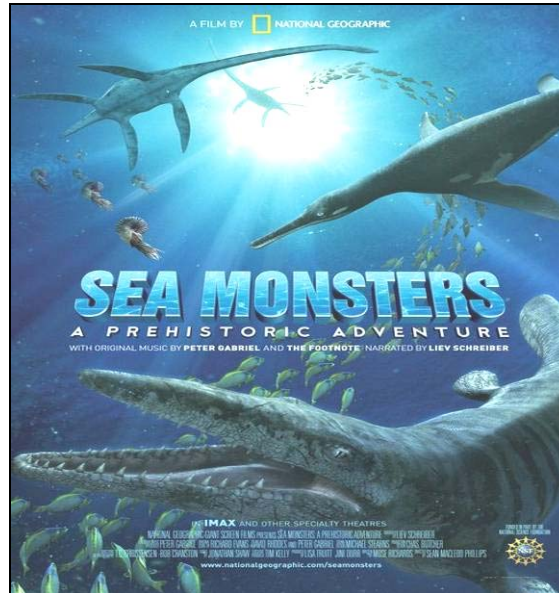


Sea Monsters: A Prehistoric Adventure Summative Evaluation Report



Prepared for
National Geographic Cinema Ventures

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¹ All Aquarium images are the copyrighted property of the Monterey Bay Aquarium Foundation and are provided for one-time use in conjunction with the evaluation. Images may not be archived or transferred to a third party. Credit for individual images goes to the Monterey Bay Aquarium Foundation and the photographer named in the caption information.

Introduction

Sea Monsters: A Prehistoric Adventure is a 40-minute giant screen film project developed by National Geographic Cinema Ventures. Designed for a general audience, the film is designed to stimulate the public's interest in and understanding of the exotic and little-known marine reptiles of the Late Cretaceous period through an animated story about a Dolichorhynchops ('Dolly') "as she travels through the most dangerous oceans in history."² The film draws on high-resolution 3D graphics and an investigative storyline informed by scientific data from the fossil record. This approach is further highlighted on the website of the theater where the film's summative evaluation was conducted:

Sea Monsters: A Prehistoric Adventure: Accompany a team of paleontologists as they work to solve an 82-million-year-old mystery . . . Stunning photo-realistic computer-generated animation transports audiences back to the Late Cretaceous Era, when a great inland ocean divided North America in two. The film will follow a curious and adventurous Dolichorhynchops (familiarily known as a 'Dolly') as she travels through life's stages, experiencing the world from her spot near the bottom of the food chain. Along the way, she'll encounter long-necked plesiosaurs, giant turtles, enormous fish, ferocious flippered crocs, fierce sharks, and the most dangerous sea monsters of all, the mosasaurs.

Sea Monsters weaves together a series of palaeontological digs from around the globe in a compelling story about scientists working as prehistoric detectives to answer questions about this ancient and mysterious ocean world. Viewers accompany modern and historical paleontologists to remote locations as they excavate the remains of some of the most awe-inspiring creatures of all time, and together they'll discover fossils which shed light on exactly what happened to the film's incredible cast of characters.

The film combines the powerful and experiential nature of the giant screen with strong science and educational materials, highlighting the complexity and fragility of life in Earth's oceans. Merging ultra-high-resolution 3D graphics with National Geographic's trademark authenticity, compelling imagery and powerful storytelling, *Sea Monsters* is an unforgettable prehistoric adventure.

<http://www.bellacinema.com/featured.html>

Knight-Williams Research Communications (Knight-Williams), an independent evaluation firm specializing in the development and evaluation of science education media, conducted the summative evaluation of *Sea Monsters* within the first 9 months of the film's release. The evaluation focused on the extent to which the film and ancillary educational materials achieved the goals described in the project's grant to the National Science Foundation (NSF) Informal Science Education (ISE) program, which provided funding for both the film project and the independent evaluation. Although the giant screen film is the core of the *Sea Monsters* project, the project also includes an in-depth website <http://www.nationalgeographic.com/seamonsters/index.html>, activity guide, and companion book designed to enrich and extend the film's viewing experience.

² Language relating to the projects' goals was adapted from the *Sea Monsters* proposal to the National Science Foundation.

Following from the project's goals, the evaluation addresses several broad questions for an adult and youth audience that viewed *Sea Monsters* of their own accord at an IMAX theater site in June 2008 (described under Theater Context on page 4):

- To what extent did the film appeal to the viewers?
- What did viewers like and dislike about the film?
- How did viewers react to the film's investigative storytelling and use of 3D?
- How did viewers respond to the film's clarity of presentation and the amount of information and science presented?
- What were the most interesting things viewers felt they learned from the film?
- What new information, ideas, and concepts did they learn about the Late Cretaceous period, the marine animals of this period, and research that paleontologists have conducted to learn about these animals?
- To what extent did they feel they were likely to recommend the film to others and seek out information about the Late Cretaceous period?
- To what extent did they discuss, think about, or engage in any film-related activities subsequent to viewing?

To address the above set of questions, the evaluation was conducted in three phases, as follows:

Phase 1 – Pre-post questionnaires: The first phase of the evaluation examined the appeal and immediate educational impact of the film as assessed by adult and youth performance on a post-viewing questionnaire completed within minutes of seeing the film, as compared to the performance of a separate sample of viewers who completed the same set of content questions prior to seeing the film.

Phase 2 – Focus groups: Drawing from the same group of participants recruited for the Phase 1 post-viewing questionnaire, the evaluation team then conducted a total of 5 focus groups with adult and youth viewers following 5 separate showings of *Sea Monsters*. The group discussions allowed for a more in-depth exploration of viewers' reactions to the film's storyline, use of 3D, and depiction of Late Cretaceous marine animals.

Phase 3 – Follow-up interviews: Follow-up telephone interviews were conducted with a subset of adult viewers who completed questionnaires but did not participate in the focus groups. The interviews were conducted approximately 2-2.5 weeks after viewers visited the theater. The interviews explored the longer term impact of the film and whether and how viewers or their families used the project's outreach components.

Additional details about each phase of evaluation are provided under Method, starting on page 8.

Theater Context

Phases 1 and 2 of the summative evaluation occurred at the Cannery Row IMAX Theater located in Monterey, California. The theater was opened on Cannery Row in 2008 as: "*a new state of the art IMAX 3D Theater to bring to 'The Row' the Ultimate Movie Experience to offer visitors and locals immersive film experiences on the giant screen for their enjoyment.*" <http://www.bellacinema.com/cannery.html>

Photographs of exterior and interior views of the theater are provided below for context.



Exterior view of theater (front entrance)
Courtesy of Onetake Productions



Pedestrian walkway in front of theater
Courtesy of Onetake Productions



Front doors leading into theater complex
Courtesy of Onetake Productions



Inside theater complex leading to downstairs theater entrance
Courtesy of Onetake Productions



Downstairs concession area leading into theater
Courtesy of Onetake Productions

The Cannery Row IMAX Theater was chosen from among a short list of theaters showing the film at the time of the evaluation for the following reasons. First, at the time the evaluation took place, the theater had the highest number of daily shows (4 per day), offering a higher potential participation rate for the evaluation.



Sign displayed at theater showing *Sea Monsters* schedule
Courtesy of Onetake Productions

Second the theater was showing the film in 3D, an integral aspect of the evaluation, as described in the NSF proposal.



Viewers watching *Sea Monsters* inside the theater
Courtesy of Cannery Row IMAX Theater
<http://www.bellacinema.com/index.html>

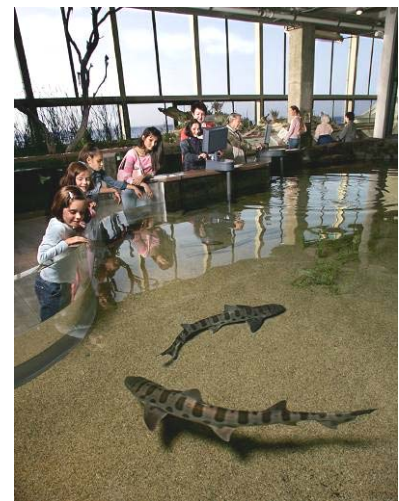


Third, the theater is located within a short walking distance from the Monterey Bay Aquarium, one of the world's largest aquariums, and in 2007 named the top kid-friendly aquarium among the "The 10 Best Aquariums for Kids" by Parents Magazine. Each year approximately 1.8 million people visit the aquarium, including over 80,000 students from throughout California.

http://www.montereybayaquarium.org/storage/pressroom/presskit/pdf/MBA_08_Basic_Kit.pdf



The majority of the family groups that participated in the evaluation reported that they made their trip to the IMAX Theater before or after visiting the Aquarium. Theater staff also confirmed this to be a common practice among their family visitors. This natural pairing of a commercial theater with a non-profit informal science education center focused on aquarium education and outreach seemed an appropriate fit for a summative evaluation funded by the ISE division of the National Science Foundation.



Photographs on this page courtesy of Monterey Bay Aquarium (individual image credits below)

Exterior views of the aquarium entrance on Cannery Row © Monterey Bay Aquarium/Rick Browne; Walk-through wave crash tunnel in the Rocky Shore gallery of Ocean's Edge © 2005 Monterey Bay Aquarium/Randy Wilder; Family learns about marine life through hands-on touch pool experiences © Monterey Bay Aquarium; Leopard sharks in a wetland pool in the Coastal Wetland to Sandy Shore exhibit in Ocean's Edge © Monterey Bay Aquarium/Randy Wilder.

Method

The evaluation focused on adult and youth who self-selected to visit the IMAX Theater and view *Sea Monsters* during the last week of June 2008. The evaluation team conducted both the Phase 1 and Phase 2 portions of the evaluation at the theater site during weekday and weekend showings of *Sea Monsters* to help ensure the evaluation recruited a balance of participants who visited the theater at different days and times. The Phase 3 telephone interviews were subsequently held 2-2.5 weeks later. The specific procedures used for each of the three evaluation phases are outlined below.

Phase 1: Pre-post questionnaire assessment of the film's overall appeal and learning value

The questionnaire portion of the evaluation was based on a separate-sample pre-test/post-test design and occurred at the theater site as follows:³

- i. Evaluators approached all eligible adult and family theater visitors about the evaluation opportunity as they stood in line to view the film.⁴ Approximately half of these visitors were asked to complete a 5-8 minute pre-viewing questionnaire before seeing the film, and half were asked to complete a 15-20 minute post-viewing questionnaire following the film.⁵ Parent/ guardian permission was obtained prior to youth's completing questionnaires. Evaluators directed participants to the instructions at the top of the questionnaire which asked them to complete all questions and to do so without the help of others. They were reminded that participation in the evaluation was voluntary, informed that their responses were confidential, and thanked for their feedback.
- ii. Visitors who completed a pre-viewing questionnaire served as a control group for the evaluation. These visitors (hereafter called "pre-viewers") typically completed the

³ A brief explanation of the rationale for choosing this quasi-experimental design for evaluating giant screen films in a theater setting design choice follows: First, when selecting among possible evaluation designs, it is important to ask: To what population do we want to generalize? Giant screen films such as *Sea Monsters* represent an informal science education and entertainment media currently featured in science centers and commercial theaters possessing giant screen format capacity. The population to which we want to generalize is self-selected visitors who choose to view such a film. Therefore, this evaluation focuses on visitors who choose to view *Sea Monsters* on their own accord (naturalistic viewers). Since it is essentially impossible to locate an equivalent control group of visitors from whom the film is withheld, the most appropriate control group is a sample of visitors who intend to view the film but have yet to do so. Administering a pretest and posttest to the same group of visitors may seem like an attractive alternative, but this is neither a) practical given the challenges of obtaining visitor cooperation, nor b) desirable as the pretest would sensitize visitors to the film's content, and hence affect their posttest performance. Typically, the shortcomings with the separate-sample pretest/posttest design involve its failure to control for history, maturation, mortality and their interaction. However, in the case of the giant screen film treatment, where the viewing audience is essentially stationary for close to forty minutes, group changes of this nature are unlikely. The separate-sample design controls for the main and interactive effects of testing and, is overall, an effective approach for evaluating giant screen films in a natural theater setting. This design has been cooperatively utilized in the past by Multimedia Research initially, ourselves, and Edumetrics in the interest of also creating a body of work that can be compared, as Barbara Flagg of Multimedia Research recently did in her review: Beyond entertainment: Educational impact of films and companion materials, *The Big Frame*, Spring 2005, pps. 51-66.

⁴ Individuals who weren't eligible included: unaccompanied children, adults accompanied by children below the age of 5, and individuals that were part of a tour or organized trip.

⁵ Completion time varied between 10-15 minutes depending on respondents' thoroughness. The evaluators over-sampled the number of viewers recruited to complete a post-viewing questionnaire to ensure a sufficient number of participants in the viewing group given the uncertain attendance rate of each show and the possibility of family groups having to opt out of the evaluation after viewing the film due to unforeseen factors that might arise (e.g., children in need of food, naps, or other caretaking, having to meet up with other members of a group).

questionnaire using a clipboard provided by the evaluators while standing in line, although some participants chose to complete the questionnaire sitting on chairs situated near the theater entrance. The pre-viewing questionnaire included demographic and background questions about visitors' age, gender, ethnicity/race, educational level, number of giant screen and 3D films seen, and included a short knowledge assessment of content covered in the film.

- iii. Visitors who agreed to complete a post-viewing questionnaire (hereafter called "viewers") were asked to remain in the theater to complete the questionnaire in their seats immediately following the film. The post version of the questionnaire included the same demographic, background and film content questions asked in the pre-viewing questionnaire, as well as questions that asked for viewers' reactions to the film with respect to appeal, entertainment value, clarity, information and science density, and learning value.
- iv. Upon completion of either survey, evaluation participants were given a *Sea Monsters*' poster.

The evaluation team identified the above set of evaluation themes and procedures by: reviewing the project proposal submitted to the National Science Foundation, consulting with the project team, reviewing the film script, and viewing the film in an IMAX theater setting and on DVD. Pilot testing of the evaluation instruments was conducted prior to the site evaluation with both adult and youth giant screen film viewers for readability, length, clarity, and level of difficulty.

Phase 2: Focus group discussions on the film's marine animals, 3D, and investigative storyline

A set of five separate focus groups was conducted with a subset of parent and youth viewers who saw the film and completed a post-viewing questionnaire. The focus groups were held at the theater site immediately following five separate shows. Recruitment for the sessions focused on parents and youth because the project team expected that *Sea Monsters* would be a particularly appealing and effective learning tool for families. The focus groups explored how these viewers reacted to the film's 3D, storyline, and prehistoric marine animals. Participants were provided an honorarium for their involvement in the 40-45 minute discussion session.

Phase 3: Follow-up telephone interview of *Sea Monsters*' extended impact

Adults who completed a post-viewing questionnaire were asked to participate in a 10-minute telephone interview 2 to 2.5 weeks after their theater visit. The interview and contact information request was made on a small piece of paper that was handed to participants along with the survey. Those interested, available, and willing to be contacted placed the request form in a box after completing the post-viewing questionnaire. Those who participated in the focus groups were ineligible to participate in the telephone interviews. The interviews explored: 1) Whether viewers discussed *Sea Monsters* with others in the weeks after seeing the film and, if so, what they discussed; 2) Whether and how seeing the film affected anything they thought about or did since viewing *Sea Monsters*; 3) Whether they found connections to the film in other media they had come across, such as print materials, television, film, and radio; 4) Whether they (or their family members) had gone to the *Sea Monsters* website after seeing the film and, if so, how they responded to the website; 5) What, if anything, they (or their family members did) with the *Sea Monsters* poster they were given at the theater; 5) And finally, whether they had any further thoughts or comments they wanted to share about their experience with the film. Participants who completed an interview were given an honorarium for their involvement in the 10-minute interview.

Data analysis and reporting

Statistical analyses were conducted on all quantitative data generated from the evaluation. To test for possible significant differences between the viewing and pre-viewing groups and for subgroup differences within the viewing group, analyses included Pearson chi-square and *t*-tests, as appropriate.^{6 7} Results with a *p*-value of less than .05 are reported as "significant." To help determine whether a significant difference was a difference of practical significance, effect sizes were also computed for the pre vs. post knowledge questions in Part 2 of the report using Cohen's *d* measure.⁸ As noted by Tahlheimer and Cook (2002), "*Whereas statistical tests of significance tell us the likelihood that experimental results differ from chance expectations, effect-size measurements tell us the relative magnitude of the experiment treatment. They tell us the size of the experimental effect.*"⁹ Effect sizes are important to report, particularly when sample sizes are sufficiently large, as it is possible to produce statistically significant differences between groups when the size of the effect is in fact very small. The effect size helps us to interpret whether the difference observed is a difference of practical significance, in other words, a difference that matters. To help with this interpretation, effect sizes are reported in the text where appropriate. Following Cohen's interpretation (Cohen, 1992), .2 is indicative of a small effect, .5 a medium effect, and .8 a large effect.¹⁰ At the same time, while Cohen's accepted values are used to help gauge the effect sizes computed for the pre vs. post knowledge questions in Part 2, these values should also be interpreted along with a comparison of the actual difference in raw scores in the context of the topic addressed.

The demographic and background variables used in the analyses included: age, gender, educational level, and number of giant screen and 3D films viewed. Given the relatively small number of participants in each of the separate racial/ethnic groups represented, results related to this demographic factor were not explored. Note, however, that the percentage of minorities participating in the *Sea Monsters* evaluation was somewhat higher than the percentage of minorities traditionally found among giant screen audiences (see Table 1 for further breakdown). According to a 2004 Taylor Nelson Sofres Intersearch research study sponsored by the Giant Screen Theater Association (GSTA) and conducted at 44 institutional theaters and 5 commercial theaters in 11 countries, less than one-tenth of the typical viewing market is minority.¹¹

Content analyses were performed on the qualitative data generated in the open-ended questions. All analyses were conducted by two independent coders. Each coder independently coded randomly ordered open-ended responses, blind to group assignment. Any differences that emerged in coding were resolved with the assistance of a third coder.

⁶ When examining subgroups with two categories (e.g., gender) using the two-independent-samples *t*-test, Levene's test was first used to determine whether the separate-variance *t*-test or pooled-variance *t*-test was appropriate for testing the means of the measured variables. If the test indicated the variances were significantly different, the separate-variance *t*-test was used. In addition, parametric tests were utilized for the appeal, clarity, and density of science and information rating questions after taking into account the sample size and use of a semantic differential response format, with a 7-point rating response scale and a clearly delineated mid-point in the instructions for each question.

⁷ Parametric tests were utilized for the appeal, clarity, and density of science and information rating questions after taking into account the sample size and use of a semantic differential response format, with a 7-point rating response scale and a clearly delineated mid-point in the instructions for each question.

⁸ *d* is defined as the difference between the 2 means divided by the pooled standard deviation for those means.

⁹ Thalheimer, W. and Cook, S. (2002). How to calculate effect sizes from published research: A simplified methodology, *Work-Learning Research*, p. 2.

¹⁰ Cohen, J. (1992). A Power Primer. *Psychological Bulletin*, 112 (1), pps. 155-159.

¹¹ Kennedy, M.K., (2004), GSTA's 2003 Worldwide Viewers and Nonviewer Research Programs: Key Results and how to use them, *The Big Frame*, Winter, pps. 40-59.

Sample information

A total of 259 adults and youth participated in the evaluation. From this total, 141 viewers and 118 pre-viewers completed questionnaires that subsequently formed the basis for this evaluation report. Table 1, below, summarizes the demographic and background information for the viewer and pre-viewer groups.

