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Working Paper Series

Covering Controversial Science: Improving Reporting on Science and Public Policy

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Covering Controversial Science: Improving Reporting on Science and Public Policy

By Cristine Russell[i]

Abstract

As the pace of new developments in science and technology quickens, journalists are increasingly confronted with covering complicated technical information as well as the potential social, legal, religious, and political consequences of scientific research. Avian flu, embryonic stem cell research, genetic engineering, global warming, teaching of evolution, and bio-terrorism are just a few of the topics on journalists' plates today.

More coverage of the complex intersection of science and public policy is needed to help citizens understand the issues. But the resources to do so are limited: print and electronic media have fewer skilled staff science reporters and smaller news holes than in the past. Newspaper science sections, once a popular venue for in-depth reporting, have been declining in number and size and shifting toward consumer-oriented medicine and personal health coverage. At the same time, journalism programs are turning out more trained science reporters than ever before.

Opportunities for science and policy reporting need to be improved, in quantity and quality, with writing that puts the science in context and enhances public understanding of the policy options. New approaches for journalism education and on-the-job training in science coverage are recommended, including novel online opportunities for specialty beat reporting. Guidelines for better coverage of science and public policy are suggested.

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I. INTRODUCTION

"Global Warming Threatens Millions," *Associated Press*, May 14, 2006
"Bush Releases Plan for Possible Flu Pandemic," *Washington Post*, May 3, 2006
"Democrats Hope to Divide G.O.P. over Stem Cells," *New York Times*, April 19, 2006

On a daily basis, news headlines blast warnings and trumpet battles over controversial scientific research and public policy issues that confront the United States and the rest of the world with difficult decisions in the early 21st century. Avian flu, embryonic stem cell research, genetic engineering, global warming, diet and obesity, evolution teaching in the schools, and bio-terrorism are just a few of the subjects that have significant implications for both public policy and personal decision-making. There is a greater need than ever before for journalists who are skilled in reporting both the underlying complexity of the science as well as the legal, ethical, and political ramifications of its uses. Unfortunately, jobs for fulltime science writers at major print and electronic outlets are declining, while the number of important science and science policy developments to cover is increasing. The news hole is shrinking, and the stories that do appear may be confusing, misleading, or downright wrong. Many important topics are left unreported in favor of soft "news you can use" consumer health and medical features on everything from fad diets to the latest exercise machines. The Internet offers an unlimited source of information, but, unsorted and unevaluated, it can be bewildering and inaccurate for the unsophisticated user.

Surveys show that many Americans are "scientifically illiterate" and woefully unprepared to understand basic scientific concepts or the applications of science and technology. Since the general public gets most of its scientific, environmental, and health information from the news media, journalists have an opportunity to help fill the information gap. But leaders in both the scientific and journalistic communities feel that too often reporters and scientists are themselves ill-prepared for communicating about science and public policy in a manner that helps the public

better understand pressing issues, from climate change to the potential epidemic spread of bird flu into humans.

As a result, science and policy issues are frequently presented as a battle between "dueling" experts at two extremes, an approach that gives a false sense of balance and often overemphasizes minority views. Complicated issues become oversimplified; uncertainty is underemphasized; controversy trumps consensus. "Yo-yo" reporting swings from breakthroughs that over-promise to disasters that disproportionately emphasize the negative. Coverage, particularly by inexperienced reporters, may fall short on science and long on political reporting, promoting conflict and personality over substance and overemphasizing who is winning or losing the race to capture public and political support.

The challenge ahead is to boost both spot news and analytical coverage in old and new media of the important issues in science and technology, providing insight and context for understanding the status of important debates involving scientific research. In doing so, the news media must help sort out the potential public and personal choices facing both decision makers and individual citizens.

This paper will examine some of the following questions:

- What is the supply and demand for specialized science reporters, and what is the pipeline?
- Is the amount of science coverage declining in the major news media?
- What types of science and policy stories receive the most coverage?
- Who is best equipped to cover science and public policy?
- How responsive is the scientific community to participating in media coverage of controversial science and policy?
- How does media coverage affect public understanding of current scientific debates?

- What efforts are needed or underway to improve media coverage of science and policy?

II. THE SUPPLY AND DEMAND FOR SCIENCE WRITERS

II. 1 History of science news coverage in the U.S.

The development of science writing as a journalism specialty mirrors the growth of the scientific research enterprise in the United States. Starting as early as 1934, a dozen science writers from major American newspapers banded together to form the National Association of Science Writers (NASW), an organization dedicated to improving the popular reporting of new scientific developments for the general public.[1] Since then, science writers have covered "some of the most momentous events in human history. Science reporters were the first to tell the public of the splitting of the uranium atom and of the consequent explosion of the first atomic bomb" as well as the discovery of antibiotic "wonder drugs" that could cure deadly diseases. [2] Following World War II, as the federal government began to invest heavily in scientific and medical research, the pace of new developments required science reporters to be prepared to follow everything from physics to polio vaccine development.

Science writing really took off as a staple of daily news coverage when a large cadre of general assignment reporters, many with little or no knowledge of science, were "flung into covering science by editors seeking to sate the reader appetite for science news that exploded in the wake of the Soviet Sputnik in the fall of 1957,"[3] notes pioneering science writer Jerry Bishop, a retired *Wall Street Journal* reporter. For much of the 1960s, science reporting was on-the-job training, as the space race received extensive—and usually laudatory—coverage in newspapers, magazines, and television. At the same time, the successful transplant of a heart into

a human patient in 1967 and the pioneering use of chemotherapy to treat cancer promoted the ever-growing coverage of medicine.

The early reporting was often characterized by a "gee-whiz" fascination with the new developments in science, medicine, and technology. But in the 1970s, the coverage turned more skeptical as concerns about environmental contamination led to calls for more government regulation, and rapid developments in biology research raised new ethical concerns. In the 1980s, new diseases, such as AIDS, surprised a world that thought deadly infectious diseases were a thing of the past, while the pace of technological developments such as the computer quickened. In the 1990s and early 21st century, an international effort to determine the structure of the entire human genome, as well as the cloning of animals such as the sheep Dolly, drew attention to the benefits and risks of genetic technology and the global nature of the scientific enterprise.

Along the way, some science reporters were required to cover the whole gamut of science, from basic research to the public policy implications of the use and potential misuse of science. Others specialized further into sub-beats of science writing, from neurobiology to earth sciences. Print journalists at major newspapers, magazines and wire services provided the most in-depth coverage, with the electronic media (with the exception of public television and radio) often limited in content and dominated by the need for compelling visuals. In recent years, the rapid growth of the Internet has provided a new venue for public access to both scientific developments and writing about science, as well as opportunities for citizen journalism. The 24-hour electronic news cycle has also put more pressure on all journalistic outlets to put out information more quickly than ever before, often with little time to do in-depth reporting.

Today, those who cover science and technology range from fulltime science reporters to general assignment reporters who literally catch the story on the run. In addition to news and science sections, science and policy stories increasingly appear in less traditional arenas, including business, education, religion, and political coverage. The biotech and pharmaceutical

industries have become a staple of business news. Debates over the teaching of evolution and intelligent design have dominated some local school board and court coverage, while state and local ballot initiatives force legal and political reporters to cover a variety of scientific, medical, and environmental issues.

Throughout these stories, there has been a growing emphasis on the intersection between science, policy, and politics. As the introduction to a new science writing guide notes, science has become "more a part of daily life. Some of the leading issues in today's political marketplace—embryonic stem cell research, global warming, health care reform, space exploration, genetic privacy, germ warfare—are informed by scientific ideas."[4]

In this paper, science will be defined broadly: physical and life sciences; social sciences such as psychology; medicine and health; environment; environment and energy; space; engineering and technology. The common denominator is the use of standard research methodology designed to ask questions and derive answers. Science news ranges from basic research to applications of science and technology, as well as society's response to scientific developments. Given the breadth of the subject, this paper will focus primarily on the print media, particularly newspaper coverage of science and medicine.

II.2 Number of staff science writers and newspaper science sections declines

It is ironic that as science writing has matured as a profession, both in sophistication and numbers, the traditional media outlets for reaching the general public have shrunk. Cutbacks in the news business, particularly newspapers, have meant a decline in the number of jobs for fulltime staff science writers as well as a drop in the number of weekly science sections. Those that remain have increasingly become consumer-oriented sections that specialize more in soft health and fitness trends than research information based on scientific studies.

From its humble beginnings more than 70 years ago, the National Association of Science Writers (NASW) is now the largest membership organization devoted to professional science writers. It has seen a strong growth in numbers—to more than 2,400 members in mid-2006.[5] But only a small number are employed as fulltime news media staff. An analysis of NASW 2005 membership records conducted for this project found that only about four percent of members—85 people—are staff reporters and editors for newspapers; two percent for popular magazines; one percent for radio and television. Nine percent work for specialty magazines or newsletters. About 40 percent of NASW members are freelance writers for a variety of publications. Another 42 percent write or edit science information or do public affairs for universities, companies, government and other institutions, or teach and study science journalism. By far the most dominant specialty among this science-writing group is medicine and health, [6] although all branches of science writing are represented. (Appendix II)

Newer specialty organizations are also growing, such as the Society of Environmental Journalists, which has jumped to more than 1,400 members since its founding in 1990,[7] and the nine-year-old Association of Health Care Journalists, [8] with about 950 members. They report far larger numbers of newspaper reporters, but many of their members focus largely on environmental or health care policy and politics, with far less emphasis on the underlying science. (Appendix III)

One measure of the interest in science coverage and the willingness of newspapers to showcase it is the decision to run dedicated science sections—usually produced on a weekly basis with a range of stories, from short takes to in-depth features. The *New York Times'* Tuesday "Science Times," started in 1978, is still the gold standard of science sections, both in space, content, and the size of its contingent of highly skilled science reporters. At least 15 fulltime staff science reporters and six editors work on science coverage for the news pages and the science section, as well as a host of outside contributors.[9] The weekly section's coverage

ranges from the arcane—the latest in dinosaur bones and black holes—to the pressing personal and public policy issues of the day. A March 28, 2006, "Science Times" special section on avian or bird flu exemplified the value of a science section in putting the daily news in perspective. The array of stories presented, in great detail, what is currently known and not known about bird flu, how scientific opinion about the likelihood of a human epidemic varies (from the perspective of a "worrier" to that of a "skeptic"), how serious (but uncertain) the potential risk appears to be, and what clues the 1918 human flu pandemic might hold. The coverage was strong and skillful, walking a fine line that gave readers insight into the dangers of a highly unpredictable life-threatening event without scaring them to death.

