



MULTIMEDIA RESEARCH

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*Earth & Sky*  
Summative Evaluation: Edge of Discovery Series  
Study 1

Report for  
EarthTalk, Inc.

by  
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**EXECUTIVE SUMMARY OF SUMMATIVE EVALUATION**  
**MULTIMEDIA RESEARCH**  
**AUGUST 12, 2002**

*Earth & Sky* is a daily short-format science series for both commercial and public radio. Produced by EarthTalk, Inc. of Austin, TX, the series is hosted by Deborah Byrd and Joel Block and consists of 90-second programs on a wide variety of topics mostly drawn from environmental sciences, earth sciences and astronomy. With support from the National Science Foundation, Multimedia Research presents the first study of a two-part summative evaluation on the impact of *Earth & Sky* on public radio listeners, focusing on traditional formats as well as the new "Edge of Discovery" programming that presents scientists describing their own research.

The evaluation focused on what demographic or background characteristics relate to whether or not one listens to *Earth & Sky* and to frequency of listening; what effects the series has on listeners and what kind of actions the series has prompted in listeners. Questionnaires were mailed to random names drawn from member subscriber lists of public radio stations serving the areas surrounding Missoula, MT, Columbia, MO, and Boston, MA. Of the 2954 questionnaires that adult public radio members received, 2019 or 69% were returned for analysis. Given that 2.1 million listeners contribute to public radio according to CPB revenue report data and that there are about 21 million listeners according to Arbitron estimates, our contributor lists represent about 10% of the listening audience. Thus, we can generalize our results to all subscribers and to about 10% of the total public radio audience.

### **Who are Listeners of *Earth & Sky*?**

Almost 9 out of 10 public radio member respondents reported listening to *Earth & Sky*. Five out of 10 respondents heard the series "frequently," and 4 out of 10 heard it "sometimes." Our respondent sample is typical of a public radio member audience – more educated, better employed, older with fewer minorities compared to the general U.S. adult population. Only the demographic of age significantly differentiated listeners and non-listeners. On average, listeners were significantly younger (51) than non-listeners (55), although this is possibly not a meaningful difference.

Listeners of *Earth & Sky* rated themselves as significantly more interested in science generally and significantly more knowledgeable about science than non-listeners. Also, listeners were significantly more likely than non-listeners to list "radio" as one of their two major sources of science news; whereas non-listeners were significantly more likely to list "television" as one of their two sources. "Magazines/journals" and "news-papers" were also major sources of science news for both groups.

Listeners differed with respect to science attitudes in a few ways. Listeners agreed significantly more than non-listeners with the following science attitude statements:

- "I like learning how contemporary scientists carry out their research."
- "Keeping up with current science news is a critical responsibility of the public."
- "Failures are as important as successes in learning the truth in science."
- "Research is essential to understanding human impact on the environment."

However, both listeners and non-listeners equally felt that it is important to hear from scientists about their research – this result supports the need for scientists themselves presenting research in the “Edge of Discovery” format.

### **Appeal of *Earth & Sky***

Listeners rate the series as highly appealing. Nine out of 10 listeners agree or strongly agree that they “enjoy listening to the series,” and 8 out of 10 agree or strongly agree that they “listen attentively” to the show. Nine out of 10 listeners disagree or strongly disagree that they “dislike hearing scientists talk about their own work on the show.”

Those who reported listening “frequently” to *Earth & Sky* enjoy the series more, listen more attentively and like hearing from scientists more than those who listen “sometimes.” Listeners who listed “newspapers” as a primary or secondary source of science news felt they listened less attentively to the show.

### **Comprehension of *Earth & Sky***

Listeners rate the series as highly understandable. Nine out of 10 listeners disagree or strongly disagree that the “information on *Earth & Sky* is too technical” and that “the process of science is confusing when discussed on the radio show.” The series information was rated as “usually familiar” to less than a third of the listening audience, novel to more than a third and sometimes familiar and sometimes novel to the remaining third of listeners. Thus, the information on *Earth & Sky* is targeted at an appropriate level to reach the mass radio audience effectively.

Those who reported listening to the series “frequently” found it more understandable than those who listened “sometimes.” The higher a listener’s estimation of their knowledge of science was, the more understandable the series was rated. Those who listed newspapers as a primary or secondary source of information were more likely to feel less familiar with the show’s information.

### **Learning from *Earth & Sky***

Listeners felt they learn from the series in a variety of ways. Nine out of 10 listeners agree or strongly agree that the series “teaches interesting discoveries about the natural world.” More than 8 out of 10 listeners feel they “have expanded their knowledge of science by listening” and have “increased their awareness of science news topics.” Two-thirds of listeners agree or strongly agree that the series “has affected the way they look at the night sky” and that the series keeps them “up to date with current environmental science.”

“Frequent” listeners felt the series had more impact on their learning than “sometime” listeners. In addition, women agreed more strongly than men that the series teaches them interesting discoveries about the natural world, affects the way they look at the night sky and keeps them up to date with current environmental science. Those who

chose radio as a major source for their science news also agreed more strongly that the series keeps them up to date.

### **Impact of *Earth & Sky***

An open-ended question regarding how respondents felt *Earth & Sky* has affected them personally elicited answers from 83% of the sample and yielded three major categories of impact. Of all listeners who wrote about any personal impact, 92% indicated positive impact. Almost half of the listeners reported a positive affective impact -- listeners found the show interesting, felt it increased their appreciation of the natural world, and they enjoyed hearing it. Over one-third of listeners focused on the series' positive impact on them cognitively -- listeners felt they learn from the series, that it increases their knowledge or understanding of the natural world and that they learn information to which they would not normally be exposed. The series motivated 14% of listeners to take action, mainly looking for celestial events. "No effect" was reported by 6% of listeners, and a small 2% of listeners disliked the short format.

Provided with a list of 11 different actions, respondents determined whether listening to *Earth & Sky* had ever prompted them to take those actions. The most frequent activities are viewing the night sky (72%), discussing topics with others (71%), reading related information (48%), searching for more information about a topic (30%) and accessing a web site (25%). Other prompted activities include visiting a planetarium or science museum (22%), modifying personal habits or philosophies (22%), purchasing a book or other item (15%), making donations to a non-profit institution (12%), using content in teaching (11%), and writing to *Earth & Sky*, a politician or scientist (2%).

