

Museum Visitor Studies, Evaluation & Audience Research

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Summative Evaluation:
Ecosystems Exhibition
The Extreme Zone

Prepared for the
California Science Center
Los Angeles, CA

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SUMMARY AND DISCUSSION

This report presents findings of a summative evaluation conducted by Randi Korn & Associates, Inc. (RK&A), for the California Science Center in Los Angeles, California. The summative evaluation, funded by the National Science Foundation, examined visitors' learning in the Extreme Zone section of the new *Ecosystems* exhibition. To examine the degree to which the Extreme Zone meets its educational objectives, RK&A conducted in-depth interviews with adult, drop-in visitors: one sample was interviewed before they entered *Ecosystems* and a separate sample was interviewed as they exited the exhibition. RK&A scored interviewees' responses using a rubric to assess the degree to which 18 learning objectives were achieved and conducted statistical analyses comparing the pre-visit (control group) and post-visit (treatment group) samples. In total, 228 interviews were conducted in October and November 2010.

The findings presented here are among the most salient. Please read the body of the report for a more comprehensive presentation of findings.

DEMOGRAPHICS

- ◆ 61 percent were female and 39 percent were male
- ◆ Median age was 37 years
- ◆ 40 percent self-identified as Hispanic/Latino, 32 percent as Caucasian, 10 percent as Asian/Pacific Islander, 9 percent African American/Black
- ◆ Bilingual English-Spanish interviewers were available during each data collection shift—95 percent of the interviewees chose to be interviewed in English.
- ◆ All interviewees were accompanied by at least one child (per recruiting protocol)—46 percent of the children were elementary school-aged (ages 5 to 10).

VISIT CHARACTERISTICS

- ◆ 55 percent were repeat Science Center visitors and 45 percent were visiting for the first time.
- ◆ All four of the Extreme Zone sections were visited by at least one-half of the post-visit interviewees. The most visited sections were the desert (88 percent) and the rocky shore (84 percent).
- ◆ Of post-visit interviewees, 54 percent watched videos, 50 percent read information, 45 percent looked at animal displays, 42 percent used hands-on exhibits, 42 percent used computer-based exhibits, and 41 percent watched the *Ecosystems* introduction film.
- ◆ Of post-visit interviewees who watched the *Ecosystems* introduction film, 58 percent said it provided an overview of ecology.

INTEREST IN SCIENCE AND KNOWLEDGE OF ECOLOGY

- ◆ Using a question developed by the Science Center, 79 percent of post-visit interviewees indicated that the *Ecosystems* exhibition stimulated their interest in science “a lot.”
- ◆ Using a question developed by the Science Center, 59 percent of post-visit interviewees indicated that the *Ecosystems* exhibition increased their general knowledge of ecology “a lot.”

RUBRIC-SCORED LEARNING OBJECTIVES

EXPLANATION OF RUBRIC SCORING AND ANALYSIS

RK&A scored verbatim interview transcripts using a rubric designed to measure visitor learning outcomes. The scorers reviewed each respondent’s interview data and rated how well s/he accomplished the exhibition objectives according to specific criteria. Based on the criteria for each objective, the scorers classified each interviewee’s accomplishment of each objective into one of four ordered categories: 1) Below Beginning, 2) Beginning, 3) Developing, or 4) Accomplished.

For each objective, the frequencies of pre- and post-visit interviewees who scored at each ordered category were examined with cross-tabs. For each section—overarching objectives, Earth’s poles, desert, deep sea vents, and rocky shore—RK&A created total scores by adding up the rubric scores for that section. Then correlations for the total scores were examined using ANOVAs.

SUMMARY OF FINDINGS

- ◆ Post-visit interviewees showed greater accomplishment than the pre-visit group on three of the 18 objectives: Objective One (awareness and interest in ecology), Objective Five (unique conditions at the Earth’s poles), and Objective Fourteen (animal examples at the deep sea vents).
- ◆ Post-visit interviewees also showed better overall performance than the pre-visit group on their total scores for the Earth’s poles objectives and the rocky shore objectives.
- ◆ No statistically significant differences were found by age, first/repeat visit, or use of the introduction film. A few differences by gender were found—in all cases males scored higher than females.

FINDINGS BY OBJECTIVE

OBJECTIVE ONE

Visitors will express an awareness and interest in ecology.

- ◆ Most interviewees scored at the Beginning level; however, post-visit interviewees were more likely to score at the higher levels (Developing and Accomplished) than were pre-visit interviewees.

OBJECTIVE TWO

Visitors will be able to define “adaptation.”

- ◆ Most interviewees (pre and post-visit) scored at the Beginning level.

OBJECTIVE THREE

Visitors will understand that the earth’s poles, desert, deep sea vents, and rocky shore are examples of extreme environments.

- ◆ Most interviewees scored at the Beginning level.

OBJECTIVE FOUR

Visitors will understand the value of studying extreme environments.

- ◆ Most interviewees scored at the Beginning level.

OBJECTIVE FIVE

Visitors will be able to describe the unique conditions that animals and plants face at the poles.

- ◆ Most interviewees scored at the Beginning level. However, post-visit interviewees were more likely to score at the Beginning level and above, while pre-visit interviewees tended to score at the Below Beginning level.

OBJECTIVE SIX

Visitors will be able to provide examples of adaptations to the conditions at the poles.

- ◆ Most interviewees scored at the Below Beginning level.

OBJECTIVE SEVEN

Visitors will be able to name plant or animal species found at the poles.

- ◆ Most interviewees scored at the Beginning or Developing levels.

OBJECTIVE EIGHT

Visitors will be able to describe how scientists study changes in the polar environment.

- ◆ Most interviewees scored at the Beginning level.

OBJECTIVE NINE

Visitors will be able to describe the unique conditions that animals and plants face in the desert.

- ◆ Most interviewees scored at the Beginning or Developing levels.

OBJECTIVE TEN

Visitors will be able to provide examples of adaptations to the conditions in the desert.

- ◆ Most interviewees scored at the Below Beginning level.

OBJECTIVE ELEVEN

Visitors will be able to provide examples of plant and animal species found in the desert.

- ◆ Most interviewees scored at the Beginning or Developing levels.

OBJECTIVE TWELVE

Visitors will be able to describe the unique conditions that animals and plants face in the deep sea vents.

- ◆ Most interviewees scored at the Below Beginning level.

OBJECTIVE THIRTEEN

Visitors will be able to provide examples of adaptations to the conditions in the deep sea vents.

- ◆ Most interviewees scored at the Below Beginning level.

OBJECTIVE FOURTEEN

Visitors will be able to provide examples of plant and animal species found in the deep sea vents.

- ◆ Most interviewees scored at the Below Beginning or Beginning levels. However, post-visit interviewees tended to score at the Beginning level and pre-visit interviewees tended to score at the Below Beginning level.

OBJECTIVE FIFTEEN

Visitors will be able to describe how scientist study the deep sea vents.

- ◆ Most interviewees scored at the Beginning level.

OBJECTIVE SIXTEEN

Visitors will be able to describe the unique conditions that animals and plants face along the rocky shore.

- ◆ Most interviewees scored at the Below Beginning or Beginning levels.

OBJECTIVE SEVENTEEN

Visitors will be able to provide examples of adaptations to the conditions along the rocky shore.

- ◆ Most interviewees scored at the Below Beginning level.

OBJECTIVE EIGHTEEN

Visitors will be able to provide examples of plant and animal species found along the rocky shore.

- ◆ Most interviewees scored at the Below Beginning or Beginning levels.

CONCLUSIONS

Overall, visitors have limited knowledge and understanding of ecology, in general, and of extreme environments, in particular. For all but three of the learning objectives, visitors scored at the Below Beginning and/or Beginning levels. This provides the Science Center with great opportunity and challenges.

The *Ecosystems* exhibition was successful in conveying its main message to visitors and enhancing their general understanding of ecology. The study found increased awareness and interest in ecology among post-visit interviewees as compared with pre-visit interviewees. Post-visit interviewees also self-reported increased interest in and greater understanding of ecology.

The exhibition was less successful in explaining adaptation, as there were no pre-post differences found for the overarching adaptation objective or any of the Extreme Zone-specific adaptation objectives. This is not altogether surprising, considering that adaptation is a complex concept. Furthermore, based on interviewees' comments, it is difficult for visitors to think outside the "just so" or teleological story of why plants and animals live in certain places. For example, when asked why certain animals are best suited for the desert, a frequent response was, to paraphrase, "because these animals are able to live in the desert." It is also worth noting that the frequency distributions for the pre- and post-visit samples were nearly identical, suggesting that prior knowledge (or lack thereof) strongly influences visitors' understanding of adaptation.

The exhibition also had limited success in providing visitors with a general understanding of extreme environments. No differences between the pre- and post-samples were found for either one of the overarching objectives related to extreme environments. This finding may indicate that visitors had difficulty differentiating the Extreme Zone from the other *Ecosystems* sections or seeing the Earth's poles, desert, deep sea vents, and rocky shore as thematically connected.

While visitors did not grasp the overarching idea of extreme environments, post-visit interviewees gained knowledge about some specific topics featured in the Extreme Zone; namely, the environmental conditions at the Earth's poles and the animals that inhabit the deep sea vents. Post-visit interviewees also showed better overall performance than the pre-visit group on their total scores for the Earth's poles objectives and the rocky shore objectives. For the Earth's poles, the exhibition seems to have added to visitors' existing knowledge. For the deep sea vents and rocky shore, the rubric scores suggest that visitors knew very little before seeing the exhibition and that the exhibition provided them with new knowledge. It is particularly noteworthy that visitors came into the exhibition with so little familiarity with the rocky shore, considering the proximity of the Science Center to the coast. Teaching specific, detailed content through the exhibition medium is difficult at best. As such, Science Center staff may want to concentrate any remediation efforts on helping visitors understand extreme environments and grasp how certain characteristics help plants and animals live in these inhospitable habitats.

INTRODUCTION

This report presents findings of a summative evaluation conducted by Randi Korn & Associates, Inc. (RK&A), for the California Science Center in Los Angeles, California. The summative evaluation, funded by the National Science Foundation, examined visitors' learning in the Extreme Zone section of the new *Ecosystems* exhibition. To examine the degree to which the Extreme Zone met its educational objectives, RK&A conducted in-depth interviews with adult, drop-in visitors: one sample was interviewed before they entered *Ecosystems* and a separate sample as they exited the exhibition. The study is quantitative in nature, as RK&A scored interviewees' responses using a rubric to assess the degree to which 18 learning objectives were achieved and conducted statistical analyses comparing the pre-visit (control group) and post-visit (treatment group) samples. In total, 228 interviews were conducted in the fall of 2010.

Specifically, the evaluation objectives were to examine visitors':

- ◆ Awareness of and preconceived notions about ecology (affective/attitudinal measure);
- ◆ Understanding of ecology (cognitive measure);
- ◆ Understanding of adaptations and the relationship between adaptations and environmental conditions (cognitive measure);
- ◆ Group composition and general demographics;
- ◆ Visitation of specific exhibition sections (e.g., Entry video, Deep Sea Vents, Poles, Rocky Shore, Desert) (post-visit interview only);
- ◆ Self-reported use of different exhibit-types (e.g., animal displays, hands-on exhibits, text) (post-visit interview only);
- ◆ Interest in science after visiting *Ecosystems* (affective/attitudinal measure) (post-visit interview only); and
- ◆ General knowledge of ecology after visiting *Ecosystems* (cognitive measure) (post-visit interview only).

METHODOLOGY

Open-ended interviews produce data rich in information because interviewees are encouraged and motivated to describe their experiences, express their opinions and feelings, and share with the interviewer the meaning they constructed during a visit. The interview guides were intentionally open-ended to allow interviewees to discuss what they felt was meaningful. All interviews were audio-recorded with participants' permission and transcribed to facilitate analysis.

Data collectors followed a quota sampling method to obtain a sample of approximately 50 percent pre-visit interviewees and 50 percent post-visit interviewees. Data collectors intercepted visitors (18 years or older), asked them screening questions (e.g., entrance interviewees were asked if they had ever visited *Ecosystems*, exit interviewees were asked if they had visited the Extreme Zone). In addition, during the final weeks of data collection (to ensure diversity in the sample), visitors were asked to self-identify their ethnicity and data collectors only interviewed visitors who described themselves as Hispanic/Latino or African American.

If visitors qualified to participate in the study based on their responses to the screening questions, data collectors invited them to take part in an interview. After completing the interview, data collectors asked the interviewee to complete a brief demographic questionnaire, thanked him/her for participating, and then selected the next eligible visitor. The interview guide asked interviewees a series of questions to assess their understanding of and attitudes toward topics presented in the Extreme Zone (see Appendix A for the interview guides and demographic questionnaires).

After the interviews were transcribed, the responses were scored quantitatively—using a rubric—and then sorted and analyzed by whether they were in the pre-visit or post-visit sample as well as by their demographic and visitation characteristics.

RK&A developed a scoring rubric that describes, on a continuum, visitors' attitudes toward and understanding of the Extreme Zone topics. For each visitor outcome, the rubric includes a continuum of understandings on a scale from 1 to 4, with 1 being “Below Beginning” to 4 being “Accomplished” (see Appendix B for the scoring rubric). To develop the rubric, RK&A used the exhibition's stated goals and objectives and interview data.

DATA ANALYSIS AND REPORTING METHOD

The interview rubric scores were analyzed using SPSS 12.0.1, a statistical package for personal computers. Analyses include descriptive and inferential statistics. Within the body of the report, only statistically significant relationships are presented; however, all statistical analyses run are listed in Appendix C.¹

Frequency distributions were calculated for all categorical variables (such as “age group”). To examine the relationship between two categorical variables (for instance, “pre-visit sample” and “gender” or “Objective One rubric score” and “pre/post sample”) cross-tabulation tables were computed to show the joint frequency distribution of the variables, and the chi-square statistic (X^2) was used to test the significance of the relationship.

Summary statistics, including the mean (average), median (data point at which half the responses fall above and half fall below), and standard deviation (spread of scores: “±” in tables), were calculated for ratio-level variables (such as, “age” or “overall score for desert objectives”). To test differences in the means of two or more groups in the rubric-scored interview data, analyses of variance (ANOVAS) were performed (for instance, to examine whether “overall score for desert objectives” differed by “pre/post sample”).

The data in this report are qualitative and, as such, the information is displayed in tables. Percentages within tables may not always equal 100 owing to rounding and interviewees' ability to provide more than one response. The findings within each topic are presented in descending order, starting with the most frequently occurring.

¹ The level of significance was set at 0.05 because of the moderate sample size. When the level of significance is set to $p = 0.05$, any relationship that exists at a probability (p -value) of ≤ 0.05 is termed “significant.” When a relationship has a p -value of 0.05, there is a 95 percent probability that the relationship being explored truly exists; that is, in 95 out of 100 cases, there would be a relationship between the two variables (e.g., age and rubric score). Conversely, there is a 5 percent probability that the relationship does not really exist; in other words, in 5 out of 100 cases, a relationship would appear by chance.

SECTIONS OF THE REPORT:

1. Background Information
2. Demographics
3. Visit Characteristics
4. Interest in Science and Knowledge of Ecology
5. Rubric-Scored Learning Outcomes

PRINCIPAL FINDINGS

The target audience for the summative evaluation of the Extreme Zone were drop-in, adult visitors who were attending the California Science Center as part of a family group (i.e., they were accompanied by at least one child under 18). Interviews were conducted in English and Spanish, according to the preference of the visitor. A total of 228 visitors were interviewed: 107 visitors before they visited *Ecosystems* (pre-visit sample) and a separate sample of 121 visitors after they had visited *Ecosystems* (post-visit sample). RK&A scored verbatim interview transcripts using a rubric that measured visitors' learning. Statistical analyses were conducted to examine correlations between the interview rubric scores, visitation to the Extreme Zone, and visitor characteristics.