While the *Times*'section has more than held its own, other newspaper science sections have not fared as well. While popular in newspapers across the U.S. in the 1980s (corresponding, in part, to computer ads), weekly science sections reached a peak of 95 in 1989 but dropped precipitously thereafter. By 1992, only 44 papers continued to run weekly science sections, according to surveys done by the now-defunct Scientists' Institute for Public Information (SIPI)[10].

Since then, science sections have continued to decline in number and size, particularly among smaller papers. Those that remain have shifted even further toward consumer health coverage. Today there are at least 34 daily newspapers in the U.S. that run weekly health and science sections, according to an analysis for this project using the 2005 *Editor & Publisher International Yearbook.*[11] Of them, more than two-thirds focus primarily on health in their titles, up from about 50 percent in 1992. In comparison, the sections that self-identify as "science" dropped from 30 percent in 1992 to 12 percent in 2004. The rest—18 percent today versus 21 percent in 1992—were listed as a combination of "health" and "science."

Of the 44 science sections in the 1992 survey, only 24 remain, with many of those dropping "science" or "discovery" titles in favor of "health" and "fitness." For example, the

Portland Oregonian's section formerly known as "Science" is now called "Accent on Health & Fitness." *Newsday*'s "Discovery" science section is now called "Health & Discovery."

Twenty of the 34 papers known to have weekly science and/or health sections are in the nation's top 50 daily papers in terms of circulation. Of those, 10 had weekly sections in the 1992 survey. Ten additional sections were started over the past decade, with eight out of 10 of them focused exclusively on health. The *New York Times* has also tucked a "Health & Fitness" tab inside its weekly "Science Times" section. (Appendix I)

At daily newspapers around the country, much of the science and health news coverage has also moved into the "lifestyle" sections and out of the news pages. *USA Today*, the United States' largest general circulation national newspaper, puts most of its science, health, and environmental coverage at the back of its "Life" section, although it frequently features medicine and health on its front page. The *Wall Street Journal* regularly puts science and health coverage in its "Personal Journal" feature section. Among regional papers, the *Dallas Morning News* killed its award-winning "Discoveries" section in 2000, moving the content into its "Lifestyles" section; in late 2004, the paper dismantled its prestigious science department, firing half of the six-person staff, according to former science editor Tom Siegfried. Today, after another recent round of staff reductions and buyouts, only one half-time science/medical writer is left, he said.[12]

The struggling newspaper economy, with cutbacks across the board, has also affected the number of experienced science reporters remaining on staff. A number of longtime reporters have taken "buyouts" and moved to freelance or other career options. In 2000, for example, the majority of senior science reporters took a "buyout" at the *Boston Globe*. Given its base in a community rich with university and industry research, the *Globe* has since built its staff back to full-strength, with seven staff reporters covering science, medicine, and the environment in mid-2006 and a five-page weekly "Health/Science" section (originally started in 1981 as "SciTech").[13] Shrinking resources, staff, and space at the *Pittsburgh Post-Gazette* contributed to

science editor Byron Spice's decision in early 2006, after more than 25 years as a newspaper science writer, to leave the paper for a media relations job at Carnegie Mellon University. The paper's weekly "Science and Environment" page in the news section was eliminated earlier this year and merged into a combined "Health and Science" feature section, among other changes. "Every place I know of is cutting back," said Spice. [14]

Science sections remain vulnerable to cutbacks because they haven't maintained strong advertising bases. However, some critics, including science reporters, question the need for separate sections, arguing that they have the danger of preaching to the converted by sequestering important science and health coverage in a section that may be read primarily by readers who are already interested in science. *Los Angeles Times* science writer Robert Lee Hotz, president of the National Association of Science Writers, worries that science sections are "often divorced from the news. They favor lovely but arcane exploration pieces on the wonders of research that may or may not have any connection to the events of the day…We do ourselves a disservice when we set up picket fences that say 'keep out, science writer inside.'" Hotz feels that science coverage needs to be pushed to the front of the paper, competing in the news section with other national and international stories, and that science writers themselves need to be stronger advocates for science and technology coverage. "If we put ourselves in competition with the news of the day, science is extremely successful at elbowing its way onto the front page," he said.[15]

However, promoting more science and science policy coverage in the daily news columns and in weekly science sections is certainly not mutually exclusive. In an ideal world, important science news would be covered as it happens in the daily news pages, and science writers would cover spot news and write in-depth analytical pieces that compete for the front page. But science and health sections provide a reliable opportunity for viewing trends in science and science policy in more depth and with more perspective than may be realistically available in

the front-section news hole. The *New York Times* "Science Times" section provided a safety net for coverage of global warming, for example, when it was difficult to get such stories in the news pages. *Times* environmental reporter Andrew C. Revkin admits that the weekly section may sometimes be perceived as a "ghetto" for science news; nonetheless, he says that, in the past, when it was hard to pitch stories on global warming to the news section, it was a valuable service to readers to be able to depend on regular coverage of the issue in the science section.[16]

The newspaper science section offers a valuable opportunity for providing in-depth coverage or "backgrounders" on topical science and health policy stories that provide readers with a context for understanding the daily news. By hiring specialty health and science writers, the sections also offer a "safety net" of trained reporters who are well-equipped to cover unpredictable spot news, particularly threats such as bird flu, bio-terrorism, or hurricanes, when the need arises. Existing sections need to encourage more substantive and timely science policy and issue stories, rather than settling into covering primarily the more comfortable and timeless "gee whiz" science or consumer health stories.

News magazines, struggling to maintain their audience, have also shifted their emphasis strongly toward health and medical consumer themes and away from pure science. In 2005, 10 of the 50 *Newsweek* covers were on health issues, such as lung cancer, autism, and heart disease, according to a *Newsweek* cover story on "Diet Hype," subtitled "How the Media Collides with Science."[17] The story also noted a potential economic connection: pharmaceutical companies spent $1.3 billion in magazine advertising last year, with another $2.4 billion on network and cable television.[18]

U.S. News and World Report, which built up a strong science and medical staff in the late 1990s, eliminated its "Science and Technology" section in 2004, with its stories folded into other sections. A series of layoffs, buyouts, and staff departures has left the magazine with only a few fulltime science and medical reporters and editors.[19]

At the moment, print opportunities in both newspapers and news magazines are more limited than in the past. However, print and electronic media are setting up extensive Web coverage of specialized topics that offers the potential for tremendous growth in the future for science writing online.

III. SCIENTISTS MORE WILLING TO COOPERATE WITH MEDIA

III.1 History of scientists' involvement with news media

Traditionally, scientists have viewed the media with suspicion and the prospect of being interviewed by a reporter akin to a visit to the dentist. In fact, such interviews often felt like pulling teeth, as reluctant researchers measured their words and feared being misquoted. Part of the tension stemmed from the scientific tradition of presenting research first to colleagues at scientific meetings and later to the scientific world through peer-reviewed journals. Only then was it considered appropriate to talk to the public through news media translators.

Early scientific popularizers like the late astronomer Carl Sagan, whose riveting books and television documentaries brought the "Cosmos" to the average American, were often viewed critically by their peers for talking directly to the public.

However, times changed as the struggle for federal research funds became ever more competitive, and public and political criticism of the products of science and technology—from environmental pollution to nuclear power—put many parts of the scientific enterprise on the defensive. Increasingly, academic institutions and scientific organizations hired communications experts to prepare press releases on their scientific work and publicize the findings to a broader audience. Groups such as the American Association for the Advancement of Science (AAAS), the nation's largest general scientific organization, as well as specialty science organizations, set

up elaborate press rooms and briefings for their annual meetings and publications, with particular attention to topical or controversial science that was under public scrutiny.

Through it all, many scientists have felt uncomfortable with press coverage, worrying about being misquoted or having their research taken out of context. Although they put the blame on the media and its shortcomings, a large part of the problem is that many prominent scientists do not see this as part of their job and are not trained to deal with the media. Cornelia Dean, a science reporter and former science editor of the *New York Times*, notes that scientists complain bitterly about the "poor quality of science journalism" and "what I always say to them is, 'You're right. But the only people who can do anything about it are you, the scientists.' As a group, they are not very good at communicating with the lay public or with reporters."[20]

Dean, who teaches a Harvard course for scientists and engineers, feels that scientists' training should include science writing: "I don't think people should get a doctorate in science without some exposure to how to tell an ordinary citizen what they're doing. Scientists have an affirmative obligation to take part in the debate. Their absence is one of the things that has debased the national dialogue."[21]

"There is an uneasy tension between reporters and scientists," admits University of Maryland professor Rita R.Colwell, who headed the National Science Foundation for six years. "We have slowly matured from the situation 20 years ago when good scientists simply refused to talk to the press. Frankly, they didn't know how, and they were afraid of being misquoted and ridiculed by their colleagues…Now there is a realization that we need to step into the public fray if the voice of science is to be heard." She benefited from media training in her days at the NSF helm, including "learning how to answer questions that don't have answers." Colwell says scientists "need to respect good science writing. It's tough to get it right." She urges her colleagues to "speak as scientists on issues and learn how to work with the press… If we don't put out the information, we have ourselves to blame."[22]

Colwell and other scientists are concerned about declining science coverage for the public. "The quantity of science reporting has decreased alarmingly," said Colwell. Donald Kennedy, a Stanford University biologist who is the editor of *Science Magazine*, agrees: "There are huge gaps…So many metropolitan dailies with substantial audiences have lost science pages in the last 10 to 20 years." At same time, says Kennedy, the scientific community has gradually become "more willing and much better at learning how to talk to the press and describe our results in language people understand."[23]

III.2 Changing Role of Science in the Political and Financial Landscape

The scientific community is only one constituency in the science and public policy world. However, it has traditionally held a privileged place in American discourse and enjoyed bipartisan support for research funding in the Nation's Capitol. But in recent years, science and science policy, as well as research budgets, have come under greater attack from legal, cultural, and religious organizations with powerful political clout that have claimed their own part of the science policy turf. Scientists and the organizations that represent them have increasingly found themselves in unfamiliar territory: sometimes treated as if they were just another special interest group in the messy political food fight.

Under the Bush administration, many scientists and journalists feel that science has been politicized to a greater extent than ever before. *The Republican War on Science,* by journalist Chris Mooney, summarized the criticism: "With the ascent of the modern conservative movement and its political domination of the Republican Party, two powerful forces had fused. On issues ranging from the health risks of smoking to global climate change, the GOP had consistently humored private industry's attempts to undermine science so as to stave off unwelcome government regulation. Meanwhile, on issues ranging from evolution to embryonic stem cell research, the party had also propped up the Christian right's attacks on science in the

service of moral and ideological objectives. In short, the GOP had unleashed a perfect storm of science politicization and abuse, in the process precipitating a full-fledged crisis over the role of scientific information in political decision-making."[24]

A *New Yorker* article by science writer Michael Specter reached similar conclusions: "From the start of his first term, George W. Bush seems to have been guided more by faith and ideology than by data in resolving scientific questions," he noted. "On issues ranging from population control to the state of the environment, and from how science is taught in the classroom to whether Iraq's research establishment was capable of producing weapons of mass destruction, the Administration has repeatedly turned away from traditional avenues of scientific advice." [25] Critics, including many in the scientific establishment, feel that the Bush administration's conservative philosophy has politicized science to a greater degree than previous Administrations: controlling whether research can take place (stopping federal funding of new avenues of embryonic stem cell research), whether scientists can talk about what it means (controlling statements by federal scientists about global warming), and whether regulatory agencies can act (the Food and Drug Administration disregarded scientific advisory committee and staff advice that emergency contraception, "the morning after pill," should be approved for adult over-the-counter sales before finally granting approval in August, 2006[26]).