Those who heard the show more frequently were more likely to report that the show had prompted them to action. Women were significantly more likely than men to report visiting a planetarium or science museum. And those with post-graduate education were more likely to use content in teaching than those with less education. When encouraged to describe other actions that have been prompted by their listening to *Earth & Sky*, respondents listed a small but varied set of actions, including environmental activism and integration of content into artistic and humanities activities.

Half of the listeners wrote of a positive impact of the "Edge of Discovery" format, featuring scientists speaking of their research. Listeners appreciated and enjoyed the format (12%), acquired a better understanding of scientific inquiry (7%), appreciated the credibility of hearing from the scientists themselves (6%), felt a greater respect for scientists and science (6%), thought the format added a personal dimension to scientists and science (5%) and indicated the format humanized scientists and science (5%). They felt the format was understandable (2%) and that it was important to hear from scientists (2%). A small 2% of listeners complained that the show was too short for scientists to present their research. The remaining listeners either did not answer the question (26%), did not recognize the format (4%), felt no impact (10%) or felt no impact because they already had a positive attitude that the format reinforced (8%).

In conclusion, 86% of our public radio members listen to *Earth & Sky* and 51% hear it frequently. Listeners rate the series as highly appealing and understandable. The series has a strong positive impact on listeners' awareness and comprehension of science is-

sues and scientists and a considerable influence on listeners' actions beyond the 90-seconds. The series clearly acts to encourage listeners to look at the night sky differently but also demonstrates a critical multiplier effect by inspiring significant numbers of listeners to discuss science with their colleagues, friends and family members.

## INTRODUCTION

*Earth & Sky* is a daily short-format science series for both commercial and public radio. Produced by EarthTalk, Inc. of Austin, TX, the series is hosted by Deborah Byrd and Joel Block and consists of 90-second programs on a wide variety of topics mostly drawn from environmental sciences, earth sciences and astronomy. Currently, the program is heard in all 50 states as well as in many countries around the world.

*Earth & Sky's* goals are to make science accessible and interesting to the radio listening population and to increase adult science literacy. The producers want the show to generate excitement about science by providing daily doses of science to people with a range of science backgrounds, knowledge and interest. As a result of listening to *Earth & Sky*, the producers hope listeners may turn to other sources of science information such as the Internet, books, museums, and television programs to learn more about covered topics.

Additionally, in 2000-2001, *Earth & Sky* launched "Edge of Discovery" programming featuring scientists themselves talking about their research. These programs feature a recorded voice of a scientist speaking about his or her own research processes and discoveries about the natural world. With support from the National Science Foundation under the Public Understanding of Research initiative, the "Edge of Discovery" programming will be expanded to approximately 75 per year in this format or about 28% of the series.

This report presents the first study of a two-part summative evaluation on the impact of *Earth & Sky* on public radio listeners, focusing on traditional formats as well as the new "Edge of Discovery" programming. The second study will occur in two years, permitting time for the "Edge of Discovery" format to be heard by most listeners.

## METHOD

### Research Design

This study involved mailing a one-page double-sided questionnaire, return envelope and \$1 incentive to a random sample of people who are subscription members of their local public radio station. Recipients were asked to fill out the questionnaire and mail it back to the researcher. The respondents were then divided for analysis into two groups -- those who listen to *Earth & Sky* and those who do not.

The following specific research questions were addressed in the data analyses:

- I. What percentage of the radio audience listens to the series and how frequently?
- II. Do demographic characteristics including age, gender, education, and occupation relate to whether a person listens to the program?
- III. Do background characteristics including interest in science, level of science knowledge, science news sources and science attitudes relate to whether a person listens to the program?
- IV. How appealing is *Earth & Sky* and do demographic or background variables relate to appeal?
- V. How understandable is *Earth & Sky* and do demographic or background variables relate to comprehension?
- VI. Do listeners feel they learn from the series and do demographic or background variables influence learning?
- VII. What effects do listeners believe the series has on them personally?
- VIII. Has the series prompted listeners to take further action?
- IX. How has the "Edge of Discovery" format affected listeners?

### Questionnaire

The questionnaire was comprised of several sections. All respondents answered sections 1 – 3. Only *Earth & Sky* listeners answered sections 4 – 6.

1. Demographic questions established the sample's distribution of age, gender, ethnicity, occupational status, and highest level of education.

2. Rating questions assessed science-related background including general interest in science, frequency of use of common sources of science information, perceived level of science knowledge, and science attitudes.
3. Exposure questions determined whether a respondent had heard of or listened to *Earth & Sky* and the frequency of listening activity.
4. Appeal, comprehension and learning were addressed by an open-ended question as well as 11 statements with which respondents agreed or disagreed on a five-point scale.
5. Impact of the “Edge of Discovery” format was addressed with a directed open-ended question.<sup>1</sup>
6. Actions taken as a result of listening to the series were assessed through a check-off list of probable activities.

## Sample

This study involved three public radio stations:<sup>2</sup>

- KUFM-FM at the University of Montana in Missoula, MT. The station reaches all of central and western Montana and has carried *Earth & Sky* for 9 years. The series airs once a day, 5 days a week. Additionally, KUFM broadcasts the short science series *Everyday Science* and *Stardate*.
- KBIA-FM at the University of Missouri in Columbia, MO. The station has a geographic reach from Kirksville in the north, to Lake of the Ozarks in the south, to the outer suburbs of Kansas City in the west and St. Louis in the east. *Earth & Sky* has aired for all 11 years of its existence and is the only program of its kind on the schedule. The series is broadcast once a day, 5 days a week.
- WUMB-FM at the University of Massachusetts-Boston in Boston, MA. The station reaches the eastern half of Massachusetts and the southern part of New Hampshire. *Earth & Sky* airs 3 times per day, 5 days a week. *Our Ocean World* is the only other short science series aired.

In the six months prior to receiving the questionnaire, at KUFM and KBIA, listeners could have heard up to 130 *Earth & Sky* shows of which approximately 37 (28%) were “Edge of Discovery” format. At WUMB, listeners could have been exposed to three repetitions of the shows daily.

During late April of 2002, double-sided questionnaires with a \$1 incentive were sent to a randomly generated subset of 1000 members of each of the three stations. The questionnaires were anonymous and confidential. Recipients were asked to complete the

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<sup>1</sup> In the six months prior to this baseline questionnaire, listeners may have heard at most 37 “Edge of Discovery” shows or about 28% of the daily series.