BACKGROUND INFORMATION

A total of 228 visitors agreed to be interviewed and 113 declined, for a participation rate of 50 percent. The refusal sample and the obtained sample have statistically similar gender and age profiles. RK&A does not have ethnicity data for the visitors who declined participation in the study, as it would have been unethical to guess their ethnicity.

RK&A conducted interviews with visitors at the Science Center over 21 days in October and November 2010—two-thirds during weekend days and one-third on weekdays (64 percent and 36 percent, respectively) (see Table 1, next page).

As stated earlier, approximately one-half of interviews were conducted with visitors before they visited *Ecosystems* and the other one-half after they visited the exhibition (47 percent and 53 percent, respectively) (see Table 2, next page).

TABLE 1**DATA COLLECTION DATE AND DAY OF WEEK**

DATE (n = 228)	TOTAL %
October 20, 2010 (Wednesday)	1
October 21, 2010 (Thursday)	1
October 22, 2010 (Friday)	6
October 23, 2010 (Saturday)	2
October 24, 2010 (Sunday)	15
October 28, 2010 (Thursday)	6
October 29, 2010 (Friday)	9
October 30, 2010 (Saturday)	6
October 31, 2010 (Sunday)	8
November 4, 2010 (Thursday)	4
November 5, 2010 (Friday)	3
November 6, 2010 (Saturday)	6
November 7, 2010 (Sunday)	11
November 11, 2010 (Thursday)	4
November 12, 2010 (Friday)	2
November 13, 2010 (Saturday)	4
November 14, 2010 (Sunday)	4
November 18, 2010 (Thursday)	1
November 19, 2010 (Friday)	1
November 20, 2010 (Saturday)	4
November 21, 2010 (Sunday)	4
DAY OF WEEK (n = 228)	TOTAL %
Weekend	64
Weekday	36

TABLE 2**RESEARCH DESIGN**

SAMPLE (n = 228)	TOTAL %
Pre-visit	47
Post-visit	53

DEMOGRAPHICS

GENDER AND AGE

About two-thirds of interviewees were female and one-third were male (61 percent and 39 percent, respectively) (see Table 3). The majority of interviewees were between 25 and 44 years of age, and the median age was 37. There were no differences between the pre- and post-visit samples for gender or age.

TABLE 3
GENDER AND AGE

GENDER (n = 226)	TOTAL %
Female	61
Male	39
AGE¹ (IN YEARS, n = 228)	
18 – 24	7
25 – 34	32
35 – 44	42
45 – 54	15
55 – 64	4
65 or older	2

¹Interviewees provided their exact ages.
Age: Range 20 – 69; Median = 37; Mean = 37 (± 9.8)

LANGUAGE AND ETHNICITY

RK&A scheduled at least one Spanish-English bilingual interviewer for each data collection shift. As Table 4 shows, nearly all of the interviews chose to be interviewed in English (95 percent).

TABLE 4
LANGUAGE

LANGUAGE (n = 228)	TOTAL %
English	95
Spanish	5

Interviewees were ethnically diverse (see Table 5A). Forty-percent of interviewees self-identified as Hispanic/Latino, 10 percent as Asian/Pacific Islander, and 9 percent as African American/Black. The post-visit sample was more ethnically diverse than the pre-visit sample, as a quota sampling strategy was used a few weeks into data collection to ensure an ethnically diverse audience (see Table 5B).

TABLE 5A

ETHNICITY

ETHNICITY (n = 220)	TOTAL %
Hispanic / Latino	40
Caucasian / White	32
Asian / Pacific Islander	10
African American / Black	9
Multi - ethnic	6
American Indian	2
Other	1

TABLE 5B

ETHNICITY BY GROUP

ETHNICITY (n = 220)	VISIT		
	PRE-VISIT	POST-VISIT	TOTAL
	%	%	%
African American / Black	7	11	9
American Indian	2	2	2
Asian / Pacific Islander	11	9	10
Caucasian / White	41	25	32
Hispanic / Latino	30	49	40
Multi - ethnic	8	4	6
Other	2	0	1

¹ $\chi^2 = 13.719$; $df = 6$; $p = .033$

AGES OF ACCOMPANYING CHILDREN

As per the recruiting protocol, all interviewees were accompanied by at least one child under 18 years of age (see Table 6). Nearly one-half of the children were elementary school-aged (ages 5 to 10) (46 percent).

TABLE 6
AGES OF ACCOMPANYING CHILDREN

AGE ¹ (IN YEARS, <i>n</i> = 380)	TOTAL %
1 or younger	7
2 – 4	24
5 – 7	22
8 – 10	24
11 – 13	17
14 – 18	6

¹ Interviewees provide the exact ages of the children.
Age: Range 1 – 18; Median = 7; Mean = 7.2 (± 4.1)

VISIT CHARACTERISTICS

FIRST OR REPEAT VISITOR

Slightly more than one-half of interviewees were repeat Science Center visitors and less than one-half were first-time visitors (55 percent and 45 percent, respectively) (see Table 7). Interviewees in the pre-visit and post-visit samples shared similar first-repeat visit frequencies.

TABLE 7
PRIOR VISITS TO THE CALIFORNIA SCIENCE CENTER

VISIT (<i>n</i> = 226)	TOTAL %
First time	45
Repeat	55

Among repeat visitors, 42 percent had visited the Science Center one to two times in the past 12 months (see Table 8).

TABLE 8
FREQUENCY OF VISITS AMONG REPEAT VISITORS

OTHER VISITS IN THE PAST 12 MONTHS (REPEAT VISITORS ONLY) (<i>n</i> = 115)	TOTAL %
None	24
1 – 2 times	42
3 – 4 times	17
5 or more times	17

VISIT EXPERIENCES (POST-VISIT SAMPLE ONLY)

Post-visit interviewees were asked which sections of the Extreme Zone they visited: Earth’s poles, desert, deep sea vents, and rocky shore (see Table 9). All four of the Extreme Zone sections were visited by at least one-half of the post-visit interviewees. The most visited sections were the desert and the rocky shore (88 percent and 84 percent, respectively).

TABLE 9
EXTREME ZONE SECTIONS VISITED AMONG POST-VISIT INTERVIEWEES (n = 121)

SECTIONS	% ¹
Desert	88
Rocky shore	84
Earth’s poles	76
Deep sea vents	60

¹The total percentage exceeds 100 because interviewees visited more than one section.

Post-visit interviewees were asked whether they used any of the six types of exhibits featured in the Extreme Zone: animal displays, computer-based exhibits, *Ecosystems* introduction film, hands-on exhibits, information to read, or videos (see Table 10). One-half of post-visit interviewees reported using videos and information to read in the exhibition (54 percent and 50 percent, respectively). Forty-one percent indicated that they watched the *Ecosystems* introduction film.

TABLE 10
USE OF EXHIBITS AND DISPLAYS AMONG POST-VISIT INTERVIEWEES

EXHIBITS AND DISPLAYS	n	%
Videos	118	54
Information to read	118	50
Animal displays	118	45
Hands-on exhibits	118	42
Computer-based exhibits	117	42
<i>Ecosystems</i> introduction film	118	41

Of interviewees who watched the *Ecosystems* introduction film, more than one-half described the main idea of the film as introducing ecology or providing an overview of ecology (58 percent) (see Table 11).

TABLE 11
MAIN IDEA OF ECOSYSTEM FILM

MAIN IDEA OF FILM (Post-Visit Interviewees Only) (n = 88)	%
Introduces ecology / overview of ecology	58
Other	42

INTEREST IN SCIENCE AND KNOWLEDGE OF ECOLOGY

Post-visit interviewees were asked, “Did the *Ecosystems* exhibition stimulate your interest in science?”² More than three-quarters of interviewees indicated that the exhibition greatly stimulated their interest in science (79 percent) (see Table 12).

TABLE 12
INTEREST IN SCIENCE AFTER VISITING *ECOSYSTEMS*

DID THE <i>ECOSYSTEMS</i> EXHIBITION STIMULATE YOUR INTEREST IN SCIENCE? (Post-Visit Interviewees Only) (n = 110)	%
No	0
A little	21
A lot	79

Post-visit interviewees were asked, “Did the *Ecosystems* exhibition increase your general knowledge of ecology?”² More than one-half indicated that the exhibition greatly increased their knowledge of ecology (59 percent) (see Table 13).

TABLE 13
KNOWLEDGE OF ECOLOGY AFTER VISITING *ECOSYSTEMS*

DID THE <i>ECOSYSTEMS</i> EXHIBITION INCREASE YOUR GENERAL KNOWLEDGE OF ECOLOGY? (Post-Visit Interviewees Only) (n = 109)	%
No	2
A little	39
A lot	59

² RK&A phrased this question and responses as requested by the California Science Center to match other studies at the Center.

RUBRIC-SCORED LEARNING OUTCOMES

This section presents interviewees' rubric scores for 18 visitor learning outcomes.

BACKGROUND INFORMATION

RK&A scored verbatim interview transcripts using a rubric designed to measure visitor learning outcomes. To avoid potential biases, RK&A trained a graduate student who had not collected the data to score the interviews.

The scorer reviewed each respondent's interview data and rated how well s/he accomplished the exhibition objectives according to specific criteria. Based on the criteria for each objective, the scorers classified each interviewee's accomplishment of each objective into one of four ordered categories: 1) Below Beginning, 2) Beginning, 3) Developing, or 4) Accomplished.

Scores for the pre-visit and post-visit interviewees are provided, and statistically significant differences between the samples are noted. Readers should note that for each specific exhibition area (e.g., desert) only post-visit interviewees who had visited that particular section were compared with the pre-visit interviewees.

For each objective, the frequencies of pre- and post-visit interviewees who scored at each ordered category are presented in graphs, and cross-tabs are used to examine correlations.³ For each section—overarching objectives, Earth's poles, desert, deep sea vents, and rocky shore—RK&A created total scores by adding up the rubric scores for that section. Then correlations for the total scores were examined using ANOVAs.

SUMMARY OF FINDINGS

Post-visit interviewees showed greater accomplishment than the pre-visit group on three of the 18 objectives: Objective One (awareness and interest in ecology), Objective Five (unique conditions at the Earth's poles), and Objective Fourteen (animal examples at the deep sea vents). Post-visit interviewees also showed better overall performance than the pre-visit group on their total scores for the Earth's poles objectives and the rocky shore objectives.

No statistically significant differences were found by age, visitation characteristics (e.g., first/repeat visit), or use of the introduction film. A few differences by gender were found—in all cases males scored higher than females. The gender relationships are presented in Appendix D, as these relationships lack practical application.

³ RK&A examined the rubric scores for individual objectives in two ways: as four ordered categories and as four intervals on a continuum. When differences between the pre- and post-visit interviewees were examined, the cross-tabs and ANOVAs often did not corroborate and, as such, RK&A chose to use the more conservative approach of four ordered categories and cross-tabs to examine correlations.

OVERARCHING OBJECTIVES

OBJECTIVE ONE: AWARENESS AND INTEREST IN ECOLOGY

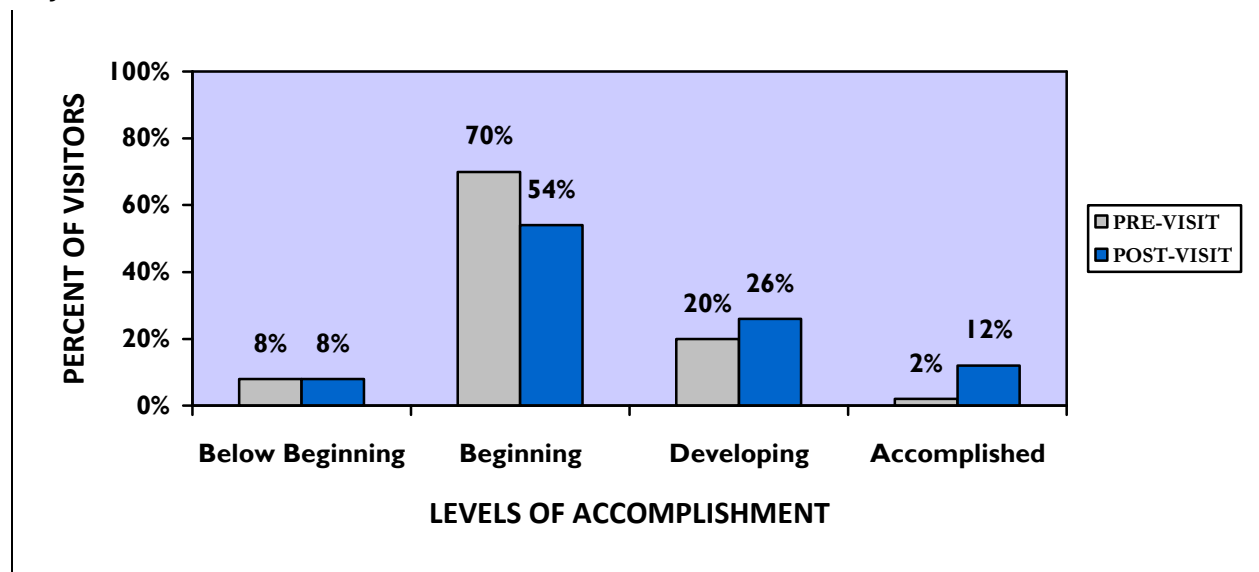
Objective One: Visitors will express an awareness and interest in ecology.

To assess the interviewees’ achievement of this objective, the pre-visit and post-visit interviews included a few questions aimed as understanding visitors’ perceptions of ecology. RK&A evaluated and scored each interviewee’s verbatim responses according to the following rubric:

Score	Criteria
Below Beginning (1)	The visitor has no awareness of or interest in ecology (e.g., states, “never heard of the term,” “nothing comes to mind,” or “I don’t know”).
Beginning (2)	The visitor states s/he has heard of ecology but provides an inaccurate description of the word (e.g., confuses ecology with environmental issues).
Developing (3)	The visitor describes one aspect of ecology (i.e., only the living world or only the physical world).
Accomplished (4)	The visitor accurately describes ecology as the study of the inter-relationship among living organisms and between living organisms and their environment. Both the living and physical worlds have to be mentioned.

Overall, most interviewees scored at the Beginning level for Objective One (70 percent for pre-visit and 54 percent for post-visit) (see Figure 1). However, one statistically significant difference was found: post-visit interviewees were more likely to score at the higher levels (Developing and Accomplished) than were pre-visit interviewees (38 percent for post-visit and 22 percent for pre-visit).

FIGURE 1
OBJECTIVE ONE SCORE – AWARENESS AND INTEREST IN ECOLOGY: PERCENTAGES



$\chi^2=10.731; df=3; p=.013$

OBJECTIVE TWO: UNDERSTANDING OF ADAPTATION

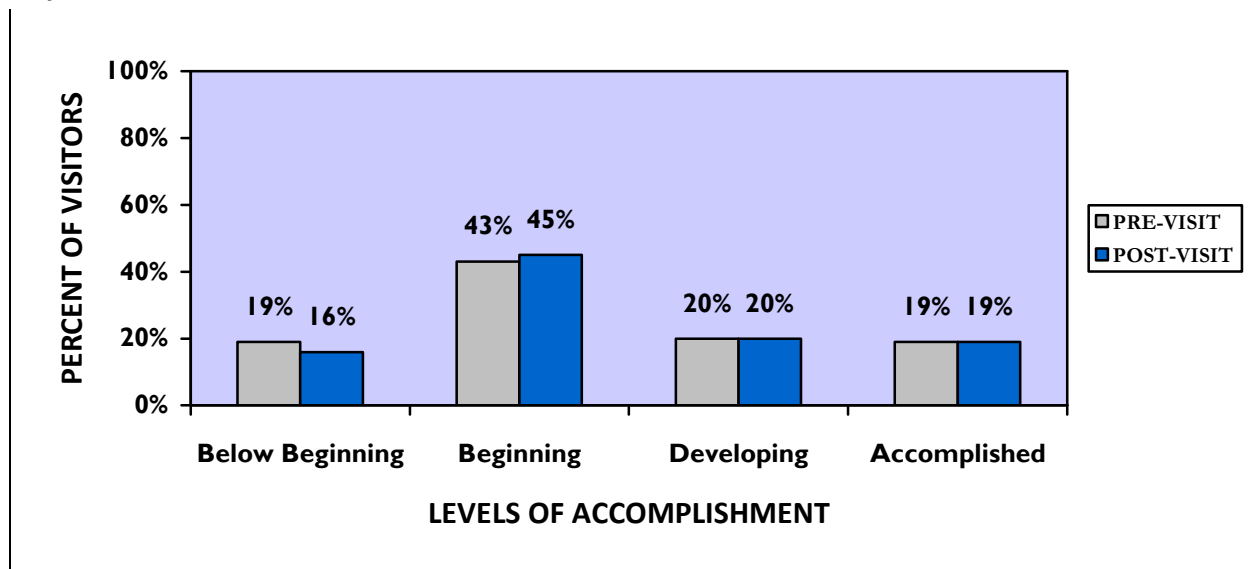
Objective 2: Visitors will be able to define “adaptation,” including the relationship of adaptations and environmental conditions.

