



MULTIMEDIA RESEARCH

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Earth & Sky
Summative Evaluation: Edge of Discovery Series
Study 2

Report for
EarthTalk, Inc.

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EXECUTIVE SUMMARY OF SUMMATIVE EVALUATION
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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 second 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 2964 questionnaires that adult public radio members received, 2005 or 68% 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. Listeners are significantly younger and better educated than non-listeners; however, age and education together predict only 2.5% (R^2) of the variance in whether or not one listens to *Earth & Sky*.

Listeners rated themselves as significantly more interested in science 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 “newspapers” 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 that they like learning how contemporary scientists carry out their research, that it is important to understand the process of science discovery, and that science can be understood and enjoyed on some level by everyone.

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 “radio” as a primary or secondary source of science news felt they enjoyed listening more 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” by 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 television as a primary or secondary source of information were more likely to feel less comfortable with the show’s technical level, perhaps missing TV’s visual support.

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 significantly more impact on their learning than “sometimes” listeners. Those who chose radio as a major source for their science news also agreed more strongly that the series keeps them up to date, increases their awareness of science news topics and affects the way they look at the night sky.

Impact of *Earth & Sky*

An open-ended question regarding how respondents felt *Earth & Sky* has affected them personally elicited answers from 84% of the sample and yielded three major categories of impact. Of all listeners who wrote about any personal impact, 91% indicated positive impact. Almost half of listeners reported a positive affective impact -- listeners found the show interesting, enjoyable, and felt it increased their appreciation of the natural world. Two-fifths 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 discussing topics with others (74%), viewing the night sky (71%), reading related information (49%), searching for more information about a topic (35%) and accessing a web site (32%). Other prompted activities include modifying personal habits or philosophies (20%), visiting a planetarium or science museum (18%), purchasing a book or other item (15%), making donations to a non-profit institution (14%), using content in teaching (12%), and writing to *Earth & Sky*, a politician or scientist (3%).

Those who heard the show more frequently were more likely to report that the show had prompted them to action. 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.

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; thought the format added a personal dimension to scientists and science; acquired a better understanding of scientific inquiry; appreciated the credibility of hearing from the scientists themselves; felt a greater respect for scientists and science; and indicated the format humanized scientists and science. A small 1% of listeners complained that the show was too short for scientists to present their research. The remaining listeners either did not answer the question (25%), did not recognize the format (5%), felt no impact (10%) or felt no impact because they already had a positive attitude that the format reinforced (6%).

In conclusion, 86% of our public radio members listen to *Earth & Sky* and 47% 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 issues and scientists and a considerable influence on listeners' actions beyond the 90-seconds. More frequent listeners report stronger impact than less frequent listeners. 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. Comparisons of listeners currently versus listeners three years ago reveal significant differences only with respect to Internet usage. Current listeners report higher use of the Internet as a major source of science news and were more likely to report that *Earth & Sky* prompted them to access a website. Otherwise, *Earth & Sky* continues to maintain the high listener appeal and impact levels that it obtained three years ago.

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 comprises about 28% of the series or 75 shows per year.

This report presents the second 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 newer “Edge of Discovery” programming. The first study, completed in August 2002, assessed listeners and non-listeners before the “Edge of Discovery” was a major part of the *Earth & Sky* broadcast. This second study, in August 2005, comes three years after the first study, permitting time for the “Edge of Discovery” format to be heard by most listeners. This document reports on the second study results as well as how they compare to the first study findings.

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?
- X. Are there differences in impact for listeners in 2005 compared with listeners surveyed in 2002?

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.
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:¹

- 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 12 years. The series airs once a day, 5 days a week, in the evening.
- 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 12 years of its existence. The series is broadcast once a day, 5 days a week, in the evening.
- 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 and northern Rhode Island. *Earth & Sky* airs 2 times per day, 5 days a week, in the morning and evening, and 3 times on Saturday.

In the years prior to receiving the questionnaire, listeners could have heard up to 260 *Earth & Sky* shows per year of which approximately 75 (28%) were “Edge of Discovery” format. At WUMB, listeners could have been exposed to repetitions of the shows.

