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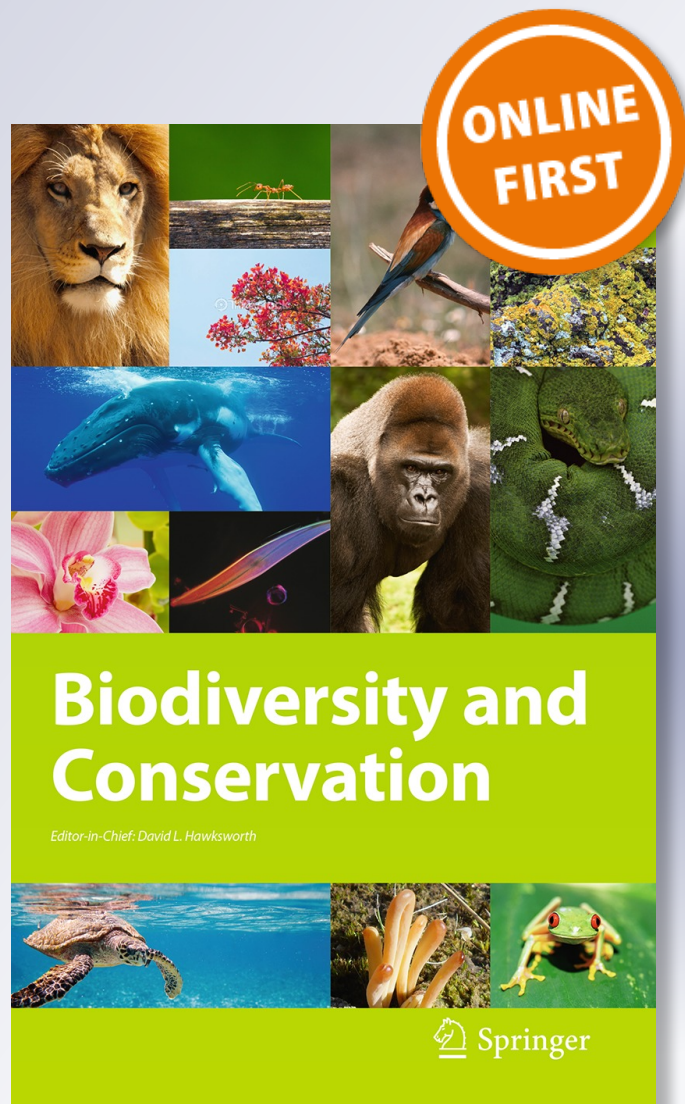
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Biodiversity and Conservation

ISSN 0960-3115

Biodivers Conserv

DOI 10.1007/s10531-013-0476-6



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Google search patterns suggest declining interest in the environment

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Received: 25 January 2013 / Accepted: 21 March 2013
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Abstract Public interest in most aspects of the environment is sharply declining relative to other subjects, as measured by internet searches performed on Google. Changes in the search behavior by the public are closely tied to their interests, and those interests are critical to driving public policy. Google Insights for Search (GIFS) was a tool that provided access to search data but is now combined with another tool, Google Trends. We used GIFS to obtain data for 19 environment-related terms from 2001 to 2009. The only environment-related term with large positive slope was climate change. All other terms that we queried had strong negative slopes indicating that searches for these topics dropped over the last decade. Our results suggest that the public is growing less interested in the environment.

Keywords Public opinion · Sustainability · Environment · Google insights for search · Google

Introduction

Conservation biologists and environmental scientists need to be aware of and react to changes in public opinion because it is an important factor in shaping government decisions (Page and Shapiro 1983; Domhoff 2002; Nisbet and Myers 2007). How interested is the public (i.e. the average person in society) in environmental issues and has this interest changed? Are they engaged in confronting these events? And, are efforts to educate the public working? In this paper we explore indications of public interests and opinion in an attempt to confront these questions.