The *New Yorker*'s Specter acknowledges, however, that the "problems facing American science have not been created by a single politician or party: they reflect a fissure in society which has grown wider as science has edged closer to the roots of life itself." [27]As a result of a virtual stalemate in Washington over the most contentious scientific issues, many of the battles have gone out to the states and localities. Given the Bush administration mandate that bans federal funding of newer stem cell lines created from human embryos, controversial stem cell research has become the subject of ballot initiatives in California and other states that are considering funding it themselves.

National coverage of congressional and administration actions in the science and technology arena has been conducted by both science and political reporters for the major papers. But as the fights have moved across the country, coverage has increasingly been carried out by political or general assignment reporters with little or no knowledge of the underlying science.

IV. THE PUBLIC ROLE IN SCIENCE AND POLICY DEBATE

The role of the news media in conveying the latest information about science and public policy is crucial, providing Americans with front-line coverage about current controversies confronting society. The problem is that the audience is composed of many publics, each bringing different backgrounds and personal agendas influenced by cultural and religious beliefs, education, political affiliation, gender, and age, among many factors.

Surveys show that television is the main outlet for information about science in its myriad forms. An October 2005 survey funded by the Pew Charitable Trusts[28] found that roughly half of those surveyed said that television, radio, and magazines are their "main source of information on science and technology." Sixteen percent cited newspapers and 12 percent the Internet. Science classes accounted for only 8 percent.

A 2002 national telephone survey for the Henry J. Kaiser Family Foundation and Harvard School of Public Health[29]found similar results in terms of information about health issues. About half of adults surveyed said that television had been their "most important source," followed by newspapers (one-fifth of respondents), talking with friends and family (about one-tenth), radio (8 percent) and magazines (4 percent). At that time, the Internet was cited by 5 percent, but recent surveys show that the Internet is growing more rapidly than any other source.

Public understanding of science is another problem. While many people are supportive of science, they still don't know much about the basic tenets of science, says Jon D. Miller, a

political scientist who has spent three decades conducting survey research for the United States' National Science Foundation and many European governments. Miller has found that only about one in five Americans is "scientifically savvy" enough to read the Tuesday *New York Times* science section, while the rest "just don't know" that much about science.[30]

He considers "civic scientific literacy" –defined as a "a level of understanding of scientific terms and constructs sufficient to read a daily newspaper or magazine and to understand the essence of competing arguments on a given dispute or controversy"[31]—as crucial to a citizen's ability to participate in public policy debates involving science or technology. His research suggests that overall scientific literacy is slowly growing—doubling since 1979—but is still a meager 17 percent[32].

In terms of basic scientific knowledge, Miller's surveys suggest that about half of Americans know that the earth orbits around the sun (and not vice versa); about half know that humans and dinosaurs did not live at the same time; less than one-third know that DNA is a basic genetic building block of life (some have guessed it to be the Drug and Narcotics Agency). Basic knowledge of DNA is important to understanding stories about the human genome, genetic engineering, or the stem cell debate. But his surveys show that, a year before the 2004 election, 40 percent of those surveyed said they had never even heard of "stem cell" research, despite considerable coverage of it since President Bush took office in 2001. On the evolution debate, his research shows considerable polarization, with only 14 percent definitely supporting the concept of evolution, one-third saying evolution is false, and the rest holding more tentative positions in between.

An important component of scientific literacy is formal education through science courses. But the media are an ongoing form of informal education, playing "a critical role as an early warning system" for the general public about news and issues of importance in science and technology, says Miller. For example, after the space shuttle Challenger blew up in January,

1986, within three days 97 percent of Americans had seen pictures of the accident on television. They followed up for more in-depth information by reading newspaper coverage and "today they would go online," says Miller.[33]

Other early-warning systems come through "social and interest groups that are able to activate large groups of people" by sending e-mail or mass mailings on controversial science issues. "The public doesn't create issues. Interest groups and political leaders create issues. The public reacts to issues," said Miller. He notes that the U.S. is unique among western industrialized countries in that religious groups have such a strong impact on public opinion and policy.[34]

Communications researcher Matthew C. Nisbet[35] agrees. He says that Americans' views on controversial science and policy are often based on what political or religious leaders believe rather than their own understanding of the issues. "The dominant assumption in science literacy is if only the public knew more, the debates would go away," said Nisbet, an assistant professor at American University. "But most of the public is unlikely to have the motivation or ability to be fully informed about topics like stem cell research, global warming, or intelligent design." Instead, he says, they tend to use "short cuts," taking their cue from politicians or other opinion leaders they respect. "They take the information and filter it through underlying values like ideology and religion," said Nisbet.

Ultimately, how the media covers or "frames" these debates—the slant of the articles and the sources of scientific and political information—helps shape the way both politicians and other leaders, as well as the public, view scientific and technological issues.

V. SCIENCE AND POLICY TOPICS IN THE NEWS

V.1 Topical science coverage in newspapers

Public understanding of science and technology depends in part on what people are exposed to in the media, including newspaper coverage of these issues. To document how coverage of key science and medical stories varies across the country, selected stories in the first quarter of 2006 were examined in nine of the top 50 national and regional newspapers in terms of circulation (the papers were selected to represent a range of sizes and geographic diversity). Our study looked at seven major subjects and found that the space devoted to these topical science and medical stories varied widely among individual papers.[36] By and large, the biggest newspapers in terms of circulation, size of news hole, and science writing staffs dominated the science writing landscape, like skyscrapers towering over the smaller regional newspapers (See graph, Appendix V).

The topics were selected to represent a spectrum of science and medical issues involving varying degrees of research, policy, and controversy. Overall, exercise and fitness, the topic that was the most consumer/least policy-oriented of the group, received the most extensive coverage among the nine papers studied—with more than 400 relevant stories, or 28 percent of the total. This was in keeping with the trend toward softer news and emphasis on health coverage. In comparison, astronomy stories and global warming stories were similar in amount—about 17 percent each. Stem cell and avian flu stories were close behind—about 14 and 13 percent, respectively—with AIDS/HIV stories at about nine percent. "Intelligent design" and evolution received the least coverage—only two percent of the total (there were undoubtedly far more stories in the last quarter of 2005, when a major legal case in Dover, PA received widespread national coverage). The numbers are based upon newspaper stories available through the online news database, LexisNexis, and represent "relevant" stories that focused primarily on these subjects, as opposed to those with casual references to the topics.[37]

Not surprisingly, the most extensive science coverage of the selected topics in this survey was in three national and major metropolitan newspapers—the *New York Times* (355 stories),

Washington Post (311 stories), and *Los Angeles Times* (232 stories)—which are among the largest in terms of circulation, daily news hole, and number of science reporters, all of which have contributed to their strong reputations for in-depth news coverage of issues such as science and medicine.[38] In contrast, *USA Today*, which has the most readers of any U.S. paper (its 2.2 million circulation is double that of the *New York Times*), had far fewer of the selected science stories studied in comparison to the other large circulation papers. This may reflect in part a smaller overall news hole (the paper does not publish on the weekend), fewer resources devoted to science and policy writing, an emphasis on other medicine and health lifestyle stories, as well as short stories that may not be picked up by the LexisNexis database.[39]

With 80 stories total across the seven topics, *USA Today*'s coverage was considerably less than the 144 science and medical stories found in the *Pittsburgh Post-Gazette*, a paper whose 239,000 circulation is one-ninth that of *USA Today*. Falling in between were the *St. Petersburg Times* and *San Diego Union-Tribune*, which have similar circulation (300,000-plus) and had 100 stories each. The *Milwaukee Journal Sentinel*, whose 240,000 circulation is similar to that of the Pittsburgh paper, had only 78 relevant stories. The fewest total stories were found in the *Denver Post*—55—with astronomy and global warming stories receiving the greatest attention there.

Variation in the number of stories also reflected pressing local issues and individual staff efforts. The *New York Times* carried more stories on global warming/climate change—93 in the three-month period—than on any of the others studied. This is in part due to *Times* science and environment reporter Andrew Revkin's dogged coverage of global warming, from basic science to politics, as well as business and foreign coverage of the issue.

The *Washington Post* had the most embryonic stem cell stories of any of the papers studied (66 in the three-month period, compared to 46 relevant stories in the *New York Times* and only six in *USA Today).* The *Post* had extensive local coverage of stem cell funding legislation

pending in the Maryland legislature, as well as exemplary national coverage by science reporter Rick Weiss, who has covered embryonic stem cells from basic science to Capitol Hill. The *LA Times* and *San Diego Union-Tribune* had considerable stem cell coverage, 34 and 20 stories respectively, in part because California has had extensive debate over state stem cell funding legislation there. The *Pittsburgh Post-Gazette*, which has a number of major universities in its region, had 24 relevant stem cell stories, including extensive coverage of a science fraud scandal involving a University of Pittsburgh researcher (science writer Spice has since departed). The remaining papers ran few stem cell stories during this period, with less than seven stories each.

In terms of exercise and fitness, the *Los Angeles Times* ran the most, with 71 relevant stories, followed by the *Washington Post* (65), the *New York Times* (54) and the *St. Petersburg Times* (53).

Although there is wide variation in the circulation, staff, and news holes of the various papers studied, all had access to the Associated Press, the international wire service that supplies news and feature stories to media outlets small and large. A separate look at AP coverage during the first quarter of 2006, using the LexisNexis database,[40] indicates a somewhat different trend than that found in the major American papers. The wire service's worldwide correspondents produced far more stories on bird flu than any of the other science topics studied—nearly 30 percent of the wire service's total—reflecting international concern in early 2006 about the potential for a human pandemic. Second in frequency were stories involving exercise and fitness (19 percent), followed closely by AIDS/HIV (17 percent), and astronomy/space stories (14 percent). Eleven percent of stories studied involved global warming, 8 percent stem cell research and less than 2 percent "intelligent design" and evolution. The American papers studied put far less emphasis than the AP on the international health issues of avian flu and AIDS/HIV, a similar amount on astronomy and more emphasis on exercise and fitness, global warming, and stem cell research.