<sup>2</sup> Our thanks to the following program directors for their cooperation and participation in this study: Michael Marsolek at KUFM-FM, Darren Hellwege at KBIA-FM and Brian Quinn at WUMB-FM.



questionnaire and mail it back. All questionnaires received within 13 weeks of mailing were included in the study analyses.

## **Analyses**

To explore possible significant differences between listeners and non-listeners, chi-square analyses, t-tests, and multiple regression were performed where appropriate. Demographic variables include age, gender, educational level and occupational status (professional, skilled, unskilled). Because of the relatively small number of minorities in this sample, results related to ethnic/racial background were not explored. Background variables include interest in science, self assessed knowledge of science, major sources of science news, science attitudes, listening or not listening to *Earth & Sky* and frequency of listening. In recognition of the large sample size, only statistically significant findings at  $p \leq .0001$  are reported in the text.

## RESULTS

### Return Rate

Of the 3000 surveys mailed out, 24 were returned as undeliverable, 18 were returned uncompleted and 4 were returned from high school students. Of the 2954 surveys remaining, 2019 were completed and returned within a 13-week period following the mailing. This represents a very high 69% return rate. The returned questionnaires include 35% from Montana, 34% from Massachusetts and 31% from Missouri.

### Listeners and Non-Listeners

#### I. What percent of the radio audience listens to the series and how frequently?

Almost 9 out of 10 respondents reported listening to *Earth & Sky*. Five out of 10 respondents heard the series “frequently,” and 4 out of 10 heard it “sometimes.”

Respondents were asked if they had ever heard of the public broadcasting radio series, *Earth & Sky* with Joel Block and Deborah Byrd. Of the 2019 respondents, 86% were listeners:<sup>3</sup>

- 51% heard the series “frequently;”
- 35% heard it “sometimes;”
- 7% never heard it or did not hear it often enough to answer the feedback questions;
- 7% were not aware of the series.

### Demographic Information

#### II. Do demographic characteristics including age, gender, education and occupation relate to whether a person listens to the program?

Our respondent sample is typical of a public radio member audience – more educated, better employed, older with fewer minorities compared to the general U.S. adult population. Only the demographic of age significantly differentiated listeners and non-listeners. On average, listeners were significantly younger (51) than non-listeners (55), although this is possibly not a meaningful difference.

Table 1 presents demographic information for the whole sample as well as for the subgroups of listeners and non-listeners. The respondent sample included few minorities (2%) and more women (56%) than men (44%). The mean age for the respondents was

<sup>3</sup> In previous similar studies, Multimedia Research found 86% of CA public radio members were *Earth & Sky* listeners (1994), 66% of MI radio members were listeners (1993) and 49% of FL radio members (1994, after one year of broadcast).

51 years, with a relatively normal distribution from 18 to 96 years. Most respondents (78%) were employed, mostly at jobs considered to be in the high level of occupational status (executive and major professionals to managers and small business owners). The majority of respondents (58%) also reported having post-college education. Thus, our respondents, drawn randomly from three stations' membership lists, are more educated, better employed, older and include fewer people of color than the general U.S. adult population. However, the sample is typical of a public radio member audience; this sample's demographics are similar to random samples Multimedia Research has obtained recently from other public radio membership lists.

Listeners with an average age of 51 were younger than non-listeners with an average age of 55; however, this age difference, although statistically significant, may not be meaningful in a practical way.

Table 1 Distribution of Demographic Variables (each cell = 100%)

	All Respondents N=2019	Listeners n=1735 (86% of sample)	Non-Listeners n=284 (14% of sample)
State: <sup>4</sup> MA	34%	37%	18%
MO	31%	28%	50%
MT	35%	35%	32%
Gender: Male	44%	46%	34%
Female	56%	54%	66%
Age: Mean	51.2	50.6	55
Range	18-96	18-87	18-96
Ethnic Status:			
White	98%	98%	97%
Minority	2%	2%	3%
Employment Status:			
Employed:	78%	81%	61%
High Status <sup>5</sup>	65%	65%	67%
Medium Status	26%	26%	24%
Low Status	9%	9%	9%
Retired	14%	12%	29%
Homemaker	5%	5%	8%
Unemployed	2%	2%	1%
Student	1%	1%	1%
Education:			
Graduated H.S.	3%	2%	5%
Some College	11%	10%	18%
Graduated College	28%	29%	26%
Post-College	58%	59%	51%

<sup>4</sup> Listening percentages were very high for all three stations: 93% of the MA sample; 87% of the MT sample and 77% of the MO sample were listeners. Note that the MA station played the series three times daily for five days compared with a daily airing over five days at the other two stations.

<sup>5</sup> "High" occupational status includes those with professional and managerial jobs; "medium" are technical or skilled jobs; and "low" are unskilled or menial labor.

## Science Interest, Knowledge, Sources and Attitudes

### III. Do background characteristics including interest in science, level of science knowledge, science news sources and science attitudes relate to whether a person listens to the program?

Listeners of *Earth & Sky* rated themselves as significantly more interested in science generally and significantly more knowledgeable about science than non-listeners.

Listeners were significantly more likely than non-listeners to list “radio” as one of their two major sources of science news; whereas non-listeners were significantly more likely to list “television” as one of their two sources. “Magazines/journals” and “newspapers” were also major sources of science news for both groups.

Listeners agreed significantly more than non-listeners with the following four of eleven attitude statements:

“I like learning how contemporary scientists carry out their research.”

“Keeping up with current science news is a critical responsibility of the public.”

“Failures are as important as successes in learning the truth in science.”

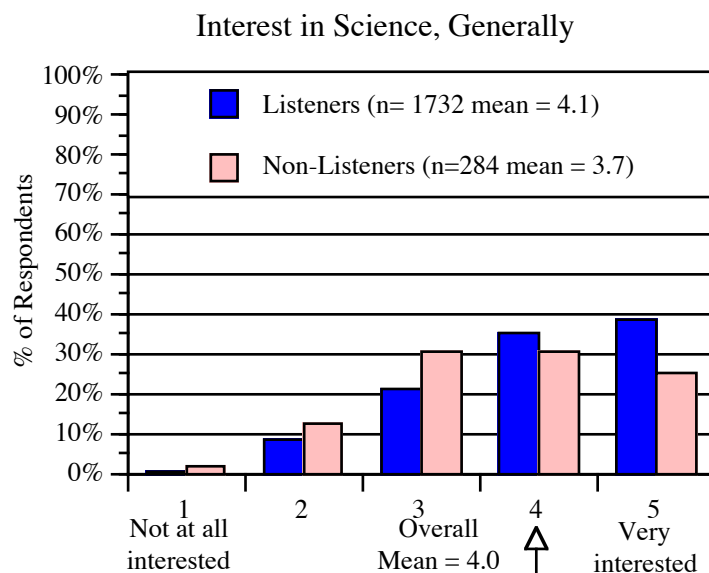
“Research is essential to understanding human impact on the environment.”