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Media coverage strongly influences public opinion (Soroko 2003; Hahn et al. 2009; Warren 2012). In the last few decades, online information has overtaken the formerly dominant source of media influence: television (O’Heffernan 1994; Ratchford et al. 2001; Nisbet et al. 2004). Community media is growing especially fast (Carpentier et al. 2003; Deuze 2006; Jakubowicz 2010), and may soon overtake television as a primary source of information for the public (Baker et al. 2003; Norris 2003; Sears 2008). This form of media is difficult to define because of its diversity, but it includes social media such as online discussion rooms, blogs, discussion forums, listservs, and similar outlets that facilitate information distribution to members (Rennie 2006; Howard and Parks 2012; Philpott and Swettenham 2012).

Search engines are now a routine and widely used form of community media available for accessing information on the Internet (Chay and Sasaki 2011; Davis et al. 2012; Weeks et al. 2012). Google is the most popular search engine on the World Wide Web drawing most (67 %) of the 113 billion web searches per month (Lipsman 2009). Google uses a complex algorithm to locate web items that interests users based on key words and phrases typed into its search engine (Cahill 2007; Li and Deng 2012; Moe and Schweidel 2012). Each search query entered into Google is logged into the Google database (Rader 2011; Westwood 2010; Zheluk et al. 2012) and until 2012 could be accessed using Google Insights for Search (GIFS) (Baily 2012; Black 2012; Lindh et al. 2012), now GIFS and Google Trends are combined into a single similar tool. People generally enter terms into this search engine because they are interested in something about them (Baram-Tsabari 2011; Margetts 2012; Vayena et al. 2012), and Google search volume is strongly correlated with public participation in political issues (Reilly et al. 2012).

Google Insights for Search is a flexible, robust data mining tool (Scheitle 2011; Black 2012; Yang 2012) that consistently gives more statistically accurate data than other survey-based indicators of public opinion and interest (Schmidt and Vosen 2011; Ripberger 2011; Kulkarni 2012). GIFS avoids the problems with telephone, mail, and email surveys which are subject to nonresponse bias (Armstrong and Overton 1977, Embree and Whitehead 1993) lying and suspicion (Hampl 1980), and with observational studies which often involve ethical and moral questions (Jackson 1983). Further, surveys may not accurately capture the link between attitudes and behavior because survey-based indicators detect an individual’s willingness to behave, whereas, the GIFS indicators provide a measure of the individual’s preparatory steps to behave in a way already selected or decided (Schmidt and Vosen 2011). Additionally, it’s one of the few available tools that can measure curiosity, an element of interest (Guo et al. 2010). The validity of GIFS for tracking public opinion and interest is well accepted (Ortiz et al. 2011; Carr and Dunsinger 2012; Gallagher et al. 2012). The data gathered using GIFS have been applied previously to study many phenomena (Scharkow and Vogelgesang 2009; 2011; Markey and Markey 2012; Wilde and Pope 2013). Some of these GIFS studies include: human disease surveillance (Mostashari 2007; Nougairède et al. 2010; Yin and Ho 2012), media influence on public opinion of environmental and health warnings (Mazur 2009; Bromberg et al. 2012; Freeman 2012), human responses to the H1N1 Flu outbreak (Bentley and Ormerod 2009; Ginsberg et al. 2009; Pervaiz et al. 2012), unemployment forecasting and study (Askitas and Zimmermann 2009; Ayers et al. 2012; Chadwick and Sengul 2012), and recreational use of natural resources (Caijas et al. 2012; Martin et al. 2012; Wilde and Pope 2013).

Google Insights for Search can provide important indications of trends in public interest of environmental issues over time (Ratchford et al. 2001; Nerlich 2010; Yang et al. 2010). However, casual searches using GIFS will not provide dependable results because terms must be chosen carefully to limit ambiguities and multiple meanings (Zhu et al. 2012).

Previous studies suggest that youth became significantly less environmentally conscious from 1976 to 2005 (Wray-Lake et al. 2010). We posed the following question: Has the public interest in conservation and biodiversity (i.e. the full range of life, from genes to landscapes, including structure, composition and function) changed since 2004? We predicted that if interest increased, then Google searches for environment-related phrases would increase, but if public interest declined, then these searches would decrease. If interest remained stable, then the search volume during the observed time frame should have a zero slope. Lastly, if changes were found, we asked what the future implications might be for the fields of conservation and environmental science.