Overall, the study conducted for this paper of the coverage of key science issues in the first quarter of 2006 provides a preliminary indication of trends among major American papers, as well as the more global coverage by the world's largest wire service. However, a more extensive look over time would provide a stronger and more representative sense of long-term trends in science news coverage.

V.2 Science writers versus general assignment coverage

Are readers and listeners best served by coverage of science and policy topics by specialized science reporters or by reporters with a general assignment or political background?

I would argue that coverage of recent controversies in science and public policy suggests that reporters with a specialty in science journalism are better equipped than general assignment reporters to provide context and background on the research itself; science reporters can pick up skills needed to write about the legal, political, and ethical debates surrounding the research. This is true of both breaking news, where there is little time to get up to speed on the science, as well as more in-depth features which require more understanding of a given science field.

In a review of coverage of the debate over teaching evolution and "intelligent design" in the schools, authors Chris Mooney and Matthew C. Nisbet agree. They contend that press coverage is often misleading when science moves into political and legal realms, and "it ceases to be covered by context-oriented science reporters and is instead bounced to political pages, opinion pages and television news."[41] In the process, they argue, the science is distorted, as non-science reporters "deemphasize the strong scientific case in favor of evolution and instead lend credence to the notion that a growing 'controversy' exists over evolutionary science."

After reviewing 17 months of evolution stories in the *New York Times* and *Washington Post*, as well as television news and local papers, Mooney and Nisbet concluded that science writers generally provide an accurate description of the scientific view of evolution, while

political, general assignment, and TV reporters provide little "real context" for the basic science and instead bend over backwards to give false "balance" to their stories by lending "undue credibility to theological attacks that masquerade as being 'scientific' in nature." Too often, "intelligent design" is presented as an alternative scientific explanation, rather than as a sophisticated religious argument that cannot be tested through normal scientific channels.

Mooney and Nisbet say that the news media, and the public, will be better served by assigning coverage of complex scientific and political debates to reporters with training and experience in covering science. "The intelligent-design debate is one among a growing number of controversies in which technical complexity, with disputes over 'facts,' data and expertise, has altered the political battleground. The traditional generalist correspondent will be hard-pressed to cover these topics in any other format… balancing arguments while narrowly focusing on the implications for who's ahead and who's behind in the contest to decide policy." [42] Instead, they argue, there should be a "growing demand for journalists with specialized expertise and background."

"Political writers clearly don't have the background. They don't know how to judge the validity" of conflicting scientific and technical information, says former *Los Angeles Times* science writer K.C. Cole, now a visiting professor at the University of Southern California. Science writers, she says, "have a bullshit detector. You know your field and smell stuff that doesn't sound right."[43]

But science writers themselves need to push for a primary role in the science policy turf. Science writer Hotz criticizes the tendency of some of newspaper science writers to "head for the hills" when a breaking news or science policy story happens, preferring instead to hang out in the ivory tower and do more timeless feature science stories.[44] Others caution that science writers need to be careful not to become cheerleaders for science or appear to get too close to their science sources. Nonetheless, some of the most effective science policy coverage has come from

experienced science reporters who have covered their field from soup to nuts and developed the ability to analyze both complex science and policy with equal competency.

VI. IMPROVING COVERAGE OF SCIENCE AND PUBLIC POLICY

VI.1 Better training for science writers

Despite the current cutbacks in news reporting jobs, the journalism pipeline for new science reporters is bigger than ever before. There are at least 30 science writing programs, almost all for graduate students, at universities around the country and roughly another 20 colleges and universities with at least one science writing course, according to University of Wisconsin journalism professor Sharon Dunwoody, who is compiling an online directory of such programs. Some of the oldest programs, at places like Columbia University and Boston University, started in the 1960s, in part because of the space program boost for science writing. A number of new programs started over the past decade. Most are broadly focused on science, while some specialize in environmental or health journalism, she said. [45]

Dunwoody notes that many of the newer programs give preference to students with an undergraduate or graduate science background. However, her own research indicates that the primary predictor of effective science reporting is number of years on the job, rather than formal science training.[46] While there is no exact count of how many science journalism graduates are coming into the marketplace, Dunwoody's rough estimate is on the order of 200 a year.

Improving specialty journalism, including science and medical reporting, is targeted in a new Initiative on the Future of Journalism Education, launched in 2005 by the Carnegie and Knight Foundations. "Reporters need to know even more about complex beats if they are to deliver stories that are both shorter and more interesting. Whether reporting on the economy,

medical advances, or the government, reporters need to provide not just facts but context," said a McKinsey & Company report prepared for the initiative.[47]

As part of a multi-year curriculum enrichment grant, the Annenberg School for Communication at the University of Southern California is launching a new Master of Arts degree in science and technology designed "to meet the profession's need for journalists who are not only educated, curious, expert and effective, but who are also prepared to report on the complex policy issues, social concerns and ethics that will shape science and technology issues in the future."[48] The Graduate School of Journalism at the University of California at Berkeley is expanding the curriculum of its two-year Master's Degree program to include joint degrees with other disciplines, starting with public health and eventually other sciences. And the Graduate School of Journalism at Columbia University, starting in the fall of 2005, launched a new Master of Arts program to help students "master complex subjects" such as science and communicate them to a general audience.[49]

VI.2 On-the-job training for journalists

There is no single route to becoming a science writer. While young science journalists are coming increasingly from specialized science journalism programs (many with formal science training), other science writers have long come from general assignment or other beats (one trip to an emergency room to cover a local disaster can create an instant medical writer). In any case, rapid advancements in science require continuous on-the-job training.

The main professional membership organization—the National Association of Science Writers (NASW)—provides national workshops on science writing, as well as a website and quarterly publication, *ScienceWriters.* [50] NASW now holds its annual meeting in conjunction with the Council for the Advancement of Science Writing (CASW). Since 1963, CASW has showcased new science by bringing distinguished scientists from a variety of disciplines to a host

university for an intensive four-day journalism seminar—New Horizons in Science—on cutting-edge work in science, medicine and technology.[51] The Society for Environmental Journalists, Association of Health Care Journalists, and American Medical Writers Association also host annual meetings to update their members. International science writers now gather annually under the auspices of the World Federation of Science Journalists, an association of 27 national, regional, and international groups founded in 2002.[52] Universities, scientific organizations, government agencies, and other groups also host seminars and backgrounders for journalists.

Increasingly, mid-career fellowships offer opportunities for science journalists to go back to school, allowing them to delve more deeply into scientific disciplines. The Knight Science Journalism Fellowships, started in 1982 at the Massachusetts Institute of Technology, allow experienced journalists who cover science, technology, medicine, or the environment to spend an academic year on campus; MIT also holds short "boot camps" on topical science issues to get reporters out of their offices and into the lab, such as a four-day stem cell research and policy seminar held in conjunction with Harvard in spring, 2006.[53] Fellowships offered by the Marine Biological Laboratory in Woods Hole, MA, allow journalists to experience research first-hand by working in the lab, while the Metcalf Institute for Marine and Environmental Reporting in Narragansett, RI, also sponsors workshops and environmental fellowships. Other programs in biomedicine and health, including Harvard Medical School and the federal Centers for Disease Control, provide journalism training as well.[54]

The quality of science journalism for the general public is another issue. While a host of prizes from journalism and scientific organizations have long rewarded the top science writers, there has been less scrutiny of science writing across the spectrum. Now, the Internet has spawned several new sites for evaluating science stories.

In May 2006, the MIT program launched the Knight Science Journalism Tracker, a website for science, medical, and environmental reporters and editors to view major stories from

across the country. KSJ Tracker, edited primarily by veteran California science writer Charles Petit, provides a sampling of recent science news—from research to policy—and, where possible, related press releases and links. Its goal is to improve the quality of science writing by giving science reporters and editors "convenient and timely access to the work of peers across the country" so "they can better evaluate and improve their own performance."[55]

In April 2006, another ambitious foundation-funded website, Health News Review, began evaluating news stories about medical treatments, tests, and procedures. Using a standardized five-star grading scale that focuses on accuracy, balance, and completeness (the ABCs), a team of medical, public health, and journalism professionals provide tough—and sometimes unrealistic—critiques of health coverage in the top 50 newspapers, as well as major television news coverage. They range from a zero-star bad review of an *ABC World News Tonight* story on a new drug to ease the pain of migraine sufferers to a five-star favorable review of a *Sacramento Bee* story suggesting that the full-body CT scans once recommended by Oprah may be more hype than help.[56] Health News Review, overseen by University of Minnesota health journalism professor Gary Schwitzer, is a valuable resource for journalists, the medical community, and consumers who use the Web for health information.

Sigma Xi, the national scientific research society, also has a daily science news website[57] that provides summaries and links to science stories from a variety of news organizations.

VI. 3 Training for non-science writers and editors

Many of the journalists who may be called upon to report about science on an occasional or regular basis are not up to the task. General assignment, education, business, investigative, religion, agriculture, political, or foreign correspondents need to be prepared for the inevitable moment when a challenging science, medical, or environmental story lands on their desks. As journalism programs expand specialty training, it is important to expose all journalism students

to techniques for writing about science and policy issues, as well as the technical skills to evaluate numbers, public opinion polls, and surveys that are a regular part of all beats.

Similarly, working reporters and editors on a variety of beats need help doing a better job writing about science and technology controversies that regularly crop up in the news. On-the-job training through professional organizations and workshops offers an opportunity for reporters of all stripes to learn how to cover pressing science and technology topics—from mad cow disease to biotechnology—better. More outreach work can and should be done in this area, finding novel ways to get professional science writing training to journalists strapped for time and money. Two new Knight Foundation initiatives in online training, for example, could provide a means of improving coverage of science and technology issues in novel ways. The News University launched in 2005 by the Poynter Institute for Media Studies is an innovative way to provide interactive, inexpensive online courses for journalists of all backgrounds and media. The Knight New Media Center, announced in April 2006, plans to offer specialty "boot camp" training courses for online journalists in a variety of specialty subjects, including science and health. At the same time, traditional journalists can find new outlets by getting multimedia training. [58] Television and radio reporters also need more opportunities for training in specialty beats.

Media outlets should explore ways to better utilize science writers in their coverage of local, national, and international policy issues. More team coverage, such as

pairing a science writer with a political reporter, could result in a better product for readers (rather than assigning the science or medical reporter to the proverbial sidebar to a story written by a general assignment or political reporter). Also, given the potential for emergency news coverage in a variety of areas, from biological or chemical warfare threats to bird flu, teams need to be trained for spot coverage that better utilizes the scientific and technical capacity of specialty reporters.