To assess the interviewees’ achievement of this objective, the pre-visit and post-visit interviews included a few questions aimed as examining visitors’ understanding of adaptation. RK&A evaluated and scored each interviewee’s verbatim responses according to the following rubric:

Score	Criteria
Below Beginning (1)	The visitor has no understanding of adaptation (e.g., states, “never heard of the term,” “nothing comes to mind,” or “I don’t know”).
Beginning (2)	The visitor states s/he has heard of adaptation but provides an inaccurate or generic description of the word. The visitor is unable to give an example of an adaptation.
Developing (3)	The visitor only describes adaptation as a characteristic and does not include the surroundings in his/her response. The visitor is able to give a general example of an adaptation.
Accomplished (4)	The visitor accurately describes adaptations as characteristics that help plants and/or animals survive in particular conditions. The visitor is also able to give a specific example of an adaptation and the condition (environmental or biotic) to which it responds.

Overall, most interviewees scored at the Beginning level for Objective Two (43 percent for pre-visit and 45 percent for post-visit) (see Figure 2). No statistically significant differences were found between the pre- and post-visit samples for Objective Two.

FIGURE 2
OBJECTIVE TWO SCORE – UNDERSTANDING OF ADAPTATION: PERCENTAGES



$\chi^2=0.379; df=3; p=.945$

OBJECTIVE THREE: UNDERSTANDING OF EXTREME ENVIRONMENTS

Objective 3: Visitors will understand that the Earth’s poles, desert, deep sea vents, and rocky shore are examples of extreme environments.

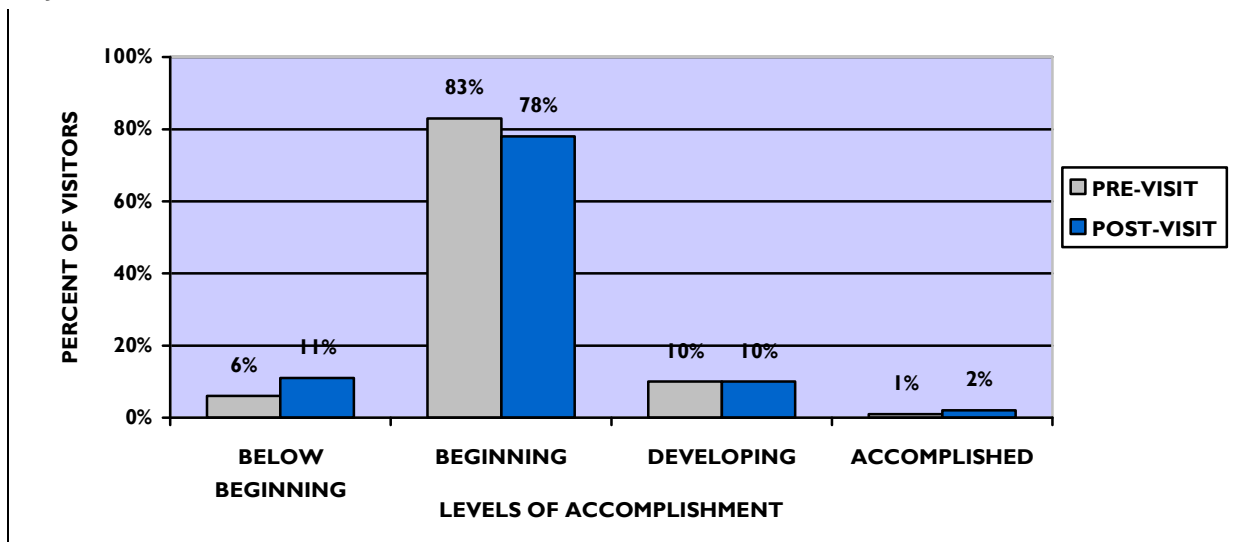
To assess the interviewees’ achievement of this objective, the pre-visit and post-visit interviews included a few questions aimed at examining visitors’ understanding that the Earth’s poles, desert, deep sea vents, and rocky shore are examples of extreme environments. RK&A evaluated and scored each interviewee’s verbatim responses according to the following rubric:

Score	Criteria
Below Beginning (1)	The visitor perceives no connection among the Earth’s poles, desert, deep sea vents, and rocky shore.
Beginning (2)	The visitor perceives a connection among the Earth’s poles, desert, deep sea vents, and rocky shore but is unable to articulate what that connection is or names a connection that is irrelevant or tangential to the concept of extreme environments.
Developing (3)	The visitor grasps that the Earth’s poles, desert, deep sea vents, and rocky shore are all extreme environments but is unable to explain what an extreme environment is.
Accomplished (4)	The visitor grasps that the Earth’s poles, desert, deep sea vents, and rocky shore are all extreme environments AND is able to describe at least two extreme conditions.

Overall, most interviewees scored at the Beginning level for Objective Three (83 percent for pre-visit and 78 percent for post-visit) (see Figure 3). No statistically significant differences were found between the pre- and post-visit samples for Objective Three.

FIGURE 3

OBJECTIVE THREE SCORE – UNDERSTANDING OF EXTREME ENVIRONMENTS: PERCENTAGES



$\chi^2=1.951; df = 3; p = .583$

OBJECTIVE FOUR: UNDERSTANDING THE VALUE OF STUDYING EXTREME ENVIRONMENTS

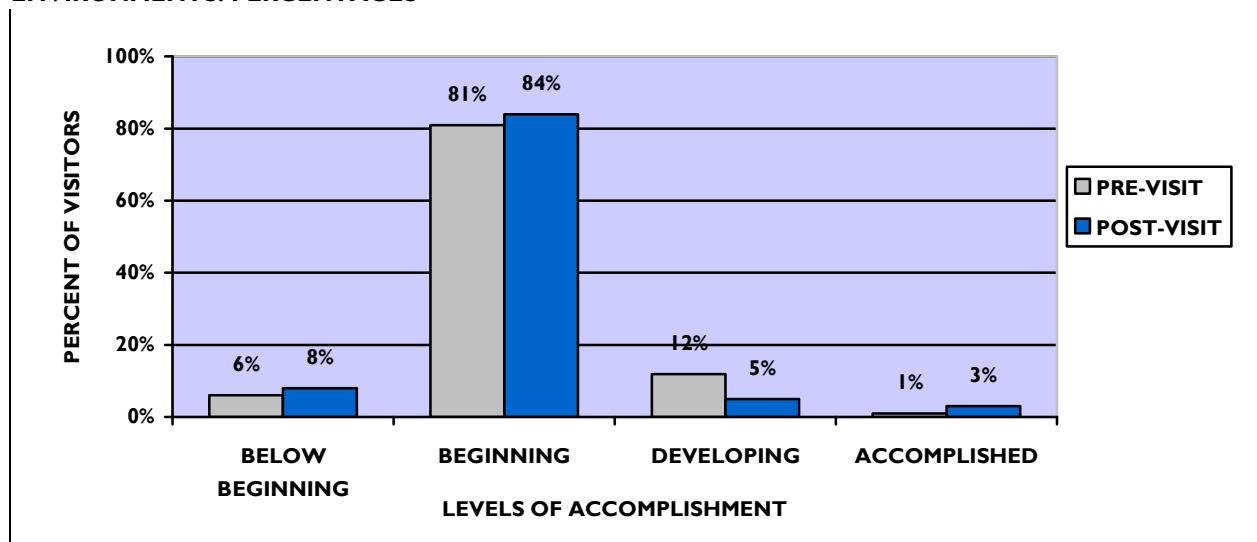
Objective 4: Visitors will understand that the Earth’s poles, desert, deep sea vents, and rocky shore are of interest to scientists because these are prime places for adaptation to occur.

To assess the interviewees’ achievement of this objective, the pre-visit and post-visit interviews included a few questions aimed at examining visitors’ understanding of why scientists study extreme environments. RK&A evaluated and scored each interviewee’s verbatim responses according to the following rubric:

Score	Criteria
Below Beginning (1)	The visitor does not know why the Earth’s poles, desert, deep sea vents, and rocky shore are of interest to scientists.
Beginning (2)	The visitor grasps that the Earth’s poles, desert, deep sea vents, and rocky shore is of interest to scientists but is unable to articulate why or names a reason that is irrelevant or tangential.
Developing (3)	The visitor grasps that the Earth’s poles, desert, deep sea vents, and rocky shore are of interest to scientist as extreme environments but does not mention adaptation.
Accomplished (4)	The visitor grasps that the Earth’s poles, desert, deep sea vents, and rocky shore are of interest to scientist as extreme environments AND mentions adaptation.

Overall, most interviewees scored at the Beginning level for Objective Four (81 percent for pre-visit and 84 percent for post-visit) (see Figure 4). No statistically significant differences were found between the pre- and post-visit samples for Objective Four.

FIGURE 4
OBJECTIVE FOUR SCORE – UNDERSTANDING THE VALUE OF STUDYING EXTREME ENVIRONMENTS: PERCENTAGES



$\chi^2=5.294; df = 3; p = .151$

OVERALL PERFORMANCE ON OVERARCHING OBJECTIVES

Table 14 shows the total scores representing visitors' overall performance on the overarching objectives. To create the total score, rubric scores of the four overarching objectives were added together (with a possible range of 4 to 16 points). The pre-visit and post-visit groups showed a similar overall performance on the overarching objectives (pre-visit mean = 8.69 and post-visit mean = 8.95).

TABLE 14

OVERALL PERFORMANCE ON THE OVERARCHING OBJECTIVES: SUMMARY STATISTICS

OVERALL PERFORMANCE ON THE OVERARCHING OBJECTIVES (POSSIBLE RANGE 4 – 16)	SAMPLE		
	PRE-VISIT (<i>n</i> = 102)	POST-VISIT (<i>n</i> = 102)	TOTAL (<i>n</i> = 204)
Mean	8.69	8.95	8.82
±	1.82	2.12	1.98
Median	8.50	9.00	9.00
Range	4 - 13	5 - 16	4 - 16

$F=0.915; p=.340$

EARTH'S POLES OBJECTIVES

OBJECTIVE FIVE: UNIQUE CONDITIONS AT POLES

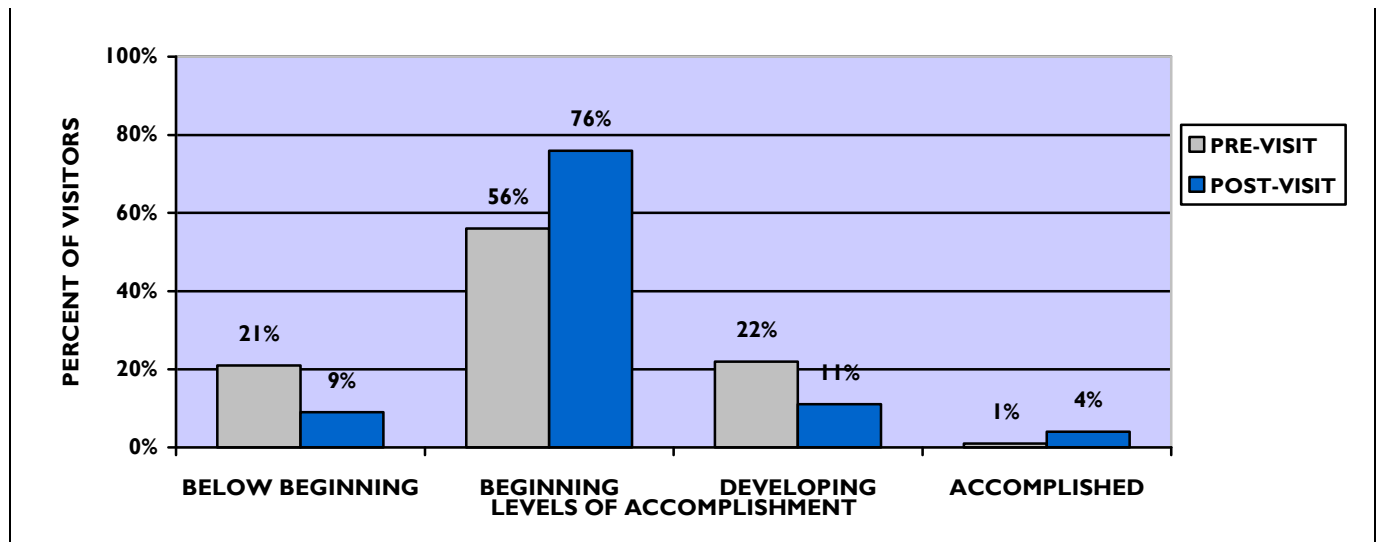
Objective 5: Visitors will be able to describe the unique conditions that animals and plants face at the poles.

To assess the interviewees’ achievement of this objective, the pre-visit and post-visit interviews included a few questions aimed at examining visitors’ understanding of the unique conditions at the Earth’s poles. RK&A evaluated and scored each interviewee’s verbatim responses according to the following rubric:

Score	Criteria
Below Beginning (1)	The visitor is unable to name any unique conditions found at the poles.
Beginning (2)	The visitor names one unique condition found at the poles (e.g., extreme cold temperatures).
Developing (3)	The visitor names two unique conditions found at the poles (e.g., extreme cold temperatures, windy).
Accomplished (4)	The visitor names three or more unique conditions found at the poles (e.g., extreme cold temperatures, windy, dry, sunlight reflection).

Overall, most interviewees scored at the Beginning level for Objective Five (56 percent for pre-visit and 76 percent for post-visit) (see Figure 5). However, two statistically significant differences were found. Post-visit interviewees were more likely to score at the Beginning level than were pre-visit interviewees (76 percent for post-visit and 56 percent for pre-visit). Conversely, pre-visit interviewees were more likely to score at the Below Beginning level than were post-visit interviewees (21 percent for pre-visit and 9 percent for post-visit).