¹ Our thanks to the program directors at KUFM-FM, KBIA-FM and WUMB-FM for their cooperation and participation in this study.

During the winter of 2005, 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 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 regressions 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, 26 were returned as undeliverable, 5 were returned incomplete and 5 were returned from high school students. Of the 2964 surveys remaining, 2005 were completed and returned within a 13-week period following the mailing. This represents a very high 68% return rate. The returned questionnaires include 35% from Montana, 34% from Missouri and 31% from Massachusetts.

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*. Almost 5 out of 10 respondents heard the series “frequently,” and almost 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 2005 respondents, 86% were listeners:²

- 47% heard the series “frequently;”
- 38% heard it “sometimes;”
- 8% 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. The demographic variables of educational background and age significantly differentiated listeners and non-listeners but together predict only 2.5% of the variance in listening behavior.

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 (3%) and more women (56%) than men (44%). The mean age for the respondents was 53 years, with a relatively normal distribution from 19 to 100 years. Most respondents (75%) were employed, mostly at jobs considered to be in the high level of occupational status (executive and major profession-

² In Study 1, utilizing the same radio station membership lists, again 86% were found to be listeners.

als to managers and small business owners). The majority of respondents (60%) 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.

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

	All Respondents N=2005	Listeners n=1714 (86% of sample)	Non-Listeners n=291 (14% of sample)
State: ³ MA	31%	33%	18%
MO	35%	33%	44%
MT	35%	35%	38%
Gender: Male	44%	45%	39%
Female	56%	55%	61%
Age: Mean	53.3	52.7	56.8
Range	19-100	19-100	21-89
Ethnic Status:			
White	97%	98%	96%
Minority	3%	2%	4%
Employment Status:			
Employed:	75%	77%	63%
High Status ⁴	64%	65%	61%
Medium Status	26%	25%	27%
Low Status	10%	10%	11%
Retired	18%	16%	31%
Homemaker	4%	4%	4%
Unemployed	1%	1%	1%
Student	1%	1%	1%
Education:			
Graduated H.S.	2%	2%	4%
Some College	11%	10%	20%
Graduated College	27%	28%	22%
Post-College	60%	61%	53%

Chi-square analysis reveals that education and listening are not significantly independent; listeners are better educated than non-listeners. Also, listeners are younger than non-listeners, but the significant mean age gap of four years may not be meaningful in a practical way. In fact, education and age predict only 2.5% of the variance in whether or not one listens to *Earth & Sky*.

³ Listening percentages were very high for all 3 stations: 91% of the MA sample; 85% of the MT sample and 81% of the MO sample were listeners. Note that the MA station played the series 2 times daily for five days and 3 times on Saturday compared with a daily airing over 5 days at the other 2 stations.

⁴ "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.

In response to eleven attitude statements, listeners agreed significantly more than non-listeners with two statements:

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

“Science can be understood and enjoyed on some level by everyone.”

And listeners disagreed significantly more than non-listeners with one statement:

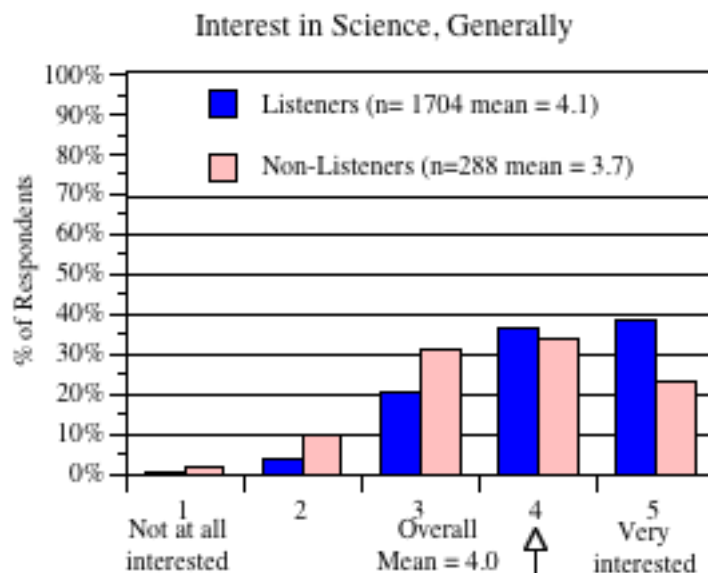
“It is not important for me to understand the process of scientific discovery.”