As biotech and pharmaceutical companies fund an increasing array of basic and clinical research and court the media, business and technology reporters also need more training. It is now standard to scrutinize potential financial conflicts of interest among university as well as industry researchers, since many academics have become consultants or participants in business-funded research projects. However, business and general assignment reporters without experience in science coverage are also susceptible to overly promotional coverage of proponents' claims of new product benefits or, alternatively, overly negative coverage of critics' claims of side-effects and other risks.

VI.4 Communications Training for Scientists

Scientists need to become better communicators about science and policy, translating technical studies into plain English that both reporters and the public can understand. Trained science writers in the public information offices of universities, government agencies, and the private sector can be invaluable in guiding this process, as long as their goal is brokering the best information possible for journalists and the public (rather than protective actions to keep scientists at arms length, as has been the case with some recent federal government global warming stories[59]).

Many of these public information offices, as well as scientific professional organizations, have organized their own training for scientists to better prepare them for the types of questions to expect in press briefings or interviews and have brought in reporters to talk about the process. In addition, science journalism groups such as the CASW have offered briefings for scientists about how to improve communication to the public about science.

For thirty years, the American Association for the Advancement of Science (AAAS) has offered "mass media" summer fellowships with media outlets nationwide for graduate and post-graduate science and engineering students who are interested in writing about science (some,

such as National Public Radio correspondent Richard Harris, become science writers; others go into scientific careers better equipped to communicate about science). The AAAS also has a variety of science and technology policy fellowships to better acquaint scientists with federal policy-making.[60]

The American Academy of Arts and Sciences, whose membership includes many distinguished scientists and journalists, has recently launched a new project to look at "The Media in Society: How the Media Cover Science and the Economy."[61]

One of the most intensive efforts to improve scientists' ability to communicate to non-scientific audiences, including the media, policy makers, and the public, has been the Aldo Leopold Leadership Program at Stanford University, which offers a model for other disciplines. Aimed at mid-career academic environmental scientists who agree to participate in two weeklong seminars, the Leopold program has trained more than 100 Fellows since 1998. One of its founders, distinguished marine biologist Jane Lubchenco of Oregon State University, says the program has empowered previously gun-shy scientists to do a better job communicating with the public. "After training, they have a better understanding of what journalists need, how much journalists know, and how to talk about science in ways that are useful and understandable," she said in an interview.[62]

VI.5 Guidelines for Improving Coverage

There is no instruction manual for writing about science. Good science writing combines knowledge of the subject, the skill to translate complexity into language understandable to the layman, and the ability to tell a story that will engage the reader, listener, or viewer. Writing about controversies involving science and public policy requires additional juggling skills, assessing the state of science, the stakeholders in the debate and the means for managing the problem, now or in the future. Although each story is different, journalists and those they cover

should keep the following ten guidelines in mind when communicating about controversial science and policy issues (Appendix VII and VIII):[63]

1. *Put new research in context.* Is it preliminary or definitive? Are the findings statistically significant, or could they have occurred by chance? Does the research confirm or conflict with past research? What additional research needs to be done? How important is the new research to advancing the field or to a given public policy issue? Who conducted the research, and what is the individual or institutional reputation or track record? Who funded the research? Has it been presented at a scientific meeting or published in a reputable scientific journal? How was the research conducted and over what period of time? Understanding the "fine print" in terms of who or what was studied and in what manner is crucial in determining the significance and relevance. Laboratory and animal research provides clues for further study but may have limited relevance to humans; smaller studies are less significant than larger ones. Studies that look back in time (retrospective) may be less reliable than prospective studies that follow a population over time. The most valuable medical study is a double-blind, controlled clinical trial in which researchers divide patients into an experimental or treatment group and an untreated "control" group and compare the outcomes in both groups.

2. *Stop the yo-yo approach to science and medical coverage (swinging from "breakthrough" to "disaster").* My colleague, the late *Washington Post* medical writer and columnist Victor Cohn, quipped that there are two kinds of front-page newspaper stories: "new hope and no hope." Journalists often emphasize the dramatic over the ordinary; pushing to get on page one or the top of the television news can distort a story. But there is plenty of blame to go around. Scientists and physicians are often overly

enthusiastic about their work; business interests can over-promote new products; interest groups often grab attention with dire warnings. Experienced science reporters put in the disclaimers, stay away from the word "breakthrough" (not always easily, since doctors and scientists themselves may throw around the term rather loosely), and let the story sell itself.

3. *Avoid "dueling" experts on science and policy*. Traditional journalism fairness means giving both sides in a controversy a chance to be heard. But it can be confusing—or even misleading—for the public if each side is given equal weight just to make a story appear "balanced." Too often science policy stories create drama by citing experts arguing from two extremes without trying to find out whether there is a scientific "middle ground." Is there a consensus view among leading researchers or mainstream professional scientific organizations? If not, what is the degree of uncertainty? Try to sort the science from the policy, and find out which hat various experts are wearing. "More than in any other field of reporting, balance in science writing requires something other than just providing an equal number of column inches to quotes from each side. Balance in science writing requires authorial guidance; it requires context, and knowing when certain points of view simply need to be ignored," notes the new NASW science writing guide.[64] This is where experience counts, says senior *Washington Post* science reporter Rick Weiss, who started in hospital laboratory work before turning to science writing: "It's not my job to find equal numbers of voices on both sides of the issue and give them all equal time. It's my job to certainly talk to people on all sides and hear them out and then do some value-added consideration of who has the stronger case for the question at hand…The reader deserves nothing less. That's why they're paying 35 cents so someone else does the homework for them."[65]

4. *Write about the process of science as well as the end results.* Science evolves; it is incremental; it has false starts; it needs to be replicated by others. Unfortunately, we often focus on artificial end points, when studies are reported at meetings or published in journals (and, of course, negative findings are seldom touted in such proceedings). Getting into the lab or out in the field gives the reporter—and the audience—a better understanding of how science is really done and results in a better enterprise piece that, unlike the stories from prepackaged journal articles, is not being written by every other reporter. The ability to make science come alive for the reader or viewer only comes with time on the road. But even a basic news story can benefit from some explanation of how the research was done. "I've become so aware of how little people understand science, how difficult people find it to even think scientifically…I try more and more in stories to include at least a couple of paragraphs about how an experiment was done and not just what the answers were," said Weiss.[66]

5. *Watch out for "anecdotal" stories.* Stories involving children or celebrities may dramatize or personalize a particular problem, helping to draw in the audience, particularly on local television. But they may overshadow the underlying science (or lack thereof). A story needs to distinguish an individual case or set of cases from what is known or not known about a given problem. Victims of cancer, or a cluster of cancer cases, may prematurely point the blame at certain products or polluters, for example. But science reporters need to explain the uncertainties in proving cause-and-effect without extensive research, and even then it may be extremely hard to determine conclusively for chronic diseases like cancer. In the early 1990s, claims by individuals, citizen groups and politicians on Long Island, New York, that environmental pollution was responsible for

an increased rate of breast cancer among women there drew national attention and a clamor for scientific research. But several studies have since found no evidence to support such claims, including a June 2006 New York State Health Department study that found "no local environmental factors that were likely related to the elevated breast cancer rates."[67]

6. *Be careful in citing risk statistics*. Distinguish between *relative* risk (a 9 times greater risk of stroke) and *absolute* risk (a one in 10,000 risk of stroke per year among women in a given age group). Too often studies in scientific journals, such as the *New England Journal of Medicine*, emphasize relative risk and may not provide any information on the appropriate absolute risk numbers. The resulting stories may incorrectly suggest a major hazard, frightening the audience without giving any perspective as to what the baseline risk was in the first place. For example, British medical journals set off a "pill scare" in England in 1996 with preliminary evidence that low-dose birth control pills doubled the risk of blood clots. A follow-up letter to *The Lancet* pointed out how small the risk was in the first place: it went from a risk of about one case per 10,000 users to two cases per 10,000 users. Going off the pill posed the obvious greater risk of pregnancy.[68] It takes extra time and initiative to push for underlying risk numbers. Look also for comparable risks from other activities that may help put the numbers in perspective for the consumers in a helpful way. Try to include information about potential benefits, if there are any; however, potential beneficiaries and at-risk groups may well be different (the consumers of a product may benefit, but workers in a plant may be at risk).

7. *Distinguish between the impact on individuals versus the impact on society.* Public policy is generally geared toward societal impact, not individual problems or risks.

Information in the story should give individuals a sense of who is most at risk and what the consequences of that risk may be. A large individual risk may affect only a small group of people. A small risk for any one individual may still pose a larger societal risk if a significant number of individuals are involved in a shared activity. Does the risk involve voluntary or involuntary exposure (through common sources of air, water, or food)? Much of public outrage, as well government regulation, focuses on involuntary exposure, even though such risks may be far smaller than voluntary everyday risky behaviors, such as driving, eating poorly, or smoking. (Watch out for parties with economic interests that may try to diminish concern about an involuntary risk, like environmental pollution, by comparing it to remote risks, like the chance of being hit by lightning, and then suggesting that nothing really needs to done. It may be apples and oranges for your audience.)

8. *Provide information on what, if anything, can be done about a given problem by individuals, government, or the private sector, as well as the degree to which the available science supports such action.* There is always more research to do; the question for citizens and public policy makers is when to act on the results of incomplete science, weighing the dangers of premature action and being wrong against the hazards of waiting too long for more answers and causing more harm along the way. It's really a judgment call, with input from scientific (and often legal) experts and decision-making by policy makers. "Most people think science is about facts and are quite frustrated when they find that science is in large part about uncertainty," said University of Michigan professor Dr. Gilbert S. Omenn,[69] chair of the American Association for the Advancement of Science and a former federal government official. Prudent public policy, particularly in the health arena, may require action before there is definitive evidence; "more research is needed"

may sometimes be an excuse for avoiding tough policy decisions, particularly those with large economic consequences. Complex science policy stories often require presenting the array of options—including knowns and unknowns—on both sides of the equation. What is the best available scientific advice, and how long will it take to get better answers? What are the economic and human costs of taking action now versus waiting? Who pays? Who may benefit? Is it prevention or treatment/amelioration? What can individuals do on a voluntary basis to help solve a problem? What can businesses do? What are the options for government agencies charged with deciding whether to take action? In terms of global warming, for example, there is a limited amount that individuals can do to make a dent in the problem; however, public understanding of the issue is crucial to the policy and political debate about what, when, or if to take broader action in the public and private sector.

9. *Avoid becoming an advocate for any side*. Leave that to the editorial pages. Present the information fairly, but be skeptical about the sources of information. Look for conflicts; follow the money. And remember, even "good" causes can distort a news or feature story. Advocacy groups push hard for their positions; it is not the traditional journalists' job to side with one group or point of view; help the audience figure out who is behind what cause and why. A scientist may be wearing both a research and a policy hat; find out which one and what personal or financial incentives may be involved. Transparency is the best approach.