FIGURE 5
OBJECTIVE FIVE SCORE – UNIQUE CONDITIONS AT POLES: PERCENTAGES



$X^2=13.815; df = 3; p = .003$

OBJECTIVE SIX: ADAPTATIONS AT POLES

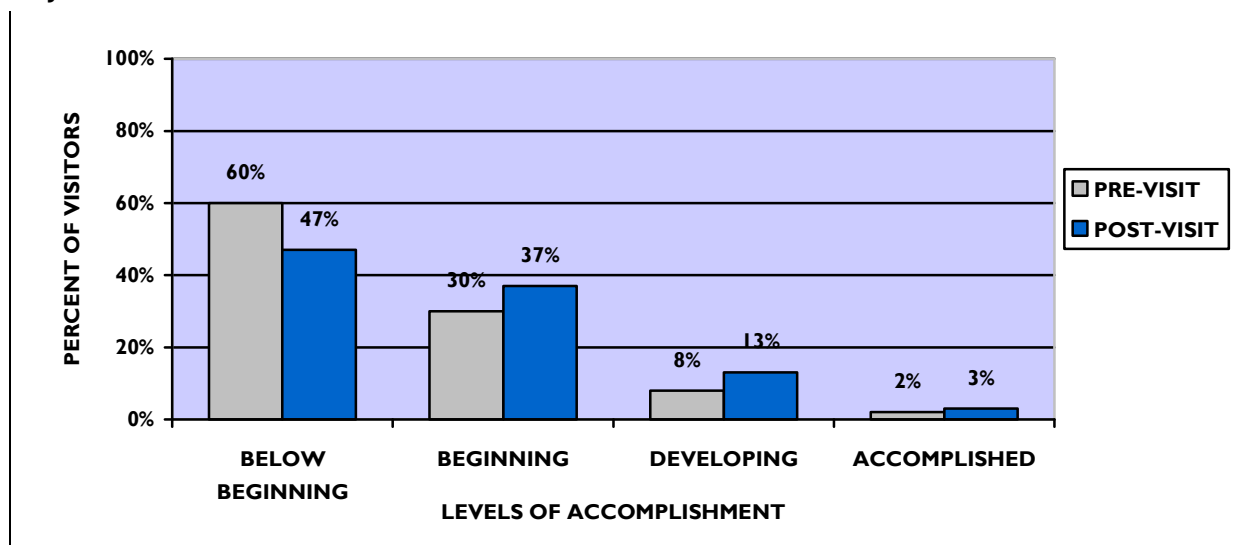
Objective 6: Visitors will be able to provide examples of adaptations to the conditions at the poles.

To assess the interviewees' achievement of this objective, the pre-visit and post-visit interviews included a few questions aimed at examining visitors' understanding of polar adaptations. RK&A evaluated and scored each interviewee's verbatim responses according to the following rubric:

Score	Criteria
Below Beginning (1)	The visitor is unable to name any adaptations to the conditions at the poles.
Beginning (2)	The visitor names one example of an adaptation found at the poles (e.g., thick fur).
Developing (3)	The visitor names two examples of adaptation found at the poles (e.g., thick fur, layers of blubber).
Accomplished (4)	The visitor names three or more adaptations found at the poles (e.g., thick fur, layers of blubber, short appendages, white fur).

Overall, most interviewees scored at the Below Beginning level for Objective Six (60 percent for pre-visit and 47 percent for post-visit) (see Figure 6). No statistically significant differences were found between the pre- and post-visit samples for Objective Six.

FIGURE 6
OBJECTIVE SIX SCORE - ADAPTATIONS AT POLES: PERCENTAGES



$\chi^2=3.771$; $df=3$; $p=.287$

OBJECTIVE SEVEN: PLANT AND ANIMAL EXAMPLES AT POLES

Objective 7: Visitors will be able to name plant or animal species found at the poles.

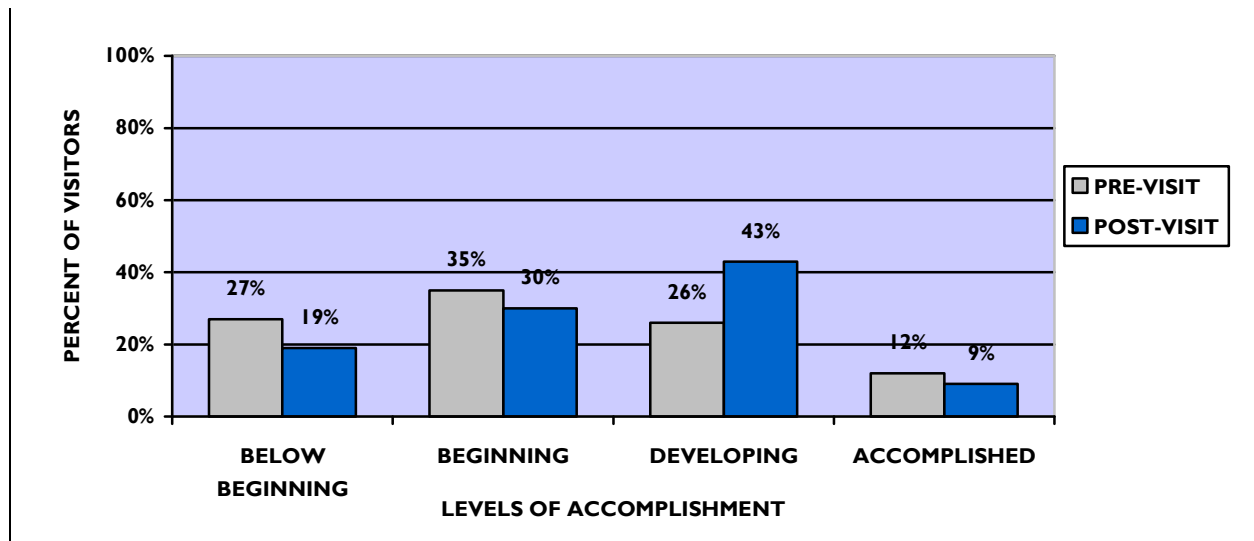
To assess the interviewees’ achievement of this objective, the pre-visit and post-visit interviews included a few questions aimed at examining visitors’ understanding of organisms that are adapted to the polar environment. RK&A evaluated and scored each interviewee’s verbatim responses according to the following rubric:

Score	Criteria
Below Beginning (1)	The visitor is unable to name any plant or animal species that live at the poles.
Beginning (2)	The visitor names one plant or animal species that lives at the poles (e.g., polar bears).
Developing (3)	The visitor names two plant or animal species that live at the poles (e.g., polar bears, seals).
Accomplished (4)	The visitor names three or more plant or animal species that live at the poles (e.g., polar bears, seals, Emperor penguins, lichens).

Overall, most interviewees scored at the Beginning or Developing levels for Objective Seven (61 percent for pre-visit and 73 percent for post-visit) (see Figure 7). No statistically significant differences were found between the pre- and post-visit samples for Objective Seven.

FIGURE 7

OBJECTIVE SEVEN SCORE - PLANT AND ANIMAL EXAMPLES AT POLES: PERCENTAGES



$X^2=6.438; df = 3; p = .092$

OBJECTIVE EIGHT: HOW SCIENTISTS STUDY THE POLES

Objective 8: Visitors will be able to describe how scientists study changes in the polar environment.

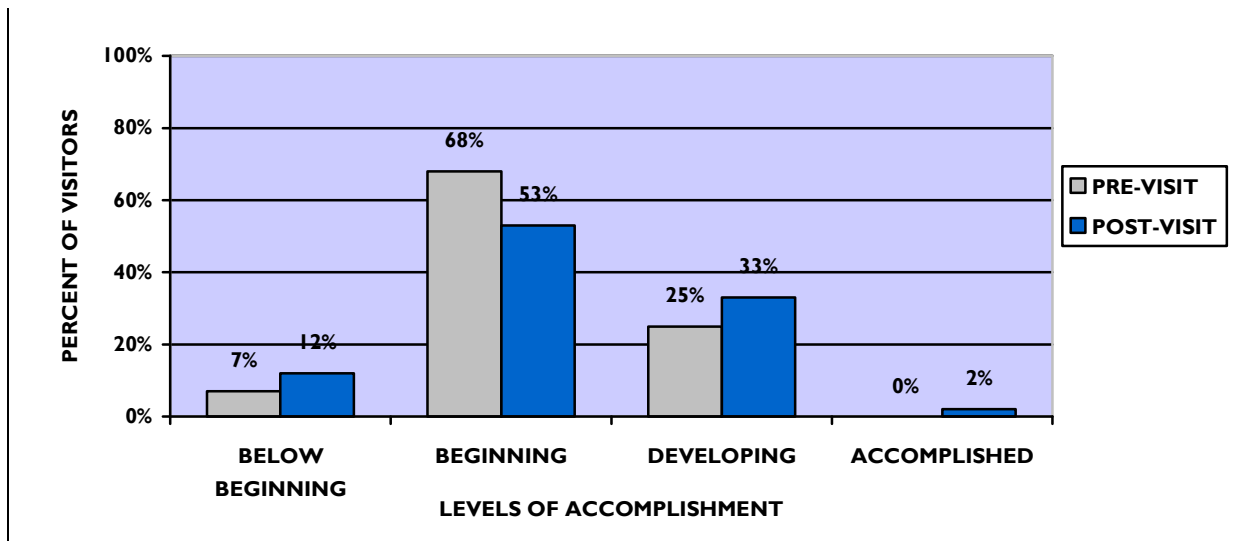
To assess the interviewees’ achievement of this objective, the pre-visit and post-visit interviews included a few questions aimed at examining visitors’ understanding of how scientists study the polar environment. RK&A evaluated and scored each interviewee’s verbatim responses according to the following rubric:

Score	Criteria
Below Beginning (1)	The visitor is unaware that scientists are studying the poles.
Beginning (2)	The visitor acknowledges that scientists are studying the poles but is unable to describe how.
Developing (3)	The visitor gives a generic explanation of how scientists are studying changes in the polar environment (e.g., scientists use computers to study the poles).
Accomplished (4)	The visitor gives a detailed explanation of how scientists are studying changes in the polar environment (e.g., analyzing tree rings and ice cores).

Overall, most interviewees scored at the Beginning level for Objective Eight (68 percent for pre-visit and 53 percent for post-visit) (see Figure 8). No statistically significant differences were found between the pre- and post-visit samples for Objective Eight.

FIGURE 8

OBJECTIVE EIGHT SCORE - HOW SCIENTISTS STUDY THE POLES: PERCENTAGES



$\chi^2=6.965; df=3; p=.073$

OVERALL PERFORMANCE ON POLES OBJECTIVES

Table 15 shows the total scores representing interviewees' overall performance on the Earth's poles objectives. To create the total score, rubric scores of the four poles objectives were added together (with a possible range of 4 to 16 points). The post-visit group showed better overall performance than the pre-visit group on the Earth's poles objectives (pre-visit mean = 7.98 and post-visit mean = 8.51).

TABLE 15

OVERALL PERFORMANCE ON THE POLES OBJECTIVES: SUMMARY STATISTICS

OVERALL PERFORMANCE ON THE POLES OBJECTIVES (POSSIBLE RANGE 4 – 16)	SAMPLE		
	PRE-VISIT (<i>n</i> = 107)	POST-VISIT (<i>n</i> = 90)	TOTAL (<i>n</i> = 197)
Mean	7.98	8.51	8.22
±	1.71	1.79	1.76
Median	8.00	8.00	8.00
Range	4 - 12	5 - 12	4 - 12

F=4.501; *p*=.035

DESERT OBJECTIVES

OBJECTIVE NINE: UNIQUE CONDITIONS IN THE DESERT

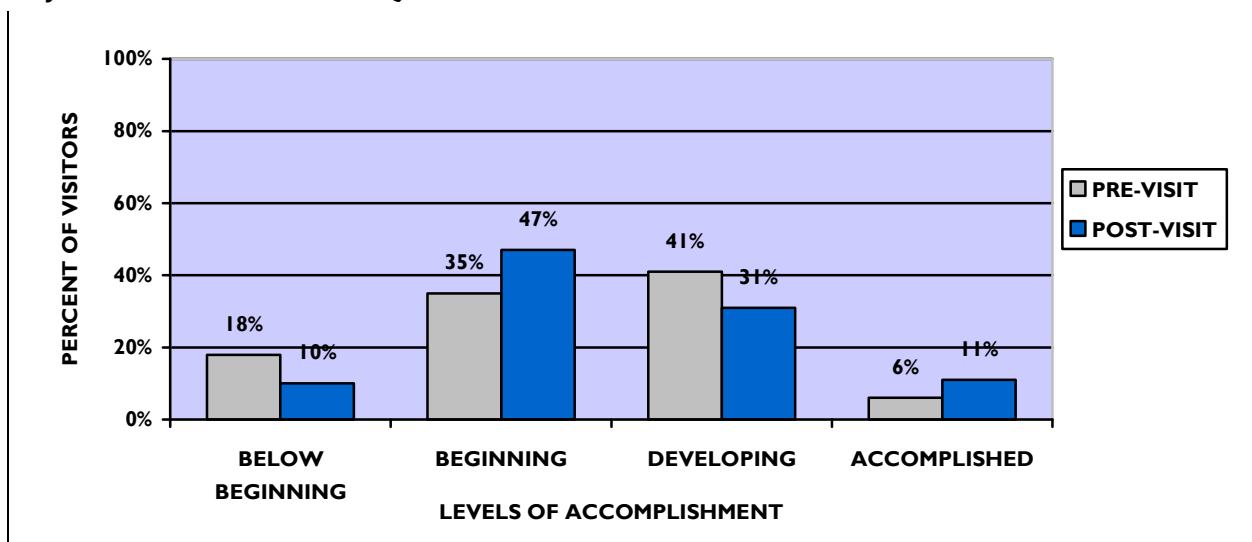
Objective 9: Visitors will be able to describe the unique conditions that animals and plants face in the desert.

To assess the interviewees’ achievement of this objective, the pre-visit and post-visit interviews included a few questions aimed at examining visitors’ understanding of the desert’s unique environmental conditions. RK&A evaluated and scored each interviewee’s verbatim responses according to the following rubric:

Score	Criteria
Below Beginning (1)	The visitor is unable to name any conditions found in the desert.
Beginning (2)	The visitor names one unique condition found in the desert (e.g., extreme temperatures)
Developing (3)	The visitor names two unique conditions found in the desert (e.g., extreme temperatures, dry).
Accomplished (4)	The visitor names three or more unique conditions found in the desert (e.g., extreme temperatures, dry, intense sun, flash floods)

Overall, most interviewees scored at the Beginning or Developing levels for Objective Nine (76 percent for pre-visit and 78 percent for post-visit) (see Figure 9). No statistically significant differences were found between the pre- and post-visit samples for Objective Nine.

FIGURE 9
OBJECTIVE NINE SCORE – UNIQUE CONDITIONS IN THE DESERT: PERCENTAGES



$\chi^2=6.959; df = 3; p = .073$

OBJECTIVE TEN: ADAPTATIONS IN THE DESERT

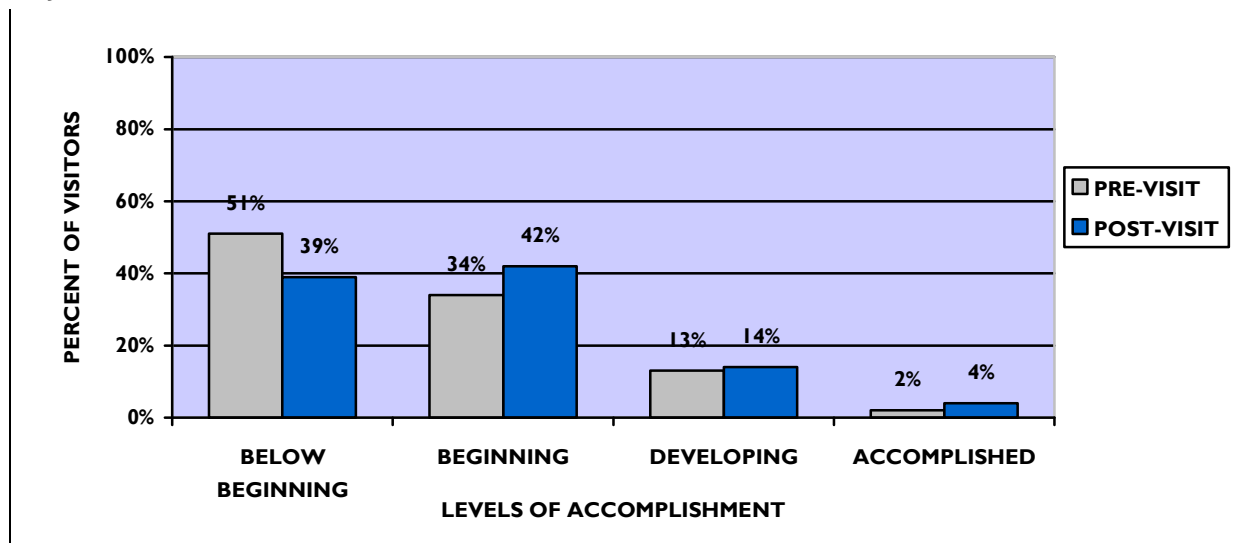
Objective 10: Visitors will be able to provide examples of adaptations to the conditions in the desert.