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, 73% 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.

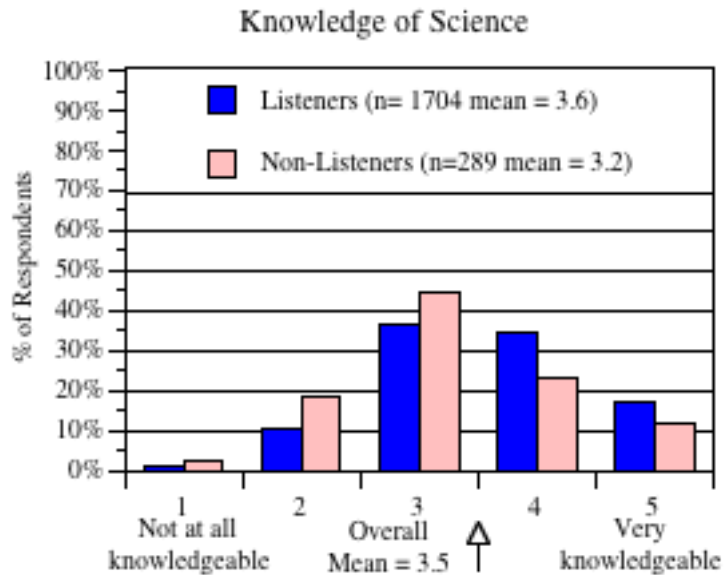
As shown in the chart to the right, listeners are more interested in science than non-listeners. Listeners reported a significantly higher mean interest in science (4.1) than non-listeners (3.7). Interest in science is a small but significant predictor of listening to *Earth & Sky*, accounting for 2.6% (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, 49% 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 (3.6) than non-listeners (3.2).



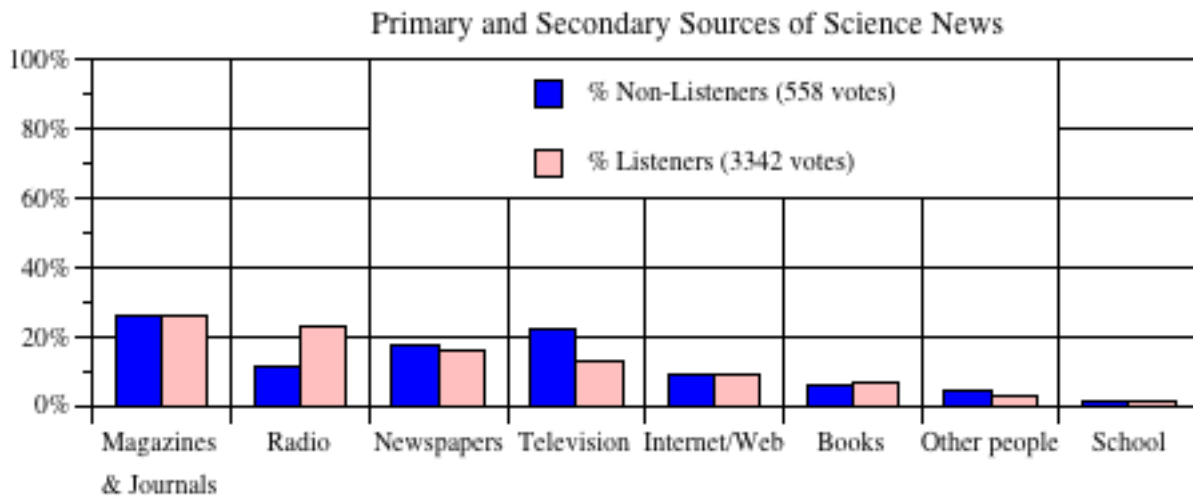
Science News Sources

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 42% of members; newspaper for 32% 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:⁵ Listeners (34%); Non-Listeners (36%). 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” (23%) and “radio” (22%).

⁵ 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” (26%), “radio” (23%), “newspapers” (17%) and “television” (13%). Non-listeners indicated their major sources of science news as “magazines/journals” (27%), “television” (23%), “newspapers” (18%) and “radio” (12%). 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* ($R^2 = 3.7\%$).