Table 1			
Sample demographic and background information¹²			
Demographic/ background factor	Categories	Pre-Viewers (n=118)	Viewers (n=141)
Gender	Female	51%	57%
	Male	49%	43%
Age Group	Age range	6-71	6-91
	18 or under	35%	32%
	19 or older	64%	68%
	Non-response	1%	0%
	Mean	32	34
Racial/Ethnic Group	African-American/Black	2%	3%
	Asian	6%	6%
	Native American Indian or Alaskan Native	0%	0%
	Native Hawaiian or Pacific Islander	2%	1%
	White	75%	78%
	Multiracial	5%	4%
	Non-response ¹³	10%	8%
	Hispanic Origin	23%	11%
	Non-response	8%	0%
Highest level of education	Less than high school	34%	31%
	Completed high school or equivalent	12%	10%
	Some college but no degree	19%	24%
	College graduate	20%	18%
	Some graduate school but no degree	3%	6%
	Completed graduate school	12%	11%
	Non-response	2%	0%
Number of giant screen films viewed	0	30%	16%
	1-2	27%	33%
	3-4	29%	31%
	5 or more	14%	20%
	Non-response	1%	0%
Number of 3D films viewed	0	21%	8%
	1-2	44%	30%
	3-4	17%	34%
	5 or more	18%	28%
	Non-response	1%	0%

¹² Some column percentages exceed 100% due to rounding.

¹³ Note that in the viewing group 6% of the 8% non-response statistic comprised individuals who checked that they were of Hispanic Origin but left the racial question blank. The same applies in the non-viewing group where 8% of the 10% comprised such individuals.

The viewer portion of the sample included:

- Somewhat more females (57%) than males (43%).
- A wide range of ages, spanning 6-91 years, with a mean age of 34.
- A racial distribution comprising 78% Whites and 21% minorities, including: 6% Asian, 3% African-American, 1% Native Hawaiian or Pacific Islander, and 12% mixed-race viewers. One-tenth of the participants (11%) were of Hispanic Origin.
- A combination of high school through graduate level educated respondents, including: 41% with a high school education or less (includes youth viewers), 42% with some college education or a college degree, and 17% with some graduate school education or a graduate degree.
- An equal balance of frequent vs. occasional viewers of giant screen films, including 49% who reported they had seen only 0-2 films prior to seeing *Sea Monsters* and 51% who reported they had seen 3 or more films (see Table 1 for further breakdown).
- A higher percentage of frequent 3D film viewers compared to less frequent viewers, with 64% reporting they had seen 3 or more and 38% reporting they had seen only 0-2 films prior to seeing *Sea Monsters* and (see Table 1 for further breakdown).

Group comparability

The evaluation gathered demographic and background information to determine whether the two independent samples (viewers vs. pre-viewers) should be evaluated as having come from the same population. Chi-square analyses indicated that the two groups did not differ significantly with respect to 5 of the 6 measured variables, including: gender, race/ethnicity, age group, education, or number of giant screen films viewed. Differences were found for the number of 3D films viewed, however, such that the viewing group included a significantly higher percentage of more frequent viewers (3+films) than did the pre-viewing group.¹⁴

Response rate

Response rate for the evaluation was calculated by dividing the number of questionnaires accepted for analysis by the number of visitors from whom the evaluators requested to complete a questionnaire, which in this case included all those who entered the theater and met the eligibility requirements described under Method. Evaluators were able to monitor the number of questionnaire requests at most shows as visitors typically streamed into the theater site over a period of 10-30 minutes prior to the show. However at two shows, large crowds of visitors arrived at the theater at roughly the same time, which didn't permit accurate tracking of the number of requests.

Pre-questionnaire response rate: The estimated request was 130 for the pre-questionnaire. The total number of collected pre-questionnaires was 120, resulting in an estimated initial response rate of 92% (120/130). Two questionnaires were not included in the analysis because the respondents did not answer any of the background information questions and didn't complete over one-third of the assessment questions, resulting in a final response rate of 90% (118/130).

Post-questionnaire response rate: The estimated request was 165 for the post-questionnaire. The total number of collected post-questionnaires was 142, resulting in an estimated initial response rate of 86% (142/165). One questionnaire was not included in the analysis because the respondent did not complete more than one-third of the questionnaire, including the assessment questions, resulting in a final response rate of 85% (141/165).

¹⁴ No. of 3D films viewed (chi-square=19.158, df=1, p=.000)

Where possible evaluators attempted to record reasons for not completing the questionnaire, which included: having to tend to children's needs, having to meet other members of a group, not having reading glasses, or being too tired to complete a questionnaire.

Where evaluators encountered blank questions, they asked respondents if they wished to complete those questions. In each case left blank the respondent indicated they didn't know or have a response. As there was minimal item non-response, the study did not explore additional methods of substituting missing values with estimates, either by multiple imputation methods or maximum likelihood procedures.

Findings

Phase 1: Questionnaire Findings



Viewers at end of *Sea Monsters* (credits rolling) awaiting survey instructions
Courtesy of Onetake Productions

This section includes findings on the overall appeal, learning value, and motivational impact of *Sea Monsters* as determined by viewers' responses and, in some cases, pre-viewers' responses on the questionnaires completed at the theater site immediately after viewing. Findings are presented in 3 parts as follows:

Part 1: Viewers' reactions to the appeal and entertainment value of Sea Monsters

Part 2: Viewers' learning experience from Sea Monsters

Part 3: Viewers' intentions of recommending Sea Monsters and seeking out information related to the film

Part 1: Viewers' reactions to the appeal and entertainment value of *Sea Monsters*

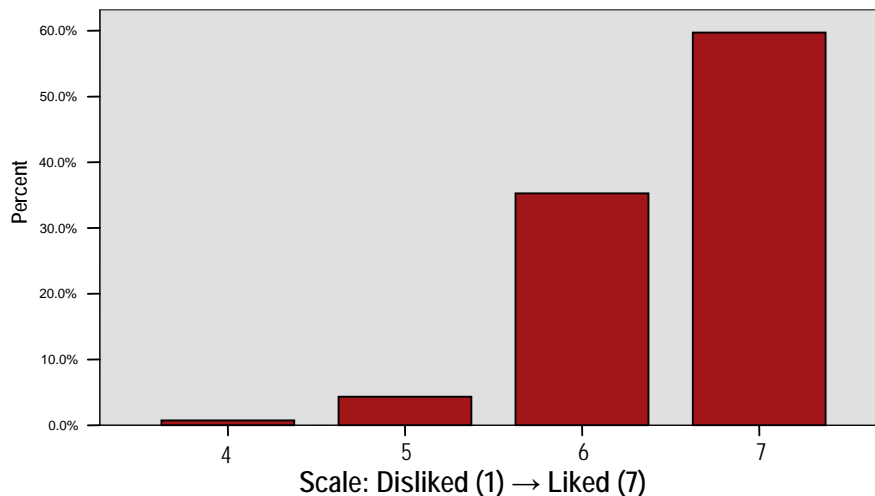
Viewers were asked to rate how much they liked the film, to describe what they liked and didn't like about it, and to rate the film's entertainment value with respect to storytelling and visual excitement. These findings are presented in sections 1.1 – 1.4 below.

1.1 How much did viewers like or dislike *Sea Monsters*?

When viewers were asked to rate how much they liked or disliked *Sea Monsters* on a scale of 1 (disliked) to 7 (liked), they typically reported liking the film. Table 2 shows the mean rating of 6.5 while the corresponding graph shows the percentage of viewers selecting each rating. No subgroup differences were found among viewers' ratings with respect to gender, age, education, or number of giant screen or 3D films previously seen.

Table 2							
Mean viewer ratings for the overall likeability of <i>Sea Monsters</i>							
(n=139, SD ¹⁵ =0.617)							
1	2	3	4	5	6	7	
Disliked						6.5	Liked

Frequency distribution for Table 2



¹⁵ SD refers to Standard Deviation

1.2 What did viewers like most about *Sea Monsters*?

When viewers were asked to describe what they liked about *Sea Monsters*, 96% identified at least one thing that appealed to them, with most viewers mentioning two or more things. Table 3, below, summarizes the categories of responses most frequently mentioned and the percentage of viewers offering each response.

Table 3 What did viewers like about <i>Sea Monsters</i> ?	
What viewers liked:	(n=141) ¹⁶
Use of 3D – <i>cool, realistic, high quality, felt like part of the action</i>	47%
Use of storyline – <i>engaging, cohesive, interesting way to present science</i>	35%
History of the Earth/evolution – <i>time-lapse communicates well</i>	29%
Focus on marine animals – <i>particularly variety shown</i>	27%
Generally informative/educational	27%
Visually pleasing – <i>colorful, compelling</i>	23%
Generally exciting/fun	18%
Sound/music – <i>nice backdrop</i>	12%
Portrayal of scientists' work	4%
No response	4%

Nearly half the viewers (47%) pointed to the film's use of 3D, characterizing it as *cool, realistic, high quality*, or observing that it made them feel like they were *part of the action*. One-third (35%) pointed to the film's storyline, describing it as *engaging, cohesive*, or as an *interesting way* to present science information. The next three top themes to emerge across the viewers' responses related to the film's educational value,¹⁷ with 29% liking the information presented on the Earth's history or evolution, particularly as communicated through the time-lapse sequence, and 27% each liking the variety of marine animals featured or the fact the film was generally informative and educational. Somewhat less frequently viewers' pointed to the film's aesthetic or

¹⁶ Note that the column sums in many tables will exceed the total (n) for the column if participants offered more than one category of response.

¹⁷ In a recent review of giant screen film learning (Flagg, 2000) Dr. Barbara Flagg observed that viewers typically report that a "wonderful learning experience" is among the top three things they like about giant screen films, with viewers particularly enjoying the opportunity to learn new and unfamiliar facts, concepts, methods, or processes and frequently complaining that giant screen films are too light on information. The review further observed that the typical audience of giant screen films in American museum theaters is highly educated, with approximately one-third having a post-graduate degree. In this evaluation of *Sea Monsters*, however, only 11% of the viewers had a post-graduate degree. Note also though that this evaluation was conducted in a commercial theater situated in close proximity to an aquarium, and that the recruiting priority was on youth and adults given that families were a key audience for the film. Flagg, B.N. (2000), Lessons learned from Giant Screen Films. Giant Screen Films and Lifelong Learning, *Complete Symposium Proceedings*, (August), Giant Screen Theater Association (GSTA).

entertainment value, with 23% enjoying that the film was visually pleasing and 18% liking that it was exciting or fun. Much smaller groups of viewers pointed to the film's sound or music as a nice back-drop (12%) or the portrayal of scientists' work (4%).

Examples of viewers' comments on all these themes are presented below.

On the 3D – cool, realistic, high quality, felt like part of the action (47%)

- *3D is very cool!*
- *3D really made you feel like you were in it; Interesting.*
- *3D It was cool. It looked real. It jumped out at you.*
- *I liked the quality of the 3D film.*
- *The 3D effect was the best. It seemed so real, not phony.*
- *Movement of the film came so close and made everything so big & close to us in the seats; I liked how they made the marine animals swim out at you... Overall, it was the best 3D movie EVER.*
- *I liked how the animals that came close stayed in place and you could study the animal.*
- *Close ups of the animals-seeing inner rows of teeth, for example. That they swim "very close to you so that you can see them from more than one angle. Comparisons regarding scale of creatures (today) with sea monsters helped give better perspective of size.*
- *Movement of the film came so close and made everything so big & close to us in the seats.*
- *The way the fish come right in front of your face.*

On the storyline – engaging, cohesive, interesting way to present science (35%)

- *Also that it wasn't fact after fact after fact, there was an actual story to it.*
- *The creativity of the writer to take what may have been fact and divert from a common conception of the simplest explanation, to one that better tells a story.*
- *The story about Dolly and her family.*
- *The beginning connected to the end (girl camping)...consistent theme, attempt at cohesive story.*
- *The story of predators/family/progeny.*
- *Great way to tell scientific history in a story.*
- *I liked how it was all one story and not just explaining 50 million.*
- *The storylines and how it all comes together.*
- *The "story" point of view added to the presentation of archaeological data.*
- *The way they followed one animal "Dolly." Helped keep the audience from losing patience. Switching back and forth from paleontologist digs to "Dolly" helped also.*
- *I appreciated the "family" story of the female "Dolly" with her 2 offspring...*
- *I enjoyed...how all aspects of the story connected to each other.*
- *The overlapping story lines (little girl finds bones, uncovering fossils, story about the Dolly).*

On the information presented on the history of Earth/evolution - with time lapse sequence communicating well (29%)

- *I liked how the movie explained about the creatures & the evolution of them. And how it explained the evolution of earth.*
- *The moving through various eras illustrating how the earth has changed.*
- *Well done, good historical sequence...how the earth changed in time and helped cause all the events.*
- *Timeline keeps going back and forth to keep you in focus of where you are in time . . . past and present linked together.*
- *Seeing how different and similar the prehistoric marine animals are from today's sea animals.*
- *The history and timelines....The shifting of the earth through time-mountain, volcanoes, glaciers, etc. The flashbacks and flash forwards.*
- *That just because of a shark's tooth embedded in "Dolly's" flipper, that a movie was made and taught my children and me about this period of time. Loved the "fast forward" filming of the earth's landscape changes/evolution.*

On the variety of marine animals shown (27%)

- *All the marine animals esp. when you feel surrounded by tons of them.*
- *The many prehistoric sea animals.*
- *Seeing how different and similar the prehistoric marine animals are from today's sea animals.*
- *The variety of prehistoric animals that were represented.*
- *I like the fact that they covered more than one species.*
- *Liked that it covered several species.*

On being generally informative/educational (27%)

- *Lots of facts, facts with out being boring.*
- *Science info . . .*
- *Educational . . .*
- *Information provided . . .*
- *And it had a lot of information . . .*
- *Very educational.*
- *Easy learning...*

On being generally visually pleasing – colorful, compelling (23%)

- *Visual effects . . .*
- *Great color, visuals . . .*
- *Very compelling graphic*
- *Visuals were amazing!*
- *Visuals, color, depth of visuals . . .*
- *Very colorful...*

On being generally exciting/fun (18%)

- *It was a lot of fun to watch.*
- *It was exciting.*
- *It was exciting, educational, and sweet at the end. My five year old loved it.*
- *I enjoyed the excitement of not knowing what's gonna happened next.*
- *Very interesting . . . exciting and fun to watch.*
- *How it was entertaining and educational for kids, so when I get back to school I can tell all my friends to see it and my teachers to see it and they'll be happy I did. It was great.*

On the sound/music - nice backdrop (12%)

- *3D, good sound.*
- *Accompanying music went well with action in films.*
- *Good music.*
- *Music, presentation, interesting, well done.*
- *Music background.*

On the portrayal of the scientists' work (4%)

- *. . . showing some paleontologist work.*
- *. . . the way the scientists' jobs are portrayed.*
- *. . . made me want to be an archeologist.*

1.3 What did viewers dislike about *Sea Monsters*?

When viewers were asked to describe what they disliked about *Sea Monsters*, the largest group (33%) countered that they liked “everything” about the film, while an additional 11% left the question blank.¹⁸ Table 4 summarizes the categories of responses most frequently mentioned among those who disliked some aspect of the film, and the percentage of viewers offering each response.

What viewers disliked:	(n=141)
Liked it all	33%
Too loud	17%
Too short	12%
Storytelling – <i>choppy, predictable, repetitive, dull, cheesy acting</i>	11%
Emotional – <i>Sad ending/scary parts</i>	6%
Too much focus on Dollys and not other creatures	6%
Not enough science/too much story	5%
Evolution and age of Earth presented as fact not theory	4%
Time-lapse sequence – <i>too fast paced/dizzying</i>	4%
Other	5%
No response	11%

The largest group of viewers (17%) said they felt the film was *too loud*, followed by two smaller groups who either felt the film was *too short* (12%) or the storytelling was *choppy, predictable, repetitive, lacking action or excitement*, or had *cheesy acting* (11%). Five additional issues were mentioned by 6% or less of the viewers, including those who: did not like the film’s sad ending or scary parts (6%), felt there was too much focus on Dollys and not other creatures (6%), wanted more science and less story (5%),¹⁹ took issue with the evolution/age of Earth information presented as fact instead of theory (4%), and/or felt the time-lapse sequence was too *fast paced* or *dizzying* (4%).

Examples of viewers’ comments on all these themes are presented on the next page.

¹⁸ Note that all of the viewers answered the two open-ended questions about what they liked about and learned from the film.

¹⁹ Note that the percentage of viewers citing a preference for more science in this summative evaluation conducted in 2008 (5%) was considerably smaller than was found for the *Forces of Nature* evaluation conducted in 2004 (22%), although the *Forces of Nature* evaluation was conducted with adults only and in a museum-based theater setting (the Reuben F. Fleet Science Center in San Diego).

On the film being too loud (17%)

- *Nothing but sound too loud for me but I know others liked it.*
- *It was really loud.*
- *Loud music and commentary.*

On the film being too short (12%)

- *Too short for \$.*
- *Too short.*
- *Wished it was longer – left me wanting even more.*
- *Short. Could be longer.*

On the storytelling being *choppy, predictable, repetitive, dull, cheesy acting* (11%)

- *I didn't like how it would stop in the middle of a very climatic part for the finding of the fossils.*
- *Fossil stories were pretty dull.*
- *I didn't like the plot too much . . . A little too educational instead of exciting.*
- *I think it could have had a little more action between monsters.*
- *Storytelling – boring.*
- *Lots of characters and stories.*
- *Predictable.*
- *Story was feeble. Portions were repetitive, music boring.*
- *Acting pretty cheesy.*
- *Element of surprise was very few like creature staring you at your face or coming at you.*

On the film having a sad ending or scary parts (6%)

- *When the mother and brother died it was very sad.*
- *Some part, like when the creatures died was sad, that's it.*
- *It was kind of scary.*

On the film having too much focus on Dollys and not other creatures (6%)

- *Would've been nice if it covered other forms of life in the sea such as jellyfish, plankton, etc.*
- *Depicted minimal types of marine animals.*
- *The main character was a boring creature.*
- *A little too much just on the Dolly. Would have liked to see other creatures.*
- *Could have had a wider range of time span and types of creatures (monsters).*
- *The only thing that I didn't like is that there wasn't enough info on a couple of dinos.*
- *They could have shown more big creatures. They should have included whales.*
- *Length, diversity of creatures.*

On the film lacking science/having too much story emphasis (5%)

- *Too much story not enough science based information.*
- *The story was presented as fact, yet due to its very nature much of it makes me speculate.*
- *Nothing really, could use more science. But overall great view on ancient life.*
- *I didn't like that the film was represented as educational, or documentary. The elements of facts were loosely tied to a fictional story.*

On the film presenting evolution/age of Earth information as fact not theory (4%)

- *I believe in dinosaurs, but I do not believe they are millions of years old. Holy Bible= Book of Job Chapter 40 Bohemath, and 41 Leviathan.*
- *The assumption of an old earth. Creation science has as much evidence to prove a young earth. All creatures' fossils worldwide can be explained by the worldwide universal flood recorded in genesis (the Bible). Current research is showing that a much younger earth is plausible, with creatures and man co-existing.*
- *The emphasis on the age of the earth, as fact not theory with regards to when living creatures existed.*

On the time-lapse sequence being too fast-paced/dizzying (4%).