To assess the interviewees’ achievement of this objective, the pre-visit and post-visit interviews included a few questions aimed at examining visitors’ understanding of the desert adaptations. RK&A evaluated and scored each interviewee’s verbatim responses according to the following rubric:

Score	Criteria
Below Beginning (1)	The visitor is unable to name any adaptations to the conditions in the desert.
Beginning (2)	The visitor names one example of an adaptation found in the desert (e.g., water storage).
Developing (3)	The visitor names two adaptations found in the desert (e.g., water storage, waxy or scaly surfaces to minimize water loss).
Accomplished (4)	The visitor names three or more adaptations found in the desert (e.g., water storage, waxy or scaly surfaces to minimize water loss, physiological ways of minimizing water loss, large ears for dissipating heat).

Overall, most interviewees scored at the Below Beginning level for Objective Ten (51 percent for pre-visit and 39 percent for post-visit) (see Figure 10). No statistically significant differences were found between the pre- and post-visit samples for Objective Ten.

FIGURE 10
OBJECTIVE TEN SCORE – ADAPTATIONS IN THE DESERT: PERCENTAGES



$\chi^2=3.501; df=3; p=.321$

OBJECTIVE ELEVEN: PLANT AND ANIMAL EXAMPLES IN THE DESERT

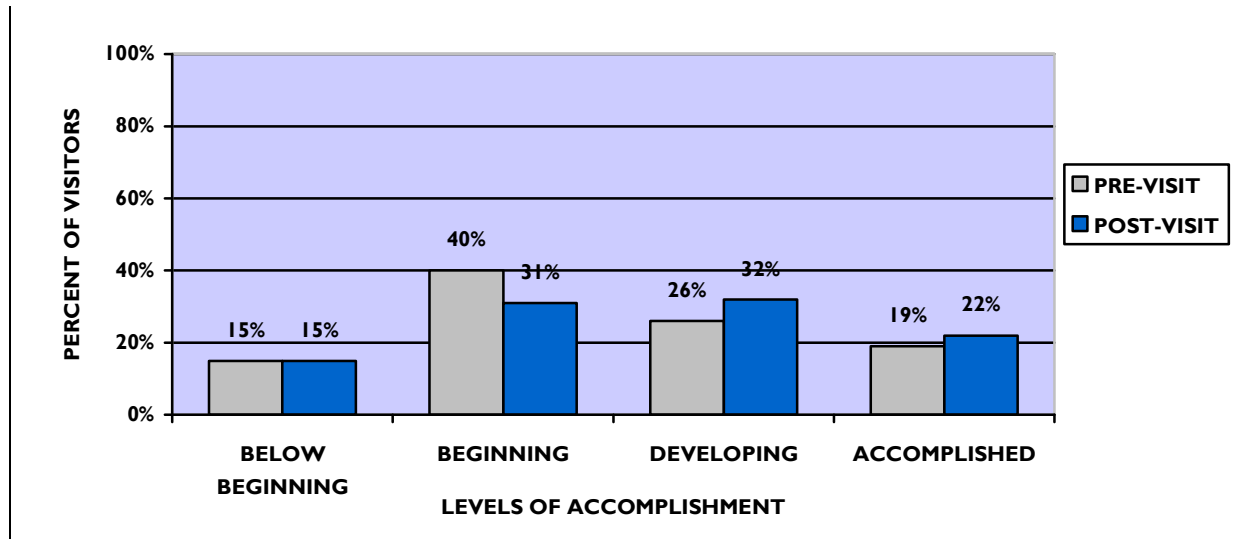
Objective 11: Visitors will be able to provide examples of plant or animal species found in the desert.

To assess the interviewees’ achievement of this objective, the pre-visit and post-visit interviews included a few questions aimed at examining visitors’ understanding of plants and animals that live in the desert. RK&A evaluated and scored each interviewee’s verbatim responses according to the following rubric:

Score	Criteria
Below Beginning (1)	The visitor is unable to name any plant or animal species that live in the desert.
Beginning (2)	The visitor names one plant or animal species that live in the desert (e.g., tortoise).
Developing (3)	The visitor names two plant or animal species that live in the desert (e.g., tortoise, cactus).
Accomplished (4)	The visitor names three or more plant or animal species that lives in the desert (e.g., tortoise, chuckwalla, scorpion, cactus, packrat, bats).

Overall, most interviewees scored at the Beginning or Developing levels for Objective Eleven (66 percent for pre-visit and 65 percent for post-visit) (see Figure 11). No statistically significant differences were found between the pre- and post-visit samples for Objective Eleven.

FIGURE 11
OBJECTIVE ELEVEN SCORE – PLANT AND ANIMAL EXAMPLES IN THE DESERT: PERCENTAGES



$X^2=2.385; df = 3; p = .497$

OVERALL PERFORMANCE ON DESERT OBJECTIVES

Table 16 shows the total scores representing visitors' overall performance on the desert objectives. To create the total score, rubric scores of the three desert objectives were added together (with a possible range of 3 to 12 points). The pre-visit and post-visit group showed similar overall performance on the desert objectives (pre-visit mean = 6.50 and post-visit mean = 6.90).

TABLE 16

OVERALL PERFORMANCE ON THE DESERT OBJECTIVES: SUMMARY STATISTICS

OVERALL PERFORMANCE ON THE DESERT OBJECTIVES (POSSIBLE RANGE 3 - 12)	SAMPLE		
	PRE-VISIT (<i>n</i> = 107)	POST-VISIT (<i>n</i> = 103)	TOTAL (<i>n</i> = 210)
Mean	6.50	6.90	6.70
±	1.57	1.61	1.60
Median	6.00	7.00	7.00
Range	3 - 11	4 - 11	3 - 11

F=3.293; *p*=.071

DEEP SEA VENT OBJECTIVES

OBJECTIVE TWELVE: UNIQUE CONDITIONS IN DEEP SEA VENTS

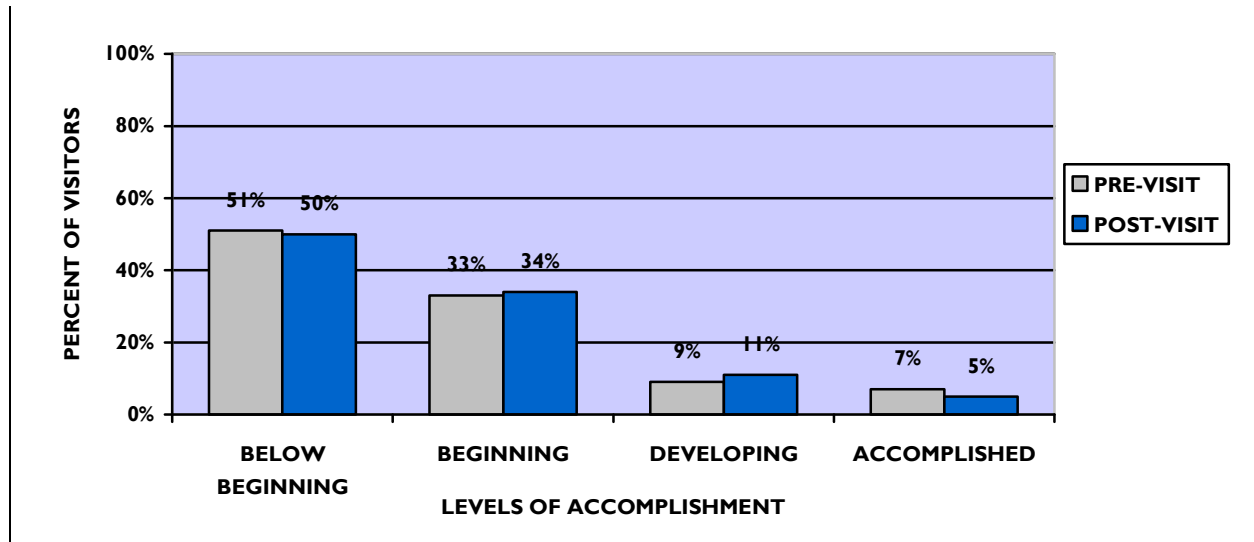
Objective 12: Visitors will be able to describe the unique conditions that animals and plants face in the deep sea vents.

To assess the interviewees’ achievement of this objective, the pre-visit and post-visit interviews included a few questions aimed at examining visitors’ understanding of the deep sea vents’ unique conditions. RK&A evaluated and scored each interviewee’s verbatim responses according to the following rubric:

Score	Criteria
Below Beginning (1)	The visitor is unable to name any conditions found in the deep sea vents.
Beginning (2)	The visitor names one unique condition found in the deep sea vents (e.g., extreme pressure).
Developing (3)	The visitor names two unique conditions found in the deep sea vents (e.g., extreme pressure, extreme temperatures).
Accomplished (4)	The visitor names three or more unique conditions found in the deep sea vents (e.g., extreme pressure, extreme temperatures, lack of sunlight, noxious chemicals).

Overall, most interviewees scored at the Below Beginning level for Objective Twelve (51 percent for pre-visit and 50 percent for post-visit) (see Figure 12). No statistically significant differences were found between the pre- and post-visit samples for Objective Twelve.

FIGURE 12
OBJECTIVE TWELVE SCORE – UNIQUE CONDITIONS IN DEEP SEA VENTS: PERCENTAGES



$X^2=0.220; df = 3; p = .974$

OBJECTIVE THIRTEEN: ADAPTATIONS IN DEEP SEA VENTS

Objective 13: Visitors will be able to provide examples of adaptations to the conditions in the deep sea vents.

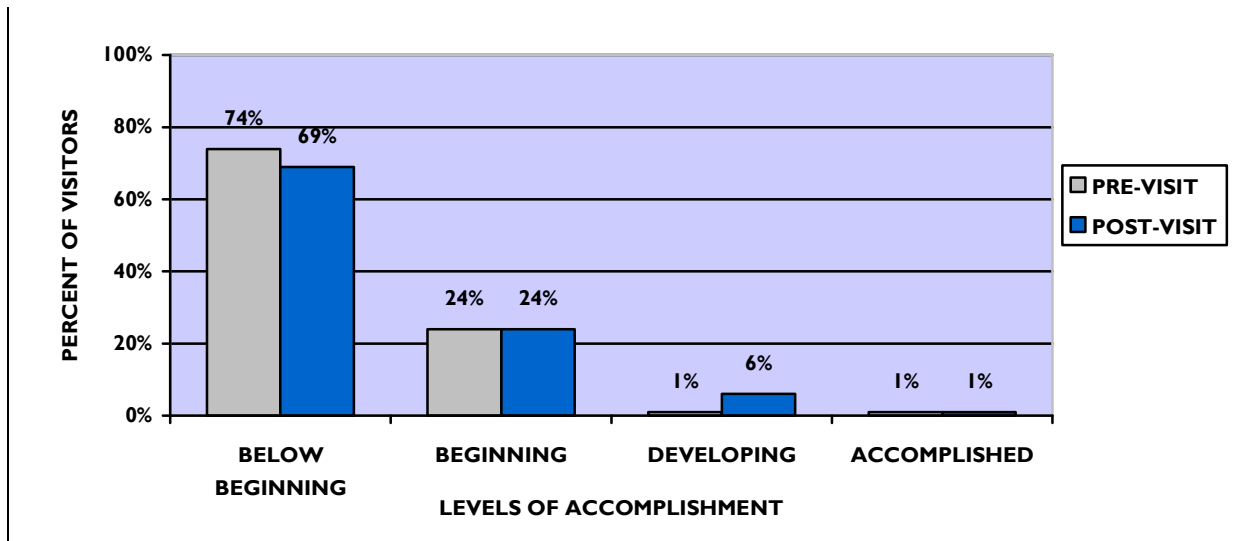
To assess the interviewees’ achievement of this objective, the pre-visit and post-visit interviews included a few questions aimed at examining visitors’ understanding of the deep sea vent adaptations. RK&A evaluated and scored each interviewee’s verbatim responses according to the following rubric:

Score	Criteria
Below Beginning (1)	The visitor is unable to name any adaptations to the conditions in the deep sea vents.
Beginning (2)	The visitor names one example of an adaptation found in the deep sea vents (e.g., blindness).
Developing (3)	The visitor names two adaptations found in the deep sea vents (e.g., blindness, bioluminescence).
Accomplished (4)	The visitor names three or more adaptations found in the deep sea vents (e.g., blindness, bioluminescence, chemosynthesis, gigantism).

Overall, most interviewees scored at the Below Beginning level for Objective Thirteen (74 percent for pre-visit and 69 percent for post-visit) (see Figure 13). No statistically significant differences were found between the pre- and post-visit samples for Objective Thirteen.

FIGURE 13

OBJECTIVE THIRTEEN SCORE – ADAPTATIONS IN DEEP SEA VENTS: PERCENTAGES



$\chi^2=3.614; df=3; p=.306$

OBJECTIVE FOURTEEN: ANIMAL EXAMPLES IN DEEP SEA VENTS

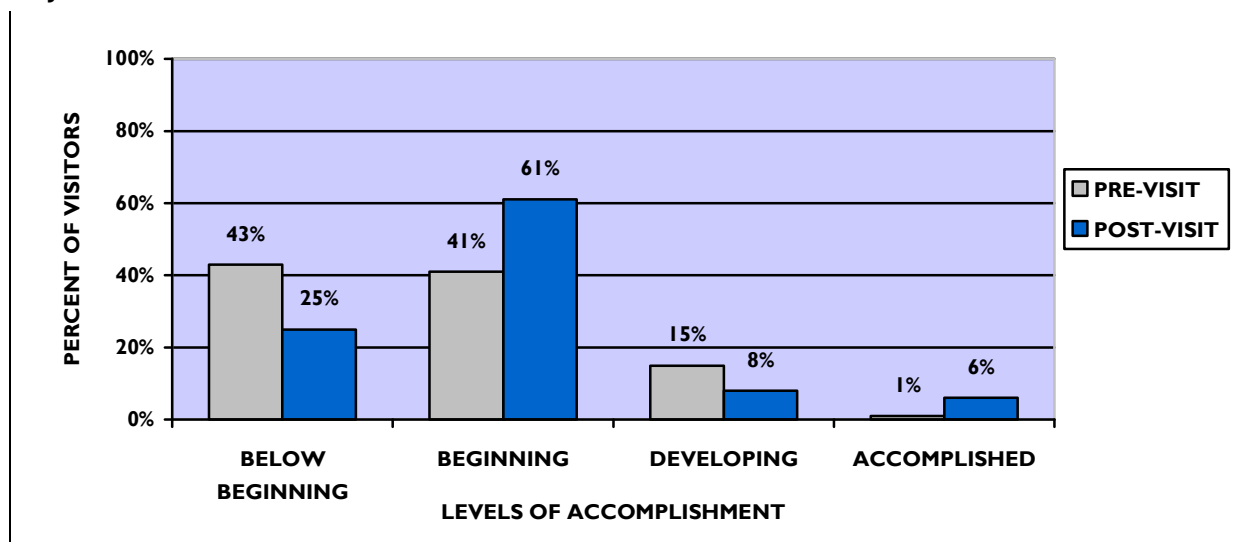
Objective 14: Visitors will be able to provide examples animal species found in the deep sea vents.