Methods

We accessed internet activity from 2004 to present using GIFS (<http://www.google.com/insights/search>). In response to investigator queries, GIFS reports how often the worldwide population of internet users does Google searches for a given term in proportion to the total of all Google searches during the given range of dates. Google excludes repeated queries from a single user over a short time-period to avoid pseudoreplication of web searches. The reported output provides normalized search data presented on a scale from 0 to 100. If the number of Google searches for a term drop over time, then we are hypothesizing that the public's interest in that term fell concurrently (Lincoln 2011; Kasesbauer et al. 2012; Mohammed et al. 2012). None of the other search engines (e.g. excite, Yahoo, etc) currently make search data available, which is why we only analyzed the results from GIFS in this paper.

We queried GIFS for 19 environmentally-related search terms and phrases. All terms were submitted in English. Six of these were generalized, encompassing terms: conservation, ecology, environment, biodiversity, wildlife, fisheries. These were the first terms selected for analysis and we selected them because they serve as the most broad and generalized terms, albeit overlapping in meaning. When you query GIFS, it automatically provides a list of closely related searches. Among these we selected the seven most commonly searched phrases focused on organism conservation: endangered species, fish conservation, amphibian conservation, reptile conservation, mammal conservation, invertebrate conservation and bird conservation. Then we selected the seven most commonly searched phrases that were specific conservation or environmental issues: climate change, global warming, sustainability, habitat fragmentation, pollution, extinction, and invasive species. We chose terms that had enough data to analyze over the time period of interest. That is, we did not use terms whose low usage volume prevented GIFS from providing data output for more than 2 years of our data. We also excluded terms if they did not have continuous usage after their initial appearance. All of these problems cause the data volume from many terms to be insufficient to analyze.

We downloaded the normalized search data from the GIFS website and performed linear regression with MiniTab[®] 13.3 (Minitab, State College, PA) to identify possible changes in the global community's interest in the selected topics. In these analyses, the predictor was time and the response variable was the Google search volume as expressed by GIFS. We used no geographical restrictions when using GIFS, so our data reflects worldwide results from users searching the internet with Google in English.

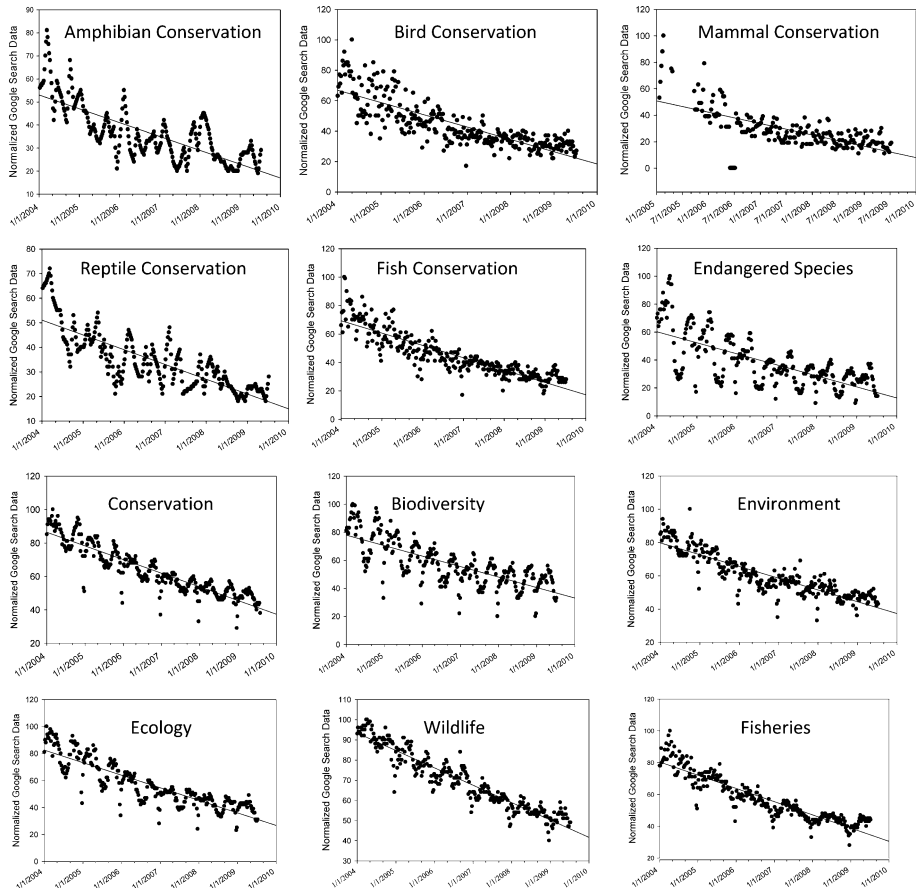


Fig. 1 Selected terms or phrases of Google Insights for Search queries for conservation of organisms (*rows 1–2*); and generalized key words related to conservation (*rows 3–4*)