Both listeners and non-listeners equally felt that it is important to hear from scientists about their research – this result supports the need for scientists themselves presenting research in the “Edge of Discovery” format.

### Science Interest

Respondents were asked how interested they are in science, generally speaking. They responded using a five-point scale from not at all interested (1) to very interested (5). Of the sample as a whole, 71% were either interested or very interested (4, 5) in science. The average rating for the sample was 4.0 with a standard deviation of .9.

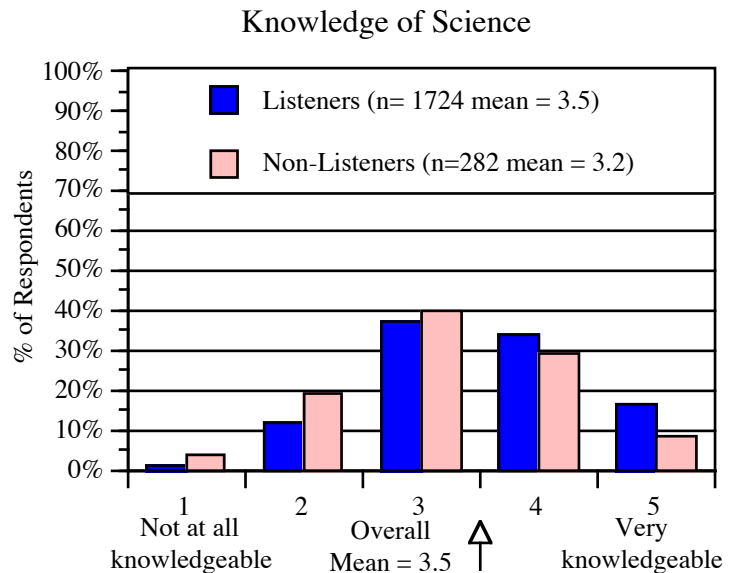
As shown in the chart to the right, listeners are more interested in science than non-listeners. Listeners reported a significantly higher mean interest in science (4.1) than non-listeners (3.7). Interest in science is a small but significant predictor of listening to *Earth & Sky*, accounting for 2% ( $R^2$ ) of the variance in listening/non-listening.



## Science Knowledge

Respondents rated their level of science knowledge as a member of the general public, using a five-point scale from not at all knowledgeable (1) to very knowledgeable (5). Of the sample as a whole, 48% ranked themselves as knowledgeable or very knowledgeable (4, 5). The average rating for the sample was 3.5 with a standard deviation of .9.

As shown in the chart to the right, listeners rated themselves as more knowledgeable about science than non-listeners. Listeners reported a significantly higher mean knowledge of science (3.5) than non-listeners (3.2).



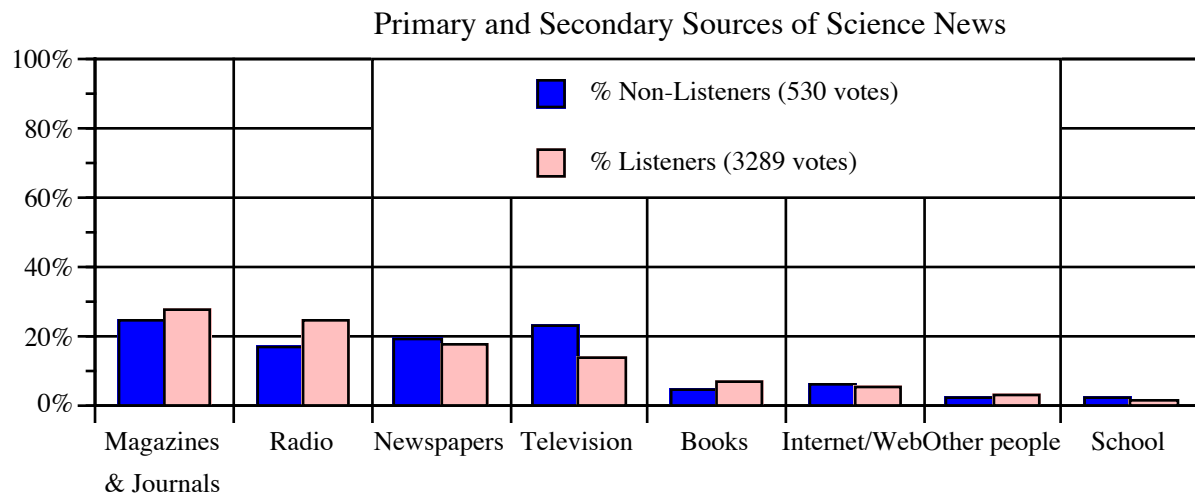
## Science News Sources

Respondents were asked to indicate their primary and secondary source of science news, given eight possible sources. Combining primary and secondary responses, half (51%) of public radio members said their primary or secondary source of science news was “magazines/journals.” Radio was a major source of science news for 45% of members; newspaper for 34% and television for 29% of all member respondents.

The largest percentage of both listeners and non-listeners reported that “magazines/journals” were their primary source of science news:<sup>6</sup> Listeners (36%); Non-Listeners (35%). Respondents also identified their secondary source of science information from the same list. Listeners of *Earth & Sky* indicated “radio” as their most frequent secondary choice (27%), whereas the most frequent secondary choice for non-listeners was a tie between “television” (26%) and “radio” (25%).

<sup>6</sup> This result is consistent with previous Multimedia Research studies of public radio audiences.