To assess the interviewees’ achievement of this objective, the pre-visit and post-visit interviews included a few questions aimed at examining visitors’ understanding of animals that live in the deep sea vents. RK&A evaluated and scored each interviewee’s verbatim responses according to the following rubric:

Score	Criteria
Below Beginning (1)	The visitor is unable to name any animal species that live in the deep sea vents.
Beginning (2)	The visitor names one animal species that lives in the deep sea vents (e.g., giant tubeworms).
Developing (3)	The visitor names two animal species that live in the deep sea vents (e.g., giant tubeworms, shrimp).
Accomplished (4)	The visitor names three or more animal species that live in the deep sea vents (e.g., giant tubeworms, shrimp, mussels, bacteria, fish).

Overall, most interviewees scored at the Below Beginning or Beginning levels for Objective Fourteen (84 percent for pre-visit and 86 percent for post-visit) (see Figure 14). However, two statistically significant differences were found. Post-visit interviewees were more likely to score at the Beginning level than were pre-visit interviewees (61 percent for post-visit and 41 percent for pre-visit). Pre-visit interviewees tended to score at the Below Beginning level (43 percent for pre-visit and 25 percent for post-visit).

FIGURE 14
OBJECTIVE FOURTEEN SCORE – ANIMAL EXAMPLES IN DEEP SEA VENTS: PERCENTAGES



$X^2=11.809$; $df = 3$; $p = .008$

OBJECTIVE FIFTEEN: HOW SCIENTISTS STUDY DEEP SEA VENTS

Objective 15: Visitors will be able to describe how scientists study the deep sea vents.

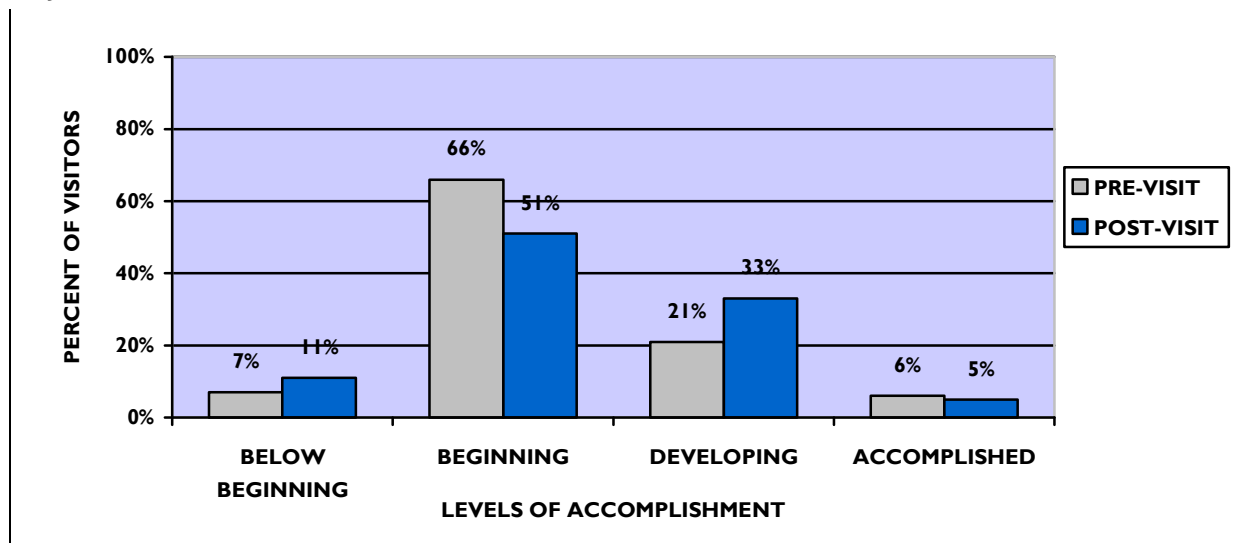
To assess the interviewees’ achievement of this objective, the pre-visit and post-visit interviews included a few questions aimed at examining visitors’ understanding of how scientists study the deep sea vents. RK&A evaluated and scored each interviewee’s verbatim responses according to the following rubric:

Score	Criteria
Below Beginning (1)	The visitor is unaware that scientists are studying the deep sea vents.
Beginning (2)	The visitor acknowledges that scientists are studying the deep sea vents but is unable to describe how.
Developing (3)	The visitor gives a generic explanation of how scientists are studying the deep sea vents (e.g., scientists use computers to study the vents).
Accomplished (4)	The visitor gives a detailed explanation of how scientists are studying the deep sea vents (e.g., using remotely-operated vehicles—ROVs—and manned submersibles).

Overall, most interviewees scored at the Beginning level for Objective Thirteen (66 percent for pre-visit and 51 percent for post-visit) (see Figure 15). No statistically significant differences were found between the pre- and post-visit samples for Objective Fifteen.

FIGURE 15

OBJECTIVE FIFTEEN SCORE – HOW SCIENTISTS STUDY DEEP SEA VENTS: PERCENTAGES



$\chi^2=4.945; df = 3; p = .176$

OVERALL PERFORMANCE ON DEEP SEA VENTS OBJECTIVES

Table 17 shows the total scores representing visitors' overall performance on the deep sea vents objectives. To create the total score, rubric scores of the four deep sea vents objectives were added together (with a possible range of 4 to 16 points). The pre-visit and post-visit group showed similar overall performance on the deep sea vents objectives (pre-visit mean = 6.97 and post-visit mean = 7.39).

TABLE 17
OVERALL PERFORMANCE ON THE DEEP SEA VENTS OBJECTIVES: SUMMARY STATISTICS

OVERALL PERFORMANCE ON THE DEEP SEA VENTS OBJECTIVES (POSSIBLE RANGE 4 – 16)	SAMPLE		
	PRE-VISIT (<i>n</i> = 106)	POST-VISIT (<i>n</i> = 69)	TOTAL (<i>n</i> = 175)
Mean	6.97	7.39	7.14
±	1.83	1.86	1.85
Median	7.00	7.00	7.00
Range	4 - 14	5 - 12	4 - 14

F=2.167; *p*=.143

ROCKY SHORE OBJECTIVES

OBJECTIVE SIXTEEN: UNIQUE CONDITIONS ALONG ROCKY SHORE

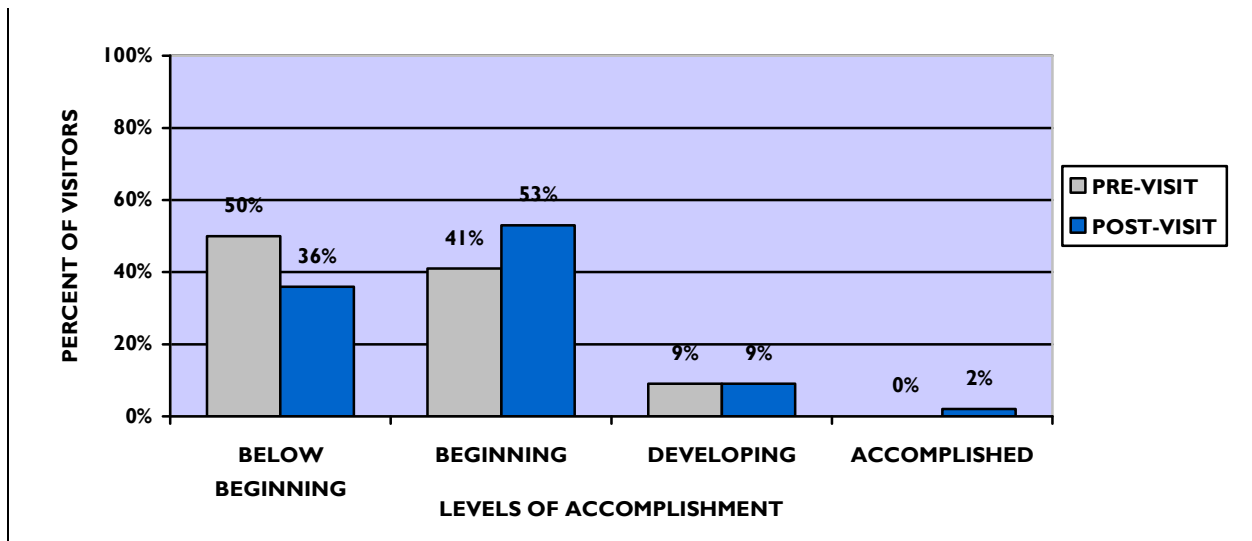
Objective 16: Visitors will be able to describe unique conditions that animals and plants face along the rocky shore.

To assess the interviewees’ achievement of this objective, the pre-visit and post-visit interviews included a few questions aimed at examining visitors’ understanding of the rocky shore’s unique conditions. RK&A evaluated and scored each interviewee’s verbatim responses according to the following rubric:

Score	Criteria
Below Beginning (1)	The visitor is unable to name any conditions found along the rocky shore.
Beginning (2)	The visitor names one unique condition found along the rocky shore (e.g., variable tides).
Developing (3)	The visitor names two unique conditions found along the rocky shore (e.g., variable tides, forces generated by waves).
Accomplished (4)	The visitor names three or more unique conditions found along the rocky shore (e.g., variable tides, forces generated by waves, lack of space).

Overall, most interviewees scored at the Below Beginning or Beginning levels for Objective Sixteen (91 percent for pre-visit and 89 percent for post-visit) (see Figure 16). No statistically significant differences were found between the pre- and post-visit samples for Objective Sixteen.

FIGURE 16
OBJECTIVE SIXTEEN SCORE – UNIQUE CONDITIONS ALONG ROCKY SHORE: PERCENTAGES



$\chi^2=5.801; df = 3; p = .122$

OBJECTIVE SEVENTEEN: ADAPTATIONS ALONG ROCKY SHORE

Objective 17: Visitors will be able to provide examples of adaptations to the conditions along the rocky shore.

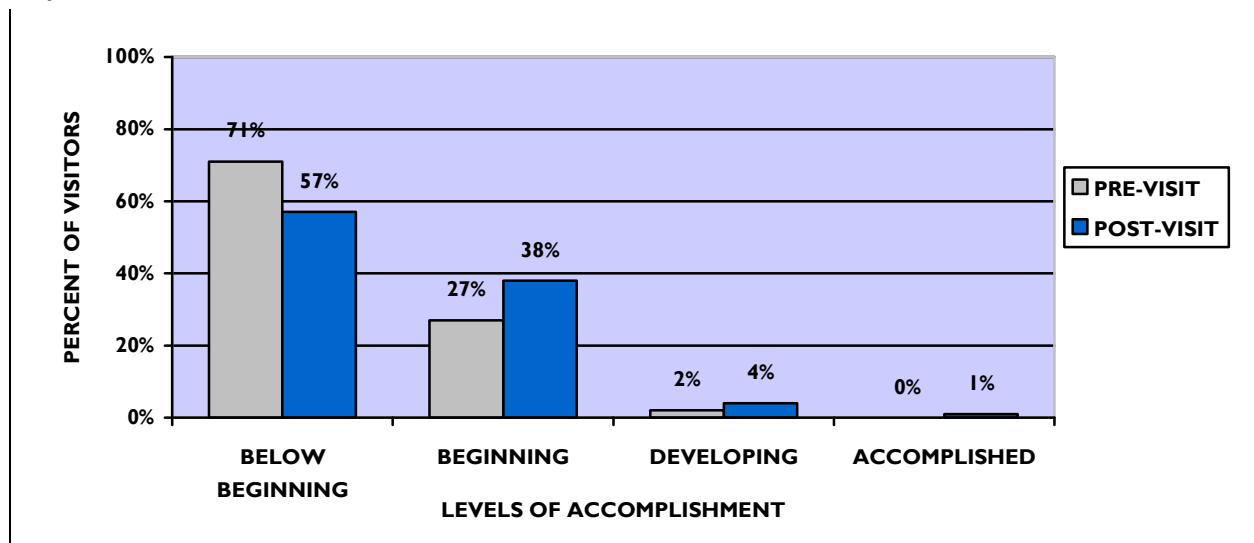
To assess the interviewees’ achievement of this objective, the pre-visit and post-visit interviews included a few questions aimed at examining visitors’ understanding of rocky shore adaptations. RK&A evaluated and scored each interviewee’s verbatim responses according to the following rubric:

Score	Criteria
Below Beginning (1)	The visitor is unable to name any adaptations to the conditions along the rocky shore.
Beginning (2)	The visitor names one example of an adaptation found along the rocky shore (e.g., hard shells).
Developing (3)	The visitor names two adaptations found along the rocky shore (e.g., hard shells, holdfasts).
Accomplished (4)	The visitor names three or more adaptations found along the rocky shore (e.g., hard shells, holdfasts, growing quickly to outcompete others for space).

Overall, most interviewees scored at the Below Beginning level for Objective Seventeen (71 percent for pre-visit and 57 percent for post-visit) (see Figure 17). No statistically significant differences were found between the pre- and post-visit samples for Objective Seventeen.

FIGURE 17

OBJECTIVE SEVENTEEN SCORE – ADAPTATIONS ALONG ROCKY SHORE: PERCENTAGES



$\chi^2=5.125; df=3; p=.163$

OBJECTIVE EIGHTEEN: PLANT AND ANIMAL EXAMPLES ALONG ROCKY SHORE

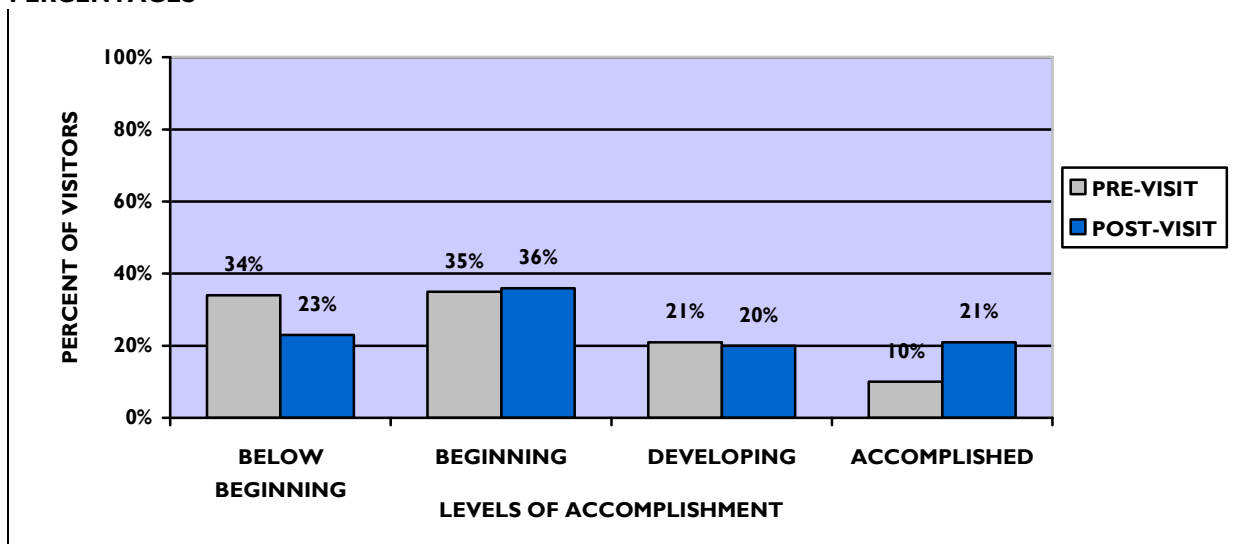
Objective 18: Visitors will be able to provide examples of plant or animal species found along the rocky shore.