Results

Our analysis of the GIFS data produced a clear pattern of decline in most environmentally-related search terms between 2004 and 2009 (Figs. 1, 2; Table 1), thus suggesting an eroding public interest in the environment. One term (invertebrate conservation) had insufficient data to analyze. The number of searches per month for the terms we queried varied from 13.6 million (environment) to 100 (invertebrate conservation) (Table 1). In all cases below, searches for any phrase or term used with other words are encompassed by the results. For example, ecology includes searches for animal ecology. Each term was also queried in Google Adwords Keyword Tool to establish the number of queries per term.

Most trends for the search phrases related to organism conservation that we queried had steep downward slopes (Fig. 1, amphibian conservation = $-5.0/\text{yr}$, bird conservation = $6.71/\text{yr}$, fish conservation = $-7.57/\text{yr}$, and reptile conservation = $-5.29/\text{yr}$). The search data from 2004 strongly influenced the trends for the phrase “mammal conservation” due to the propensity of outliers and substantial data spread ($r^2 = 0.031$, $P < 0.003$) creating much heteroscedasticity. There was little heteroscedasticity in the data from 2005

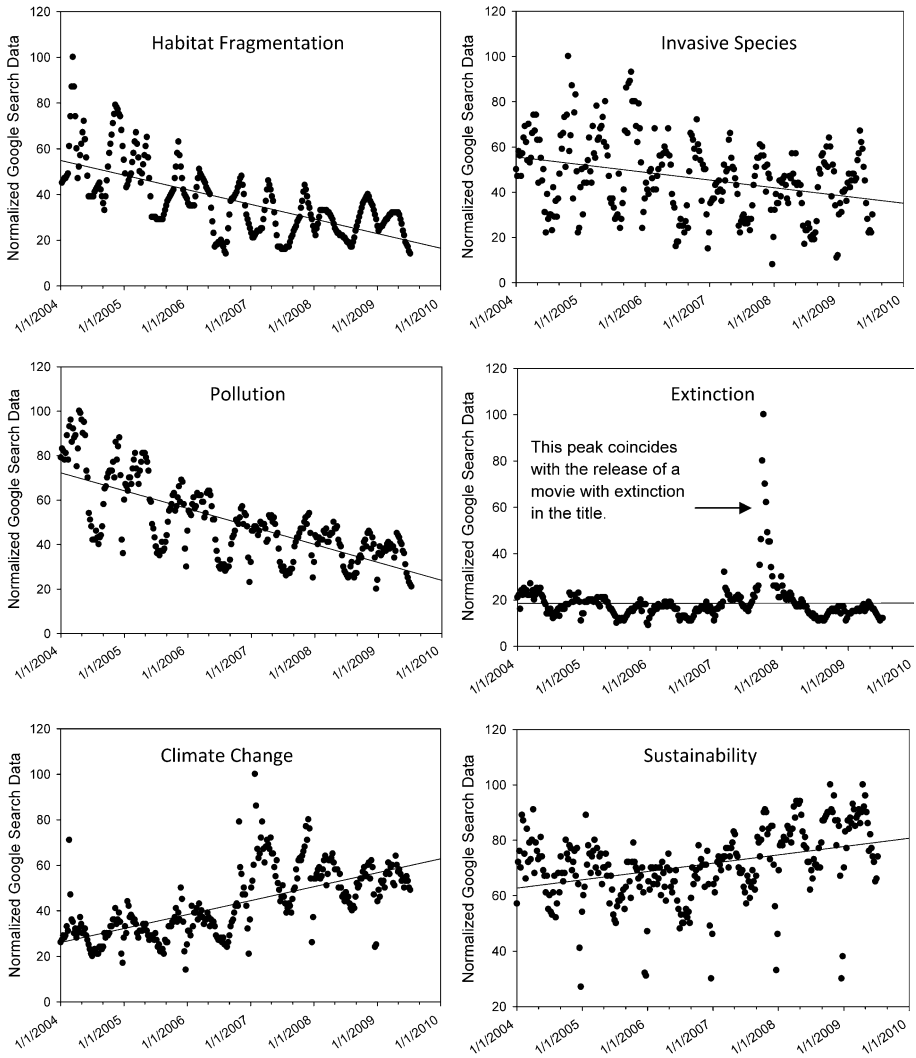


Fig. 2 Selected terms or phrases of Google Insights for Search queries for conservation issues

to 2009, so we excluded the 2004 data. From 2005 to 2010 the frequency of this term trended downward (slope = $-5.71/\text{yr}$) similar to other organismal phrases (Fig. 1; $r^2 = 0.453$, $P < 0.001$). Searches for the phrase endangered species dropped sharply as well (slope = $-6.86/\text{yr}$). Searches for environment (slope = $-5.71/\text{yr}$), ecology (slope = $-7.29/\text{yr}$), conservation (slope = $-6.43/\text{yr}$), biodiversity (slope = $-6.0/\text{yr}$), wildlife (slope = $-7.14/\text{yr}$), and fisheries (slope = $-7.0/\text{yr}$) fell sharply from 2004 to 2010.

Of the six environmental issues queried, interest clearly declined for habitat fragmentation (slope = $-5.29/\text{yr}$) and pollution (slope = $-7.43/\text{yr}$, Fig. 2). Interest in invasive species declined (slope = -2.86), but these data were more widely scattered. The trends for sustainability (slope = $2.29/\text{yr}$) and climate change (slope = $5.29/\text{yr}$) increased (global