The following chart combines the votes for primary and secondary sources of science news and gives an overall picture of where the public radio members feel they obtain most of their science news. Listeners of *Earth & Sky* considered their major sources of science news to be “magazines/journals” (28%), “radio” (25%), “newspapers” (18%) and “television” (14%). Non-listeners indicated their major sources of science news as “magazines/journals” (25%), “television” (23%), “newspapers” (19%) and “radio” (17%).<sup>7</sup> Listeners were significantly more likely than non-listeners to list “radio” as one of their two sources of science news; whereas non-listeners were significantly more likely to list “television” as one of their two sources. Choosing television and radio as major sources of science news is a small but significant predictor of listening or not listening to *Earth & Sky* ( $R^2 = 2.5\%$ ).



<sup>7</sup> Similar differences in science information sources were found between listeners and non-listeners of the radio series *Science Friday* (Multimedia Research report # 98-017, December, 1998).

## Science Attitudes

Science attitudes were assessed by asking respondents to rate their agreement or disagreement with a series of positive and negative statements, using a 5-point scale where (1) indicates strongly disagree and (5) indicates strongly agree. Twelve statements were presented in the questionnaire, but one statement was dropped from the analysis because it evoked numerous comments from respondents as being too confusing to rate (“Most people are confused by the work of science because it is very complex.”). Mean agreement was calculated for each statement and compared for listening and non-listening samples. Table 3 presents the means of agreement for each statement; asterisks indicate mean differences between listener and non-listener samples, significant at  $p \leq .0001$ . [The Appendix contains a table that presents percentages of agreement and disagreement for each statement for the member respondent sample as a whole.]

Table 3 Attitudes about Science: 1 = strongly disagree; 5 = strongly agree

<b>Attitude: Positive &amp; Negative Statements</b>	Listeners	Non-Listeners
<b>Do respondents feel science is understandable?</b>		
Science can be understood and enjoyed on some level by everyone.	4.6	4.5
<b>Is understanding science process important?</b>		
I like learning how contemporary scientists carry out their research.	4.0*	3.7*
It is <u>not</u> important for me to understand the process of scientific discovery.	1.8	1.9
<b>Are respondents aware of the reality of doing research?</b>		
Failures are as important as successes in learning the truth in science.	4.5*	4.4*
Breakthroughs in science typically involve a brilliant person working alone.	1.9	2.0
<b>How important is it to hear from scientists themselves?</b>		
It is important that scientists explain the relevance of new scientific findings.	4.2	4.2
Journalists, not scientists themselves, should interpret research for the public.	2.1	2.1
<b>How important is learning about current science?</b>		
Keeping up with current science news is a critical responsibility of the public.	4.1*	3.9*
It is too hard to keep up-to-date with what’s happening in science research.	3.0	3.1
<b>How important is research in earth and atmospheric sciences?</b>		
Research is essential to understanding human impact on the environment.	4.7*	4.5*
Science about Earth, its oceans and the universe has little relevance to my life.	1.5	1.6

Listeners and non-listeners differed significantly in their mean responses to four of the eleven statements (as indicated by asterisks in Table 3):

- 77% of listeners compared with 65% of non-listeners agreed or strongly agreed that they “like learning how contemporary scientists carry out their research.
- 81% of listeners compared with 75% of non-listeners agreed or strongly agreed that “keeping up with current science news is a critical responsibility of the public.”
- 97% of listeners compared with 94% of non-listeners agreed or strongly agreed that “failures are as important as successes in learning the truth in science.”

- 98% of listeners compared with 96% of non-listeners agreed or strongly agreed that “research is essential to understanding human impact on the environment.”

Note that both listeners and non-listeners equally felt that it is important to hear from scientists about their research – this result supports the need for scientists themselves presenting research in the “Edge of Discovery” format.

### Appeal of *Earth & Sky*

**IV. How appealing is *Earth & Sky* and do demographic or background variables relate to appeal?**

Listeners rate the series as highly appealing. Nine out of 10 listeners agree or strongly agree that they “enjoy listening to the series,” and 8 out of 10 agree or strongly agree that they “listen attentively” to the show. Nine out of 10 listeners disagree or strongly disagree with the sentiment that they “dislike hearing scientists talk about their own work on the show.”

Those who reported listening “frequently” to *Earth & Sky* enjoy the series more, listen more attentively and like hearing from scientists more than those who listen “sometimes.” Listeners who listed “newspapers” as a primary or secondary source of science news felt they listened less attentively to the show. No other variables relate to appeal of the show.

Listeners responded to statements reflecting feelings about the series using a 5-point scale from strongly disagree (1) to strongly agree (5). Three statements relating to appeal appear in Table 4 with their mean ratings.

Table 4. Agreement with Statements on Appeal of *Earth & Sky*

Means	Statements
4.4	I enjoy listening to the series, <i>Earth &amp; Sky</i> .
4.0	I listen attentively when I hear the series come on the radio.
1.7	I dislike hearing scientists talk about their own work on the show.

- 94% of listeners agree or strongly agree that they “enjoy listening to the series, *Earth & Sky*. Those who reported listening “frequently” enjoyed the series more than those who reported listening “sometimes” (means = 4.6, 4.1; respectively).
- 80% agree or strongly agree that they “listen attentively when they hear the series come on the radio.” Those who reported listening “frequently” agree more with this statement than those who reported listening “sometimes” (means = 4.2, 3.8; respectively). Listeners who listed “newspapers” as a primary or secondary source of science news agreed significantly less with this statement than those who did not use newspapers (means = 3.9, 4.1; respectively).



- 88% disagree or strongly disagree with the sentiment that they “dislike hearing scientists talk about their own work on the show.”<sup>8</sup> Those who reported listening “frequently” disagree more strongly with this statement than those who reported listening “sometimes” (means = 1.6, 1.9; respectively).

### Comprehension of *Earth & Sky*

**V. How understandable is *Earth & Sky* and do demographic or background variables relate to comprehension?**

Listeners rate the series as highly understandable. Nine out of 10 listeners disagree or strongly disagree that the “information on *Earth & Sky* is too technical” and that “the process of science is confusing when discussed on the radio show.” The series information was rated as “usually familiar” to less than a third of the listening audience, novel to more than a third and sometimes familiar and sometimes novel to the remaining third of listeners. Thus, the information on *Earth & Sky* is targeted at an appropriate level to reach the mass radio audience effectively.

Those who reported listening to the series “frequently” found it more understandable than those who listened “sometimes.” The higher a listener’s estimation of their knowledge of science was, the more understandable the series was rated. Those who listed newspapers as a primary or secondary source of information were more likely to feel less familiar with the show’s information. No other variables relate to comprehension of the show.