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. 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

Attitude: Positive & Negative Statements	Listeners	Non-Listeners
Do respondents feel science is understandable?		
Science can be understood and enjoyed on some level by everyone.	4.6*	4.4*
Is understanding science process important?		
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*	2.0*
Are respondents aware of the reality of doing research?		
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.	1.8	2.0
How important is it to hear from scientists themselves?		
It is important that scientists explain the relevance of new scientific findings.	4.3	4.2
Journalists, not scientists themselves, should interpret research for the public.	2.1	2.1
How important is learning about current science?		
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.	2.9	3.1
How important is research in earth and atmospheric sciences?		
Research is essential to understanding human impact on the environment.	4.7	4.6
Science about Earth, its oceans and the universe has little relevance to my life.	1.4	1.6

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

- 77% of listeners compared with 63% of non-listeners agreed or strongly agreed that they “like learning how contemporary scientists carry out their research.”
- 84% of listeners compared with 77% of non-listeners agreed or strongly agreed that it is important for them “to understand the process of scientific discovery.”
- 97% of listeners compared with 92% of non-listeners agreed or strongly agreed that “science can be understood and enjoyed on some level by everyone.”

Note that listeners feel they should understand the process of scientific discovery and like hearing from scientists; thus supporting 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 “radio” as a primary or secondary source of science news felt they enjoyed listening more 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 & Sky</i> .
4.1	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.

- 93% 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). Listeners who listed “radio” as a primary or secondary source of science news agreed significantly more with this statement than those who did not use radio as a major science news source (means = 4.3, 3.9; respectively).
- 82% 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 = 4.3, 3.9; respectively).

- 89% disagree or strongly disagree with the sentiment that they “dislike hearing scientists talk about their own work on the show.”⁶ Those who reported listening “frequently” disagree more strongly with this statement than those who reported listening “sometimes” (means = 1.6, 1.8; 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” by 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 television as a primary or secondary source of information were more likely to feel less comfortable with the show’s technical level. 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.
1.7	The process of science is confusing when discussed on the radio show.
1.6	The information on <i>Earth & Sky</i> is too technical for me.

- In response to the statement “I am usually familiar with most of the information given in the show,” 28% of listeners agreed, 36% were neutral, and 36% 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

⁶ This result can be considered in the positive as follows: 89% of listeners agree that they like hearing scientists talking about their own work.

statement were correlated with self-assessed knowledge of science ($R_s = .31$). 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). Men were more likely to agree that they were familiar with most of the show's information than women (means = 3.1; 2.8; respectively).

- 91% disagreed or strongly disagreed with the statement that "the process of science is confusing when discussed on the radio show."⁷ Those who reported listening "frequently" to *Earth & Sky* disagree more with this statement than those who reported listening "sometimes" (means = 1.6, 1.9; respectively).
- 92% disagreed or strongly disagreed with the statement that "the information on *Earth & Sky* is too technical for me."⁸ 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 ($R_s = .33$). As the audience members' knowledge of science increases, so does their disagreement that "the information is too technical." Those who listed television as a primary or secondary source of science news were more likely to agree that the show is technical for them (means = 1.8 for television as a source; 1.6 for television not a source); perhaps television viewers miss their familiar visual support.

⁷ This negative statement can be reconsidered in the positive as follows: 91% of listeners agree that the process of science is clear when discussed on *Earth & Sky*.

⁸ This statement can be reconsidered in the following way: 92% 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 significantly more impact on their learning than “sometime” listeners. Those who chose radio as a major source for their science news also agreed more strongly that the series keeps them up to date, increases their awareness of science news topics and affects the way they look at the night sky.

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
4.3	The series teaches me interesting discoveries about the natural world.
4.1	I have expanded my knowledge of science by listening to the series.
3.8	The series keeps me up to date with current environmental science.
3.7	Listening to the series has affected the way I look at the night sky.
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).
- 86% 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, 3.9; respectively).
- 85% disagree or strongly disagree that “the series has not increased their awareness of science news topics.”⁹ More frequent listeners of the series disagreed more strongly with this

⁹ The negative statement may be rephrased as 85% agree that the series has increased their awareness of science news topics.

statement (“frequent” = 1.7; “sometimes” = 2.1). Disagreement was also significantly stronger for those who chose radio as a source of science news (mean = 1.8) than for those who did not (2.0).