Table 1 Comparison of selected environmental terms for number of articles accessed in Google Scholar, and changes over time (2004–2010) in Google Insight for Search (GIFS)

Term	Number of queries per term (millions/month) from Google Adwords Keyword Tool	GIFS normalized query data			r^2	Sign. $P < 0.001$
		2004	2010	Change		
Environment	13.6	79	39	-40	0.776	**
Conservation	4.1	85	40	-45	0.813	**
Ecology	1.8	81	30	-51	0.755	**
Global warming	2.7	22	14	-8	0.105	0.025
Climate change	2.2	26	63	+37	0.428	**
Fish conservation	0.2	71	18	-53	0.770	**
Sustainability	1.2	64	80	+16	0.139	**
Extinction	1.5	20	21	+1	<0.001	-
Pollution	5.0	74	22	-52	0.526	**
Fisheries	1.0	81	32	-49	0.838	**
Wildlife	5.0	93	43	-50	0.897	**
Invasive species	0.2	58	38	-20	0.106	**
Biodiversity	1.0	78	36	-42	0.553	**
Bird conservation	0.01	65	18	-47	0.663	**
Endangered species	0.8	60	12	-48	0.468	**
Mammal conservation	0.004	50	10	-40	0.453	**
Habitat fragmentation	0.01	55	18	-37	0.444	**
Invertebrate conservation	0.0001	-	-	-	-	-
Amphibian conservation	0.002	53	18	-35	0.592	**
Reptile conservation	0.001	52	15	-37	0.653	**

Google Adwords Keyword Tool results indicate the monthly number of queries per term as of 15 September 2011

warming was stable [slope = $-1.14/\text{yr}$], and the trend for extinction was difficult to interpret ($P < 0.001$; Fig. 2). Extinction remained stable (slope = $0.14/\text{yr}$) with a large peak in interest that occurred in late 2007; probably caused by the release of a movie during 2007 that had this term in its title.

Discussion

Our data are biased to the results of people who search the internet with English terms and nations in which English is a major language (see Al-Eroud et al. 2011). Although the data we obtained spanned all countries in the world, the percent contribution of specific regions or countries was not available at the time we collected the data. These data neglect to represent portions of the global community who do not use the internet or search engines. Regardless, the results still comprise the largest and broadest available dataset involving public interests (Caneiro and Mylonakis 2009; Lipsman 2009; Choi and Varian 2012) and dependably reveals important and enlightening trends about public interest and opinion (McNab 2009; Breyer and Eisenberg 2010; Vosen and Schmidt 2011), specifically that the relative interest in conservation and the environment is declining and is cause for concern.