10. *Recognize that there is no single "public."* The audience reads and listens through multiple lenses of age, gender, ethnicity, education, politics, and religion, to name a few. But we often write as if there was a generic "public." In writing about science,

environment, medicine, and health, consider the diversity of the audience and its reaction to news, particularly to stories in the "no hope, new hope" category. It helps to break down stories, with details about who is most affected, how, and why, as well as the potential timeline. Some people personalize every story; others turn off if they don't think it is relevant to them. If science stories are too technical or difficult, those who are less educated may tune out as well. Visualize a grandmother, an eighth-grade son, or a new mother. And, yes, you do need to explain what DNA is.

VII. CONCLUSION

Media coverage of controversial scientific issues needs to be improved on both the science and policy sides. This paper has provided a wide-ranging look at the state of science writing for the general public, with the following conclusions:

- There are more potential science and science policy stories than ever before, as new scientific developments push the ethical, political, and legal envelopes of the past.
- The news media is short-handed, with fewer reporting and editing jobs for reporters trained or experienced in covering specialty beats like science. There is also less space and time to tell the story in traditional media outlets; science sections, particularly in smaller newspapers, have been cut back in numbers and scope.
- The existing coverage is skewed toward one end of the spectrum of science coverage—consumer-driven health and medicine—leaving the audience less informed about many other important developments in science and technology that may affect their lives.

- Reporters with knowledge of how best to communicate about science and technology, as well as the policy issues that they generate, are better equipped to tell the story than general assignment reporters with no science writing experience.
- New initiatives are needed to help improve coverage by all reporters who might cover science and policy issues. This includes better training about how to cover technical stories, as well as convenient, easy access to resources that may provide accurate information about science and policy issues. Again, the Internet offers the potential for training journalists and providing better and faster information-gathering than in the past.
- Members of the scientific community, particularly those receiving public funding, have an obligation to make communicating with the public through the news media a valued part of their jobs. Scientists also need more training about how best to work with the media.
- There is an opportunity for the news media to provide better information to a diverse public, which is generally not well-educated about issues involving science and technology. The media can help bridge this gap, using both traditional news outlets as well as non-traditional outlets such as the Internet to provide helpful, accurate, thoughtful, and engaging coverage of science and technology that is accessible to a wide audience.

Ultimately, better, more balanced coverage of science and technology policy will help the public, and their representatives, understand the crucial issues that individuals, local communities, the United States, and countries of the world face in the years to come.

Appendix

APPENDIX I Ten New Science Sections in 2005

	State	Newspaper	Science Section	Day	Circ
1	CA	Los Angeles Times	Health	Mon	902,164
2	CA	San Diego Union-Tribune	Health & Fitness	Mon	311,324
3	CO	Rocky Mountain News	Spotlight on Health	Tues	275,136
4	FL	South Florida Sun-Sentinel	Health & Family	Sat	266,889
5	FL	Tampa Tribune	Science	Mon	226,573
6	GA	Atlanta Journal & Constitution	Healthy Living	Tues	441,427
7	KY	The Courier-Journal	Health	Tues	207,665
8	NC	The Charlotte Observer	Health	Mon	226,082
9	PA	Pittsburgh Post-Gazette	Science	Mon	275,136
10	TX	Houston Chronicle	Food-Health-Happenings	Sat	554,783

Source: *2005 Editor and Publisher International Yearbook*, 85th Ed.

Twenty-Four Science Sections in 1992 AND 2005

	State	Newspaper	Science Section Then	Science Section Now	Day	Circulation
1	AL	Huntsville Times	Science Week	Health & Science	Tues	53,145
2	CA	Orange County Register	Health & Fitness	Food, Health and Fitness	Wed	303,418
3	CA	San Jose Mercury News	Science & Medicine	Science & Health	Tues	263,067
4	CA	Riverside Press Enterprise	Health & Fitness	Health & Fitness	Tues	182,682
5	CO	Boulder Daily Camera	Discovery	Fit	Mon	32,761
6	CT	New London Day	Health/Science	Health & Fitness	Mon	39,472
7	DC	Washington Post	Health	Health Tab	Tues	661,124
8	MA	Boston Globe	Health/Science	Health/Science	Tues	423,632
9	MA	Cape Cod Times	Health/Science	Business, Health & Science	Tues	50,815
10	MI	Detroit Free Press	Stretch	Body & Mind	Tues	510,736
11	MI	Alpena News	Health	Health Page News	Sat	11,025
12	MI	Ann Arbor News	Connection	Wellness Wednesday	Wed	50,815
13	MI	Kalamazoo Gazette	Health/Science	Health & Science	Tues	62,350
14	MI	Saginaw News	Health/Living	Health/Living	Fri	46,439
15	ND	Grand Forks Herald	Discover	Science	Thur	31,524
16	NJ	Asbury Park Press	Health	Health & Fitness	Tues	160,339
17	NY	New York Times	Science Times	Science Times	Tues	1,056,390
18	NY	Newsday	Discovery	Health & Discovery	Tues	392,650
19	OR	Portland Oregonian	Science	Accent on Health & Fitness	Mon	324,836
20	TN	Knoxville News Sentinel	Health & Science	Health & Science	Mon	136,027
21	TN	The Oak Ridger	Science/Health	Health News	Wed	7,554
22	TX	Dallas Morning News	Discoveries	Health	Mon	573,340
23	TX	Corpus Christi Caller Times	Your Health	Health & Fitness	Mon	57,591
24	WI	Milwaukee Journal Sentinel	Health	Health	Mon	227,387

Sources: *2005 Editor and Publisher International Yearbook*, 85th Ed.;
SIPIScope, Scientists' Institute for Public Information, Fall, 1992, 20:1

APPENDIX II

National Association of Science Writers (NASW)

MEMBERSHIP 2005

	Total
Staff Writers/Editors	
Newspapers	85
General/Popular Mag.	49
Specialty Mag./Newsletter	182
Journal	13
Television	11
Radio	14
Internet	16
Other	2
Staff Writers/Editors	**372**
Freelance	**860**
Total Media Members[1]	**1,232**
Total Institutional/Other[2]	**894**
TOTAL MEMBERS	**2,126**

Source: *NASW Membership Directory, July 2005*

[1]Freelance and staff members who write/edit for general media outlets.
[2]Science writing/editing for institutional and public relations outlets; journalism school/academic members; other.

APPENDIX III

Society of Environmental Journalists
MEMBERSHIP 2006

	Total
Newspaper	432
Magazine	96
Television	90
Radio	74
Internet	31
Freelance	317
Authors	46
Faculty	109
Educator	2
Government	7
News Service	31
Newsletter	32
Non-Profit	38
Photographer	9
Publisher	9
Student	142
University	9
Total	**1,474**

Source: E-mail correspondence with SEJ (March 14, 2006).

Association of Health Care Journalists, Inc.
MEMBERSHIP 2006

	Total
Newspaper	328
Broadcast	72
Newsletter	30
Mixed Media	275
Magazines	61
Books	19
Online	76
News Service	8
Journals	2
Academic	23
Associate	22
Students	32
Total	**948**

Source: E-mail correspondence with AHCJ (March 13, 2006).

APPENDIX IV Selected Newspaper Science and Health Stories[1]

Stem Cell	AP[2]	USA Today[3]	NYT	LA Times	Wash Post	St. Pete Times	San Diego UT	Denver Post	Milwaukee JS	Pittsburgh PG	Total Newspaper Stories
Net relevant stories	559	6	46	34	66	2	20	4	7	24	209

Intelligent Design	AP	USA Today	NYT	LA Times	Wash Post	St. Pete Times	San Diego UT	Denver Post	Milwaukee JS	Pittsburgh PG	Total
Net relevant stories	130	0	13	8	4	5	0	1	0	3	34

Global Warming	AP	USA Today	NYT	LA Times	Wash Post	St. Pete Times	San Diego UT	Denver Post	Milwaukee JS	Pittsburgh PG	Total
Net relevant stories	750	12	93	33	49	8	15	16	7	9	242

Avian Flu	AP	USA Today	NYT	LA Times	Wash Post	St. Pete Times	San Diego UT	Denver Post	Milwaukee JS	Pittsburgh PG	Total
Net relevant stories	2,013	15	59	23	47	9	5	4	7	14	183

AIDS/HIV	AP	USA Today	NYT	LA Times	Wash Post	St. Pete Times	San Diego UT	Denver Post	Milwaukee JS	Pittsburgh PG	Total
Net relevant stories	1,132	2	37	23	24	3	15	2	4	18	128

Astronomy	AP	USA Today	NYT	LA Times	Wash Post	St. Pete Times	San Diego UT	Denver Post	Milwaukee JS	Pittsburgh PG	Total
Net relevant stories	928	17	52	40	56	20	9	17	3	32	247

Exercise/Fitness	AP	USA Today	NYT	LA Times	Wash Post	St. Pete Times	San Diego UT	Denver Post	Milwaukee JS	Pittsburgh PG	Total
Net relevant stories	1,285	28	54	71	65	53	36	11	50	44	412
Total	**6,797**	**80**	**355**	**232**	**311**	**100**	**100**	**55**	**78**	**144**	**1,455**