- 67% 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 = 4.0, 3.6; respectively). Agreement was also significantly higher for those who chose radio as a source of science news (mean = 3.9) than for those who did not (3.7).
- 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, 3.5; respectively). Agreement was significantly higher for those who chose radio as a source of science news (mean = 3.8) than for those who chose other primary or secondary science news sources (3.6).

Impact of "Earth & Sky" on Listeners

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

A positive series impact was indicated by 77% of listeners of *Earth & Sky*. "No effect" was reported by 6% of listeners. A small 2% of listeners dislike the short format, and 16% did not provide an answer.

Of the whole listening sample (n=1714), 44% spontaneously reported that the series had a positive affective impact on them; 40% focused on the series' positive cognitive impact; and 14% described an impact on their behavior. Listeners find the show interesting and enjoyable; they feel it increases their appreciation of the natural world. Listeners report 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. The series also motivates listeners to look for celestial events and share information with others.

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, 84% answered this question. Responses to this question were categorized and sorted by keywords and content. For example, the following response: "I almost always find it interesting – sometimes it gets me to think/read more about subject on my own," was categorized as positive affective impact ["...find it interesting"], positive cognitive impact ["...gets me to think"] and positive behavioral impact ["read more..."]. As another example of the coding, the following response: "I've learned things about a variety of topics from the show. I've enjoyed hearing the scientists on the show and I've used the website for info about the night sky," was categorized as positive affective impact ["enjoyed hearing..."], positive cognitive impact ["learned things..."] and positive behavioral impact ["used the website..."].¹⁰ Of the 84% of listeners who answered the open-ended question (n=1443), 91% 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 (44%) of the listening sample spontaneously reported that *Earth & Sky* had a positive affective impact. Mainly, listeners found the show interesting, enjoyable and felt it increased their appreciation of the natural world and universe. Smaller portions of the audience reported liking the format, finding the show entertaining, feeling more connected to nature or science because of it or simply liking or loving it.

Two-fifths (40%) of all listeners focused on the series' impact on them cognitively. Most listeners in this group reported that they learn generally from the series. Smaller portions felt that the series increases their knowledge or understanding of the natural world; that they learn information to which they would not normally be exposed; that the show updates them on current events;

¹⁰ Only 1% of respondents provided answers that fell into all three main impact categories- affective, cognitive and behavioral.

provides them with important information relevant to their lives; makes them think, and is “enlightening.” Only 14% of listeners reported spontaneously that the series had an impact on their behavior, motivating them to look for celestial events, look for more information and share information with others. Another 6% said the series had no effect, and 16% 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 & Sky</i> has affected you personally, if at all?	Listeners (n = 1714)
Positive Affective Impact	44%¹¹
Interesting; very interesting; intriguing	14%
Enjoy; enjoy listening; enjoyable	13%
Broadens or increases interest/appreciation/awareness of natural world, universe; piques/stimulates curiosity	12%
Like format: well-presented, concise, easy to understand, accessible	4%
Like it; look forward to hearing it	3%
Entertaining; fun; fascinating	2%
Feel more connected with nature/world/science	2%
Love it	1%
Positive Cognitive Impact	40%
Informative; educational; learn from it	18%
Increases/broadens knowledge/understanding of natural world, environment, universe	7%
Learn info not learned otherwise; increases awareness of info not normally exposed to	5%
Updates on current events	4%
Useful, valuable or important information, relevant to me	3%
Makes me think/ponder	2%
Enlightening, enriching, ah-ha moments	2%
Positive Behavioral Impact	14%
Motivates to look for celestial events	8%
Share/Discuss information with others	4%
Look for more information in books, on web, classes, in news	3%
No Answer	16%
No Effect	6%
Negative Reaction to Short Length	2%

¹¹ 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 discussing topics with others (74%), viewing the night sky (71%), reading related information (49%), searching for more information about a topic (35%) and accessing a web site (32%).