Internet searches on all environmental terms except climate change declined during our study period, though the cause of the decline is undetermined. This suggests there may be disconnections between climate change and other environmental issues. If this is true, then this a serious threat to global environmental efforts because public policy formation, such as environmental policy, depends on public support which stems from public interest and peer pressure (Noelle-Neumann 1974; Lax and Phillips 2009; Brulle et al. 2012). In fact, if few are interested in conservation then policy responses proceed down a “spiral of silence” in which publicly voiced pro-conservation opinions are suppressed due to fear of sanctions by peers, or in the case of politicians, distancing voters (Noelle-Neumann 1974; Matthes et al. 2010; Dalisay et al. 2012).

Within the dataset we analyzed there are yearly fluctuations and patterns produced by events unrelated to the definitions we utilized. There is a regular repeating wave in search patterns for many of the search terms used in this study (Figs. 1, 2). We speculate that this wave pattern may reflect fluctuations in student internet activity because the troughs line up with non-school periods (Christmas and summer vacation) and the peaks line up with late spring and fall when many students in North America and elsewhere are writing term papers. This may demonstrate that online academic activity can influence GIFS data output and must be examined as an influential predictor of trends for selected terms. This undulating pattern is very evident in seven and marginally evident in five more of the 18 terms (Figs. 1, 2). The amplitude of the undulations appears stable throughout the observation period for eight of the terms, suggesting that their use in school has not changed much. However, it is pretty obvious that the amplitude gets shorter over time in five terms (amphibian conservation, reptile conservation, endangered species, pollution, and habitat fragmentation). It is possible that these terms are getting less attention in the classroom, providing incentive that educators spend more time on these topics in the future. If students are not learning about these topics as thoroughly as in the past, it could further exacerbate the falling interest in these topics, and lead to a voter population who lacks interest in supporting environmental initiatives or environmental protection (Lundholm 2011; Levy and Zint 2012).

Some single search terms displayed variation from the overall trends. We examined many related terms that encompass specific and broad areas of our subject area, which allowed us to more accurately deduce what is occurring in the realm of public opinion. The term “extinction” appeared to remain stable with a large peak in 2007 (Fig. 2). This large peak coincides with the release of the movie “Resident Evil: Extinction”. The flood of searches for information about the movie confuses the analysis of these search data. However, it does demonstrate how non-environment related searches including environmental terms can influence the data (see Zhu et al. 2012). Had we looked at only this single term, we might have come to different conclusions.

Although GIFS is a powerful tool with robust data sets (Brownstein et al. 2009; McCarthy 2010; Munk 2010), it is one of several tools available to measure trends in what interests the public (Huss et al. 2010; Markey and Markey 2010; Preis et al. 2012). Some potential drawbacks of GIFS include a relatively short period available for analyses (only 2004 to present). Like other gauges of public opinion, GIFS may be sensitive to fads, whims or other stochastic changes in public perception and language requiring careful selection of terms (Zhu et al. 2012). Regardless, search behavior appears to reflect public interest, engagement and opinion (Connolly et al. 2009; Bentley, and Ormerod 2010; Guo et al. 2010). Public interest is important to track because the degree of concern that the public has for an issue drives public policy (Page and Shapiro 1983; Domhoff 2002; Burstein 2010). Political leaders and non-internet media can shape public opinion and drive

policy (McGraw 1998; Baum and Groeling 2009; Gelpi 2010), as can internet media (see Jimenez and Scifo 2010). If the trends we report reflect the interests of the public as a multitude of previous studies suggest (e.g. Ellery et al. 2008; Goal et al. 2010; Preis et al. 2010), then interest in conservation and environmental issues may be waning and, perhaps, leading to indifference. Of particular concern is the combination of our findings with those suggesting a “precipitous decline” in American high school students’ environmental engagement from 1973 to 2005 (Wray-Lake et al. 2010). If we believe as many suggest, that the views of adolescents are tied to those of their parents (Tedin 1974; Francis 1993; Austin and Pinkleton 2001), then one can reasonably conclude that the erosion of the environmental interest has continued unhindered since 1973, despite numerous efforts to educate and foster environmental ethics (e.g. Negra and Manning 1997; McKenzie-Mohr 2000; Hsu 2004). These trends should make the scientific community wary that public support may become more difficult to garner in the future, and ultimately lead to the further degradation of environmental policies and laws.