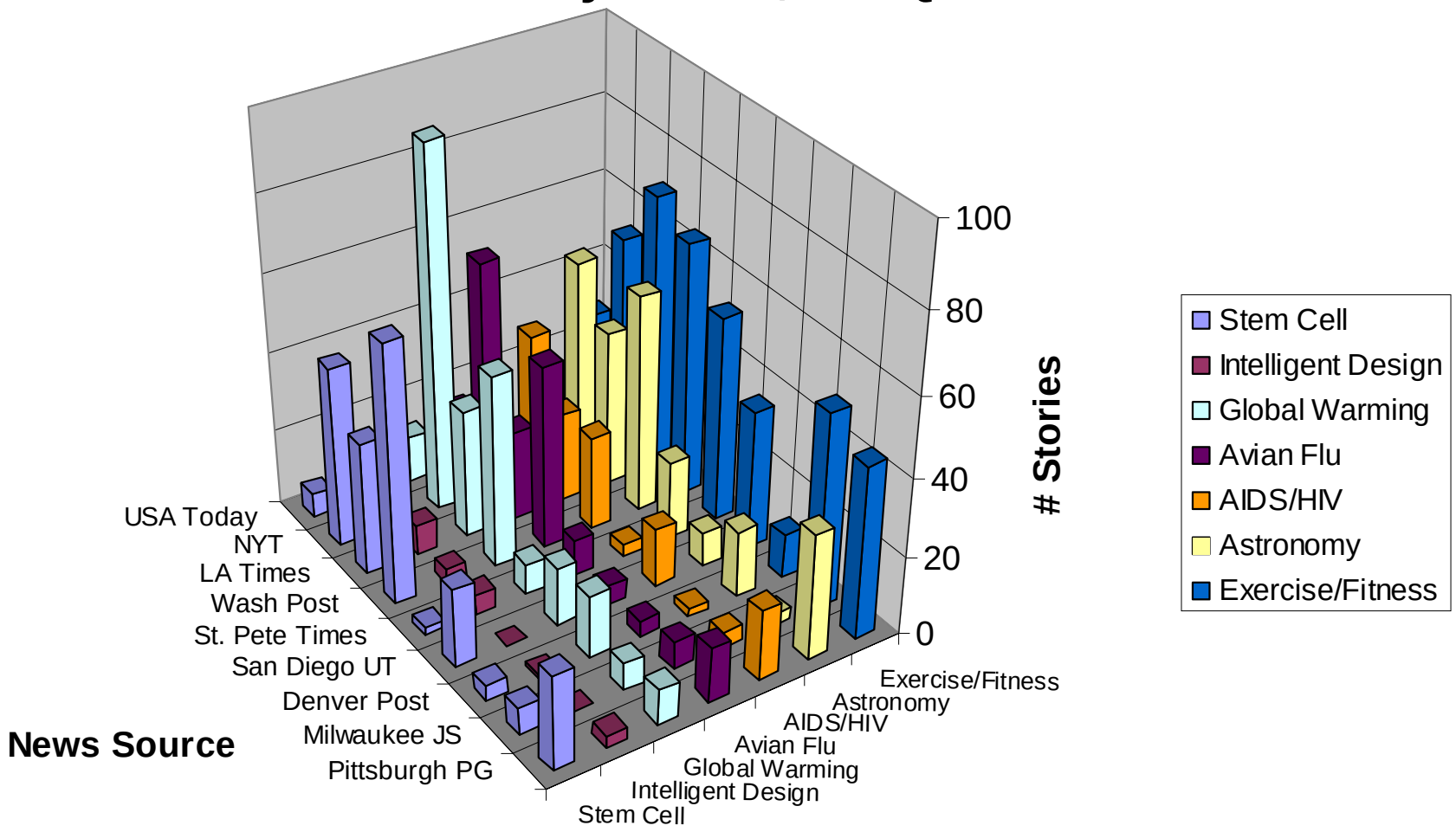
[1]The number of stories listed is based on a search using LexisNexis Research Software for Information Professionals, v 7.2.1 from Jan. 1, 2006-March 31, 2006. For the newspapers, the total number of stories in each subject category was reviewed by individual story (based on description of story and LexisNexis determination of relevance). Then the number of "irrelevant hits" was subtracted, leaving the "net relevant stories." Stories considered "irrelevant" were hits that contained the search terms, but were not primarily focused on the specific topic. Articles that were duplicates were also eliminated from the count. The search involved looking for stories by key words. The search terms used were as follows: stem cell or cloning, intelligent design or creationism, global warming or climate change, avian flu or bird flu, AIDS and HIV, NASA or astronomy or planet, and exercise and fitness.

[2]Due to the large volume of hits from the Associated Press wire service database, the stories were not individually reviewed and represent the total number of hits by search term. Thus, duplicates and stories involving casual references to the search terms may be included.

[3]News sources include: Associated Press, USA Today, New York Times, Los Angeles Times, Washington Post, St. Petersburg Times, San Diego Union-Tribune, Denver Post, Milwaukee Journal Sentinel, Pittsburgh Post-Gazette. The papers were selected to represent a range of circulation size and geographic diversity.

APPENDIX V

Selected Science Story Count, 1st Quarter 2006



Source: LexisNexis Research Software for Information Professionals, v.7.2.1 from Jan 1, 2006 to March 31, 2006. See Chart Appendix IV for details.

APPENDIX VI

Selected Newspapers and Circulation

Newspaper	Circulation
USA Today	2,220,863
New York Times	1,121,057
Los Angeles Times	902,164
Washington Post	707,690
St. Petersburg Times	330,091
San Diego Union-Tribune	311,324
Denver Post	275,292
Milwaukee Journal Sentinel	240,581
Pittsburgh Post-Gazette	238,860

Source: *2005 Editor and Publisher International Yearbook*, 85th Ed.

APPENDIX VII

GUIDELINES
FOR IMPROVING COVERAGE OF SCIENCE AND PUBLIC POLICY

(1) Put new research in context with earlier studies.
Does it confirm or conflict with past research? Is it preliminary or definitive? Are the findings statistically significant, or could they have occurred by chance? What additional research needs to be done? Who conducted the research, and what is the track record for the researcher or institution?

(2) Stop the yo-yo approach to science, environmental and medical coverage (swinging wildly from "breakthrough" to "disaster").
Journalists tend to emphasize the dramatic over the ordinary. Scientists and physicians may be overly enthusiastic about their work. Business interests can over-promote new products. Advocacy groups may seek attention with dire warnings. Experienced science reporters put in disclaimers, stay away from the word "breakthrough," and let the story sell itself.

(3) Avoid "dueling" experts on science and policy; giving equal weight to opposing viewpoints does not make a story "balanced."
Is there a consensus about the science? If not, what is the degree of uncertainty? What is the range of policy options?

(4) Write about the process of science as well as the end results.
Science evolves; it is incremental; it has false starts; it needs to be replicated by others. Scientists and institutions need to let journalists get their noses under the tent. Getting into the lab or out in the field gives the reporter—and the audience—a better understanding of how science is really done and results in a better enterprise piece.

(5) Watch out for "anecdotal" stories involving children or celebrities.
Sad personal stories may help illustrate or dramatize an issue but may also attract undue attention if they are mistaken as evidence by the lay audience. Victims of cancer, or a cluster of cancer cases, for example, may prematurely point the blame at certain products or polluters. Science reporters need to explain the uncertainties in proving cause-and-effect and the need for follow-up research.

(6) Use caution in citing risk statistics.
Distinguish between relative risk (i.e., a 9 times greater risk of stroke) versus absolute risk (i.e., a one in 10,000 risk of stroke among women in a given age group). Look for comparable risks from other activities that may help put the numbers in perspective for consumers in a helpful way.

(7) Distinguish between impacts on individuals versus impacts on society.
Does the risk involve voluntary or involuntary exposure (through common sources of air, water, or food)? Information in the story should give individuals a sense of who is most at risk and what the consequences of that risk may be. A large individual risk may affect only a small group of people. A small risk for any one individual may still pose a larger societal risk if a significant number of individuals are involved in a shared activity.

(8) Provide information about what, if anything, can be done about a given problem by individuals, government, and the private sector.

What is the best available scientific advice, and how long will it take to get better answers? What are the economic and human costs of taking action now versus waiting? Who pays? Who may benefit? Is it prevention or treatment/amelioration?

(9) Avoid becoming an advocate for any side.
Leave that to the editorial pages. Present the information fairly, but be skeptical about the sources of information. Look for conflicts; follow the money. Remember, even "good" causes can distort a news or feature story.

(10) Recognize that there is no single "public."
The audience reads, views and listens through multiple lenses of age, gender, ethnicity, education, politics and religion, to name a few. Give details about who is most affected, how and why, as well as the potential timeline.

APPENDIX VIII

TEN TIPS

FOR MEDIA COVERAGE OF SCIENCE AND PUBLIC POLICY

(1) Put new research in context with earlier studies.

(2) Stop the yo-yo approach to science, environmental and medical coverage (swinging from "breakthrough" to "disaster").

(3) Avoid "dueling" experts on science and policy; giving equal weight to opposing viewpoints does not make a story "balanced."

(4) Write about the process of science as well as the end results.

(5) Watch out for "anecdotal" stories involving children or celebrities.

(6) Use caution in citing risk statistics.

(7) Distinguish between impacts on individuals versus impacts on society.

(8) Provide information about what, if anything, can be done by individuals, government, and the private sector.

(9) Avoid becoming an advocate for any side.

(10) Remember that there is no single "public;" recognize the diverse perspectives in your audience.

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ENDNOTES

[1]National Association of Science Writers (NASW) website. Online. www.nasw.org .
[2] "Careers in Science Writing," Council for the Advancement of Science Writing (CASW). Online: www.casw.org/careers.htm.
[3] Jerry Bishop, immediate past president, Council for the Advancement of Science Writing. Online: www.casw.org/history.htm.
[4] Deborah Blum, Mary Knudson, Robin Marantz Henig, Editors' Note, *A Field Guide for Science Writers*, 2nd Ed. The Official Guide of the National Association of Science Writers. New York: Oxford University Press, 2006, p. vii.
[5] Diane McGurgan, NASW executive director, telephone interview, September 27, 2006.
[6] NASW membership directory, July 2005. Membership in NASW is only one measure of the number of fulltime science reporters, since membership is voluntary and not all staff science reporters choose to join their professional organizations. The NASW did not have a breakdown of members' work affiliation so the 2005 membership directory and database was reviewed for this project and categorized into the chart in Appendix II.
[7] Society of Environmental Journalists, e-mail, March 14, 2006. See Appendix III for breakdown of 2006 membership, as reported by SEJ. Website is www.sej.org.
[8] Association of Health Care Journalists, Inc., e-mail, March 13, 2006. See Appendix III for breakdown of 2006 membership as reported by AHCJ. Website is www.healthjournalism.org.
[9] Laura Chang, science editor, *New York Times*, e-mail and telephone conversation, April, 2006.
[10] *SIPIScope*, Scientists' Institute for Public Information, fall, 1992, 20:1. In 1992, only 44 newspaper dailies published weekly science sections, but three of these papers published two different weekly science and health sections. Therefore, there were a total of 47 different science sections published in 44 papers.
[11] *Editor & Publisher International Yearbook*, 85th Ed. New York: VNU Business Media, Inc., 2005. *Editor & Publisher* includes information on special sections from 2004 submitted by individual newspapers. Our project survey examined information from the 44 papers that had science sections in 1992 and found 24 of them that still had sections. In addition, research asst. M. Alvarado examined entries from the top 50 newspapers in terms of circulation and found another 10 new sections, for a total of 34 newspapers with special weekly sections involving science, health or medicine. There may be additional science and/or health sections that were started among smaller newspapers since the full directory was not reviewed. (See Appendix I for newspaper science section charts.)
[12]Tom Siegfried, former science editor, *Dallas Morning News*, e-mails, May 3, 2006 and October 4, 2006.
[13] Gideon Gil, health and science editor, *Boston Globe*, e-mail, May 10, 2006.
[14] Byron Spice, co-director of media relations at the Carnegie Mellon School of Computer Science, covered and edited science at the *Pittsburgh Post-Gazette* from 1990 to 2006. Telephone interview, June 13, 2006.
[15] Robert Lee Hotz, telephone interview, April 17, 2006.
[16] Andrew C. Revkin, "Covering Climate Change: A story that doesn't fit journalism norms," Interview with Paul D. Thacker. *SEJournal*, spring, 2006. Online: www.sej.org.
[17] Barbara Kantrowitz and Claudia Kalb, "Food News Blues," *Newsweek*, March 13, 2006.
[18] Ibid.
[19] Charles Petit, former *U.S. News and World Report* science correspondent, e-mail, May 17, 2006.
[20] Cornelia Dean, quoted in "Covering Science and Technology: An Interview with Cornelia Dean," by Alex Jones, *The Harvard International Journal of Press/Politics,"* Vol. 8, No. 2 (spring, 2003), p.5.
[21] Cornelia Dean, interview, March 21, 2006.
[22] Dr. Rita R. Colwell, director of the National Science Foundation, 1998-2004, and currently Distinguished University Professor at University of Maryland, College Park, and Johns Hopkins School of Public Health, as well as Chairman of Canon US Life Sciences, Inc. Interview, February 18, 2006.
[23] Dr. Donald Kennedy, professor, Stanford University and editor-in-chief, *Science Magazine*. Interview, February 18, 2006.
[24] Chris Mooney, Introduction, *The Republican War on Science* website. Online: www.waronscience.com/introduction.php.
[25] Michael Specter, "Political Science: The Bush Administration's War on the Laboratory," *The New Yorker*, March 13, 2006. p.62.