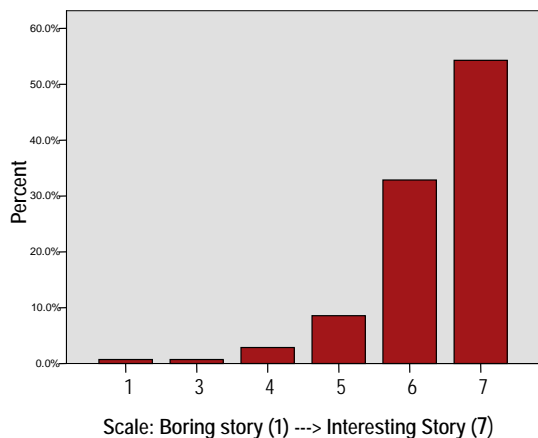
- You should watch about the speedy and flashing film-could "set off" seizures, I think.
- The ways the seasons changed so fast.
- Fast paced changing of the scenery.
- When the film moved quickly through ages, too fast makes you dizzy.

1.4 How interesting did viewers find the *Sea Monsters'* story and how exciting was it for them visually?

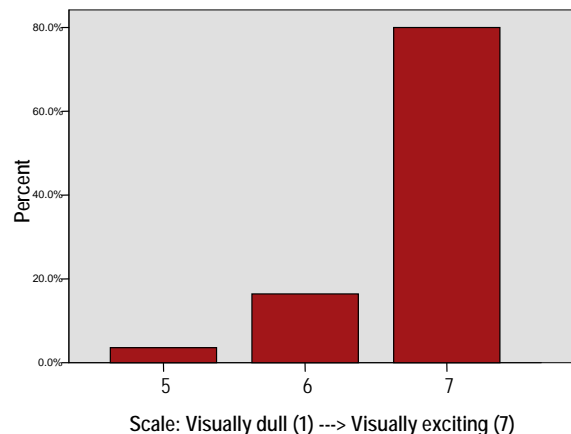
Using scales of 1 to 7, viewers were asked to rate the extent to which they found the story boring or interesting and the film visually dull or exciting. The mean ratings in each case are shown in Table 5 below. Viewers generally agreed that *Sea Monsters* offered an interesting story (mean, 6.3) and they were even more enthusiastic about the film's level of visual excitement (mean, 6.8).

Table 5 Mean viewer ratings for story interest and visual excitement of <i>Sea Monsters</i> (n=140, SD=0.935, 0.503)							
	1	2	3	4	5	6	7
Boring story						6.3	Interesting story
Visually dull						6.8	Visually exciting

Frequency distribution for Table 5 "story" rating



Frequency distribution for Table 5 "visual" rating



No subgroup differences were found among viewers' ratings with respect to gender, age, education, or number of giant screen or 3D films previously seen.

Part 2: Viewers' learning from *Sea Monsters*

The film's learning value was evaluated with a combination of open-ended and forced-choice self-report and objective content-based assessments. First, viewers rated the film for clarity, amount of information, amount of science, and how much they estimated they learned using scales from 1-7. Second, viewers described the most interesting things they learned from the film. Third, to assess knowledge gains relating to the Late Cretaceous period and marine animals, both viewers and pre-viewers completed a "quiz" type assessment that included a total of 28 true/false, multiple choice, and open ended questions. Finally, both viewers and pre-viewers were asked to estimate their own knowledge about "the age of the sea monsters" on a scale of 1 to 7 as a measure of self-reported knowledge about the film's overall topic prior to and after the film.

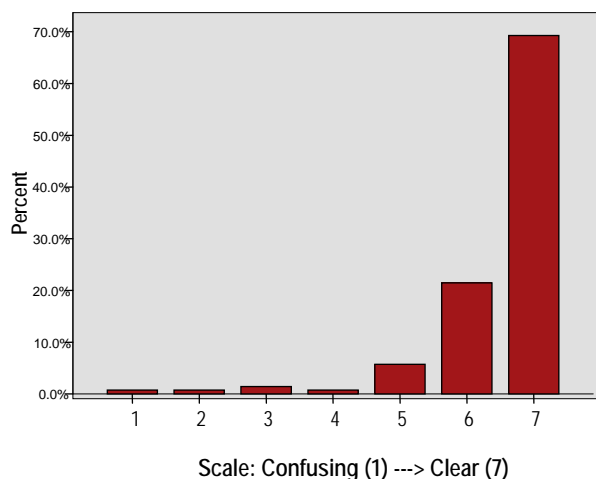
The results from the above assessments are reviewed in sections 2.1 – 2.6.

2.1 How clear or confusing did viewers find *Sea Monsters*?

When viewers were asked to rate how clear or confusing they found the film using a scale of 1 (confusing) to 7 (clear), they typically reported that the film was clear. Table 6 shows the mean rating of 6.5 while the corresponding graph shows the percentage of viewers selecting each rating. No subgroup differences were found with respect to gender, age, education, or number of giant screen or 3D films previously seen.

Table 6 Mean viewer rating for the clarity of <i>Sea Monsters</i> (n=140, SD=0.971)							
	1	2	3	4	5	6	7
Confusing						6.5	Clear

Frequency distribution for Table 6 "clarity" rating



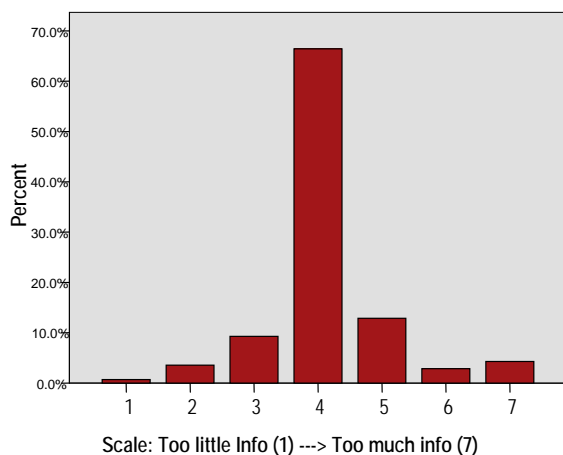
2.2 How did viewers react to the amount of information and science presented in *Sea Monsters*?

Viewers rated *Sea Monsters* for the amount of information and science provided on a scale of 1 (too little) to 7 (too much), with 4 being just right. Table 7 presents the mean ratings in each case while the corresponding graphs show the percentage of viewers selecting each rating.

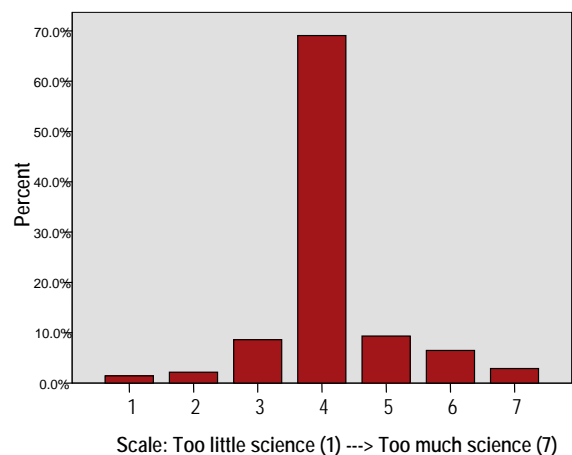
Table 7
Mean viewer ratings for the amount of information and science in *Sea Monsters*
 (n=140,139; SD=0.958, 0.949)

	1	2	3	4	5	6	7
Too little information				4.0			Too much information
Too little science				4.0			Too much science

Frequency distribution for Table 7 "information" rating



Frequency distribution for Table 7 "science" rating



The evaluation found that:

- Viewers generally felt the amount of information presented in the film was about right (mean, 4.0). One subgroup difference was found for gender, as females rated the amount of information significantly higher than did males, who generally felt the amount of information was about right (means, 4.3 vs. 3.9).²⁰
- Viewers generally felt the amount of science was also about right (mean, 4.0). Here again one subgroup difference was found, but this time for education. Viewers with a lower level of education (high school or less) rated the amount of science significantly higher than did those with a higher level of education (some college or beyond), who generally felt the amount of science was about right (means, 4.4 vs. 3.9).²¹

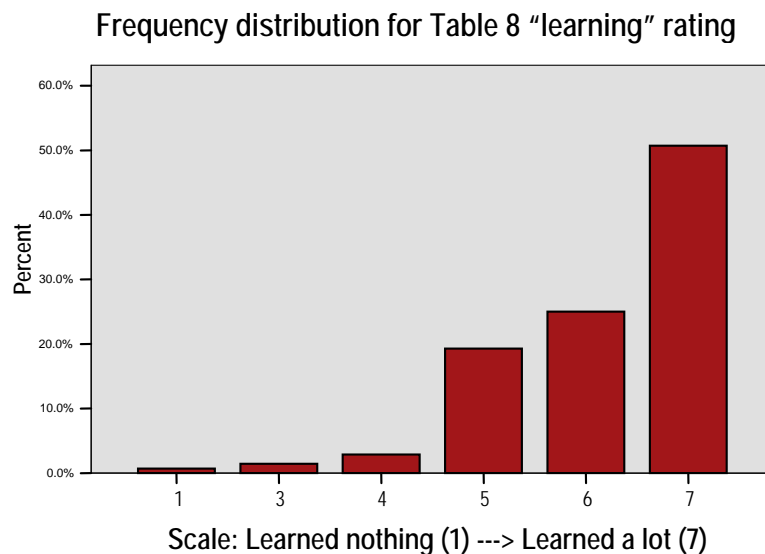
²⁰ ($t=2.281$, $df=138$, $p<.02$)

²¹ ($t=3.030$, $df=137$, $p<.003$)

2.3 How much did viewers estimate they learned from *Sea Monsters*?

When viewers were asked to estimate how much they learned from *Sea Monsters* on a scale of 1 (learned nothing) to 7 (learned a lot), they typically reported learning a considerable amount. Table 8 presents the mean rating of 6.2 while the corresponding graph shows the percentage of viewers selecting each rating.

Table 8						
Mean viewer rating for amount learned from <i>Sea Monsters</i> (n=140, SD=1.048)						
1	2	3	4	5	6	7
Learned nothing					6.2	Learned a lot



Two subgroup differences were found for this question as females estimated they learned significantly more from the film than did males (means, 6.4 vs. 5.9),²² and less frequent or first time viewers of 3D films estimated they learned significantly more than did more frequent viewers (means, 6.5 vs. 6.0).²³

²² ($t=2.968$, $df=138$, $p<.004$)

²³ ($t=2.862$, $df=138$, $p<.005$)

2.4 What were the most interesting things viewers learned from *Sea Monsters*?

When asked to describe the most interesting things they learned from watching *Sea Monsters*, 96% of the viewers identified one or more new things of interest. Table 9, below, summarizes the categories of responses most frequently mentioned and the percentage of viewers offering each response.

Table 9 What were the most interesting things viewers felt they learned from <i>Sea Monsters</i> ?	
Viewers were most interested to learn about:	(n=141)
The diversity of Late Cretaceous marine animals	26%
How Late Cretaceous marine animals lived:	22%
<i>Marine animals generally - how and where they survived, ate, bred</i>	12%
<i>Dolys - how and where they lived, migrated, bred</i>	10%
Fossil discoveries and research – <i>the stories they can tell</i>	22%
How Earth has changed over time – <i>geological/animal evolution</i>	13%
The large size of Late Cretaceous marine animals	6%
How Late Cretaceous marine animals resemble animals today	4%
Other	4%
Nothing stood out or was new	4%

Viewers were most interested to learn about: the diversity of the Late Cretaceous marine animals (26%), how these animals survived, ate, and bred (22%), and/or the kinds of information that can be uncovered from fossil discoveries and research (22%). A smaller group of viewers (13%) enjoyed learning about how the Earth has changed over time, while a few small groups pointed to information they learned about the large size of the Late Cretaceous marine animals (6%), how they resemble animals today (4%), other themes (4%), or indicated that nothing stood out or was new for them (4%).

Examples of viewers' comments on these themes are presented below:

On the diversity of marine animals (26%)

- *The many different marine animals that I didn't know existed.*
- *Diversity of marine animals.*
- *How many ancient marine animals there were.*
- *I hadn't heard of any of these animals so being exposed to all of them was very interesting.*
- *I learned about more kinds of sea monsters, all different from each other.*
- *The variety and diversity of prehistoric sea life.*

On how Late Cretaceous marine animals lived – generally and Dollys in particular (22%)

- *Existence of such marine animals. How they survived. Where some of the sea monsters breed.*
- *I thought it was interesting that they all ate different animals and that it was in 3D and IMAX.*
- *Ancient creature, their lives what they ate, where they were raised.*
- *That virtually all the sea monsters were prey for least one other predator.*
- *Interesting to know how animals live underwater; That there was a reptile ruler of the sea when it has been made to believe that a shark has always been in control of the seas.*
- *About the Dolly's and how they lived.*
- *It was interesting to learn that the Dolly returns to its same place of birth*
- *The migration of Dollys.*
- *I learned . . . that the "Dolly" was at the bottom of the food chain.*
- *Survival of the fittest. If you have a will, you will find a way (Dolly). No body escapes death, whether you are small or big.*

On fossil discoveries and research – the stories they can tell (22%)

- *Fossil finding around the world can tell many stories and we can find out a lot from fossils.*
- *How discovered, the various animals and traits, sizes, etc.*
- *How fossils can tell a story.*
- *How they can find other animals inside the stomach of the fossils.*
- *I enjoyed the fact that fossils were used as the base for the creatures used in the movie. Now days creatures are made up on a computer.*
- *The way that the shape, size, and general appearance of these reptiles can be discovered from their fossils.*

On how the Earth has changed over time – geological and animal evolution (13%)

- *How these animals were discovered around the globe. The prehistory that showed how small the land masses were and how huge the ocean was then. That our world is always evolving/changing.*
- *How long our planet has been evolving. Kansas was underwater at one time. That they are finding fossils there.*
- *What the planet used to look like; that the inner sea was only a few hundred feet deep.*
- *The different period's earth has gone through.*
- *Different types of historic creatures not here today. How the earth changed so much, middle V.A. and a lot of Europe and other places under water.*
- *Life is always tough. History repeats. Dramatic changes were world wide.*
- *The global scenes where it depicted landmass changing back to prehistoric times where the earth was covered with water.*

On the large size of the Late Cretaceous marine animals (6%)

- *That there were HUGE creatures prowling the oceans, and I'm glad I was not there to see them!*
- *The monsters were huge. I liked learning about the size and how the monsters lived.*

On how Late Cretaceous marine animals resemble animals today (4%)

- *How related they were to sea life today.*
- *That some of the marine animals of millions of years ago somewhat resemble today's creatures.*
- *All the marine animals, as many of those are still alive, jellies, seals.*
- *That sharks have been around so long.*

2.5 What was the impact of *Sea Monsters* on viewers' knowledge of the Late Cretaceous period and marine animals?

To evaluate the impact of *Sea Monsters* on viewers' knowledge of the Late Cretaceous period and marine animals both viewers and pre-viewers were asked to complete a 28-point assessment consisting of true/false, multiple choice, and short answer questions about information presented in the film.²⁴

Summary of findings

Viewers significantly outperformed pre-viewers on the assessment. Out of a possible score of 28, the viewing group averaged 22 correct responses, while the pre-viewing group averaged 11.²⁵ The effect size in this case was 2.11, generally considered a very large effect. As noted under Method, the effect size helps interpret whether the difference observed is a difference of practical significance, in other words, a difference that matters. Following Cohen's (1992) interpretation, .2 indicates a small effect, .5 a medium effect, and .8 a large effect. Effect sizes are important to report when presenting group differences, particularly when sample sizes are sufficiently large, as it is possible to produce statistically significant differences between groups when the size of the effect is in fact very small.

No subgroup differences were found among viewers' scores with respect to gender, age, education, or number of giant screen or 3D films previously seen.²⁶

Detailed results

The 28-point assessment consisted of 4 sets of questions covering the major informal science themes presented in the film, as follows:

2.5a: Questions relating to the Doliochorhynchops

2.5b: Questions relating to other marine animals that lived during the Late Cretaceous period

2.5c: Questions relating to the Earth during and after the Cretaceous period

2.5d: Questions relating to the discoverers of fossil evidence relating to the Cretaceous period

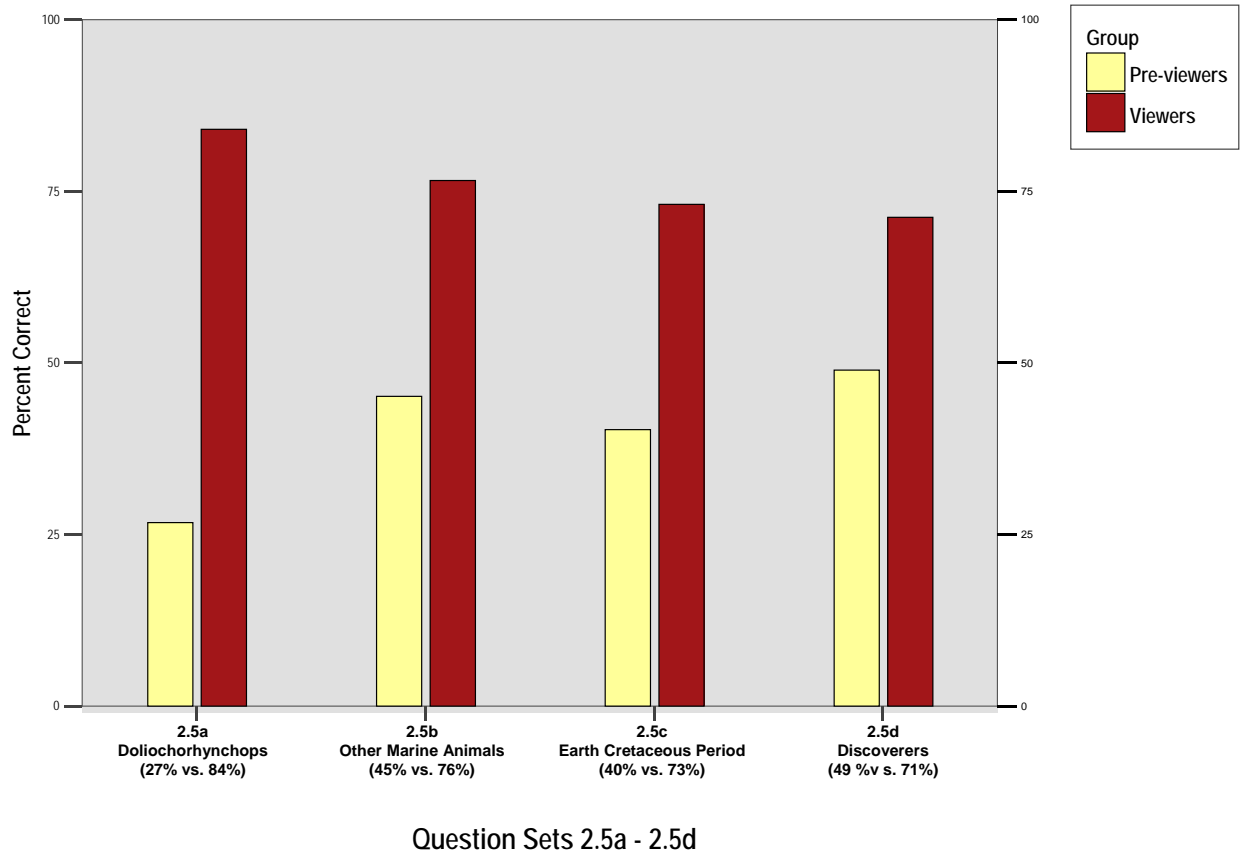
The graph on the next page compares the scores of viewers and pre-viewers for each of the 4 question sets. Results are presented in terms of the percentage of correct answers. As with the overall assessment, the evaluation found that viewers outperformed pre-viewers on each individual question set.