To assess the interviewees’ achievement of this objective, the pre-visit and post-visit interviews included a few questions aimed at examining visitors’ understanding of the plants and animals that inhabit the rocky shore. RK&A evaluated and scored each interviewee’s verbatim responses according to the following rubric:

Score	Criteria
Below Beginning (1)	The visitor is unable to name any animal species that live along the rocky shore.
Beginning (2)	The visitor names one animal species that live along the rocky shore (e.g., barnacle).
Developing (3)	The visitor names two animal species that live along the rocky shore (e.g., barnacle, mussels).
Accomplished (4)	The visitor names three or more animal species that live along the rocky shore (e.g., barnacle, mussels, sea stars).

Overall, most interviewees scored at the Below Beginning or Beginning levels for Objective Eighteen (69 percent for pre-visit and 59 percent for post-visit) (see Figure 18). No statistically significant differences were found between the pre- and post-visit samples for Objective Eighteen.

FIGURE 18
OBJECTIVE EIGHTEEN SCORE – PLANT AND ANIMAL EXAMPLES ALONG ROCKY SHORE:
PERCENTAGES



$\chi^2=5.517; df = 3; p = .138$

OVERALL PERFORMANCE ON ROCKY SHORE OBJECTIVES

Table 18 shows the total scores representing visitors' overall performance on the rocky shore objectives. To create the total score, rubric scores of the three rocky shore objectives were added together (with a possible range of 3 to 12 points). The post-visit group showed a better overall performance than the pre-visit group on the rocky shore objectives (pre-visit mean = 4.98 and post-visit mean = 5.62).

TABLE 18

OVERALL PERFORMANCE ON THE ROCKY SHORE OBJECTIVES: SUMMARY STATISTICS

OVERALL PERFORMANCE ON THE ROCKY SHORE OBJECTIVES (POSSIBLE RANGE 3 – 12)	SAMPLE		
	PRE-VISIT (n = 107)	POST-VISIT (n = 101)	TOTAL (n = 208)
Mean	4.98	5.62	5.29
±	1.47	1.60	1.57
Median	5.00	5.00	5.00
Range	3 - 9	3 - 10	3 - 10

F=9.096; *p*=.003

APPENDICES

APPENDIX A: INTERVIEW GUIDES AND DEMOGRAPHIC QUESTIONNAIRES

PRE-EXPERIENCE INTERVIEWS

Screener

Hi, today I'm talking with visitors about their visit. Your feedback would be appreciated and it will only take a few minutes.

- **Have you ever visited this exhibition [point to *Ecosystems* (don't say name)] today or on a previous visit?** [If "No," continue; if "Yes," thank them and say we are only interviewing visitors who have never visited this exhibition.]
- **Are there any children under 18 in your group today?** [If "Yes," continue; if "No," thank them and say we are only interviewing visitors with children.]

Great. I have a few questions for you. Do you mind if I audio record—it's just quicker than taking notes? [Once agreement is reached] **We can go sit at this table [point] and the rest of your group can go look around while we talk.**

Entrance Interview Guide

Turn on the recorder and **PRE OR POST, INITIALS, INTERVIEW#.**

1. So far, how is your visit to the California Science Center?
2. The Science Center features exhibits about lots of different science topics. This new wing focuses on ecology. When I say "ecology" what, if anything, comes to mind for you?
3. What associations—positive and negative—do you have with the word "ecology?"
4. If scientists were studying the ecology of a place, what kinds of things would they look at?
5. Have you ever heard of the term "adaptation?" [If yes] How would you describe an adaptation? What are some examples of adaptations?
6. The new ecology exhibition features several environments. I'd like to ask you a few questions about four of them: the Earth's poles, desert, deep sea vents, and rocky shore [show handout with environment names and images]. All of the questions I'm going to ask are about these environments in the real world, not these specific photos.

The Earth's poles, desert, deep sea vents, and rocky shore are different kinds of environments. Can you think of any unique characteristics or features of each environment? [Probe for each environment.]

What kinds of animals are best suited to live in each environment? Why is that? [Probe for each environment.]

How do you think scientists study these environments?

Why might scientists be interested in studying these environments?

7. We've talked about differences among these four environments. What, if anything, do these four environments have in common?

Thank you so much for your time. Please complete this short demographic survey.

[Once form is returned] Thank you again. Please wear this sticker so we don't ask you to participate in another interview. [Hand visitor thank-you gift.]

California Science Center *Ecosystems* Pre-visit Interviewee Questionnaire

Please complete these background questions.

1. **Is today your first visit to the California Science Center?**
 Yes No → How many times in the past 12 months have you visited the California Science Center? None 1-2 3-4 5+
2. **What is the age of each child in your group?** _____
3. **Are you:** male female?
4. **What is your age?** _____
5. **OPTIONAL: With which group(s) do you most identify? (Mark all that apply.)**
 African American/Black American Indian Asian/Pacific Islander
 Caucasian/White Hispanic/Latino Multi-ethnic
 Other _____

Thanks! Your input has been very helpful.

DATA COLLECTOR, PLEASE COMPLETE:
INTERVIEW#: _____ DATE: ____/____/____ WEEKDAY WEEKEND
DATA COLLECTOR INITIALS: _____

POST-EXPERIENCE INTERVIEWS

Screener

Hi, today I'm talking with visitors about their visit. Your feedback would be appreciated and it will only take a few minutes.

- [Show handout with environment names and images.] While in this exhibition [point to Ecosystems], did you visit any of these sections? [If "Yes," to one or more sections continue; if "No," thank them and say we are only interviewing visitors to those areas.]
- Are you visiting with any children today? [If "Yes," continue; if "No," thank them and say we are only interviewing visitors with children.]

Do you mind if I audio record—it's just quicker than taking notes? [Once agreement is reached] We can go sit at this table [point] and the rest of your group can go look around while we talk.

Exit Interview Guide

Turn on the recorder and **ANNOUNCE DATE, NAME, INTERVIEW#.**

1. So far, how is your visit to the California Science Center?
2. The Science Center features exhibits about lots of different science topics. This new wing focuses on ecology. When I say "ecology" what, if anything, comes to mind for you?
3. What associations—positive and negative—do you have with the word "ecology?"
4. If scientists were studying the ecology of a place, what kinds of things would they look at?
5. Have you ever heard of the term "adaptation?" [If yes] How would you describe an adaptation? What are some examples of adaptations?
6. The new ecology exhibition features several environments. I'd like to ask you a few questions about four of them: the Earth's poles, desert, deep sea vents, and rocky shore [show handout with environment names and images]. All of the questions I'm going to ask are about these environments in the real world, not these specific photos.

Remind me again, which of these environments did you visit?

Let's talk about [name(s) of environment(s) visited]. Can you think of any unique characteristics or features of [environment]? [Probe for each environment visited.]

What kinds of animals are best suited to live in [environment]? Why is that? [Probe for each environment visited.]

How do you think scientists study these environments?

Why might scientists be interested in studying these environments?

7. We've talked about differences among these four environments. What, if anything, do these four environments have in common?
8. In [environment], what kinds of exhibits do you recall using? There are animal displays (tanks), hands-on exhibits, computer-based exhibits, information to read, and videos. [Show photos.] [Probe for each environment visited.]
9. As you entered the new *Ecosystems* exhibition, did you stop and watch the film?
[If yes] What do you think the film was trying to show and tell visitors?

Thank you so much for your time. Please complete this short demographic survey.

[Once form is returned] Thank you again. [Hand visitor thank-you gift.]

**California Science Center *Ecosystems*
Post-visit Interviewee Questionnaire**

Please complete these background questions.

1. Did the *Ecosystems* exhibition stimulate your interest in science?
 No A little A lot
2. Did the *Ecosystems* exhibition increase your general knowledge of ecology?
 No A little A lot
3. Is today your first visit to the California Science Center?
 Yes No → How many times in the past 12 months have you visited the California Science Center? None 1-2 3-4 5+
4. What is the age of each child in your group? _____
5. Are you: male female?
6. What is your age? _____
7. **OPTIONAL: With which group(s) do you most identify? (Mark all that apply.)**
 African American/Black American Indian Asian/Pacific Islander
 Caucasian/White Hispanic/Latino Multi-ethnic
 Other _____

Thanks! Your input has been very helpful.

DATA COLLECTOR, PLEASE COMPLETE:

INTERVIEW#: _____ DATE: ____/____/____ WEEKDAY WEEKEND

DATA COLLECTOR INITIALS: _____

ENVIRONMENT NAMES AND PHOTOS (PRE- AND POST-INTERVIEW)

The Extreme Zone Sections: The Earth's Poles



The Extreme Zone Sections: The Desert



The Extreme Zone Sections: The Deep Sea Vents



The Extreme Zone Sections: The Rocky Shore (Inside)



The Extreme Zone Sections: The Rocky Shore (Outside)



EXHIBIT TYPES (POST-INTERVIEW ONLY)

Animal Display (Tank) Example



Hands-on Exhibit Example




Computer-based Exhibit Example



Who lives on rocks?

It's tough, but many do well

Everyone wants to live on the rocky shore, where waves deliver food. But shore life has challenges. Over time, living things have adapted to survive low tides, dry times, hot sun, strong waves and hungry sea stars.



These animals get caught between a rock and a hard-hitting wave.

Use these cards to see who lives here, and how they live.

Please put the cards back when you're done.

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Video Example



APPENDIX B: SCORING RUBRIC

Q1 – Will not be scored (“ice-breaker” question)

OVERARCHING GOALS

Objective 1: Visitors will express an awareness and interest in of ecology. [Variable: Awareness of ecology, Variation: Depth of response; Q2/Q3/Q4]	
Score	Criteria for Objective 1
Below beginning (1)	The visitor has no awareness of or interest in ecology (e.g., states, “never heard of the term,” “nothing comes to mind,” or “I don’t know”).
Beginning (2)	The visitor states s/he has heard of ecology but provides an inaccurate description of the word (e.g., confuses ecology with environmental issues).
Developing (3)	The visitor describes one aspect of ecology (i.e., only the living world or only the physical world). For example, the visitor might state that ecology is the study of how plants and animals interact.
Accomplished (4)	The visitor accurately describes ecology as the study of the inter-relationship among living organisms and between living organisms and their environment. Both the living and physical worlds have to be mentioned.

Objective 2: Visitors will be able to define “adaptation,” including the relationship of adaptations and environmental conditions. [Variable: Understanding of adaptation, Variation: Depth of response; Q5]	
Score	Criteria for Objective 2
Below beginning (1)	The visitor has no understanding of adaptation (e.g., states, “never heard of the term,” “nothing comes to mind,” or “I don’t know”).
Beginning (2)	The visitor states s/he has heard of adaptation but provides an inaccurate or generic description of the word. For example, the visitor might state that “animals are constantly adapting.” The visitor is unable to give an example of an adaptation.
Developing (3)	The visitor only describes adaptation as a characteristic and does not include the surroundings in his/her response. For example, the visitor might state that “Thick fur is an adaptation.” The visitor is able to give a general example of an adaptation.
Accomplished (4)	The visitor accurately describes adaptations as characteristics that help plants and/or animals survive in particular conditions. The visitor is also able to give a specific example of an adaptation and the condition (environmental or biotic) to which it responds (e.g., “Polar bears have thick fur to keep them warm in the freezing conditions of the North pole.”).

Objective 3: Visitors will understand that the Earth’s poles, desert, deep sea vents, and rocky shore are examples of extreme environments [Variable: Understanding of extreme environments, Variation: Depth of response; Q7]	
Score	Criteria for Objective 3
Below Beginning (1)	The visitor perceives no connection among the Earth’s poles, desert, deep sea vents, and rocky shore.
Beginning (2)	The visitor perceives a connection among the Earth’s poles, desert, deep sea vents, and rocky shore but is unable to articulate what that connection is or names a connection that is irrelevant or tangential to the concept of extreme environments (e.g., says these are places that people don’t live).
Developing (3)	The visitor grasps that the Earth’s poles, desert, deep sea vents, and rocky shore are all extreme environments but is unable to explain what an extreme environment is. For example, the visitor may say, “Those are all harsh places for animals to live.”
Accomplished (4)	The visitor grasps that the Earth’s poles, desert, deep sea vents, and rocky shore are all extreme environments AND is able to describe at least two extreme conditions. For example, the visitor may say “Those are all harsh places for animals to live. It’s really cold at the poles and really hot in the desert.”

Objective 4: Visitors will understand that the Earth’s poles, desert, deep sea vents, and rocky shore are of interest to scientists because these are prime places for adaptation to occur. [Variable: Understanding of the value of studying extreme environments , Variation: Depth of response; Q6]	
Score	Criteria for Objective 4
Below beginning (1)	The visitor does not know why the Earth’s poles, desert, deep sea vents, and rocky shore are of interest to scientists.
Beginning (2)	The visitor grasps that the Earth’s poles, desert, deep sea vents, and rocky shore is of interest to scientists but is unable to articulate why or names a reason that is irrelevant or tangential.
Developing (3)	The visitor grasps that the Earth’s poles, desert, deep sea vents, and rocky shore are of interest to scientist as extreme environments but does not mention adaptation.
Accomplished (4)	The visitor grasps that the Earth’s poles, desert, deep sea vents, and rocky shore are of interest to scientist as extreme environments AND mentions adaptation.

GOALS BY EXHIBITION AREA

EARTH'S POLES

Objective 5: Visitors will be able to describe the unique conditions that animals and plants face at the poles. [Variable: Knowledge of adaptation at the Earth's poles, Variation: Number of examples; Q6]	
Score	Criteria for Objective 5
Below beginning (1)	The visitor is unable to name any unique conditions found at the poles.
Beginning (2)	The visitor names one unique condition found at the poles (e.g., extreme cold temperatures).
Developing (3)	The visitor names two unique conditions found at the poles (e.g., extreme cold temperatures, windy).
Accomplished (4)	The visitor names three or more unique conditions found at the poles (e.g., extreme cold temperatures, windy, dry, sunlight reflection).

Objective 6: Visitors will be able to provide examples of adaptations to the conditions at the poles. [Variable: Knowledge of adaptation at the Earth's poles, Variation: Number of examples; Q6]	
Score	Criteria for Objective 6
Below beginning (1)	The visitor is unable to name any adaptations to the conditions at the poles.
Beginning (2)	The visitor names one example of an adaptation found at the poles (e.g., thick fur).
Developing (3)	The visitor names two examples of adaptation found at the poles (e.g., thick fur, layers of blubber).
Accomplished (4)	The visitor names three or more adaptations found at the poles (e.g., thick fur, layers of blubber, short appendages, white fur).

Objective 7: Visitors will be able to name plant or animal species found at the poles. [Variable: Knowledge of adaptation at the Earth's poles, Variation: Number of examples; Q6]	
Score	Criteria for Objective 7
Below beginning (1)	The visitor is unable to name any plant or animals species that live at the poles.
Beginning (2)	The visitor names one plant or animal species that lives at the poles (e.g., polar bears).
Developing (3)	The visitor names two plant or animal species that lives at the poles (e.g., polar bears, seals).
Accomplished (4)	The visitor names three or more plant or animal species that lives at the poles (e.g., polar bears, seals, Empire penguins, lichens).

Objective 8: Visitors will be able to describe how scientists study changes in the polar environment. [Variable: Awareness of how scientists study the polar environment, Variation: Depth of response; Q6]	
Score	Criteria for Objective 8
Below beginning (1)	The visitor is unaware that scientists are studying the poles.
Beginning (2)	The visitor acknowledges that scientists are studying the poles but is unable to describe how.
Developing (3)	The visitor gives a generic explanation of how scientists are studying changes in the polar environment (e.g., scientists use computers to study the poles).
Accomplished (4)	The visitor gives a detailed explanation of how scientists are studying changes in the polar environment (e.g., analyzing tree rings and ice cores).