Listeners responded to statements reflecting comprehension of the series using a 5-point scale from strongly disagree (1) to strongly agree (5). Three statements relating to clarity appear in Table 5 with their mean ratings.

Table 5. Agreement with Statements on Comprehension of *Earth & Sky*

Means	Statements
2.9	I am usually familiar with most of the information given in the show.
1.8	The process of science is confusing when discussed on the radio show.
1.6	The information on <i>Earth &amp; Sky</i> is too technical for me.

<sup>8</sup> This result can be considered in the positive as follows: 88% of listeners agree that they like hearing scientists talking about their own work.

- In response to the statement “I am usually familiar with most of the information given in the show,” 27% of listeners agreed, 34% were neutral, and 39% disagreed. This distribution indicates that the information is targeted at a level to reach the mass radio audience effectively – the information is usually familiar to less than a third, novel to more than a third and sometimes familiar and sometimes novel to the remaining third of the audience. Ratings of this statement were correlated with self-assessed knowledge of science ( $R_s = .32$ ). As the audience members’ knowledge of science increases, so does their agreement that they are “usually familiar with most of the information given in the show.” Those who reported listening “frequently” agree more with this statement than those who reported listening “sometimes” (means = 3.0, 2.8; respectively). Those who listed newspapers as a primary or secondary source of science news were more likely to disagree that they were familiar with most of the show’s information (means = 2.7 newspaper as a source; 3.0 newspaper not a source).
- 92% disagreed or strongly disagreed with the statement that “the process of science is confusing when discussed on the radio show.”<sup>9</sup> Those who reported listening “frequently” to *Earth & Sky* disagree more with this statement than those who reported listening “sometimes” (means = 1.7, 1.9; respectively).
- 94% disagreed or strongly disagreed with the statement that “the information on *Earth & Sky* is too technical for me.”<sup>10</sup> Those who reported listening “frequently” to *Earth & Sky* disagree more with this statement than those who reported listening “sometimes” (means = 1.5, 1.8; respectively). Ratings of this statement were correlated with self-assessed knowledge of science ( $R_s = .34$ ). As the audience members’ knowledge of science increases, so does their disagreement that “the information is too technical.”

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<sup>9</sup> This negative statement can be reconsidered in the positive as follows: 92% of listeners agree that the process of science is clear when discussed on *Earth & Sky*.

<sup>10</sup> This statement can be reconsidered in the following way: 94% of listeners agree that the information on *Earth & Sky* is not too technical for them.

## Learning from *Earth & Sky*

### VI. Do listeners learn from *Earth & Sky* and do demographic or background variables relate to learning?

Listeners felt they learn from the series in a variety of ways. Nine out of 10 listeners agree or strongly agree that the series “teaches interesting discoveries about the natural world.” More than 8 out of 10 listeners feel they “have expanded their knowledge of science by listening” and have “increased their awareness of science news topics.” Two-thirds of listeners agree or strongly agree that the series “has affected the way they look at the night sky” and that the series keeps them “up to date with current environmental science.”

“Frequent” listeners felt the series had more impact on their learning than “sometime” listeners. In addition, women agreed more strongly than men that the series teaches them interesting discoveries about the natural world, affects the way they look at the night sky and keeps them up to date with current environmental science. Those who chose radio as a major source for their science news also agreed more strongly that the series keeps them up to date.

Listeners responded to statements reflecting learning from the series using a 5-point scale from strongly disagree (1) to strongly agree (5). Five statements relating to learning appear in Table 6 with their mean ratings.

Table 6. Agreement with Statements on Learning from *Earth & Sky*

Means	Statements
4.2	The series teaches me interesting discoveries about the natural world.
4.1	I have expanded my knowledge of science by listening to the series.
3.7	Listening to the series has affected the way I look at the night sky.
3.7	The series keeps me up to date with current environmental science.
1.9	The series has <u>not</u> increased my awareness of science news topics.

- 93% of listeners agree or strongly agree that the “series teaches interesting discoveries about the natural world.” Those who reported listening “frequently” agreed more strongly than those who reported listening “sometimes” (means = 4.4, 4.1; respectively). Additionally, women agreed more strongly with this statement than men (means = 4.3, 4.1; respectively).
- 85% agree or strongly agree that they “have expanded knowledge of science by listening to the series.” Those who reported listening “frequently” agree more with this statement than those who reported listening “sometimes” (means = 4.2, 3.8; respectively).

- 85% disagree or strongly disagree that “the series has not increased their awareness of science news topics.”<sup>11</sup> More frequent listeners of the series disagreed more strongly with this statement ( “frequent” = 1.7; “sometimes” = 2.2).
- 66% agree or strongly agree that “listening to the series has affected the way they look at the night sky.” Those who listen to the series “frequently” agreed more than those who listen “sometimes” (means = 3.9, 3.4; respectively). Women agreed more strongly with this statement than men (means = 3.8, 3.6; respectively).
- 65% agree or strongly agree that the series keeps them “up to date with current environmental science.” “Frequent” series listeners agreed more strongly with this statement than “sometime” listeners (means = 3.9, 3.5; respectively). Women also agreed more strongly than men (means = 3.8, 3.6; respectively). Agreement was also significantly higher for those who chose radio as a source of science news (mean = 3.8) than for those who did not (3.6).

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<sup>11</sup> The negative statement may be rephrased as 85% agree that the series has increased their awareness of science news topics.

## Impact of "Earth & Sky" on Listeners

### VII. What effects do listeners of *Earth & Sky* believe the series has on them personally?

Of the 83% of listeners who wrote about any personal impact, 92% indicated a positive impact. Of the listening sample, 46% spontaneously reported that the series had a positive affec-tive impact on them; 37% focused on the series' positive impact on them cognitively; and 14% described an impact on their be-havior. Listeners found the show interesting, felt it increased their appreciation of the natural world, and they enjoyed hearing it. Listeners felt they learn from the series, that it increases their knowledge or understanding of the natural world and that they learn information to which they would not normally be exposed. The series also motivated listeners to look for celestial events.

"No effect" was reported by 6% of listeners, and a small 2% of listeners disliked the short format.