²⁴ For true/false questions, respondents were asked to circle an answer of True, False, or Don't Know. Don't know was scored as an incorrect response.

²⁵ ($t=11.605$, $df=213$, $p<.0001$)

²⁶ Note that in the *Forces of Nature* evaluation, one subgroup difference was found within the viewing group combined assessment scores, as more educated viewers scored significantly higher than did less educated viewers. However, the *Forces of Nature* evaluation was conducted with adults only and the educational background variable was divided into three categories. The *Sea Monsters* evaluation was conducted with youth and adults, since families were a key audience, and the educational variable was divided into 2 categories.

Comparison of Viewers' and Pre-viewers' Scores on the 28-Item Assessment (Performance across 4 Question Sets)



Sections 2.5a - 2.5d provide further detail on the percentage results in each case.

2.5a: Questions relating to Doliochorhynchops

To evaluate the film's impact on viewers' knowledge of *Doliochorhynchops*, the Late Cretaceous marine animal most prominently featured in the film, viewers and pre-viewers were asked to identify which of the 10 physical attributes and behaviors listed in Table 10 scientists believe to be true of the animal.

Summary of findings

Viewers significantly outperformed pre-viewers on this question set. Out of a possible score of 10, the viewing group averaged 9 correct responses, while the pre-viewing group averaged 3.²⁷ The effect size in this case was 2.36, generally considered a very large effect.

Item results

Looking across the 10 questions presented in Table 10, the percentage differences between the two groups for each question were consistently high, 58% on average. There was a 70% difference for the item "Ate only plants," where 95% of viewers knew this to be false compared to 25% of pre-viewers.

One exception was found for the item "Was a reptile." The difference between the two groups in this case was only 8%, as 36% of viewers knew this to be true compared to 28% of pre-viewers. There are several possible interpretations for this finding. For example:

- Turning first to the film narration for context, the term reptile is used 12 times over the course of the film, 11 times in reference to various marine reptiles of the Late Cretaceous period, but only 1 time when specifically referencing a Dolly. Across these uses the word reptile is either used alone or prefaced with the word "marine," "oceanic," or "enormous." An additional indirect reference is also made to Dollys as being reptiles when the narrator observed that the female Dolly and her brother were air breathers. The viewing group's lack of a higher score on this question could therefore have to do with the varying ways in which the term reptile was used in the film.
- Alternatively, the background knowledge viewers brought to the film could be at play. As will be observed in the Phase 2 focus group findings, one group's discussion about the diversity of marine animals featured in the film segued into a debate about whether the Dolly was a reptile or a mammal. As participants exchanged information they recalled learning about the Dolly from the film against any prior knowledge they had about what constitutes a mammal versus a reptile, they focused on the significance of laying eggs vs. having a live birth, nursing, caring for young, and air breathing. This group of viewers encountered

Table 10 Percentage of correct answers to questions about Doliochorhynchops' physical attributes and behaviors		
The "Dolly" ...	Pre-viewers (n=118)	Viewers (n=139)
True		
Had paddle-like flippers	42%	96%
Was a fast swimmer	37%	96%
Was an air breather	25%	93%
Was a little bigger in size than a dolphin	31%	89%
Was a reptile	28%	36%
False		
Ate only plants	25%	95%
Was shaped like a giant squid	29%	94%
Was born on land	27%	93%
Stayed in deep waters year-round	15%	84%
Had a long neck, about half its body length	12%	74%

²⁷ ($t=19.783$, $df=250$, $p<.0001$)

some challenges in squaring the film's portrayal of the Dolly with their prior knowledge about reptiles vs. mammals.

- Finally, while a brief literature search uncovered little on the public's knowledge or attitudes toward marine reptiles specifically, references to reptiles in general were found. A common theme in this work involved the public's misconceptions about and even negative attitudes toward reptiles, as reflected in the following quote from Kaplan (1997) on the use of reptiles in public education: "*Wildlife educators who use reptiles, either solely or as part of a larger group of animal representatives, have a great opportunity to help individuals overcome fears and learn facts to replace myths.*"²⁸ It is possible that the Dolly did not fit into viewers' pre-existing misconceptions about reptiles.

Other interpretations are possible, however, and might be looked at by the project team.

2.5b: Questions relating to other animals that lived during the Late Cretaceous period

For this second question set, viewers and pre-viewers answered 6 questions about animals other than the Dolly featured in the film. Four questions were true/false items (see Table 11), while one was a 2-part question, first asking whether sharks lived during the "age of the sea monsters" and then asking for an explanation of why scientists know this to be the case (see Table 12).

Summary of findings

Viewers significantly outperformed pre-viewers on this second question set as well. Out of a possible score of 6, the viewing group averaged 5 correct responses, while the pre-viewing group averaged 3.²⁹ The effect size in this case was 1.20, generally considered a very large effect.

Table 11 Percentage of correct answers to questions about other Late Cretaceous animals		
<i>During the age of the sea monsters...</i>	% True	% False
<i>Ammonites</i> were rare among the sea creatures	Viewers	68%
	Pre-viewers	22%
Only the largest sea monster was safe from attack	Viewers	60%
	Pre-viewers	41%
Dinosaurs roamed the Earth	Viewers	81%
	Pre-viewers	65%
<i>Tylosaurs</i> were likely territorial with each other	Viewers	84%
	Pre-viewers	36%
*Viewers n= 139, Pre-viewers n = 118		

²⁸ Melissa Kaplan's Herp Care Collection: The Use of Reptiles in Public Education ©1997 Melissa Kaplan

<http://www.anapsid.org/repineduc.html>

²⁹ ($t=9.940$, $df=254$, $p<.0001$)

Item results

Results for the 5 true/false questions are as follows:

- More than two-thirds of viewers (68%) compared to one-fifth of pre-viewers (22%) correctly answered that the statement "*During the age of the sea monsters Ammonites were rare among the sea creatures*" was false.
- Three-fifths of viewers (60%) compared to two-fifths of pre-viewers (41%) correctly answered that the statement "*Only the largest sea monster was safe from attack*" was false.
- Four-fifths of viewers (81%) compared to two-thirds of pre-viewers (65%) correctly answered that the statement "*During the age of the sea monsters dinosaurs roamed the Earth*" was true.
- Four-fifths of viewers (84%) compared to one-third of pre-viewers (36%) correctly answered that the statement "*During the age of the sea monsters Tylosaurs were likely territorial with each other*" was true.

For the 2-part question that asked "*Did sharks live during the age of the sea monsters?*" a higher percentage of viewers correctly answered "Yes" to this question compared to pre-viewers (89% vs. 64%) and were then able to identify that scientists know this to be the case as a result of evidence obtained from the fossil record (76% vs. 42%).

Table 12 Percentage of correct answers to question about whether sharks lived during the "age of the sea monsters"		
Pre-viewers (n=118)	<i>Did sharks live during the age of the Sea Monsters?</i>	Viewers (n=139)
64%	Answered "yes"	89%
42%	Provided explanation that identified evidence from the fossil record	76%

2.5c: Questions relating to the Earth during and after the Late Cretaceous period

For this third question set, viewers and pre-viewers completed 3 questions that related to the Earth during and after the Late Cretaceous period. Two questions were true/false items (see Table 13) and one was a 2-part open-ended question (see Table 14).

Summary of findings

Viewers significantly outperformed pre-viewers on this third question set as well. Out of a possible score of 4, the viewing group averaged 3 correct responses, while the pre-viewing group averaged 2.³⁰ The effect size in this case was 1.39, generally considered a very large effect.

Item results

Results for the 2 true/false questions are as follows:

- Almost all of the viewers (94%) compared to less than half of pre-viewers (46%) correctly answered that the statement "*During the age of the sea monsters the states we now know as Kansas and Texas were under water*" was true.
- Almost all of the viewers (96%) compared to two-thirds of pre-viewers (64%) correctly answered that the statement "*During the age of the sea monsters most of the Earth was covered by land*" was false.

Table 13		
Percentage of correct answers to questions about the Earth during the Late Cretaceous period		
	% True	% False
<i>During the age of the sea monsters . . .</i>		
The states we now know as Kansas and Texas were under water.	Viewers Pre-viewers	94% 46%
Most of the Earth was covered by land.	Viewers Pre-viewers	96% 64%
<i>*Viewers n= 139, Pre-viewers n = 118</i>		

The 3rd question began "*Imagine...Millions of years ago a sea creature dies of old age and then sinks to the bottom of the sea*" and then asked respondents to identify the natural events that occurred over time to make it possible to discover the remains of this creature today. For this two-part question, one point was awarded for identifying either of two types of natural events presented in the film, summarized here as "fossilization" or "exposure." Fossilization was defined as the process of converting or being converted into a fossil (preserved from a previous geological age) where exposure was defined as a lowering or receding of the waters or uncovering through other natural forces such as through volcanic activity. Two points were awarded for identifying both types of events.

³⁰ ($t=11.443$, $df=254$, $p<.0001$)

As summarized in Table 14 below, four-fifths (83%) of viewers compared to half (49%) of pre-viewers scored at least 1 point on this question.

Table 14 Percentage of correct answers to question about natural events that occurred over time to make it possible to discover the remains of Late Cretaceous marine animals		
Pre-viewers (n=118)	Response types	Viewers (n=139)
51%	Incorrect responses	16%
47%	Responses identify fossilization OR exposure	65%
2%	Responses identify fossilization AND exposure	18%

2.5d: Questions relating to the discoverers of fossil evidence relating to the Cretaceous period

Finally, in the fourth and last question set viewers and pre-viewers were asked to identify the types of individuals who have discovered the remains of sea monsters. There were 8 true/false questions, of which 5 were true (see Table 15).

Summary of findings

Viewers significantly outperformed pre-viewers on this final question set as well. Out of a possible score of 8, the viewing group averaged 6 correct responses, while the pre-viewing group averaged 4.³¹ The effect size in this case was .93, generally considered a large effect.

Item results

As Table 15 shows, the percentage differences between the two groups for each of the 5 true items were consistently high, 38% on average. There was a 45% difference for the items "hikers/campers" and "construction workers," where 90% and 91%, respectively, of viewers knew these to be true, compared to

Table 15 Percentage of correct answers to question about the discoverers of fossil evidence relating to the Cretaceous period		
Pre-viewers (n=118)		Viewers (n=139)
65%	Amateur fossil collectors	94%
45%	Hikers/campers	90%
46%	Construction workers	91%
76%	Paleontologists	92%
58%	Miners	69%

³¹ ($t=8.544$, $df=244$, $p<.0001$)

45% and 46%, respectively, of pre-viewers. The differences were somewhat smaller for “miners” and “paleontologists,” but still between 11% - 20%. In the case of paleontologists, the smaller difference could be partly a function of viewers and pre-viewers having prior knowledge that paleontologists discover prehistoric remains and then extrapolating this definition to marine animals. In the case of “miners,” viewers might not have recognized their role as discoverers given that the film briefly showed miners at a phosphate mine within an Israeli construction site. Some viewers may have assumed the miners were construction workers, which, as noted above, 91% of viewers correctly identified as a type of discoverer.

2.6 How much did viewers and pre-viewers estimate they knew about the age of the *Sea Monsters*?

Finally, viewers and pre-viewers were asked to estimate how much they knew about the age of the sea monsters on a scale of 1 (know nothing) to 7 (know a lot). Table 16 shows the mean ratings for this simplified self-report measure, where viewers rated their knowledge significantly higher than did pre-viewers (means, 4.2 vs. 2.2).³²

Table 16						
Mean viewer and pre-viewer ratings of how much they knew about the age of the sea monsters (SD=Pre-viewers 1.448; Viewers 1.591)						
1	2	3	4	5	6	7
Know nothing	2.2 (pre-viewers)		4.2 (viewers)		Know a lot	
*Viewers n= 139, Pre-viewers n = 118						

³² ($t=10.317, df=253, p<.0001$)

Part 3: Looking ahead: Viewers' intentions of recommending *Sea Monsters* and seeking out information related to the film

Viewers were asked to rate their likelihood of recommending the film and seeking out information about the age of the sea monsters. Tables 17 and 18, below, summarize the mean ratings in each case.

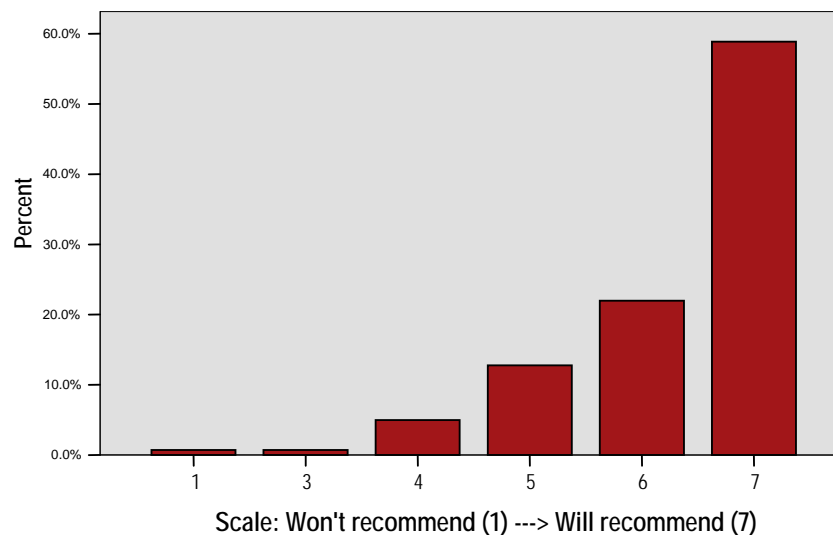
3.1 Viewers' intentions of recommending *Sea Monsters*

Using a scale of 1 (won't recommend) to 7 (will recommend), viewers were asked to rate their intentions of recommending the film. As Table 17 shows, viewers generally agreed that they would recommend the film (mean, 6.3).

Table 17 Mean viewer ratings of intentions to recommend <i>Sea Monsters</i> (n=141; SD=1.035)						
1	2	3	4	5	6	7
Won't recommend					6.3	Will recommend

Two subgroup differences were found for this question as adults were more likely to recommend the film than were youth (6.5 vs. 5.9)³³ and viewers with a higher level of education (some college or beyond) were more likely to recommend the film than were those with a high school education or less (means, 6.5 vs. 6.0).³⁴

Frequency Distribution for Table 17 "Recommend" Rating



³³ ($t=2.487$, $df=57.772$, $p<.02$)

³⁴ ($t=2.591$, $df=84.168$, $p<.01$)

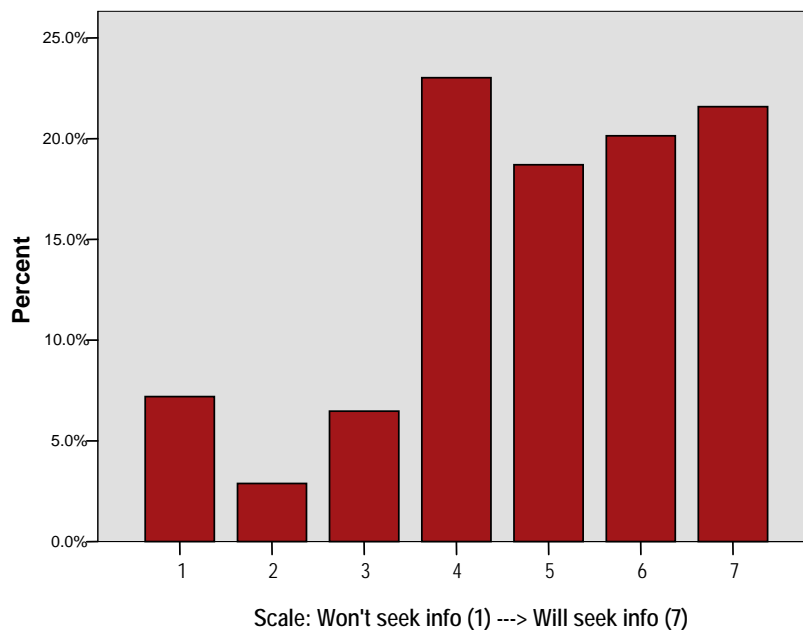
3.2 Viewers' intentions of seeking out information about the age of the sea monsters

Using a scale of 1 (won't seek out) to 7 (will seek out), viewers were asked to rate their intentions of seeking out information about the age of the sea monsters. As Table 18 shows, viewers were somewhat likely to seek out information (mean, 4.9). As reflected in the frequency distribution for Table 18, the ratings ranged from a low of 1 to a high of 7, with the majority clustering between 4 - 7.

Table 18 Viewers' likelihood of seeking out information about the age of the sea monsters Mean ratings (n=139; SD=1.725)						
1	2	3	4	5	6	7
Won't seek out info			4.9		Will seek out info	

One subgroup difference was found as more frequent viewers of giant screen films (3+films) felt they were significantly more likely to seek out information than did less frequent or first time viewers (means, 5.2 vs. 4.6).³⁵

Frequency Distribution for Table 18 "Seeking" Rating



³⁵ ($t=2.096$, $df=137$, $p<.04$)

Phase 2: Focus Group Findings

Immediately following five separate showings of *Sea Monsters*, Knight-Williams conducted focus group sessions with parents and youth to explore their reactions to the film’s marine animals, use of 3D, and investigative storyline.

Recruitment

Recruitment for the sessions focused on families because the project team expected that *Sea Monsters* would be a particularly appealing and effective learning tool for families. Recruitment was purposive, focused on identifying family groups with youth as opposed to young children. The recruitment goal was approximately 50 participants, divided roughly equally between males and females, youth and adults. The cooperation rate was 85% as 50 out of 61 viewers (described as ‘participants’ in this Phase 2 section of the report) consented to participate in the group discussions. The viewers who declined comprised 2 family groups that indicated they either had to meet another party or had dinner reservations.

Procedure

All 5 sessions were held in an open room located adjacent to the theater lobby and were led by the same trained moderator and an assistant. The moderator informed participants: that their participation was voluntary; that only their opinion mattered and there were no right or wrong answers; that their names and identities would be protected in the reporting; and that as with the questionnaires, the focus groups were made possible with support from the National Science Foundation.

The discussion sessions ran approximately 50 minutes, which included time for recruiting and settling participants into the discussion room, introductions, an ice-breaker activity, discussion, wrap-up, and providing an honorarium.

Participant information

Table 19 presents basic demographic and background information for the 50 participants. This group comprised one-third (35%) of the viewers who completed a post-viewing questionnaire.

Across the five groups, there was an even split between males and females. A total of 26 participants were 15 years or younger while 24 were 16 years or older. The average age of the adults was 47 while the average age of youth was 12. On average, participants had previously seen 3 giant screen films and 3 3D films. As with

Table 19
**Focus group participants’
demographic and background information**

Demographic/ background factor	Categories	Participants (n=50)
Gender	Female	50%
	Male	50%
Average age	Adults	46
	Youth	12
Race/ethnicity	White	80%
	Asian	8%
	Native Hawaiian or Pacific Islander	2%
	African American	4%
	Multiracial	6%
Average # giant screen films viewed		3
Average # 3D films viewed		3

the Phase 1 questionnaire evaluation, the majority of the participants were White (80%), with 8% Asian, 6% multiracial, 4% African-American, and 2% Native Hawaiian or Pacific Islander.

Analysis

Two evaluators prepared the analysis by reviewing all available session materials, including: participant drawings, discussion recordings, and post-session notes.

The following summary identifies the major themes that were uncovered looking across the 5 groups relating to the following 4 issues:

Issue 1: What did participants notice about the Late Cretaceous marine animals?

