regehr et al. 2016). These facts are not accurately reflected in the views expressed by denier blogs.

Overcoming reticence: Scientists as advocates in countering AGW denial

Pimm and Harvey (2000) provided three criteria with which to evaluate the credibility of scientific studies. First and most importantly, follow the data. They emphasized that the data trails of skeptics generally go cold very quickly. Second, follow the money. Some of the most prominent AGW deniers, including Crockford, are linked with or receive support from organizations that downplay AGW (e.g., Dr. Crockford has previously been paid for report writing by the Heartland Institute). Third, follow the credentials. As we have illustrated here, scientists such as Crockford who are described as “experts” on denier blogs in fact typically have little in the way of relevant expertise, and their expertise is often self-manufactured to serve alternative agendas. These criteria confirm that many denier blogs are deliberately distorting science to promote predetermined worldviews and political or economic agendas (Oreskes and Conway 2011, Dunlap 2013). A fourth criterion that we can add here is to follow the language. As Whitmarsh (2011) explained, those who deny AGW do not hesitate to attack their opponents with insults, and have smeared scientists by calling them names such as “eco-fascists,” “fraudsters,” or “green terrorists” or by accusing them of being part of a global “scam” or “hoax.”

The considerable influence that blogs exert on public opinion and decision-making should not be underestimated. Among users, trust for blogs has been reported

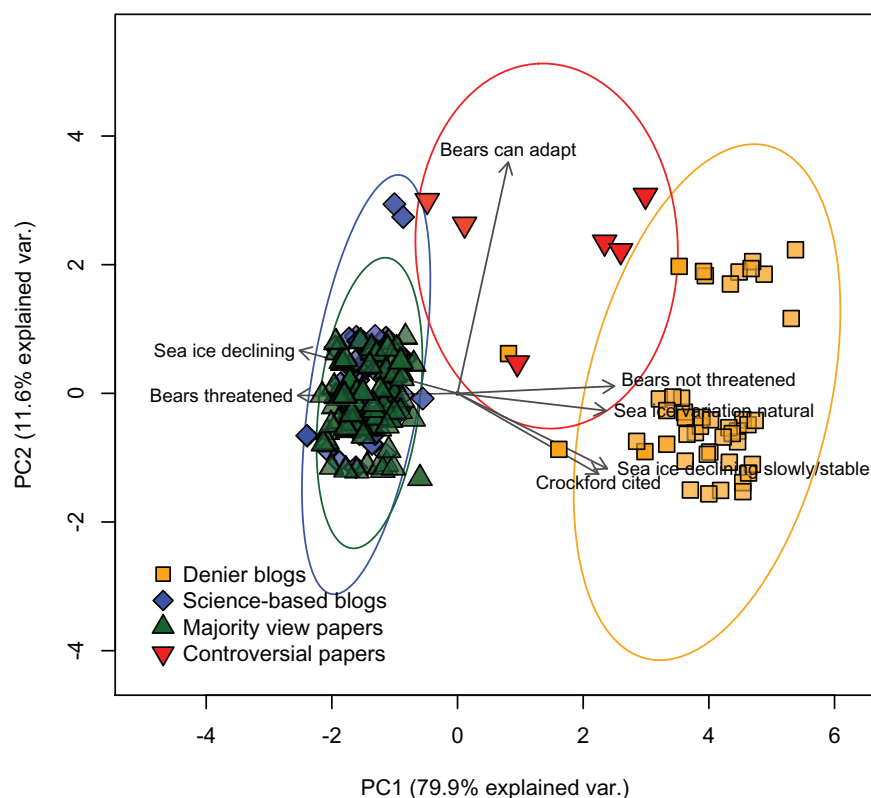


Figure 2. Principle component analysis of scores for six statements, three about Arctic ice and three about polar bears, and citations of Susan Crockford. Scores were extracted from 90 blogs and 92 peer reviewed scientific papers. The blogs were color-coded according to their group in a cluster analysis using Manhattan distances and Ward's clustering. The papers were classified as controversial when they evoked critical comments and discussion in the peer-reviewed literature. The ellipses around the data points indicate 95% normal probability. The first PCA axis clearly shows the consensus gap, with fully separated positions for the scientific literature and blogs that deny problems with Arctic ice or polar bears. Science-based blogs, on the other hand, take positions that completely overlap with the peer-reviewed literature. Note that even the small number of more "controversial" scientific papers still exhibit less extreme positions on the first axis than those expressed in the majority of denial blogs. The second PCA axis represents a much smaller amount of variation that appears to represent the presumed adaptive potential of the bears.

to exceed that of other traditional news or information sources (Johnson and Kay 2004). In our opinion, combating distortions of AGW in blogs and other online sources requires a greater level of direct engagement between scientists, the public, and the media. We strongly believe that scientists have a professional and moral obligation not only to inform the public about the findings and implications of their research but also to counter misinformation, especially where vested interests are concerned (Mann 2014). However, there appears to be a reticence on the part of many scientists to enter the public arena and especially to challenge the unscientific arguments propounded by AGW deniers (Hansen 2007). The reasons for this reticence are many and varied and include balancing arguments for

"crying wolf" against the implications of "fiddling while Rome burns" (Hansen 2007). Furthermore, there is reluctance among many scientists to counter the scientific distortions of deniers because there is no traditional reward system for academics to engage in what amounts to "trench warfare." Indeed, there is a concern, not necessarily unfounded, that speaking out may actually harm one's career prospects (Barber 1961, Nordhagen et al 2014). There is also a tradition for scientists to focus on the remaining uncertainties in their knowledge, which still require investigation, rather than the certainties that require no more attention. Scientific focus on uncertainties, although a critical part of science, provides the "grain for the grist mill" of the blog deniers, and scientists need to more effectively express established certainties while placing remaining uncertainties into their appropriate context. Finally, we feel that many scientists mistakenly believe that debates with deniers over the causes and consequences of climate change are purely science driven when in reality the situation with deniers is probably more akin to a street fight (Nature Editors 2010) based on those deniers' political or economic agendas (Oreskes and Conway 2011, Farrell 2016a, 2016b)—something that urgently needs to be recognized.

We believe that it is imperative for more scientists to venture beyond the confines of their labs and lecture halls to directly engage with the public and policymakers, as well as more strongly confronting and resisting the well-funded and organized network of AGW denial. This can be done in numerous ways. For

example, scientists can be more proactive in approaching the media to emphasize the importance of research findings or to counter misinterpretations. They can also begin to encourage initiatives that empower citizen participation in scientific research, such as citizen science, as is being done currently at several major universities and research institutes. Moreover, scientists need to more effectively use Internet-based social media to their full advantage in order to turn the tide in the battle for public opinion. In this vein, the prominence and importance of blogs such as *Real Climate* show how climate scientists can successfully enter the blogosphere. Expanding this to include Twitter, Facebook, YouTube, and other social-media sources may help to close the consensus gap, and we urgently encourage such efforts.

Acknowledgments

The authors wish to thank the three anonymous reviewers for their helpful comments on the manuscript.

Supplemental material

Supplementary data are available at *BIOSCI* online.

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