The questionnaire asked the open-ended question: "How do you feel listening to *Earth & Sky* has affected you personally, if at all?" Of listening respondents, 83% answered this question. Responses to this question were categorized and sorted by keywords and content. For example, the following response: "it has added to my knowledge of the natural world while entertaining and stimulating me intellectually. I've looked at the night sky much more than I would have," was categorized as positive cognitive impact ["added to my knowledge..."], positive affective impact ["entertaining..."] and positive behavioral impact ["looked at night sky..."]. As another example of the coding, the following response: "I enjoy it, learn from it, teach with what I learn from it. It made me get out and watch the last great meteor shower which I might not have done otherwise," was categorized as positive affective impact ["enjoy it"], positive cognitive impact ["learn from it"] and positive behavioral impact ["teach" and "watch meteor shower"].<sup>12</sup> Of the 83% of listeners who answered the open-ended question, 92% indicated a positive impact of some kind – note that those who did not answer could have had positive or negative feelings that were not expressed.

Table 7, on the next page, presents details of the classification of the open-ended responses. Almost half (46%) of the listening sample spontaneously reported that *Earth & Sky* had a positive affective impact. Mainly, listeners found the show interesting, felt it increased their appreciation of the natural world and they enjoyed hearing it. Smaller portions of the audience reported liking the format, finding the show entertaining, feeling more connected to nature because of it or simply liking or loving it.

Over one-third of listeners focused on the series' impact on them cognitively. Listeners in this group felt mostly that they learn from the series, that it increases their knowledge or understanding of the natural world and that they learn information to which they would not normally be exposed. Smaller portions of listeners mentioned that the show

<sup>12</sup> Only 0.9% of respondents provided answers that fell into all three main impact categories- affective, cognitive and behavioral.

updates them on current events, provides them with important information relevant to their lives, makes them think, and is even “enlightening” or “enriching.” Only 14% of listeners reported spontaneously that the series had an impact on their behavior, mostly motivating them to look for celestial events, sharing information with others and looking for more information in books or on the Internet. In terms of neutral impact, 6% said the series had no effect, and 17% gave no answer, which could be interpreted as meaning “no effect.” As far as negative impact, 2% were frustrated by the short length of the program.

Table 7. Personal Impact of *Earth & Sky*

How do you feel <i>Earth &amp; Sky</i> has affected you personally, if at all?	Listeners (n = 1735)
<b>Positive Affective Impact</b>	<b>46%<sup>13</sup></b>
Interesting; very interesting; intriguing	13%
Broadens or increases interest/appreciation of natural world, universe	13%
Enjoy; enjoy hearing	12%
Like format: well-presented, concise, easy to understand, accessible	6%
Entertaining; fun; fascinating	3%
Like it; look forward to hearing it	3%
Feel more connected/more in touch with nature	2%
Love it	2%
<b>Positive Cognitive Impact</b>	<b>37%</b>
Informative; educational; learn from it	16%
Increases or broadens knowledge/understanding of natural world, environment, astronomy, universe	8%
Learn information not learned otherwise; increases awareness of info not normally exposed to	6%
Updates on current events	3%
Useful, valuable or important information, relevant to me	3%
Makes me think	3%
Enlightening, enriching	1%
<b>Positive Behavioral Impact</b>	<b>14%</b>
Motivates to look for celestial events	10%
Share/Discuss information with others	3%
Look for more information in books, on web	2%
<b>No Effect</b>	<b>6%</b>
<b>No Answer</b>	<b>17%</b>
<b>Negative Reaction to Short Length</b>	<b>2%</b>

<sup>13</sup> Bolded categories add up to more than 100% because listeners’ responses often included more than one major category of impact. The subcategories add up to more than the bolded categories because listeners’ responses could include more than one subcategory.

**VIII. Has the series prompted listeners to take further action?**

The series has prompted listeners to take at least eleven different listed actions. The most frequent activities are viewing the night sky (72%), discussing topics with others (71%), reading related information (48%), searching for more information about a topic (30%) and accessing a web site (25%).

Those who heard the show more frequently were more likely to report that the show had prompted them to action. Women were significantly more likely than men to report visiting a planetarium or science museum. And those with post-graduate education were more likely to use content in teaching than those with less education.

When encouraged to describe other actions that have been prompted by their listening to *Earth & Sky*, respondents listed a small but varied set of actions, including environmental activism and integration of content into artistic and humanities activities.

Respondents were asked whether listening to *Earth & Sky* had ever prompted them to take any of 11 further actions, as shown in Table 8.

Table 8. Actions Prompted by Listening to *Earth & Sky*

<u>Has listening to <i>Earth &amp; Sky</i> ever prompted you to . . .</u>	<u>Listeners (n=1735)</u>
view the night sky	72%
discuss the topics with others	71%
read related information in books, magazines, newspapers	48%
search for more information about a topic	30%
access an Internet web site, including <i>Earth &amp; Sky's</i>	25%
visit a planetarium or science museum	22%
modify personal habits or philosophies	22%
purchase a book or other item related to a show topic	15%
make donations to a non-profit institution	12%
use content in teaching	11%
write to <i>Earth &amp; Sky</i> , a politician, scientist or other	2%

Table 8 shows that almost three-quarters of listeners have “viewed the night sky,” and “discussed topics with others” in response to the series. Respondents added comments about viewing comets, planet configurations and meteor showers and reported discussing the show’s contents with colleagues and relatives; for example,

- Emailed the Leonid meteor shower information to my entire company.
- I often drag others out to view the night sky.
- I attended stargazing events sponsored by local enthusiasts.

Went to first astronomy club meeting.  
I share topics with my grandchildren, make sure the girls know they can become scientists too.  
I often share what I hear with elders I work with in my adult day care.  
Makes more interesting conversation at social gatherings.  
My coworkers [clerical] are often surprised by what I can tell them about stars.

Half of *Earth & Sky* listeners "read related information in books, magazines, newspapers." One-third "searched for more information about a topic," and one-quarter 'accessed an Internet web site." Added comments included, for example:

Check out books on stars from local library.  
Follow up by reading *Sky & Telescope* or *Scientific American* or related publications.  
Pull out a volume of science to ascertain my preconceptions.  
Review my own position by rereading my bible.

One-fifth of listeners were encouraged to "visit a planetarium or science museum" and "modify personal habits or philosophies." A purchase related to the show was reported by 15%. Purchases mentioned included buying telescopes, star computer software, a star calendar, subscribing to *Sky & Telescope*.