Issue 2: How did participants respond to the 3D?

Issue 3: How did participants respond to the investigative storyline?

Issue 4: What remaining questions did participants have about the film?



Family viewers prior to focus group session
Courtesy of Onetake Productions

Issue 1. What did participants notice about the Late Cretaceous marine animals?



Participants preparing drawings
Courtesy of Onetake Productions

To help break the ice and explore what participants noticed about the diversity and adaptations of the marine animals featured in *Sea Monsters*, the moderator asked participants to draw as many animals as they could remember from the film, and to try to include features that helped each animal adapt to its environment. Participants were encouraged: to enjoy the drawing activity, to not worry about creating works of art, and to view the activity as an informal exercise designed to break the ice while also helping the producers to get some sense of film-goers visual impressions of the animals shown in the film. To accommodate anyone who might be uncomfortable drawing, the moderator also offered the option of using words, an option which 1 adult chose to take.

Participants seemed engaged in the drawing activity, with several commenting that they found it to be *amusing*, a *good ice breaker*, or a *useful way to think about what stood out* for them about the animals featured in the film. Although 8 minutes was set aside for this activity, most participants wanted additional time to work on their drawings. Given other priorities and time constraints, the moderator asked participants to put their pencils down at around 10 minutes, which proved a challenge for some younger participants. To illustrate the range of drawings produced, sample youth and adult drawings are included on the next page, with additional drawings included in Appendix 1.

	(n=50)
Dolichorhynchops (Dolly)	93%
Ammonites	91%
Tylosaurus	76%
Styxosaurus (long neck)	76%
Tusoteuthis (giant squid)	71%
Sharks (Cretoxyrhina or Squalicorax)	67%
Birds (Hesperornis or Pteranodon)	42%
Little fish (non-specific)	36%
Sea turtle	20%

Table 20 shows the marine animals that participants most frequently drew. The major themes that emerged from the drawing activity and subsequent discussions are summarized below.

- While participants drew as few as 3 to as many as 11 different marine animals, the group average was 7. Nearly all the participants drew Dolichorhynchops (93%) and Ammonites (91%). These two animals are illustrated in the following images from the *Sea Monsters* website photo gallery: <http://www.nationalgeographic.com/seamonsters/photogallery>



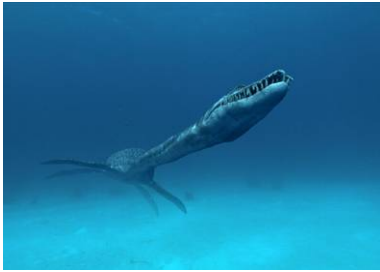
Dolichorhynchops



Ammonites



Tylosaurus seizes a Squalicorax



Styxosaurus



Small fish (image cropped to highlight small fish)



Cretoxyrhina

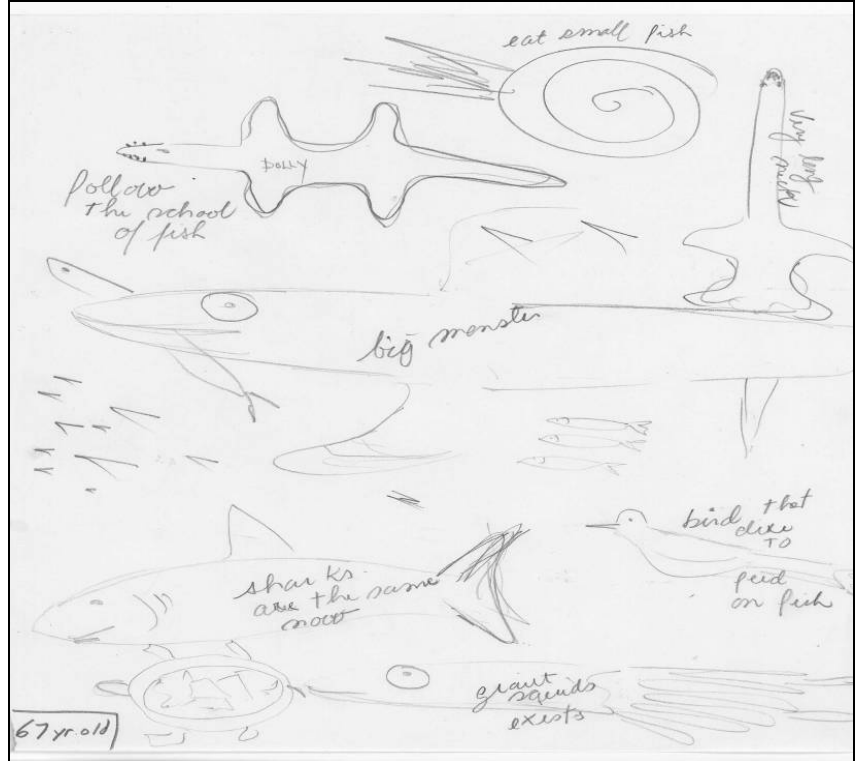


Sea turtle

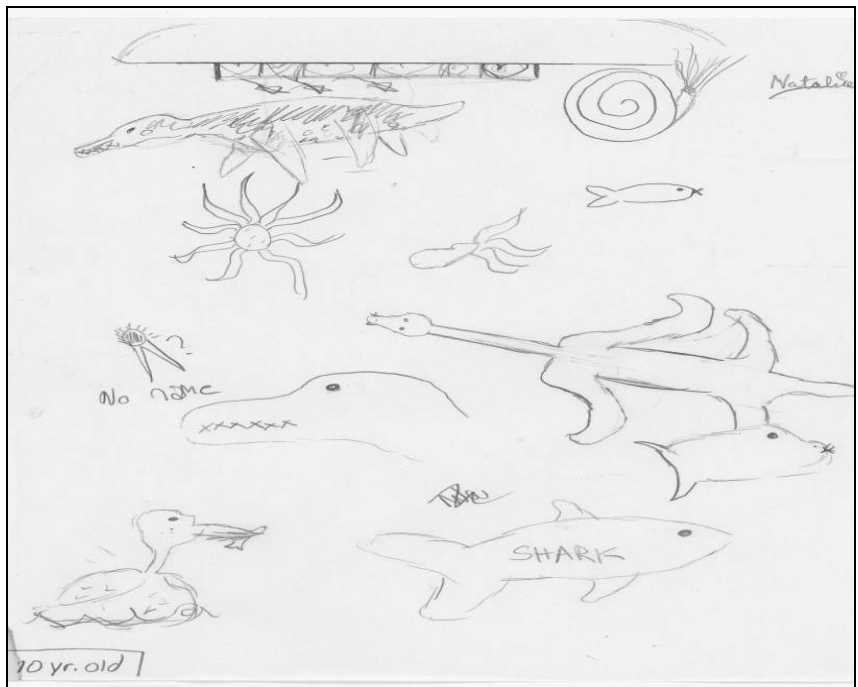
Additional images of creatures participants most frequently drew, as shown on the Sea Monsters website

<http://www.nationalgeographic.com/seamonsters/>

Between two-thirds and three-quarters of the participants drew pictures of Tylosaurus (76%), Styxosaurus (76%), Tusoteuthis (71%), or sharks such as Cretoxyrhina or Squalicorax (67%). Between one-fifth and two-fifths of the participants drew birds such as Hesperornis or Pteranodon (42%), little fish (36%), and/or sea turtles (20%).



Drawing by 67 year old



Drawing by 10 year old

- Participants frequently observed that the marine animals featured in *Sea Monsters* were diverse and huge, with some participants wishing the film had shown even more animals that lived during the Late Cretaceous period. When the moderator invited the groups to talk about the animals featured in the film, many participants, particularly adults and younger children, expressed surprise at how many different marine animals appeared in the film. Their remarks were often joined with exclamations of how huge the animals were or how little they previously knew about the marine animals featured in *Sea Monsters*, as in: (adult) *There were a lot of them. BIG animals! And I have never heard of any of these animals. I've never been exposed to any of them, other than sharks. Never heard of any of them before.*

Older youth were more divided on this issue, however, with some reasoning that it wasn't surprising that the marine animals were so large given the size of dinosaurs and others wishing the film had covered other animals that lived during the age of the sea monsters, as in:

- *Maybe every once in a while see a new type of animal, it seemed like there were 10 and they just kept swimming by. There wasn't a lot of variety.*
 - *They never showed a different kind of animal coming by so you start to think they only had like 20 animals or something.*
 - *It would have been cool to have some other kind of big animal come by every once in a while and snatch something.*
 - *You would kind of expect the sea creatures to be big. I mean look at the dinosaurs. And there are still big sea animals today as well so it shouldn't be that surprising.*
- Participants were also quick to point out that the marine animals of *Sea Monsters* resemble modern animals. When invited to discuss anything else that surprised them about the animals featured in the film, participants most often pointed to *similarities* they observed between prehistoric and modern animals. Adults tended to discuss the concept of similarities in general terms, as in: *"Some of the animals they showed . . . they are similar in some way to what we are used to seeing."* Youth were noticeably more focused on calling out specific similarities, and while they most often pointed out comparisons between modern vs. prehistoric sharks, they also compared other animals such as: Tylosaurs and alligator, Hesperornis and puffins, Ammonite and Nautilus, Dolichorhynchops and dolphins, and even *Styxosaurus* and giraffes. For example:
 - *(youth) There were a lot of them but I mean you go to the aquarium down the street and there's a huge variety of them there too, so we still have a lot of marine animals. But I also noticed that there were like a lot of distant cousins, so animals like what you see today, only bigger ones.*
 - *(group in chorus) The sharks!*
 - *(youth) The Tylosaur reminded me of a big alligator . . .*
 - *(youth) The giant bird thing kind of looked like a puffin.*
 - *(youth) Like squids had tentacles and used that to move.*
 - *(youth) The one that got squirted with the ink, we have that, that happened to me when I was scuba diving.*
 - *(youth) The Dolly thing it was awesome, it looked like a dolphin if its back flipper went back a little more. Or it looked like a platypus. Because it had legs folded in like a platypus.*
 - *(youth) The long necked thing looked like a giraffe.*
 - *(youth) Like the little red minnow type things, those reminded me of things deep down in the ocean.*
 - *(youth) They are bigger things than what we have now, if it was good strategy in terms of evolution then why not use it again, so it's kind of like what we have now, like that giant turtle. We have turtles now, they just aren't as big, and like they said herring like fish, well we have herring now . . . and then like sharks and jellyfish.*

- **Some participants debated about whether Dolly was a marine reptile or mammal.** In one group, a 13 year old girl's observation about the Dolly seeming similar to a modern day dolphin segued into a lively discussion about whether the Dolly was in fact a mammal or a reptile. When the girl elaborated that she was interested to learn that the Dolly was a mammal since it didn't lay eggs, another youth quickly countered with a loud "No!" which led to a brief silence among the group members, followed by a collegial debate about whether the Dolly qualified as a mammal or reptile. In the process, the group exchanged information they recalled learning about the Dolly from the film against any prior knowledge they had about what constitutes a mammal versus a reptile. As illustrated in the following excerpt, participants tended to focus on the significance of laying eggs, having a live birth, nursing, caring for young, and air breathing:
 - (youth) *I didn't know the Dollys were mammals; they don't put out eggs for when they have babies.*
 - (youth) *No!*
 - (Group becomes quiet)
 - (adult) *Well, it looked like a live birth.*
 - (adult) *It was a live birth but they didn't nurse, a mammal has to nurse.*
 - (adult) *Ah, they didn't nurse.*
 - (youth) *Right, a mammal has to nurse, like a cow, right?*
 - (adult) *Ah yes, but she was saying that they don't give eggs.*
 - (youth) *Well, reptiles lay eggs but don't care for their young.*
 - (adult) *But they [Dollys] don't have eggs?*
 - (youth) *Like birds.*
 - (adult) *Right a bird has eggs. But that's a bird . . . not a reptile.*
 - (youth) *But it [Dolly] was an air breather*
 - (youth) *A bird is an air breather, and it's cold blooded.*
 - (adult) *Right, but that's not a mammal.*

Issue 2: How did participants respond to the film's 3D?

In the proposal to the NSF, the project team expected that the 3D and hi-resolution computer graphics and animations used in *Sea Monsters* would set a new standard for giant screen films, as follows: *"Informed and endorsed by leading scientists, they will be the most accurate representations of prehistoric marine reptiles to date, and will reinforce National Geographic's belief that accuracy creates more compelling content than fiction. Further, the Sea Monsters animation will significantly appeal to children who are growing up in a media-rich society where educational programming must compete with hi-tech, hi-budget Hollywood feature films. The film will go beyond what's been done before to capture the attention of children today and to engage and excite these viewers in science-based programming."*³⁶ The focus groups explored whether and how viewers felt the 3D aspect in particular was successfully applied in *Sea Monsters* and whether it helped to satisfy the appetites of youth who are used to hi-tech Hollywood animations and 3D, and who might be resistant to traditional science-based documentary programs.

The major themes that emerged from the discussions are summarized on the next page.

³⁶ Note that the proposal language submitted in the final proposal may have shifted somewhat from the version used to develop the summative evaluation plan.

- Participants overwhelming agreed that seeing *Sea Monsters* in 3D was central to their enjoyment of the film. Many participants observed that they couldn't imagine seeing the film in 2D while a father and son pair went so far to say that the large group with whom they accompanied to see the film would not have made the trip were it not for the 3D.
- When characterizing its appeal, participants most often described the 3D as offering them *lifelike* or *realistic* views of prehistoric life that enabled them to study the marine animals up close or just feel that they were among them. Youth also noticed on how much they enjoyed the experience of *reaching out* or *grabbing* at the animals that swam by them. Parents of younger children often chimed in with a different perspective, observing that from their standpoint, the film struck just the right balance of being realistic but *not thrill-seeking* or *too scary* for young children. Frequent viewers of 3D films added that the quality of the 3D compared favorably to other 3D films they had seen because it was more *true-to-life* or *less cartoonish*. The range of participants' comments on the film's 3D included:
 - *(adult) For me, I was having a hard time thinking of it not being a real thing. It didn't have that animation aspect. It was like watching an underwater film as opposed to watching an animation. It was very, very compelling.*
 - *(adult) They were so vivid, where the other films we are used to, you know regular film, but these were so vivid and clear, it felt like life right there.*
 - *(adult) Loved the 3D. Especially when the big ones pass over you and you see the size and if it wasn't you wouldn't get the feel of the size. I could imagine the depth and the size.*
 - *(adult) In some 3D films they overdo the coming at you. It wasn't a thrill catcher here, it was more realistic.*
 - *(adult) I think we wouldn't have come seen the movie It looked real, as real as it can get. When the close-ups came you could see their eyes and teeth I saw a lot of grabbing at the screen. A lot of you [pointing to youth in group] tried to reach out and grab the sea monsters.*
 - *(adult) Oh yes, I kept dodging the monsters! It looked like you brought it all out of prehistoric time and brought it out to film it When we were looking at it I didn't feel like we were looking at it as animation, it seemed real, not fake. It felt like we were looking at the creature.*
 - *(adult) I really liked the fact that they didn't make it too scary. They had their mouths open but it wasn't like this attack, that they were going to eat you. It was good for kids. Some 3d movies are terrifying, and you think like they are going to eat you. This one I was worried about her [granddaughter] and she was behind me. I kept listening to see if she was scared, but she wasn't.*
 - *(adult) It wasn't intimidating and you aren't afraid to take little ones to it. They veered off and it was never a full frontal.*
 - *(youth) It was better, it is something that you would find real; it is something that after the movie you would expect to actually see in the ocean.*
 - *(youth) It has to have 3D. If people if they just went to the regular movie they probably would want to go to another movie especially if it is the same prices; but the 3D, it just like puts it further out there.*
 - *(youth) I thought the graphics were better than ones I've seen before. They seemed like cartoons, this one seemed real.*
 - *(youth) It was good. Like Jurassic Park looked really fake, but King Kong looked really good, and this one was really good.*
 - *(youth) I was surprised in that with the title, I was expecting it to be more non-realistic perhaps more cartoonish, and it was more realistic than I thought. I could have really bought into this really being real.*

Issue 3: How did participants respond to the film's investigative storyline?

Much of the content of *Sea Monsters* was presented through an investigative detective story as paleontologists uncovered mysterious fossils and worked to interpret the past, building their knowledge of prehistoric marine reptiles. In the proposal to the NSF, National Geographic expected that: "*In an age where science is often perceived as dull, we believe that Sea Monsters will have a positive impact on young viewers, encouraging them to think science is "cool" and to investigate future careers in science.*" The project team further expected that: "*The style of the film – setting up the dramatic arc as a detective story – is highly unusual in large format. The treatment of paleontology, and by implication much of science, as a forensic activity which seeks to interpret evidence, is also unique. To engage the audience in the 'investigation,' the film employs visual elements and cinematographic techniques uncommon in LF films such as step zooms, snap zooms, and flashbacks.*" The focus groups explored participants' reactions to the film's use of an investigative detective story as a technique to both engage and educate family audiences.

The major themes that emerged from the discussions are summarized below.

- **Participants frequently praised the investigative storyline for moving the narrative, adding intrigue, and providing an interesting way to present science; although some felt it made the film seem choppy or disrupted their enjoyment of the animal action scenes.** When asked to reflect on the film's investigative story, adults and younger youth readily praised it for helping to *move the narrative forward, adding intrigue, or delivering science information in an interesting way*. Older youth were somewhat divided. While some liked the investigative storyline, others felt it made the film seem too *chopped up* or at times *disrupted the action* scenes between the marine reptiles. Some of these youth wanted to see more in-depth coverage of the fossil discoveries while others wanted more time spent on the *raw animal action*. Comments on the above themes are presented below.