[26] News reports, including Marc Kaufman, "FDA Official Quits over Delay on Plan B," *The Washington Post*, September 1, 2005, p. A08.
[27] Specter, p. 68.
[28] Pew Initiative on Food and Biotechnology telephone survey, Oct.10 to 16, 2005, of 1000 Americans. Pew Initiative, Washington, DC., a project of the University of Richmond supported by Pew Charitable Trusts. www.pewagbiotech.org
[29] Robert J. Blendon, Harvard School of Public Health, e-mail, May 23, 2006. The survey was conducted by Princeton Survey Research Associates, Jan. 31 to Feb. 3, 2002, and based upon telephone interviews with a national adult sample of 1,203.
[30] Dr. Jon D. Miller recently became a professor in the Division of Science and Mathematics Education, Michigan State University in Lansing; he was formerly Director, Center for Biomedical Communications, Northwestern University Medical School, Chicago. Interview and symposium presentations, American Association for the Advancement of Science meeting, February 17-19, 2006.
[31] Dr. Jon D. Miller, "The Measurement of Civic Scientific Literacy," *Public Understanding of Science*. 7 (1998) 204.
[32] Liza Gross, "Scientific Literacy and the Partisan Takeover of Biology," *PLoS Biology* Vol. 4, Issue 5, May 2006. http://biology.plosjournals.org.
[33] Miller, Interview.
[34] Miller, Interview.
[35] Matthew C. Nisbet, Asst. Professor, School of Communication, American University, as of Sept. 1, 2006. Formerly Asst. Professor of Communication, Ohio State University. Telephone interview, May 19, 2006.
[36] The nine daily newspapers studied, and their circulation (as reported in the *2005 Editor & Publisher International Yearbook*, 85th ed) were *USA Today (2.22 million), The New York Times (1.12 million), Los Angeles Times (900,000), Washington Post (710,000), St. Petersburg Times (330,000), San Diego Union-Tribune(310,000), Denver Post (275,000)*, *Milwaukee Journal Sentinel(240,000)*, and the *Pittsburgh Post-Gazette*(240,000). (See Appendix VI for exact numbers.)
[37] The number of stories is based on an online search using LexisNexis Research Software for Information Professionals, v 7.2.1. for the period from Jan. 1, 2006-March 31, 2006. The search involved looking for relevant stories by key words: stem cell and cloning; intelligent design and creationism; global warming or climate change; avian flu or bird flu; AIDS and HIV; astronomy or NASA or planet; and exercise and fitness. The total number of stories in each subject category was reviewed by individual story (based on description and LexisNexis determination of relevance). Then the number of "irrelevant" hits was subtracted, leaving "net relevant stories." Storied considered "irrelevant" were hits that contained the search terms but were not primarily focused on the topic; very short entries; and duplicate stories. Online: www.lexisnexis.com. (See Appendix IV for chart with numbers and V for graphic representation.)
[38] In comparison to the *New York Times*' 15 fulltime reporters and 6 editors, the *Washington Post* now has about 9 fulltime writers and three editors on health and science in the news and health sections, according to national science reporter Rick Weiss (e-mail, May 22, 2006; telephone conversation September 28, 2006). The *Post* has a Monday "Science page" in the front news section, and a 20-year-old weekly Tuesday Health tab that focuses on softer consumer health features. The *LA Times* has eight science reporters and one editor, according to editor Ashley Dunn (e-mail, March 22, 2006). The *LA Times* no longer has a science page or section; it does have a weekly Health page.
[39] *USA Today*, headquartered in McLean, VA, publishes Monday to Friday, with no papers on Saturday or Sunday (there is a separate *USA Weekend* magazine insert for newspapers across the country). Started in 1982, *USA Today* reports a paid circulation of 2.2 million but a 5.2 million readership. It has about a dozen reporters across the paper that cover science, health, and medicine, with most reporting to the Life feature section. It has 8 fulltime health and medical reporters; 2 more who cover psychology and relationships; one fulltime and two part-time science reporters; and no fulltime environmental reporters (although various reporters across the country cover environmental stories), according to science reporter Dan Vergano (telephone conversation October 4, 2006).
[40] The *Associated Press* stories were taken from the LexisNexis database, using the same time period and search terms in Endnote 37. However, given the large volume of hits—a total of 6,797 stories for the seven topics—the stories were not reviewed individually and represent the total number of hits per search term.

Thus, duplicates and stories involving casual references to the search terms may be included. The numbers are useful in comparing the relative amount of AP coverage devoted to each topic; however, the absolute numbers cannot be compared to the story numbers of the individual newspapers. The AP has a total of 10 fulltime reporters in the U.S. (four science, four health-medicine, one aerospace, and one biotech) and two overseas, according to New York science reporter Malcolm Ritter (e-mail, March 22, 2006). Much of the coverage is by general assignment reporters in bureaus around the world. (See Appendix IV for chart.)

[41] Chris Mooney and Matthew C. Nisbet, "Undoing Darwin," *Columbia Journalism Review*, September/October, 2005. http://www.cjr.org/issues/2005/5/mooney.asp

[42] Ibid.

[43] K.C. Cole, telephone interview, March 20, 2006.

[44] Hotz, interview.

[45] Sharon Dunwoody, University of Wisconsin-Madison professor of journalism and mass communication, e-mail and telephone interview, March 17, 2006.

[46] Sharon Dunwoody, "How Valuable is formal science training to science journalists?" *Comunicacao e Sociedade* 6 (2004), 75-78.

[47] McKinsey & Co. Report, Executive Summary, based on individual interviews with 40 leaders in the news industry. Online: http://www.carnegie.org/sub/program/initiative.html.

[48] Curriculum Enrichment, Initiative on the Future of Journalism Education, Online: http://www.carnegie.org/sub/program/initiative-curriculum.html.

[49] Ibid.

[50] *ScienceWriters* is published four times a year by the National Association of Science Writers. Archives are available to members only at www.nasw.org.

[51] The Council for the Advancement of Science Writing is an independent non-profit organization devoted to improving science writing, run by longtime executive director and science writer Ben Patrusky. Former *AP* and *Business Week* science editor Paul Raeburn is the program director for New Horizons in Science. The author is the current President. Online: www.casw.org.

[52] The World Federation of Science Journalists will convene the 5th World Conference of Science Journalists from April12-20, 2007, in Melbourne Australia. Online: http://www.wfsj.org/.

[53] Knight Science Journalism Fellowships program at MIT is directed by veteran science writer Boyce Rensberger, formerly of the *New York Times* and the *Washington Post*. web.mit.edu/knight-science/ .

[54] Newswise Guide to Journalism Grants and Fellowships, 2006-2007. Online: http://www.newswise.com/resources/j_grants/.

[55] Knight Science Journalism Tracker, Knight Science Journalism Fellowships at MIT. The chief tracker is Charles Petit, a longtime science writer with the *San Francisco Chronicle* and *U.S. News and World Report* and former President of the National Assn. of Science Writers. Online: http://ksjtracker.mit.edu.

[56] The Health News Review website is run by publisher Gary Schwitzer, a health journalism professor at the University of Minnesota and former CNN medical editor and reporter, and funded by the Foundation for Informed Medical Decision Making. Online: www.healthnewsreview.org.

[57] Sigma Xi "Science in the News" website. Email inthenews@sigmaxi.org for access.

[58] The John S. and James L. Knight Foundation has funded a variety of journalism initiatives (www.knightfdn.org). The Knight New Media Center is jointly operated by USC Annenberg School for Communication and the Graduate School of Journalism at the University of California, Berkeley (www.knightnewmediacenter.org). The Poynter Institute News University is at www.newu.org.

[59] See coverage by *New York Times* reporter Andrew Revkin and *Washington Post* reporter Juliet Eilperin for examples of several recent attempts by Bush Administration political appointees to control communications between journalists and scientists in agencies such as the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmospheric Administration (NOAA).

[60] American Association for the Advancement of Science. Online: www.aaas.org.

[61] American Academy of Arts and Sciences, interviews and website. Online: www.amacad.org/projects/social.aspx.

[62] Jane Lubchenko, Distinguished Professor of Zoology and Valley Professor of Marine Biology at Oregon State University, is a former president of the AAAS and of the Ecological Society of America. Interview, February 19, 2006. The Aldo Leopold Leadership Program, based at the Woods Institute for the Environment at Stanford University, is funded by the David and Lucile Packard Foundation. Website: http://www.leopoldleadership.org.

[63] These guidelines were drawn up by the author, based on personal experience as a science writer for more than 30 years, research for this project, and earlier presentations on science writing.
[64] Blum, Knudson, Henig, p.ix.
[65] Rick Weiss, *Washington Post* science reporter, telephone interview, March 27, 2006.
[66] Ibid.
[67] "State Health Department Releases Final Results of Breast Cancer Investigation in Suffolk County," New York State Health Department Press Release. June, 23, 2006. Online: http://www.nyhealth.gov/press/releases/2006/2006-06-23_cmp_final_report_release.htm.
[68] Cristine Russell, "Risk Reporting," *A Field Guide for Science Writers*, 2nd Ed. New York: Oxford University Press, 2006, p. 253.
[69] Gilbert S. Omenn, MD, PhD, professor of internal medicine, human genetics, and public health at the University of Michigan. He served as Associate Director, Office of Science and Technology Policy, and Associate Director, Office of Management and Budget, in the Executive Office of the President in the Carter Administration. Interview, Feb. 17, 2006.