Using *Earth & Sky* content in teaching was reported by 11% of the listeners, mostly those with post-graduate education but with interesting exceptions:

I used information about planet configurations this month in my preschool newsletter.  
Use scripts for literacy education course I teach.  
I used some information in my ministry as one of Jehovah's witnesses.  
As a woodworker, I talk more about sustainability - wise use of natural materials in projects, especially to architects.

Frequency of listening to *Earth & Sky* was related significantly to all 11 listed actions. Higher than expected frequencies of these actions appeared for those who heard the show "frequently" as opposed to "sometimes." Female listeners were significantly more likely than males to report visiting a planetarium or science museum in response to the series. Those with post-graduate education were more likely to use content in teaching than those with less education.

Respondents were encouraged to describe other unlisted actions that have been prompted by their listening to *Earth & Sky*. A small but varied set of actions were elicited, including environmental activism and integration of content into artistic and humanities activities; for example:

I answered a question correctly at an arboretum tour about why trees drop their leaves.  
Made a special detour on our Texas trip to see the observatory.  
Visit an aquarium. It had been years since I had.  
I contacted an old friend who was featured on the program.  
My daughter and I started a project for the child-produced show contest but alas never completed it - but it's a great idea.  
Help kids access information on topics.  
I helped my child choose a topic for a school report.  
Engage in simple science projects like fossil hunts.  
Sometime try to duplicate a simple experiment.  
I do art projects related to topics.  
I incorporate something into a painting. I'm an artist.  
I draw the sky.  
Write poetry.  
I sometimes use the information in stand-up comedy routines.  
I took an ecological vacation.



I go out and take a closer look at local flora.  
Prompted me to look into volunteering on a research team.  
It gives that much more sense of justice to my own environmentalism.  
Leads me to question more about the environment and what can be done.  
Got more involved in protecting the environment.  
Try to be more conscientious about our earth and treat it with reverence and respect it deserves.  
Recycle – including organizing where I teach to increase recycling.  
Support movement to limit artificial light sources from our night sky landscape.

### **IX. How has the “Edge of Discovery” format affected listeners?**

In response to an open-ended question, half of the listeners indicated positive impact of the “Edge of Discovery” format, featuring scientists speaking of their research. Listeners appreciated and enjoyed the format; acquired a better understanding of scientific inquiry; appreciated the credibility of hearing from the scientists themselves; felt a greater respect for scientists and science; thought the format added a personal dimension to scientists and science; and indicated the format humanized scientists and science. They felt the format was understandable and that it was important to hear from scientists.

A small 2% of listeners complained that the show was too short for scientists to present their research. The remaining listeners either did not answer the question (26%), did not recognize the format (4%), felt no impact (10%) or felt no impact because they already had a positive attitude that the format reinforced (8%).

The questionnaire asked the open-ended question: “Many of the *Earth & Sky* segments feature scientists speaking about their own research. How has this format, featuring scientists themselves, affected your attitude toward scientists or understanding of science?” Of listening respondents, 74% answered this question. A small portion (4%) indicated that they had not heard this format. Responses to this question were categorized and sorted by keywords and content, as presented in Table 9 on the next page.

Half of the sample indicated positive impact of the “Edge of Discovery” format, as shown in Table 9. They appreciated and enjoyed the format; acquired a better understanding of scientific inquiry; appreciated the credibility of hearing from the scientists themselves; felt a greater respect or appreciation for scientists and science; thought the format added a personal dimension to scientists and science; and indicated that the format humanized scientists and science. They felt the format was understandable and that it was important to hear from scientists.

Of listeners, 10% indicated no change, and 8% indicated no impact due to the fact that they already held a positive attitude because they were scientists, worked with scientists or know scientists. They felt the format reinforced and confirmed their already positive attitude. In terms of negative reactions, 2% felt the short length was not sufficient to provide the scientists with time to present their research process and conclusions. They wanted a longer show.

Table 9. Impact of “Edge of Discovery” Format

<b>How has the format featuring scientists themselves affected your attitude toward scientists or understanding of science?</b>	<b>Listeners (n = 1735)</b>
<b>Positive impact</b>	<b>50%</b>
Appreciate, enjoy, like hearing scientists; fascinating, interesting, good/great format	12%
Better understanding of motivation, process, data analysis, conclusion-making, disappointments, types of people doing research, persistence, commitment	7%
Hearing directly from “horse’s mouth” / source is better, more credible, more accurate, more authentic, unfiltered	6%
Positive influence; greater respect/appreciation for scientists; greater interest in science	6%
Adds personal dimension to scientists/science, especially if passionate, enthusiastic; makes more accessible/approachable	5%
Humanizes scientists/science; presents scientists as people; makes them more real; see science as a human endeavor	5%
Understandable, clear	2%
Important, valuable to hear from scientists	2%
Miscellaneous positive	5%
<b>No answer</b>	<b>26%</b>
<b>No impact, no change</b>	<b>10%</b>
<b>No impact because already have positive attitude -- am a scientist, work with scientists, know scientists; format reinforces</b>	<b>8%</b>
<b>Not heard format</b>	<b>4%</b>
<b>Negative reaction to short length</b>	<b>2%</b>

## APPENDIX

### Attitudes about Science

<b>Attitude: Positive &amp; Negative Statements</b>	All Member Respondents % of agree / disagree
<b>Do respondents feel science is understandable?</b>	
Science can be understood and enjoyed on some level by everyone.	97% agree
<b>Is understanding science process important?</b>	
I like learning how contemporary scientists carry out their research.	75% agree
It is <u>not</u> important for me to understand the process of scientific discovery.	83% disagree
<b>Are respondents aware of the reality of doing research?</b>	
Failures are as important as successes in learning the truth in science.	97% agree
Breakthroughs in science typically involve a brilliant person working alone.	83% disagree
<b>How important is it to hear from scientists themselves?</b>	
It is important that scientists explain the relevance of new scientific findings.	91% agree
Journalists, not scientists themselves, should interpret research for the public.	69% agree
<b>How important is learning about current science?</b>	
Keeping up with current science news is a critical responsibility of the public.	80% agree
It is too hard to keep up-to-date with what's happening in science research.	38% agree 27% neutral 35% disagree
<b>How important is research in earth and atmospheric sciences?</b>	
Research is essential to understanding human impact on the environment.	98% agree
Science about Earth, its oceans and the universe has little relevance to my life.	94% disagree