On moving the narrative forward, adding intrigue, delivering science in interesting way

- (adult) *I liked it; I felt it gave it an interesting context to view it. So it wasn't just a story of monsters in the water but to have the scientists dig up the bones out in the middle of nowhere, that was good.*
- (adult) *It worked very well. I liked that . . . it was literally breathtaking how we went through the water with them and then for a second you would like hold your breath and then say to yourself "Wait a minute! I can breathe, I don't have to do that, it's just a film!" But I liked that. I felt like I was on the journey. I've traveled a lot like in the high desert of southern Utah and I kept thinking I can't wait to go back. There were a lot of things [fossils] they showed I could look for there. We often find geodes and mollusks and stuff like that but I never really had the whole concept that that area was under the sea. I knew about rivers eroding, becoming bigger and smaller, but I never really knew how much of the planet was underwater. That was really breathtaking. I thought that was amazing.*
- (adult) *Facts tell, stories sell. Stories are the things you remember throughout history.*
- (adult) *I like the flashbacks how it went back and forth and tied in the fossil findings with where the story was going. That was effective*
- (adult) *Like the shark tooth in the flipper, without that there wouldn't have been a story. So it kept me going and wondering what would happen, whether that would be discovered later.*
- (youth) *It kept my attention. Like if I didn't have that, I didn't think I would be that interested. It would seem too bland, I mean any movie has a storyline and everyone would want to follow this if they were watching the movie, it really worked.*
- (youth) *I thought it worked how they were showing the evidence behind the whole movie, to show that it is real and true and based on a real story, not just something that was made up.*

- *(youth) It was also very scientific and accurate but it also had a story, it had it flow a lot easier than if it had just been straight science. A little more interesting.*
- *(youth) I thought that was good because they would have something come in and rather than just say "Here it is!" they introduced them and said what they did and like that.*
- *(youth) If it was only the detectives it would have been boring but it was good having them together.*
- *(youth) I liked it, how it converged like how it showed the detective part, and then all of a sudden it would show like how the animal got inside the other one.*

On making the film seem choppy or disrupted action scenes

- *(adult) I would have actually liked to have seen more on the uncovering of the bones. You were always hoping they could get it out of the ground but I never felt satisfied that they could get it out of the ground. It just sort of went back on to the underwater scenes, without explaining.*
- *(youth) In a very suspenseful part it would just jump to the finding of the fossil instead of going on with the story.*
- *(youth) I agree...sometimes it would be scary then suddenly it would pass and go to the finding of the fossil and then back and forth.*
- *(youth) They want to get kids to be interested in finding fossils so maybe they could have done more of that and less of the animals swimming so much. I like seeing the animals but sometimes it is cool seeing them discover.*
- *(youth) I think it um . . . they would start the scenes where they would like find the fossils and they wouldn't really finish it would just go into the next thing and I think it should have gone on a little longer.*
- *(youth) I wanted it to move along a little more. It slowed it a little.*

- **Participants were surprised to learn that the fossil discoveries occurred internationally, accidentally, over time, and even by non-scientists.** Participants in all groups talked about the storyline's focus on fossil discoveries, with many participants expressing surprise to learn that the discoveries have taken place *all over the world*, and at *different times*, and by *non-scientists*. Comments on these themes are illustrated in the following quotes:

- *(adult) It was really nice to see how these discoveries were happening all over the world from Australia, Israel, Kansas, North Dakota . . . and in different time frames from the 1950s to late 1998o was the last one that they showed . . . it looked like the marine animals were everywhere . . . that was nice to see.*
- *(youth) A lot of different people can find them and in a lot of different places.*
- *(youth) Not all, some were just like working and like constructing. You wouldn't expect people to find stuff like that when you are constructing. You would expect the people to only find things like rocks and dirt.*
- *(youth) I could see the miners finding it and being meant to find it. Like the people, I forget what they are called, but the ones who like to look for bones.*

Adults and older youth also tended to focus on the *accidental* or *randomness* of the fossil discoveries, or how fossils were often discovered by chance rather than someone specifically looking for them, as in:

- *(adult) They showed you how things come by chance, that was interesting...they were not looking for it, they were digging somewhere for something else and they found another thing instead.*
- *(adult) But they explain that in the film because they talk about the volcanoes and the glaciers and they get exposed and then you will find them so people will stumble on it like the construction worker or the girl in the campsite and with the rain washing away the paleontologists are going to find that. And people in just everyday life are going to stumble upon them too and then that draws the paleontologists to come in and dig in those areas.*
- *(adult) The randomness of discovery, at construction sites, rather than someone specifically looking for it. That was interesting. I knew that about dinosaur finds but this kind of reinforced that for me, that there are all these different sites and they are discovered by lots of different people.*

- *(youth) I think the first person was camping and he found a fossil, it was pure luck. And for the workers too.*
- *(youth) I found it interesting that every day blown up mountains, or building roads, that's how some of these things were discovered, by accident. Not someone specifically going out looking for it. That would be really cool finding something like.*
- *(youth) How they just stumble on fossils. It's like wow, the person is just driving on the road and he found that big whatyamacallit. People find them on accident; it's like when you go looking for them.*

Adults also frequently noticed the care with which discoverers handled the fossils they uncovered, as in:

- *They seemed really excited when they found something and how they treated it with kids' gloves. How fragile it was.*
- *I liked the respect that they showed when they found something. Whether it was in construction or whatever they could be blowing something up or they are busy doing something else but whatever it was they stopped and they notified whoever they needed to notify and took care. They didn't just keep plowing over things and keep going.*

- **Some older youth observed that the scientists portrayed in the film were, for their taste, too old, not scientific looking enough or not enough like Indiana Jones.** Several of the older youth were more focused on the researchers portrayed in the film, or those who were seen making the discoveries and doing the work of sorting and interpreting the evidence that has contributed to our understanding of prehistoric marine animals. Most often these youth observed that they didn't generally find the researchers appealing as they either didn't look *scientific*, were *too old*, or weren't enough like *Indiana Jones*. For example:

- *There is never enough action.*
- *They all seemed the same except the little girl.*
- *Except for the random road working people.*
- *The scientists seemed like people I would expect.*
- *I didn't see that much science involved it.*
- *I already knew people look for fossils.*
- *Maybe they coulda done more like testing how old it is, like in the bone marrow, not just discovering.*
- *Some of the scientists looked like ordinary people, that it was like a hobby but it was sort of weird that they didn't have a lab coat. I wouldn't imagine as scientists as something normal.*
- *I thought the scientist were just maybe a little old.*
- *Yeah too many old farts.*
- *There wasn't an Indiana Jones type or any type of kung fu going on.*
- *They should have had teenagers finding them.*
- *Even the ones in the car, they were old farts.*
- *I think there should have been more blood.*

- **Participants often mentioned the Dolly story which they variously characterized as touching, human-interest oriented, sad, sweet, having a cycle of life message, or being too predictable. How participants thought about the story seemed to vary somewhat by age.** Many participants brought up the film's story around the Dolly family, and in particular the film's ending where the female Dolly dies of old age. Several adults raised the point that they thought the story was *touching, human-interest oriented, sad, or sweet*. Some further observed that the Dolly story effectively communicated a *cycle of life* message, to which a few older youth disagreed, characterizing the death as *predictable* rather than compelling. Comments reflecting these varying perspectives included:

- *(adult) Something was trying to eat her (Dolly) and then it didn't. I was worried, like "Oh no, she is going to get eaten, but no!"*
- *(adult) I thought the story was really cute with the sister and the brother and it was like really sad with the floating to the bottom and all that. It was seriously sad. You showed death in a real different way, from like old age to being killed.*
- *(adult) It was sad, but okay.*
- *(adult) Yeah, it showed the circle of life.*
- *(adult) I like the gentleness.*
- *(youth) It was sad.*
- *(youth) It was fine but kind of predictable that she lived.*
- *(youth) I thought it was kind of predictable. When they kept saying that the tooth was in the fin, that was kind of predictable, I knew that was going to happen.*

Many of the youngest participants focused on the Dolly's death as being *sad*, with a few going further to say that they wished she had died from *being eaten* rather than old age, explaining that this would have been *easier to take*. An excerpt from one group's discussion about this point follows:

- *(adult) The topic of death and the circle of life – I thought they did a good job of showing that and it was very tasteful and I don't think younger kids would be bothered by it or so upset that the Dolly died. It was natural.*
 - *(youth) I was upset. I don't like it when animals die. The thing that I liked about the death though was that it wasn't killed it was more like just old.*
 - *(youth) I didn't like that . . . the old age is a little bit harder to take in then it being eaten.*
 - *(adult) Because of the circle of life?*
 - *(adult) You'd rather be eaten as dinner?*
 - *(adult) They apparently lived a really long time. You got to see its child and children, offspring of the offspring.*
 - *(youth) Every time they had a baby, happy music came.*
- (Group laughs)*
- *(adult) Yeah we never had jaws music. Only some suspense when the alligator type thing came on.*

Issue 4: What remaining questions did participants still have about the film?

Before wrapping up the group sessions, the moderator asked participants if the film left them with any remaining questions. The major themes that emerged from the discussions are summarized below.

- **Several different types of questions emerged across the groups, ranging from: predator-prey relations, what you can or can't tell from fossil evidence, how prehistoric marine reptiles became extinct, what else lived at the time of the prehistoric marine reptiles, how the Earth has changed since prehistoric times and will continue to change, and the film's educational applications.**

Comments on each of these themes are provided below.

On predator-prey relations

- *I was surprised of the Dolly dying of old age. I mean there is the cycle of life, but usually they get eaten, not just die of old age.*
- *When an animal gives birth do they just not pay attention to the new arrival and just go on and do they leave it to fend for itself? That is what I felt.*
- *We had a debate about what percent died of old age vs. got hunted and killed. We figured most became food.*

- *I had to wonder with the long neck why doesn't someone come up and bit it. I would have thought that some of those big barracuda type guys would have come up and gone after it.*
- *I was looking for places for smaller creatures to hide from predators. I guess they would go to the bottom.*

On what you can or can't tell from fossil evidence

- *One thing I wondered is if there is any way of knowing what the real color of these creatures was. They basically seem to assume grey, but coming out of the aquarium an hour ago they are all different colors.*
- *I thought it was weird that they always find fish with other fish in the fossils.*
- *You just guess the color of the animals? Can you tell that from the fossils?*
- *I thought we wouldn't find a full body inside another animal . . . you would just see this dissolved thing in there, just their bones.*

On how marine animals became extinct

- *I thought they didn't really answer when they went extinct. I wanted to know how that happened. It would have been interesting to see if it was a giant meteor or something else.*
- *I want to know why the sharks made it but the others didn't. What was that about?*
- *It would be cool to see the progression from where they left it. It showed them falling and going extinct but what happened next? So they said 82 million years, but what about in between so maybe even to 50 million years from now.*

On what else lived at the time

- *I wanted more information, more species, more diff kinds of information it was too much the same. It was all about how they got eaten.*
- *They could have done more variety with more animals.*
- *Why wasn't it a mix of land creatures and marine animals?*
- *I think I expected to see more corals, clams, rather than just fish or big fish. More coral scenery.*
- *It was an empty ocean bottom. Like if you go diving now you see caves not just deep ocean bottom*
- *I kept wondering how you could translate this down to school level but to me the education part would benefit. I'm not sure how you take it to the school, almost like a traveling exhibit of some sort.*

On how the Earth has changed/where it's headed

- *How much the Earth has changed over the years and how much our environment changed. It was very interesting that we were under water and how our planet changed.*
- *Just made me worried about the future. I know I kept thinking maybe we are going back to where we started. This whole global warming thing and everything. I started getting worried with all this global warming and everything where are we headed?*
- *To see the change in the ocean, like Kansas . . . you see it when you go to the museum in info, but not all together how they showed it. It makes you wonder where we are going to be. We are here for just a blink.*

On educational applications

- *I think something missing at the end would be for more info . . . give a website address.*
- *Remember the one that ate too much and died, and then there is a massive one at the Smithsonian . . . that would be cool for kids to say hey mom and dad take me there. But I never knew how it dies, they didn't tell us there at the museum. So there is a connection there that could be built on.*
- *It would be great if there is a companion book to go along with the film. I think in my life at various times I will think about this.*
- *Do you have a website? Are there trailers for the movie? And for schools it would be more interesting for the kids. Whenever we are watching something, if it isn't exciting it doesn't get our attention and we don't watch. When I think about when I started to teaching 20 years ago and the film strips we had to use and how kids would fall asleep this is really exciting, with the 3d and animation and science.*

Phase 3: Follow-up telephone interview findings

Follow-up telephone interviews were conducted with a subset of adult viewers who completed questionnaires but did not participate in the focus groups. The interviews were conducted approximately 2-2.5 weeks after viewers visited the theater. The interviews explored the longer term impact of the film and whether and how viewers or their families used the project's outreach components.

Recruitment and procedure

Adults who completed a post-viewing questionnaire were asked to participate in a 10-minute telephone interview 2-2.5 weeks after their theater visit.³⁷ The interview request was printed on a small sheet of paper that was handed to participants along with the post-viewing survey. Those interested, available, and willing to be contacted placed the request form in a box after completing a survey. Among the 24 forms returned, 20 included contact information that was legible, complete, and belonged to individuals who could be reached within the 2-2.5 week evaluation period. Among this group of 20, 14 were reachable and able to participate in the interviews during the evaluation window, resulting in a 70% response rate.

Interviewee information

Eight (8) interviewees were women and 6 were men. The average age was 47, with a range of 25-70. All of the participants were White.

The findings relating to the following 7 issues are reviewed below.

Issue 1: Did interviewees discuss Sea Monsters with others?

Issue 2: Did interviewees continue to think about Sea Monsters?

Issue 3: Were interviewees reminded of the film when encountering other print, visual, or audio media?

Issue 4: Did interviewees do anything new or different as a result of seeing Sea Monsters?

Issue 5: What did interviewees do with the Sea Monsters posters?

Issue 6: Did interviewees visit the Sea Monsters website?

Issue 7: Did interviewees have additional comments they wanted to share with the producers?

³⁷ Adults who participated in the focus groups were not eligible for participation in the telephone interviews.

Issue 1: Did interviewees discuss *Sea Monsters* with others?

All of the interviewees said they had discussed the film subsequent to their visit to the IMAX Theater. The majority said they recommended the film to others, particularly the educational and 3D aspects, while a few described conversations about the film that were of a more personal or analytical nature, as follows.

- **Two-thirds (n=9) they said they had recommended the film to one or more people, including significant others, family members, friends, children or grand children, or colleagues.** Their recommendations typically focused on one of two themes: the educational content, particularly the fossil evidence presented, or the 3D, which one woman likened to her experience of seeing fish swim around her in the large fish tanks at the neighboring Monterey Bay Aquarium. For example:
 - *I talked about it with the people I went with and then other people who were around when we were talking about it. And I talked about it with people at work and I said they should take their grandchildren. I was saying it was a good movie to take kids or grandkids to because it gives them a sense of fossils and what happened in the past. I also talked about how the 3d pulled them in and that there was enough there for anyone, kindergarten age up so basically, there was something for everyone.*
 - *I talked to my friends in general and added that it was one of the neat things we got to do. The visuals, the presentation, and the perspective on fossil research was great.*
 - *I talked to a couple of teachers that I work with about the film and told them they should check out the website and see the film if they get the chance. Probably have told another 20 people or so that they should see the film.*
 - *I talked with co-workers, my daughter, sister, family members – I went on about the 3D effect as I was very impressed with the 3D but also the educational aspects. How it was talking about fossils and what the film did to make them alive again so you could visualize them again, and what they looked like based on the fossil evidence.*
 - *My wife and I talked about it and then I talked with my son. He was really into the Dollys and the way the sea monsters came out of the screen. It was cool for him because he is 7 and it felt real but wasn't really scary so it struck a good balance. I think it made him feel like he was part of all that action you know? But we really liked the film and all and my son told his classmates about it I think too.*
 - *I haven't had a chance to talk with anyone except the people I went with, my daughter and domestic partner. We were all exclaiming how fantastic it was. The fact that it was 3D and how they executed that, it was spectacular, and it shows how far 3D has come. It just so happens that a few days after that I saw Journey to the Center of the Earth in 3D and I was actually more knocked out by the Sea Monsters one. I didn't think that other one was done as well. There was less of a sense of things jumping out at you with the other one. I liked that sense of having fish all around me. I've been to the Monterey Bay Aquarium and fish swimming around you, it was a good tie in with the aquarium, that sense of fish all around you. That is powerful.*
 - *Gosh just about everybody I told them to go see it. I thought it was great, I thought it was about archeology and evolution and the 3d was great and the animals were great however they did it, with the computer animation or however they did it. I've seen a lot of IMAX films and thought this was good, I was impressed.*
- **One-third (n=5) described discussions that indicated connections with the film on more personal level.** One man said he recommended the film to a relative who lived in Kansas as the film presented information about what the Earth was like in Kansas during the age of the sea monsters. One woman expressed her excitement about the film in the course of describing her satisfaction of seeing the IMAX Theater built on the site where a fire had destroyed the building the previous year.³⁸ A mother of a young

³⁸ According to the interviewee, a 100-year old building in the center of Monterey's downtown was destroyed by fire in February 2007 affecting more than 20 businesses.

child discussed with other parents the challenges she faced trying to settle her son down to watch the film after he became disturbed by a loud U2 3D preview to *Sea Monsters*. Two other interviewees discussed their reactions to the film's change over time theme from a Christian perspective. For example:

- *Yes, my brother and his cousin, I told them that it was pretty interesting for kids for one, and how it was interesting with all the different bones they found and how it would be a trip for him to see it because we used to live in Kansas. I told him how it came up in the film and that once a sea dinosaur lived that was bigger than a grey whale!*
 - *I talked to parents who have young kids who said they were going to see it. It was pretty minimal; I think we talked about mostly the fact that I've seen it and the age appropriateness. My son liked it but he is 5 and he wouldn't wear the glasses. The preview of U2 3D before was too loud and freaked him out so he refused to put the glasses on before the film and then we really struggled with that for a while into it. I didn't have anything negative to say about the film though.*
 - *In adjectives it was wows, it woos you! It's big, impressive, memorable, and it's an experience; you want to reach out and touch it and learned a lot of things I didn't know before. I have glorious reports to tell everyone. I haven't seen a lot of IMAX, a few, but this stood out. I've told customers at work, adults and kids, and neighbors, and it is a talk of the town, this theater is new to us so for us it is a new experience. All the talk was about the fire before and now for us we are looking at the positive. This theater is bringing a lot to the town.*
 - *I talk with my son, we talked about the movie and the diff things about the sea monsters and stuff like that. I liked it and I thought it was well made but the thing I didn't like is, well, I believe in a young universe not an old Earth, and most movies promote evolution and I'm not into that. Usually you see in these kinds of things like this - they say millions of years ago and then it goes on from there- well, I consider myself very into studies in the area of dinosaurs and I'm Christian, I knew what I was expecting. But basically, that's what I discussed, how it presented the evolution bent.*
 - *I talked about it with my boyfriend my response was more favorable than his. I just took geology in the spring and some of it was stuff we discussed in class. He is the kind of person though who hears any kind of speculation, especially about a time so long ago and it just turns him off. . . he said something about how the films say we think it looks like this and we think it looks like that, and he doesn't get into that, it turns him off. I said though that I thought as a story goes, it was a pretty good little story. But he retains a lot and reads a lot and saw things he thought contradicted relating to that time period. He has a harder time making the leap. Maybe because I'm pagan and he is open-minded and Christian. He doesn't believe in evolution.*
- **Finally, a couple of interviewees (n=2) had discussions of a more analytical nature, as they weighed the pros and cons of the film's use of the Dolly family storyline set against evidence from the fossil record.** A father discussed the issue with his wife after having seen the film with their 7 year old son while a docent from a local museum had a discussion with two fellow docents about whether the film was too "Disneyish." For example:
 - *I was there with two ladies, we had been at the Carmel mission working the day before as docent and we talked about it and one of the things we discussed a little more about it was the idea of having a brother and sister. We thought if we were going to make a film like this we would not include this element, that it was just a little too Walt Disneyish. . . We said we would not have had a brother and sister idea that carried through for the whole movie. Maybe it was slanted for whoever was thinking that way, like little kids would relate to the brother and sister and maybe that was their idea when they brought it into the storyline. That was the single thing we focused on in a negative way. So how this was presented against the fossil record and how that evidence is unlikely. It takes a stretch of the imagination to think it could it have happened that way. It was strictly for the story I thought. We thought it was forced and unnecessary. But we also thought maybe for the little kids it was okay. It could tie in for them a 10 year old.*
 - *We talked, me and my wife, about the things they can do with animation nowadays. But the only part we didn't really get was when the people were driving in the car and looking at hillside and then the Dollys being brother and sisters. That part seemed a little staged to us anyway or maybe we didn't get it so it didn't look like it flowed.*

Issue 2: Did interviewees continue to think about *Sea Monsters*?