DESERT

Objective 9: Visitors will be able to describe the unique conditions that animals and plants face in the desert. [Variable: Knowledge of adaptation in the desert, Variation: Number of examples; Q6]	
Score	Criteria for Objective 9
Below beginning (1)	The visitor is unable to name any conditions found in the desert.
Beginning (2)	The visitor names one unique condition found in the desert (e.g., extreme temperatures)
Developing (3)	The visitor names two unique conditions found in the desert (e.g., extreme temperatures, dry).
Accomplished (4)	The visitor names three or more unique conditions found in the desert (e.g., extreme temperatures, dry, intense sun, flash floods)

Objective 10: Visitors will be able to provide examples of adaptations to the conditions in the desert. [Variable: Knowledge of adaptation in the desert, Variation: Number of examples; Q6]	
Score	Criteria for Objective 10
Below beginning (1)	The visitor is unable to name any adaptations to the conditions in the desert.
Beginning (2)	The visitor names one example of an adaptation found in the desert (e.g., water storage).
Developing (3)	The visitor names two adaptations found in the desert (e.g., water storage, waxy or scaly surfaces to minimize water loss).
Accomplished (4)	The visitor names three or more adaptations found in the desert (e.g., water storage, waxy or scaly surfaces to minimize water loss, physiological ways of minimize water loss, large ears for dissipating heat).

Objective 11: Visitors will be able to provide examples of plant or animal species found in the desert. [Variable: Knowledge of adaptation in the desert, Variation: Number of examples; Q6]	
Score	Criteria for Objective 11
Below beginning (1)	The visitor is unable to name any plant or animals species that live in the desert.
Beginning (2)	The visitor names one plant or animal species that lives in the desert (e.g., tortoise).
Developing (3)	The visitor names two plant or animal species that lives in the desert (e.g., tortoise, cactus).
Accomplished (4)	The visitor names three or more plant or animal species that lives in the desert (e.g., tortoise, chuckwalla, scorpion, cactus, packrat, bats).

DEEP SEA VENTS

Objective 12: Visitors will be able to describe the unique conditions that animals and plants face in the deep sea vents [Variable: Knowledge of adaptation in the deep sea vents, Variation: Number of examples; Q6]	
Score	Criteria for Objective 12
Below beginning (1)	The visitor is unable to name any conditions found in the deep sea vents.
Beginning (2)	The visitor names one unique condition found in the deep sea vents (e.g., extreme pressure).
Developing (3)	The visitor names two unique conditions found in the deep sea vents (e.g., extreme pressure, extreme temperatures).
Accomplished (4)	The visitor names three or more unique conditions found in the deep sea vents (e.g., extreme pressure, extreme temperatures, lack of sunlight, noxious chemicals).

Objective 13: Visitors will be able to provide examples of adaptations to the conditions in the deep sea vents. [Variable: Knowledge of adaptation in the deep sea vents, Variation: Number of examples; Q6]	
Score	Criteria for Objective 13
Below beginning (1)	The visitor is unable to name any adaptations to the conditions in the deep sea vents.
Beginning (2)	The visitor names one example of an adaptation found in the deep sea vents (e.g., blindness).
Developing (3)	The visitor names two adaptations found in the deep sea vents (e.g., blindness, bioluminescence).
Accomplished (4)	The visitor names three or more adaptations found in the deep sea vents (e.g., blindness, bioluminescence, chemosynthesis, gigantism).

Objective 14: Visitors will be able to provide examples animal species found in the deep sea vents. [Variable: Knowledge of adaptation in the deep sea vents, Variation: Number of examples; Q6]	
Score	Criteria for Objective 14
Below beginning (1)	The visitor is unable to name any animal species that live in the deep sea vents.
Beginning (2)	The visitor names one animal species that lives in the deep sea vents (e.g., giant tubeworms).
Developing (3)	The visitor names two animal species that lives in the deep sea vents (e.g., giant tubeworms, shrimp).
Accomplished (4)	The visitor names three or more animal species that lives in the deep sea vents (e.g., giant tubeworms, shrimp, mussels, bacteria, fish).

Objective 15: Visitors will be able to describe how scientists study the deep sea vents. [Variable: Awareness of how scientists study the deep sea vents, Variation: Depth of response; Q6]	
Score	Criteria for Objective 15
Below beginning (1)	The visitor is unaware that scientists are studying the deep sea vents.
Beginning (2)	The visitor acknowledges that scientists are studying the deep sea vents but is unable to describe how.
Developing (3)	The visitor gives a generic explanation of how scientists are studying the deep sea vents (e.g., scientists use computers to study the vents).
Accomplished (4)	The visitor gives a detailed explanation of how scientists are studying the deep sea vents (e.g., using remotely-operated vehicles—ROVs—and manned submersibles).

ROCKY SHORE

Objective 16: Visitors will be able to describe unique conditions that animals and plants face along the rocky shore. [Variable: Knowledge of adaptation along the rocky shore, Variation: Number of examples; Q6]	
Score	Criteria for Objective 16
Below beginning (1)	The visitor is unable to name any conditions found along the rocky shore.
Beginning (2)	The visitor names one unique condition found along the rocky shore (e.g., variable tides).
Developing (3)	The visitor names two unique conditions found along the rocky shore (e.g., variable tides, forces generated by waves).
Accomplished (4)	The visitor names three or more unique conditions found along the rocky shore (e.g., variable tides, forces generated by waves, lack of space).

Objective 17: Visitors will be able to provide examples of adaptations to the conditions along the rocky shore. [Variable: Knowledge of adaptation along the rocky shore, Variation: Number of examples; Q6]	
Score	Criteria for Objective 17
Below beginning (1)	The visitor is unable to name any adaptations to the conditions along the rocky shore.
Beginning (2)	The visitor names one example of an adaptation found along the rocky shore (e.g., hard shells).
Developing (3)	The visitor names two adaptations found in the rocky shore (e.g., hard shells, holdfasts).
Accomplished (4)	The visitor names three or more adaptations found in the rocky shore (e.g., hard shells, holdfasts, growing quickly to outcompete others for space).

Objective 18: Visitors will be able to provide examples of plant or animal species found along the rocky shore. [Variable: Knowledge of adaptation along the rocky shore, Variation: Number of examples; Q6]	
Score	Criteria for Objective 18
Below beginning (1)	The visitor is unable to name any animal species that live along the rocky shore.
Beginning (2)	The visitor names one animal species that lives along the rocky shore (e.g., barnacle).
Developing (3)	The visitor names two animal species that lives along the rocky shore (e.g., barnacle, mussels).
Accomplished (4)	The visitor names three or more animal species that lives along the rocky shore (e.g., barnacle, mussels, seaweeds, algae, sea stars).

Only Post-experience Interview:

Q8 – For each environment, interviewee’s use of each exhibit type data will be entered as “yes” or “no.”

Q9 – Interviewee’s use of the *Ecosystems* film will be entered as “yes” or “no.”
For those who viewed the film, their description of its main message will be coded “introduces ecology” or “other.”

APPENDIX C: LIST OF STATISTICS

LIST OF STATISTICS RUN ON DEMOGRAPHIC AND VISIT CHARACTERISTICS

Frequency Distributions:

Pre-visit or Post-visit interview
 Data collection date and day of week
 Gender
 Age (6 groups: 18-24, 25-34, 35-44, 45-54, 55-64, 65+)
 Language
 Ethnicity
 Age of accompanying children (6 groups: <1, 2-4, 5-7, 8-10, 11-13, 14-18)
 First/repeat visit to California Science Center
 Frequency of other California Science Center visits (repeat visitors only)
 Use of exhibits, displays, and film (post-visit only)
 Increased interest in science (post-visit only)
 Increased general knowledge of ecology (post-visit only)

SUMMARY STATISTICS: (MEAN, MEDIAN, STANDARD DEVIATION)

Age in years of respondent
 Age in years of accompanying children

LIST OF STATISTICS RUN ON RUBRIC-SCORED INTERVIEW DATA

Chi-square Statistic

Gender	X	Pre-visit vs. post-visit Sample
Ages (3 groups: 18-34, 35-54, 55+)		
Language		
Ethnicity		
First vs. repeat visit to California Science Center		
Frequencies of rubric levels for Objective One		
Frequencies of rubric levels for Objective Two		Pre-visit vs. post-visit sample
Frequencies of rubric levels for Objective Three	X	Age group (3 groups: 18-34, 35-54, 55+)
Frequencies of rubric levels for Objective Four		Gender
Frequencies of rubric levels for Objective Five		First vs. repeat visit
Frequencies of rubric levels for Objective Six		Viewed film (Post-visit only)
Frequencies of rubric levels for Objective Seven		
Frequencies of rubric levels for Objective Eight		
Frequencies of rubric levels for Objective Nine		
Frequencies of rubric levels for Objective Ten		
Frequencies of rubric levels for Objective Eleven		
Frequencies of rubric levels for Objective Twelve		
Frequencies of rubric levels for Objective Thirteen		
Frequencies of rubric levels for Objective Fourteen		
Frequencies of rubric levels for Objective Fifteen		
Frequencies of rubric levels for Objective Sixteen		
Frequencies of rubric levels for Objective Seventeen		
Frequencies of rubric levels for Objective Eighteen		

ANOVA

Total score for overarching objectives (objectives 1-4)	X	Pre-visit vs. post-visit sample
Total score for poles objectives (objectives 5-8)		Age group
Total score for desert objectives (objectives 9-11)		Gender
Total score for deep sea vents (objectives 12-15)		First vs. repeat visit
Total score for rocky shore (objectives 16-18)		Viewed film (Post-visit only)

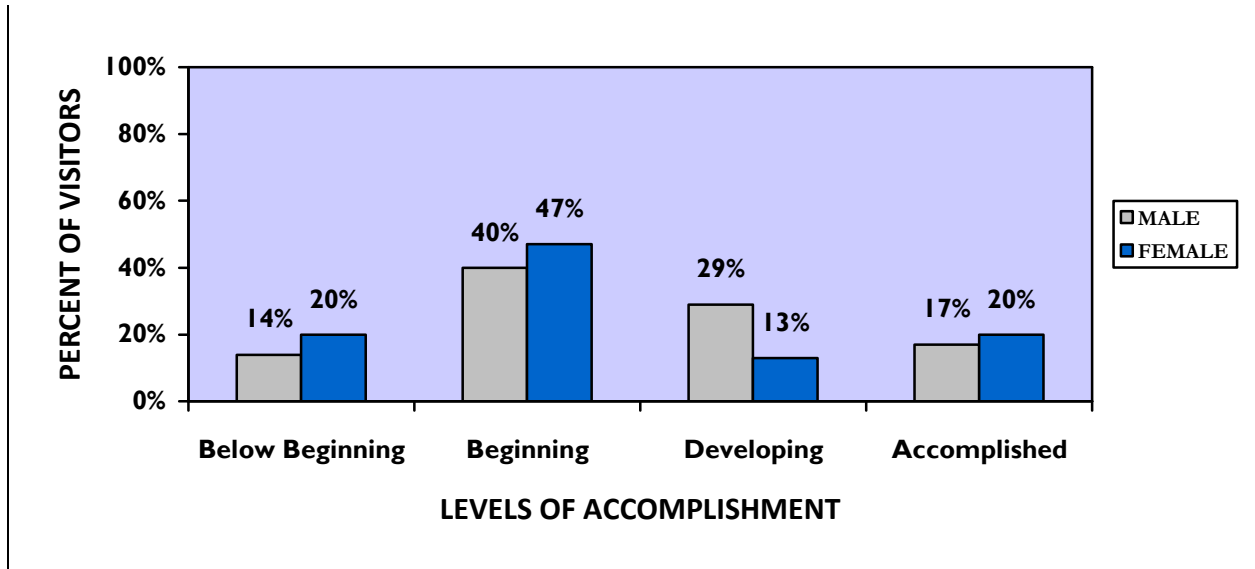
APPENDIX D: GENDER DIFFERENCES

OBJECTIVE TWO: UNDERSTANDING OF ADAPTATION

Objective 2: Visitors will be able to define “adaptation,” including the relationship of adaptations and environmental conditions.

FIGURE 19

OBJECTIVE TWO SCORE – UNDERSTANDING OF ADAPTATION: PERCENTAGES



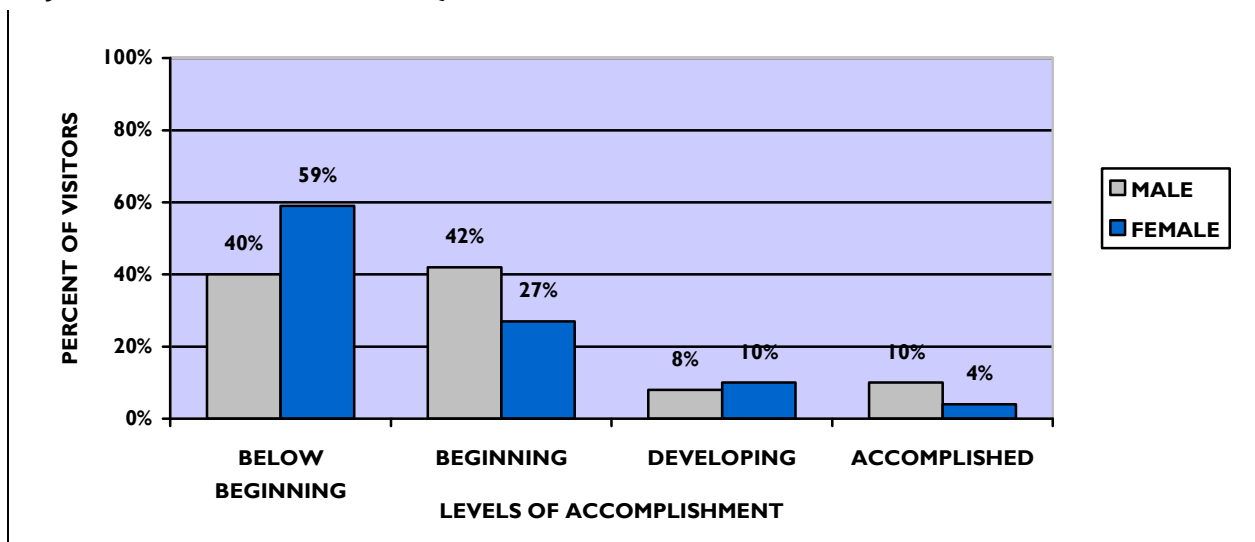
$X^2=9.215$; $df = 3$; $p = .027$

OBJECTIVE TWELVE: UNIQUE CONDITIONS IN DEEP SEA VENTS

Objective 12: Visitors will be able to describe the unique conditions that animals and plants face in the deep sea vents.

FIGURE 20

OBJECTIVE TWELVE SCORE – UNIQUE CONDITIONS IN DEEP SEA VENTS: PERCENTAGES



$X^2=8.813$; $df = 3$; $p = .032$

OVERALL PERFORMANCE ON OVERARCHING OBJECTIVES BY GENDER

TABLE 19

OVERALL PERFORMANCE ON THE OVERARCHING OBJECTIVES: SUMMARY STATISTICS

OVERALL PERFORMANCE ON THE OVERARCHING OBJECTIVES (POSSIBLE RANGE 4 - 16)	GENDER		
	MALE (n = 77)	FEMALE (n = 126)	TOTAL (n = 203)
Mean	9.21	8.57	8.81
±	1.99	1.94	1.98
Median	9.00	8.00	9.00
Range	4 - 14	4 - 16	4 - 16

F=5.042; p=.026

OVERALL PERFORMANCE ON DEEP SEA VENTS OBJECTIVES BY GENDER

TABLE 20

OVERALL PERFORMANCE ON THE DEEP SEA VENTS OBJECTIVES: SUMMARY STATISTICS

OVERALL PERFORMANCE ON THE OVERARCHING OBJECTIVES (POSSIBLE RANGE 4 - 16)	GENDER		
	MALE (n = 77)	FEMALE (n = 103)	TOTAL (n = 174)
Mean	7.46	6.89	7.13
±	1.98	1.72	1.85
Median	7.00	7.00	7.00
Range	4 - 14	4 - 12	4 - 14

F=4.090; p=.045