Those who heard the show more frequently were more likely to report that the show had prompted them to action. 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.

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*

Has listening to <i>Earth & Sky</i> ever prompted you to . . .	Listeners (n=1714)
discuss the topics with others	74%
view the night sky	71%
read related information in books, magazines, newspapers	49%
search for more information about a topic	35%
access an Internet web site, including <i>Earth & Sky</i> 's	32%
modify personal habits or philosophies	20%
visit a planetarium or science museum	18%
purchase a book or other item related to a show topic	15%
make donations to a non-profit institution	14%
use content in teaching	12%
write to <i>Earth & Sky</i> , a politician, scientist or other	3%

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

Discuss how wonderful the universe is. Thank you.

Discussions at work, discussion with my dad.

My 8 yr old son is interested when I listen to Earth & Sky. I gather facts & info to pass on to him to listen & discuss.

Pass the info on to friends far & near via Internet or phone call.

Email my teachers.

Pass to others on job site.
 I am a "birder"--so info on birds/environment I usually pass on to others.
 I talk about sky & stars with my 9 year old grandson.
 Get up early with a child to view something in the dark a.m. sky.
 Let my family know what to look for when there are special sky "events."
 Drive out into the night in my pajamas to view the night sky unobserved by city lights.
 Go out on the deck in Maine & watch the stars on a frozen winter's night.
 I've tried to look for planets & stars.
 Stayed up at night to watch meteor showers, look at the moon, look at eclipses.
 We have gone places out of town to look at meteor shower, comets, etc.
 When they predict meteor showers I always make a point to search the sky no matter what time it is!
 Join an amateur astronomy club. Share new info from the radio show with family & friends. Change my sleep schedule to get up early to go outside & view a specific sky feature. Buy a star map, study with a friend & schedule regular night sky viewing events.

Half of *Earth & Sky* listeners "read related information in books, magazines, newspapers." One-third "search for more information about a topic" or "access an Internet web site, including *Earth & Sky's*." Added comments included, for example:

Stargazing charts, Greek mythology of constellations.
 Check out Stephen Hawking's video from library (from PBS NOVA, I think).
 Look at our computer program to view a simulation of the sky when we're too lazy to get out our telescope!
 Show the earthsky.com website to others.

One-fifth of listeners were encouraged to "modify personal habits or philosophies" or "visit a planetarium or science museum."

Lead a girl scout troop in discussions of related topics & visits to planetariums & science museums.
 Pay more attention to environmental concerns when talking, traveling.
 Some years ago we toured the planetarium where Block & Byrd originate "Earth & Sky"
 Visit their home observatory in West Texas.
 Visited a nearby observatory.
 Visited our local college observatory, visited a local group that views stars on clear nights--sponsored by city parks & rec.

A purchase related to the show was reported by 15%. Purchases mentioned included telescopes, binoculars, books, star charts, E&S sweatshirt.

Using *Earth & Sky* content in teaching was reported by 12% of the listeners, mostly those with post-graduate education but with interesting exceptions, as follows:

I encourage a teacher I know to access Earth & Sky website for lesson planning.
 I use content in mentoring students & also with my grandchildren.
 I'm a leader in cub scouts so sometimes I use info I learned on Earth & Sky discussing the environment with the scouts.
 I'm an art teacher. I use some of the stories and relate them to some of my lesson plans. The way the radio articles are written they're very colorful & visual.
 Putting info in a book I'm writing. Little references to leaves dropping because a tree would die of thirst during winter otherwise.
 We home-educate our children and Earth & Sky is a nice addition to things we're talking/learning about.

Frequency of listening to *Earth & Sky* was related significantly to 10 of the 11 listed actions. Higher than expected frequencies of these actions appeared for those who heard the show "frequently" as opposed to "sometimes." Only "visiting a planetarium or science museum" was independent of listening frequency. There were no gender differences in behaviors. Those with

post-graduate education were significantly 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; for example:

- Become a naturalist working with school children.
- Involvement in Mass Audubon.
- Volunteer for nature/animal activities.
- Encourage others to become advocates for the environment.
- Support efforts to limit night lightning, particularly in rural or semi rural areas.
- Contacted NASA about an insulation we now use in our product.
- Check off "Earth & Sky" on our public radio stations annual preference survey
- Suggest listening to public radio to others due to programs like Earth & Sky.
- Watch the Discovery channel.