All but one interviewee said that they had continued to think about *Sea Monsters* in the weeks since viewing. Their thoughts tended to focus on one of three areas: (i) the kinds of information scientists can uncover about marine animals from the fossil record; (ii) the film's balance of presenting scientifically accurate information about the fossil record versus using a dramatic fictionalized storyline; or (iii) the lingering effects of the 3D presentation that created the sense of swimming among the marine animals featured in the film. In particular:

- **More than one-quarter of the interviewees (n=4) found themselves thinking about how fossil evidence can be used to learn about life on Earth at an earlier time, with two wondering about connections that can be drawn to present or future day marine animals.** For example:
 - *Well, the thing I've thought about a couple of times is how some of the things that lived then still are around now and how that happens and how it is cool that we can dig up remains to be able to piece the puzzle together. I think I've just thought of that a couple of times for some reason. I guess I had never really thought about it before. I think my son has thought about the Dolly story and the brother and sister, and the dying being sort of sad, but then also liking the sharks and how there are things that lived then but he can actually see real life examples today.*
 - *I called the film to mind when we visited the Monterey Bay Aquarium's special presentation on marine animals from the deep where they show footage from MBARI. The fact that "new" creatures continue to be found made me think about the past and the future of our world. Also, while hiking the canyons of Lake Powell a few weeks ago, we saw a huge imprint on the rocks of what looked like a giant clamshell . . . it was probably 3 feet x 2feet. It too, brought me back to the film and I told the group of 9 I was with about the film and how there was a fossil within a fossil. Ultimately, the film has made me think about how little I know about science and history and how fascinating they both can be.*
 - *Yes – I recall something on the history channel and Egypt and I liked the idea of digging in the dirt and the stories with that. So I've thought that is interesting and am making connections bringing that to life - How you can dig and learn about another time, another slice of life. Maybe even something in my backyard.*
- **More than one-quarter (n=4) thought about the film's balance between a fictional storyline and the kinds of evidence scientists have actually uncovered about the Dollys from the fossil record.** In this set of comments viewers wondered about the film's balance of science content vs. a fictional story and its likely goal of communicating to a family audience while accurately representing the fossil record, or at least what is realistically obtainable. For example:
 - *Well I thought about looking up the archeologists or paleontologists mentioned and finding out more about the finds mentioned and whether they were accurate finds or just fictionalized for the movie. Sometimes they will take 3 or 4 scientists' versions and combine them and then fictionalize it, so I wanted to know more. But between summer classes and kids and all, getting to the fun stuff very often, it is all a waiting game to have a chance on stuff I'm interested in.*
 - *The only thing about the film that bothered me was that it was a little convenient that everyone in the story was in the fossil record. But I understand that is how you draw the story together. I am thinking about it on 2 levels, in that it speaks to me as Bambi. Whenever I see a fawn now, I think of Bambi and that takes me back to the film and we have a lot of deer in the park. It so happens that it is very coincidental, the heroine of the tale so to speak, how her brother is the one who gets in the stomach and then her mother is found here...so the happenstance of being able to find everyone in that family, is as an adult scientific approach type person, it seems a little coincidental because I know how hard it is to find anything in the fossil record. So maybe a cousin once removed I could see, but to find her brother - give me a break. So for me it was a stretch. So that is why when I see Bambi or a fawn I think of the movie. On the other hand though, on the level of acceptance you want to cover all your bases. I know it is valid for younger people because it gets them to buy into the story.*

- *I more discussed it early on, then I was thinking about it. I think I've thought about the science and cinematography they created was a huge thing for me. I'm a blue earth journey to earth nut and the kind of photography they did reminded me of it. I love BBC type stuff. The guy I went with is way more into it; he is the one I went with. The evolutionary part was interesting to me and what stuck around in terms of current creatures not so much the sea monsters. He liked it; he has a paleontology background and loved it. He thought it was and I thought too that it was very plot oriented for people like us we like a bit more science, but we know there is a fine line and we understand that you need a plot for the demographics who go to IMAX. When you realize you want to reach as many people as possible so it has to be story oriented. It educates people who know nothing about so it does a great job of exposing as many people as possible and especially keeping the kids and not losing them. Monterey is so family oriented it is a great location for this place.*
- **The remaining interviewees (n=4) thought about the 3D presentation.** While 3 of these viewers had reminisced about and stayed connected with the feeling of swimming among the marine animals, another had thought about the 3D quality not quite measuring up to other 3D films he had seen. For example:
 - *I keep remembering the one fish coming out; it got me good; that 3D was spectacular. I can't remember the name of the fish with the long neck. I would like to see the film again. The 2nd time I wouldn't be waiting for the jump out of your seat factor I'd be focusing on the content.*
 - *In nature, like walking the dog, the first thing that struck me 3 dimensionally was I wanted to reach out and touch all the trees. So when I walk by trees, it triggers that for me. And the creatures that slide out to me during the film, I feel closer to them. The whole experience of that was amazing and new to me. Anything nature going by that was really close, that has stayed with me. That was neat. At the end though it would have been great to have one or both come back at you rather than fading out visually like they did. That would have been more powerful and not been such a let down.*
 - *I thought the 3d was okay but it wasn't as good as I thought. I've seen some other ones that are better; I've seen lots, like Michael Jackson at Disneyland. The effects coulda been better, like the animals coming out at you, it was sort of there, but not as convincing. I liked the story though and how they put it together.*
 - *It was well made . . . and the way they made it in the 3D version, that having everything jumping in your face, and that is how it is supposed to be. The 3D glasses were nice, of the nicer ones I've seen and they are really large and comfortable wearing them and the dinosaurs were well made, someone had to take a lot of time putting those together behind a computer. It was a plus. It would have been just as good without the 3D to look good but it was done well.*

Issue 3: Were interviewees reminded of the film when encountering other print, visual, or audio media?

Interviewees were asked if they had read anything, seen anything on television or in the movies, or heard anything on the radio that reminded them of *Sea Monsters*. All of the interviewees described at least one media experience that led them to think about the film. Most often they recalled connections that occurred through television or film experiences, print media, or radio, as follows:

- **Two-thirds (n=9) of the interviewees said that they had seen something on television that reminded them of *Sea Monsters*.** Two were reminded of the film while watching previews for other films such as the giant screen film *Wild Ocean*, while the remaining viewers were reminded of *Sea Monsters* while watching specific parts of movies they had viewed either on DVD, The History Channel or the Sci Fi Channel. Their viewing of programs like *The Naked Archeologist*, the film *The Water Horse*, or a Ray Bradbury time travel movie variously triggered thoughts back to scenes or themes from *Sea Monsters* such as: the ammonites shooting ink, how researchers use the fossil record for evidence of past life, the concept of change over time or the balance of nature, or the hope that “unseen” sea monsters perhaps still exist. For example:
 - *Oh, I did see a movie it was an adaptation of Ray Bradbury's story about going back in time and the guy stepped on a butterfly, it was on the science fiction and that would totally be linked because the people couldn't step off the runway because stepping off would affect the course of nature and there was a T-rex that scared him and he stepped on a butterfly and it completely changed time. It showed how the past completely makes our future. I wish I could remember the name of it, it was on the Sci-Fi channel I really like the thought of how little changes can affect big changes, how by removing the butterfly, it couldn't lay eggs, and it couldn't eat or be eaten and how over time when it comes to today those changes affect today. So today you wouldn't want to go back and kill one of those big things as it would affect things to today, it is in the balance. All these things are back in my mind percolating.*
 - *I'm a real fan of the History Channel on TV and I'm thinking if we got any connection there in the last couple of weeks. ..Also I was watching a program on History International called the Naked Archaeologist and he was talking about dying things in the middle east and he was talking about the kind of animal that would make blue dye since the animal makes an ink and they were trying to figure out what animal did that as described in the bible . . . this guy looks in the bible and then goes back in the archeological record to find evidence for these things, but the one that looked like a Nautilus, an Ammonite, I got the visual right there and thought of the Ammonite shooting ink.*
 - *I think my son and I saw the ads for Wild Ocean and he wanted to know if that was like Sea Monsters. We haven't seen that yet but we are thinking about it. Other than that, I can't remember.*
 - *I've seen previews for other prehistoric things on Discovery or Geographic and it made me go back to it. The sea monsters themselves stood out for me.*
 - *Watching The Water Horse on DVD with my grandson made me think about the film and our “hope” that unseen “monsters” still exist.*
- **One-third (n=5) of the interviewees reported reading something that reminded them of the film.** One grandfather visited his local library to research *Tylosaurus* with his grandson. One woman thought about the fossils shown in *Sea Monsters* while reading a book about the skeleton remains of hobbits. Another woman who read and felt moved by the book *The White Bone* said she thought back to the story of *Sea Monsters* and how it also drew her in, yet qualified that she felt let down when the film ended on a visual fadeout rather than on a *punch*. Two others commented about print advertisements they had seen for the film with one being surprised about the lack of print advertisements they had seen for the *Sea Monsters* while another recalled an advertisement in a local area guide. For example:

- *After watching the film, my grandson (6) couldn't wait to go to the library so that we could read all about the creatures we saw in the film. He particularly was fascinated with the Tylosaurus, in part I think because his dad's name is Tyler.*
 - *I just read The White Bone and it has nothing to do marine animals but it is about life in Africa from an elephants perspective and it reminded me not because it is big but because it is a story that you can empathize with and relate to, and that is one thing that made it memorable for me. Other people who I talked to about it felt this way too, the story pulls you in and you connect with it. Except for the ending it sort of faded it, it faded out visually perhaps to end the era but it didn't end with a punch, like a big sympathy so that was a bit of a let down. A lot of us, friends and family at least, we felt that way, I've had people tell me that unsolicited as well. And if stories don't end right, you are sort of left let down. But other than that, we liked it all.*
 - *Just peripherally – I was reading something about the hobbits the little people, the skeletons around java and I was thinking about fossils in general and that brought in the movie.*
 - *I can't remember reading something. I also thought there might be something like more publicity for the film. I don't remember it being well advertised. Like newspapers though, I never see the ads, I block them out*
 - *Oh, I do see the ad for it in the weekly local area guide. It is advertised there I noticed it.*
- **One-fifth (n=3) said they were reminded of *Sea Monsters* while viewing other theater-based films including *Journey to Planet Earth*, *Adrenaline Rush*, *Narnia*, and *Wall-E*.** In these cases their connections related to the film's Dolly story, 3D, or change over time theme, as follows:
 - *I took my kids to the Tech Museum there and we thought about it there. We went to see the Alps IMAX and it was different. Then we went to the Egyptian Museum and I thought about it because of the different cultures and history and how things have changed. We also went to see Wall-E and there thought about the connection of how things change and how the different strata's of the earth are going to build up again. I thought how they should have the water is built up on the continents and wondered if we might be doing that again. I thought that theme was well done in the movie.*
 - *I hardly watch TV; we just moved and are working on the house. We usually watch Discovery and Animal Planet and that would have triggered it for me. My boyfriends brother sees a lot of movies, and oh, we did see Narnia and that sort of gave a human persona and that gave a human empathy type thing where you can put yourself in their shoes, like the Dollys, and that reminded of the sea monsters as well.*
 - *Well the 3D I just saw the 3D movie Journey to Earth and I made a connection, just that both it was 3D. I thought they were very comparable in that regard. I happened to see it at San Jose Century theaters.*
 - *Well yes, when I saw Journey to Earth I thought about Sea Monsters and I did a critical comparison in my head and Sea Monsters in a sense came up better, than the so called commercial film. I think Sea Monsters was shorter but even so, it did a much better job in the 3d like I said.*
 - **Another one-fifth (n=3) said that they had heard something on the radio about time travel, Bigfoot, or evolution that brought the film to mind, with the rest of the interviewees (n=11) qualifying that they rarely or never listen to radio.** For example:
 - *I heard that some men claimed to have the frozen body of a Bigfoot, and I thought of the film because of man's innate fascination with "monsters" which made me think of the film.*
 - *I usually listen to books on tape last one was Tale of Two Cities and that one didn't remind me of that at all. And I'm now listening to Timeline but that it is time travel and - well come to think of it there is a connection there. I would hate to take a time machine back to that time though!*
 - *I listened to radio programs which occasionally brought up the subject of evolution or dinosaurs...I have videos and dinosaurs which talk about other people who are say scientists who believe in young earth. The thing is people who believe in evolution generally don't like the young earth teaching because it goes back to the bible and they usually say that is a religious teaching but when you look at it is science, not just religion. The millions of year theory is not very strong because of the piles and piles of information that is against it like the dust on the moon, the magnetic strength of the Earth which would indicate a younger Earth. So a lot of people are narrow minded in the mind of looking at religions perspective.*

Issue 4: Did interviewees do anything new or Different as a result of seeing *Sea Monsters*?

Interviewees were asked whether seeing *Sea Monsters* had affected anything that they had done in the weeks since they saw the film. More than half reported that they had done something new or differently, including: seeking out additional information about topics in the film, keeping “an eye out” for the possibility of discovering potential fossils, or not eating sushi the night of viewing the film. In particular:

- **More than one-quarter (n=4) sought out additional information about topics in the film either at a local science center, a bookstore, the National Geographic website, a television documentary, or at a rock and mineral show:** For example:
 - *We went to the aquarium and looked at the shark stuff and talked about how they live today but also so long ago and how that could happen and then about how scientists discover the fossils that tell us about that time. We are still really kind of amazed at how they haven't changed that much in appearance; it makes me respect their importance even more. I'm not sure my son gets that, but he knows they have been around along time at least.*
 - *I bought my grandson a dinosaur book called *Boy Were We Wrong About the Dinosaurs*. I went to the National Geographic website to look at other products, and as I have said, I've discussed these issues with others more than ever before. Another thing it has made me do is be more cognizant of recycling, composting, and “going green” because of the aspects the film presented on global change.*
 - *For me it also makes me want to go back and check out more nature type shows like *Blue Planet* and *National Geo* and *Discovery* that have happened. Rather than watch more regular programming that isn't so good for me so it has motivated me back to that.*
 - *The day I was going to see that show I was wearing my ammonite pendant. I got it at a rock and mineral show. I wear it frequently. I learned more about that animal and thought about it a bit more afterwards and visited another show.*
- **One-fifth (n=3) talked about keeping “an eye out” for the possibility of discovering potential fossils in a way they had never thought to do before.** For example:
 - *Actually there is a connection, one of the things I recently did, and I don't know whether this was conscious or not, I asked them to bring in some earth because I wanted to collect some pigment in the Earth, diatomaceous earth is from the diatomes so I'm not sure how far back that goes but within our local area we have all these foothills that have been deposited over time and they mine that and our local individuals use that as pigment for their paintings. So perhaps by watching I thought this is something I wouldn't otherwise do and it spurred me on.*
 - *My friend and I talked about digging some more after watching the film. It made us want to dig some more, got motivated.*
 - *It gave me a whole new awareness I didn't have before, I didn't know any of those creatures from that Crustaceous period, maybe kids do but me being in my 50s I didn't know anything like that, and to get that information in such an enjoyable format, that is exciting, I love it from an awareness point of view. I've found myself thinking about where I used to live in Arizona, and I'm like oh...that used to be under water . . . in the film it was Kansas but I also lived in Wisconsin and I wondered what that was like and how there were glaciers and what was it like then and how we are a dot in the timeline. It brought all of that more to the surface for me. I also actually keep my eye out for new discoveries a bit more. With that whole discovery theme in the film. We haven't had time yet but we like to go hunting for rocks and so where before we might say, oh maybe this is a crab thing . . . now we'd be like . . . well, this could be some kind of fossil...you never know. I see it is possible.*
- **One interviewee, alternatively, noted something he did *not* do as a result of viewing the film, as in:**
 - *I didn't go for sushi that night.*

Issue 5: What did interviewees do with the *Sea Monsters* posters?

Interviewees were asked to describe what happened to the *Sea Monsters* posters they were given at the theater site. The colored poster shows a giant *Tylosaurus* attacking a *Cretoxyrhina* as a *Dolychorhynchops* swims away. It also illustrates how millions of years later, paleontologists working far from ocean waters discover the fossil of the *Tylosaurus*. A copy of the poster can be downloaded from the project website under *Sea Monsters' Extras*.³⁹ Most of the interviewees said they had reviewed the poster and then actively did something with it, while a couple hadn't looked at the poster but still had possession of it, and a couple more either couldn't recall what happened to it or said they passed it on to children or relatives but hadn't followed up from there. In particular:

- **Nearly three-quarters (n=10) said they had read or looked at the poster and then did something with it after leaving the theater site.** Three had tacked the poster on a wall and referred to the marine animal names or looked at the activities, while two others had placed it on their desk and planned to use it with their students or with a Boy Scout troop working for geology badge. Another put it in a summer scrapbook with other memorabilia from the time he spent with his grandson and then gave an extra copy to a middle school teacher. A couple more said they reviewed the poster briefly before passing it on to grandkids or to friends with kids. Another said she had discussed the poster with friends at dinner after seeing the film. For example:
 - *But would you believe it is in my computer room? I thumb tacked it on the wall and I was glad I had to put it up. If you gave me a test I'm pretty sure I wouldn't do so well.*
 - *I looked at it and thought it was really cool, it seems like 6 months ago but I kept it around for about a week then, I looked at it and thought about the activities it called out and what I could do as part of my docent work at the historical park and I couldn't really make any connections. I have a friend at work who has 8 grandkids so I gave it to her to give her grandchildren. Recycled.*
 - *We looked at it, and he (son) has it up in his room. He hasn't done the activities yet, but it is there now up on the wall and he likes looking at it.*
 - *It is currently in my room I read it all over and saw all the activities. I didn't throw it out or anything. It helped me remember the names of the things, so I did refer to it since I don't study these things regularly. And it has a pronunciation guide so when I describe there is this thing and it looks like...it doesn't really help, so I was able to bring it out and show it to people talking about all the main ones talked about it in the film.*
 - *Since there were other people in our party, I was lucky enough to have one to give to the 7th grade science teacher at the middle school where I work, and the other is in a summer scrapbook for my six-year-old grandson who was with us at the film.*
 - *I read it and my granddaughter read it and then I packed it up for my grandson. I just thought it was well done and scientific and well presented. My granddaughter is from North Carolina and they don't believe in evolution, well she does but a lot of her friends don't so we walked through some of the issues. I hope to share it with my grandson, he will want the poster for his wall*
 - *We got there as there were 3 of us, and we took them home. It is not put up anywhere, there were 3 of us. There was my boyfriend's brother, I don't know if he put it up. My boyfriend did look at it the other day. We are both artists and we have the wall full of things. I thought that was cool in getting that, we took them to a restaurant afterwards and looked at them and it was nice to get them and do something nice for "National Geographic. It was fantastic and we will take it out sometime. We are paring down with integrating households so that says a lot right there.*
 - *It is on my desk and I am taking back to school and I am a science teachers. I teach 8th grade and it might fit in my curriculum somewhere. I have a collection of things to take to the classroom.*

³⁹<http://www.nationalgeographic.com/seamonsters/educators/>

- *I looked at it the day we got it and laid it on the shelf and did that and they only pulled it out the last couple of days. We are getting ready to talk about because our boys are in scouts and in it we talk about geology and they are getting ready to get their geology badge and we can tie that in since there were places I went to as well.*
- **A couple of interviewees (n=2) said they still had the posters and planned to do something with them, but hadn't to this point.** For example:
 - *I walked away with a poster and it went to my car. I haven't looked at it but I also haven't thrown it away so that says something I thought I would put it on my wall or look it.*
 - *I took it home. It is still there I haven't had a chance to look at it yet but have been very busy.*
- **Finally a couple more interviewees (n=2) couldn't recall what happened to the poster or gave it away to a daughter and cousin and hadn't followed up from there.** For example::
 - *No – you just reminded me. I don't know what happened to it. We only got one; my husband didn't get one, in my house it's out of site out of mind.*
 - *I gave it one of my cousins and my daughter has one, and left it in the room. I don't know if anyone has looked at it.*

Issue 6: Did interviewees visit the *Sea Monsters* website?