Climate change (and related terms such as global warming) and sustainability were the only terms that did not decline in popularity from 2004 to 2009 (Table 1). Climate change rose following the hurricane season of 2005, likely due to an increase in news stories about climate change issues. However, the rising popularity of the term “climate change” in public searches ran counter to the trends for the conservation issues that it influences, thus demonstrating the aforementioned disconnect between the close ties bridging conservation and climate change (Dawson et al. 2011). Initially, one may deduce that climate change became a meta-issue that encompasses pollution and other potential search terms indicating that interest had not fallen in these other terms, but rather a change in vocabulary use on the web. However, this is very unlikely because the number of queries for this term relative to other terms is not sufficiently large (Table 1).

Others used GIFS data to investigate the public’s interest in fishing/angling (Martin et al. 2012; Wilde and Pope 2013). They found a decline of 72.6–133.7 % in searches for 19 terms related to recreational angling. This concurs with our finding that search volume declined for Fisheries and for the hunting-related term Wildlife. Both studies, like ours and those of Wray-Lake et al. (2010), present results that bode poorly for the public’s future interest in environmentally related recreational interests.

We are unable to define the specific causes of the trends in our data. A previous study suggested that economic downturns negatively impact environmental concern (Kahn and Kotchen 2010), but others suggest there is no clear connection (Jones and Dunlap 1992). Our analysis does not support an over-riding influence of the economy on declining public interest in environmental issues. Our data reveal that declines in public interest began at least 4 years prior to the economic downturn in September 2008 (Bordo 2008) and no change in trajectory or associated dips or peaks are evident in our trend plots (Figs. 1, 2). Combined with previous findings that engagement in environmental activities fell over the previous 32 years (Wray-Lake et al. 2010), we conclude other, unknown factors are much more influential on the public’s interest in environmental issues than is the economy.

Our results using GIFS are troublesome for several reasons. First, findings using Google search data are widely accepted as dependable (Vanderelst and Speybroeck 2010; Ayers, et al. 2011; Kadry et al. 2011) making our findings a strong warning of declining public interest and engagement. Recognition of these trends for environmental topics may reflect a growing public indifference to conservation and environmental issues. To keep conservation and biodiversity efforts at the forefront of societal concerns, conservation biologists and environmental scientists need to develop more effective strategies to influence public opinion and improve public interest, especially using online methods (Johnson and

Kaye 2000, Cooper 2011). Conservation science must deliver effective on-the-ground management, yet the research must be inspired by and be useful to the public (Sutherland et al. 2009). This may include better transfer and transmission of objective information on environmental issues using traditional media and the internet (Shen et al. 2009; Iversini et al. 2010; Saebo et al. 2010). Citizens of many countries depend on the internet for their news and political information (Johnson and Kaye 2000; Nie et al. 2010; Rainie 2010), and climate deniers have mastered the use of the media to spread their misinformation (Cooper 2011) even directing audiences to climate denier websites for further study. Unfortunately, the average citizen finds the messages of climate deniers and anti-environmental groups decidedly easier to understand and rationalize than the complex messages from environmental groups (Cooper 2011). They may even be easier to find thanks to news outlets and political programs that promote naysayer views. Further, the modern internet user tends to seek out news sources that are entirely in line with their biases, thus eroding their ability to be persuaded of opposing views (Garrett 2009). They also tend to believe online news sources more than other kinds of outlets (Johnson and Kaye 2010). This suggests more effort is needed to relate the relevance and value of environmental causes to the average citizen so that public interest improves, naysayer views are confronted, and political pressure to work on environmental issues grows.

Acknowledgments We thank R. Bruce Bury for review of our manuscript. Any use of trade names is for descriptive purposes only and does not imply endorsement by the authors.

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