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; thought the format added a personal dimension to scientists and science; acquired a better understanding of scientific inquiry; appreciated the credibility of hearing from the scientists themselves; indicated that the format humanized scientists and science; and felt a greater respect or appreciation for scientists and science.

A small 1% of listeners complained that the show was too short for scientists to present their research. The remaining listeners either did not answer the question (25%), did not recognize the format (5%), felt no impact (10%) or felt no impact because they already had a positive attitude that the format reinforced (6%).

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, 75% answered this question. A small portion (5%) 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; thought the format added a personal dimension to scientists and science; acquired a better understanding of scientific inquiry; appreciated the credibility of hearing from the scientists themselves; indicated that the format humanized scientists and science; and felt a greater respect or appreciation for scientists and science.

Of listeners, 10% indicated no change, and 6% 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, 1% 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

How has the format featuring scientists themselves affected your attitude toward scientists or understanding of science?	Listeners (n = 1714)
Positive impact	53%
Appreciate, enjoy, like hearing scientists; fascinating, interesting, good/great format	14%
Adds personal dimension to scientists/science, especially if passionate, enthusiastic; makes more accessible/approachable	9%
Better understanding of motivation, process, data analysis, conclusion-making, challenges, disappointments, persistence, commitment, funding, and ramifications of research	7%
Hearing directly from “horse’s mouth”/source is better, more credible, more accurate, more authentic, unfiltered	7%
Humanizes scientists/science; presents scientists as people; makes them more real; see science as a human endeavor	7%
Positive influence; greater respect/appreciation for scientists; greater interest in science	6%
Miscellaneous positive	2%
Important, valuable to hear from scientists	1%
No answer	25%
No impact, no change	10%
No impact because already have positive attitude -- am a scientist, work with scientists, know scientists; format reinforces	6%
Not heard format	5%
Negative reaction to short length	1%

X. Are there differences in impact for listeners in 2005 compared with listeners surveyed in 2002 ?

Comparisons of listeners currently versus listeners three years ago reveal significant differences only with respect to Internet usage. Current listeners report higher use of the Internet as a major source of science news and were more likely to report that *Earth & Sky* prompted them to access a website. Otherwise, *Earth & Sky* continues to maintain the high listener appeal and impact levels that it obtained three years ago.

The respondent samples for 2005 and 2002 are the same size and have virtually the same demographic and background characteristics. The only difference is in the significantly increased use of the Internet as a major source of science news by the 2005 respondents (19%) compared with the 2002 respondents (11%). Listeners comprise 86% of both samples and frequency of listening does not differ in the two years. There is no difference between listeners for the two samples in terms of attitudes toward science, opinions of *Earth & Sky* and behaviors prompted by *Earth & Sky*, with the exception of accessing an Internet website. Listeners in the 2005 sample were significantly more likely to report that *Earth & Sky* prompted them to access a website than were listeners in the 2002 sample (32% vs. 25%, respectively).

APPENDIX

Attitudes about Science

Attitude: Positive & Negative Statements	All Member Respondents % of agree/ disagree
Do respondents feel science is understandable?	
Science can be understood and enjoyed on some level by everyone.	96% agree
Is understanding science process important?	
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
Are respondents aware of the reality of doing research?	
Failures are as important as successes in learning the truth in science.	96% agree
Breakthroughs in science typically involve a brilliant person working alone.	83% disagree
How important is it to hear from scientists themselves?	
It is important that scientists explain the relevance of new scientific findings.	93% agree
Journalists, not scientists themselves, should interpret research for the public.	69% agree
How important is learning about current science?	
Keeping up with current science news is a critical responsibility of the public.	81% agree
It is too hard to keep up-to-date with what's happening in science research.	37% agree 28% neutral 35% disagree
How important is research in earth and atmospheric sciences?	
Research is essential to understanding human impact on the environment.	97% agree
Science about Earth, its oceans and the universe has little relevance to my life.	94% disagree