Interviewees were asked if they visited the *Sea Monsters* website, and if so, to describe what they did. Most did not, and were unaware of the site, but a couple did access the site, as follows:

- **A couple of interviewees (n=2) reported visiting the *Sea Monsters* website.** One read about the animals featured in the film and did some of the interactives while another tried to watch video clips but wasn't able to get them to work at her office computer:
 - *Yes, I clicked on the thumbnails of the creatures and read the info and did some of the interactive stuff . . . very cool.*
 - *I believe I did and pulled it up. I only have a computer at work and haven't had a real chance to look at it and if it is streaming video they have blocked us so we can't see it at work. So they have it so we can't see it just read text.*
- **Among the remaining 12 interviewees who did not visit the website, 8 stated that they did not know there was a *Sea Monsters* website.** For example:
 - *No – I don't know they had a website, I would assume they would because everything has a website but it didn't cross my mind to check it out*
 - *No – I didn't know about it. It is probably on the poster.*
- **Four (n=4) stated that while they did know about the website, they either forgot about it, didn't have questions to pursue, or still planned to look at it:**
 - *No I haven't yet but it was one thing I wanted to check out. I know IMAX has one so I thoughts id look that direction first.*
 - *I haven't had a chance to. It slipped my mind. I think I heard it but it has been a rough week.*
 - *No, I think I saw that, everything has a website, so it doesn't mean anything to me. If I wanted questions answered I would look at a website, like the thing about the 3D glasses.*
 - *No I meant to with the kids but haven't gotten to it. It is mentioned on the poster I believe just didn't get to it.*

Issue 7: Did interviewees have additional comments they wanted to share with the producers?

At the conclusion of the interview, participants were offered the opportunity to add any other thoughts or comments that they would like to share with the producers of *Sea Monsters*. Two-thirds of the interviewees responded with additional comments. Most often interviewees praised something about the film while a few described mixed reactions to the film or offered suggestions. In particular:

- **One-third (n=5) of the interviewees took the opportunity to add additional praise for the film, focusing on the storyline of the fossil discoveries, the emphasis on the Dolly as a main character, or the 3D.** For example:
 - *Oh, I think they did a great a job and I hope they'll do a sequel and look at other problems. The production values were really good, and I liked them using each of the scientists in that story.*
 - *Embedding all the facts within a "story" about one creature was unique. It made following the film more enjoyable I think for both young and old.*
 - *I am from Santa Barbara and I thought it would be great for Santa Barbara natural history museum and it would be nice if there was an IMAX format there. It was the first thing like that I have seen in 20 years because what I find horrifying they find funny - I haven't seen anything like that since I went to Disneyland and saw the ghost haunted house where it seems like they are sitting next to you where he you can touch them on the nose. I am a real scary cat and if it was scary I wouldn't have stuck out my hand but I found myself putting my hand out and I saw a lot of people doing that, to see how close you could get. As for the part of the Dolly, I thought about her dying and that was really good because we don't show enough life and death in our society, so for me it was cycle of life, and we have to as a society accept that this happens and it isn't always that violent, it is important to show things going through the life cycle. I thought this was a great way of showing the cycle; if I had to talk about kids about death and dying this would be perfect. I liked it and I was rather surprised, and knew it was because we have a problem in our society and people need to address it. We need to respect creatures that hit an advanced age and note that they have a lot to teach. They want it by adventure or violence but we need to show that everyone needs to be prepared for and aware of it. It isn't all car crashes. And finally, I'm really grateful for the opportunity to provide feedback because most of the time I look at TV and movies and it doesn't talk to me or ask me for my feedback. This is great to be able to have my perspective heard. I don't get out a whole lot, but we are docents for a historic park so we went up there to demonstrate where it was available at founding day celebration. It would be great to have some IMAX in central California.*
- **More than one-quarter (n=4) of the interviewees ended by praising the film but also pointing out something they wish had been handled differently in how the film was produced or promoted.** Three interviewees focused on their desire for more science and less story from the film. For example:
 - *I like paleontologists more with facts and findings. Less story for me would have been good; there are plenty of people who are the other direction. For me it moved really fast and we were going from one thing to another quickly and didn't give me enough time to process anything in particular. I wanted more, folks.*
 - *No the only thing that hit me when I first read about Sea Monsters was I thought it would be more of a fantasy thing rather than more scientific so I kind of wish they put something also that it was more scientific like paleontologists or archeologists so something to make it so it wasn't so much Lochness monster rather than something that was more scientific. My initial thing before seeing it was that it would be more fantasy and it was actually more reality. So when I describe it to people I note that it was worldwide and science and real. I wasn't sure, that's all, but with the science and all it was more.*
 - *I think they should be complimented on their creativity and computer enhanced work. I can't imagine how they did it. From a technical standpoint I thought it was marvelous, it was just that it was a little bit too convenient is all.*

Summary of Findings

This section reviews the findings from the *Sea Monsters* giant screen film evaluation as supported by the reactions of the adult and youth audience that viewed and gave feedback on the film at an IMAX theater site in Monterey, California, in June 2008. The evaluation was conducted by Knight-Williams Research Communications, an independent evaluation firm specializing in the development and evaluation of informal science educational media.

Evaluation goals and approach

Following from the informal science education goals stated in the proposal to the National Science Foundation (NSF), which subsequently provided funding for the project, the evaluation addressed the following broad questions:

- To what extent did the film appeal to the viewers?
- What did viewers like and dislike about the film?
- How did viewers respond to the film's investigative storytelling and use of 3D?
- How did viewers respond to the film's clarity of presentation and the amount of information and science presented?
- What were the most interesting things viewers felt they learned from the film?
- What new information, ideas, and concepts did they learn about the Late Cretaceous period, the marine animals of this period, and research that paleontologists have conducted to learn about these animals?
- To what extent did they feel they were likely to recommend the film to others and seek out information about the Late Cretaceous period?
- To what extent did they discuss, think about, or engage in any film-related activities subsequent to viewing?

To address the above set of questions, the evaluation was conducted in three phases:

Phase 1 – Pre-post questionnaires: The first phase of the evaluation examined the appeal and immediate educational impact of the film as assessed by adult and youth performance on a post-viewing questionnaire completed within minutes of seeing the film, as compared to the performance of a separate sample of viewers who completed the same set of content questions prior to seeing the film.

Phase 2 – Focus groups: Drawing from the same group of participants recruited for the Phase 1 post-viewing questionnaire, the evaluation team then conducted a total of 5 focus groups with adult and youth viewers following 5 separate showings of *Sea Monsters*. The group discussions allowed for a more in-depth exploration of viewers' reactions to the film's storyline, use of 3D, and depiction of Late Cretaceous marine animals.

Phase 3 – Follow-up interviews: Follow-up telephone interviews were conducted with a subset of adult viewers who completed questionnaires but did not participate in the focus groups. The interviews were conducted approximately 2-2.5 weeks after viewers visited the theater. The interviews explored the longer term impact of the film and whether and how viewers or their families used the project's outreach components.

Theater Context

Phases 1 and 2 of the summative evaluation occurred at the IMAX Theater located in Monterey, California. The theater was opened on Cannery Row in 2008 as "*a new state of the art IMAX 3D Theater to bring to "The Row" the Ultimate Movie Experience to offer visitors and locals immersive film experiences on the giant screen for their enjoyment.*" <http://www.bellacinema.com/index.html>.

The Cannery Row IMAX Theater was chosen from among a short list of theaters showing the film at the time of the evaluation for the following reasons. First, at the time the evaluation took place, the theater had the highest number of daily shows (4 per day), offering a higher potential participation rate for the evaluation. Second the theater was showing the film in 3D, an integral aspect of the evaluation, as described in the NSF proposal. Third, the theater is located within a short walking distance from the Monterey Bay Aquarium, one of the world's largest aquariums, and in 2007 named the top kid-friendly aquarium among the "The 10 Best Aquariums for Kids" by Parents Magazine. Each year approximately 1.8 million people visit the aquarium, including over 80,000 students from throughout California. The majority of the family groups that participated in the evaluation reported that they made their trip to the IMAX Theater before or after visiting the Aquarium. Theater staff also confirmed this to be a common practice among their family visitors. This natural pairing of a commercial theater with a non-profit informal science education center focused on aquarium education and outreach seemed an appropriate fit for a summative evaluation funded by the ISE division of the National Science Foundation.

Phase 1: Questionnaire Findings

A total of 259 adults and youth participated in the Phase 1 evaluation, which examined the overall appeal, learning value, and motivational impact of the film at the theater site. From this total, 141 viewers and 118 pre-viewers completed questionnaires that subsequently formed the basis for the evaluation report. Chi-square analyses indicated that the two groups did not differ significantly with respect to 5 of the 6 measured variables, including: gender, race/ethnicity, age group, education, or number of giant screen films viewed. Differences were found for the number of 3D films viewed, however, such that the viewing group included a significantly higher percentage of more frequent viewers than did the pre-viewing group.

The viewing group portion of the sample included:

- Somewhat more females (57%) than males (43%).
- A wide range of ages, spanning 6-91 years, with a mean age of 34.
- A racial distribution comprising 78% Whites, 6% Asian, 3% African-American, 1% Native Hawaiian or Pacific Islander, and 6% multiracial viewers. One-tenth (11%) of the participants were of Hispanic Origin.
- A combination of high school through graduate level educated respondents, including: 41% with a high school education or less (includes youth viewers), 42% with some college education or a college degree, and 17% with some graduate school education or a graduate degree.
- An equal balance of frequent vs. occasional viewers of giant screen films, including 50% who reported they had only seen 0-2 films prior to seeing *Sea Monsters* and 50% who reported they had seen 3 or more films. A higher percentage of frequent 3D film viewers compared to less frequent viewers, with 64% reporting they had seen 3 or more films and 38% reporting they had only seen 0-2 3D films prior to seeing *Sea Monsters*.

Findings in this section are presented in 3 parts:

Part 1: Viewers' reactions to the appeal and entertainment value of Sea Monsters

Part 2: Viewers' learning experience from Sea Monsters

Part 3: Viewers' intentions of recommending Sea Monsters and seeking out information related to the film

Part 1: Viewers' reactions to the appeal and entertainment value of *Sea Monsters*

Viewers were asked to rate how much they liked the film, to describe what they liked and didn't like about it, and to rate the film's entertainment value with respect to storytelling and visual excitement. The main findings are summarized below.

- **Viewers rated the film high for overall appeal.** When asked to rate how much they liked or disliked *Sea Monsters* on a scale of 1 (disliked) to 7 (liked), the mean rating for the viewing group was 6.5. No subgroup differences were found among viewers' ratings with respect to gender, age, education, or number of giant screen or 3D films previously seen.
- **When viewers were asked to describe what, if anything, they liked about *Sea Monsters*, 97% identified at least one thing they liked, with most viewers mentioning two or more things.** Nearly half the viewers (47%) pointed to the film's use of 3D, characterizing it as *cool, realistic, high quality*, or observing that it made them feel like they were *part of the action*. One-third (35%) pointed to the film's storyline, describing it as *engaging, cohesive*, or as an *interesting* way to present science information. The next three top themes to emerge across the viewers' responses related to the film's educational value,⁴⁰ with 29% liking the information presented on the Earth's history or evolution, particularly as communicated through the time-lapse sequence, and 27% each liking the variety of marine animals featured or the fact the film was generally informative and educational. Somewhat less frequently viewers pointed to the film's aesthetic or entertainment value, with 23% enjoying that the film was visually pleasing and 18% liking that it was exciting or fun. Much smaller groups of viewers pointed to the film's sound or music as a nice back-drop (12%) or the portrayal of scientists' work (4%).
- **When viewers were asked to describe what, if anything, they disliked about *Sea Monsters*, the largest group (33%) replied that they liked "everything" about the film, while an additional 11% left the question blank.** Among those who did dislike some aspect of the film, the largest group of viewers (17%) said they felt the film was *too loud*, followed by two smaller groups who either felt the film was *too short* (12%) or the storytelling was *choppy, predictable, repetitive, lacking action or excitement*, or had *cheesy acting* (11%). Five additional issues were mentioned by 6% or less of the viewers, including those who: did not like the film's sad ending or scary parts (6%), felt there was too

⁴⁰ In a recent review of giant screen film learning (Flagg, 2000) Dr. Barbara Flagg observed that viewers typically report that a "wonderful learning experience" is among the top three things they like about giant screen films, with viewers particularly enjoying the opportunity to learn new and unfamiliar facts, concepts, methods, or processes and frequently complaining that giant screen films are too light on information. The review further observed that the typical audience of giant screen films in American museum theaters is highly educated, with approximately one-third having a post-graduate degree. In this evaluation of *Sea Monsters*, however, only 11% of the viewers had a post-graduate degree. Note also though that this evaluation was conducted in a commercial theater situated in close proximity to an aquarium, and that the recruiting priority was on youth and adults given that families were a key audience for the film. Flagg, B.N. (2000), Lessons learned from Giant Screen Films, Giant Screen Films and Lifelong Learning, *Complete Symposium Proceedings*, (August), Giant Screen Theater Association (GSTA).

much focus on Dollys and not other creatures (6%), wanted more science and less story (5%),⁴¹ took issue with the evolution/age of Earth information presented as fact instead of theory (4%), and/or felt the time-lapse sequence was *too fast paced* or *dizzying* (4%).

- **Viewers agreed that *Sea Monsters* offered an interesting story and they were even more enthusiastic about the film's level of visual excitement.** The mean rating for story interest was 6.3 on a scale of 1 (boring story) to 7 (interesting story) and the mean for visual excitement was 6.8 on a scale of 1 (visually dull) to 7 (visually exciting). No subgroup differences were found among viewers' ratings with respect to gender, age, education, or number of giant screen or 3D films previously seen.

Part 2: Viewers' learning from *Sea Monsters*

The film's learning value was evaluated with a combination of open-ended and forced-choice self-report and objective content-based assessments. First, viewers rated the film for clarity, amount of information, amount of science, and how much they estimated they learned using scales from 1-7. Second, viewers described the most interesting things they learned from the film. Third, to assess knowledge gains relating to the Late Cretaceous period and marine animals, both viewers and pre-viewers completed a "quiz" type assessment that included a total of 28 true/false, multiple choice, and open ended questions. Finally, both viewers and pre-viewers were asked to estimate their own knowledge about "the age of the sea monsters" on a scale of 1 to 7 as a measure of self-reported knowledge about the film's overall topic prior to and after the film. These findings are briefly summarized below:

- **Viewers found the film offered them a generally clear presentation.** Using a scale of 1 (confusing) to 7 (clear), the mean rating was 6.5. No subgroup differences were found among viewers' ratings with respect to gender, age, education, or number of giant screen or 3D films previously seen.
- **Viewers felt that the amount of information presented in the film was about right.** On a scale of 1 (too little) to 7 (too much), with 4 being just right, the mean rating was 4.0. One subgroup difference was found with respect to gender as females rated the amount of information significantly higher than did males (means, 4.3 vs. 3.9).
- **Viewers also generally felt the amount of science presented in the film was about right.** On a scale of 1 (too little) to 7 (too much), with 4 being just right, the mean rating was 4.0. Here again one subgroup difference was found, but this time with respect to education. Viewers with a lower level of education (high school or less) rated the amount of science significantly higher than did those with an education that included some college or beyond (means, 4.4 vs. 3.9).
- **Viewers estimated they learned a considerable amount from *Sea Monsters*.** When asked to rate the amount they felt they learned on a scale of 1 (learned nothing) to 7 (learned a lot) the mean rating

⁴¹ Note that the percentage of viewers citing a preference for more science in the *Sea Monsters* summative evaluation conducted in 2008 (5%) was considerably smaller than was found for the *Forces of Nature* evaluation conducted in 2004 (22%), although the *Forces of Nature* evaluation was conducted with adults only and in a museum-based theater setting (the Reuben F. Fleet Science Center in San Diego).

was 6.2, indicating viewers generally gave the film high marks with respect to overall learning value. There were two subgroup differences for this question as females estimated they learned significantly more than did males (means, 6.4 vs. 5.9), and less frequent or first time viewers of 3D films felt they learned significantly more than did more frequent viewers (means, 6.5 vs. 6.0).

- **The most interesting things viewers said they learned from watching *Sea Monsters* focused on one of three themes: the diversity of the Late Cretaceous marine animals (26%), how these animals survived, ate, and bred (22%), and/or the kinds of information that can be uncovered from fossil discoveries and research (22%).** A smaller group of viewers (13%) enjoyed learning about how the Earth has changed over time, while a few small groups pointed to information they learned about the size of the Late Cretaceous marine animals (6%), how they resemble animals today (4%), other themes (4%), or indicated that nothing stood out or was new for them (4%).
- **Viewers significantly out-performed pre-viewers on a “quiz” consisting of true/false, check-list, and short answer questions designed to estimate the impact of *Sea Monsters* on viewers’ learning about prehistoric marine animals and the Late Cretaceous period.** Out of a total possible score of 28, the viewing group averaged 22 correct responses, while the pre-viewing group averaged just 11. The effect size, which helps us to know whether the difference is a difference of practical significance, was 2.11, which is generally considered a very large effect. No subgroup differences were found among viewers’ scores with respect to gender, age, education, or number of giant screen or 3D films previously seen.

The findings for each of the 4 question sets are summarized below. The question sets addressed topics relating to: 1) the Doliochorhynchops; 2) other marine animals that lived during the Late Cretaceous period; 3) the Earth during and after the Late Cretaceous period; and 4) the discoverers of fossil evidence relating to the Late Cretaceous period.

Question set 1: the Doliochorhynchops

Out of a possible score of 10 on the first question set relating to *Doliochorhynchops*, viewers significantly outperformed pre-viewers, with the viewing group averaging 9 correct responses, and the pre-viewing group averaging just 3. The effect size in this case was 2.36, generally considered a very large effect.

This first question set asked evaluation participants to identify, through a true/false question format, which characteristics and behaviors among a list of 10 items did scientists believe applied to the sea creature. The percentages differences between the two groups for each item were consistently high, 58% on average, both for the “true” items (Had paddle-like flippers, Was a fast swimmer, Was an air breather, Was a little bigger in size than a dolphin) and the “false” items (Ate only plants, Was shaped like a giant squid, Was born on land, Stayed in deep waters year-round, and Had a long neck, about half its body length). One exception was found for the item “Was a reptile.” The difference between the two groups in this case was only 8%, as 36% of viewers knew this to be true compared to 28% of pre-viewers. There are several possible interpretations for this finding. For example:

- Turning first to the film narration for context, the term reptile is used 12 times over the course of the film, 11 times in reference to various marine reptiles of the Late Cretaceous period, but only 1 time when specifically referencing a Dolly. Across these uses the word reptile is either used alone or prefaced with the word “marine,” “oceanic,” or “enormous.” An additional indirect reference is also made to Dollys as being reptiles when the narrator observed that the female Dolly and her brother were air breathers. The viewing group’s lack of a higher score on this question could therefore have to do with the varying ways in which the term reptile was used in the film.

- Alternatively, the background knowledge viewers brought to the film could be at play. As will be observed in the Phase 2 focus group findings, one group's discussion about the diversity of marine animals featured in the film segued into a debate about whether the Dolly was a reptile or a mammal. As participants exchanged information they recalled learning about the Dolly from the film against any prior knowledge they had about what constitutes a mammal versus a reptile, they focused on the significance of laying eggs vs. having a live birth, nursing, caring for young, and air breathing. This group of viewers encountered some challenges in squaring the film's portrayal of the Dolly with their prior knowledge about reptiles vs. mammals.
- Finally, while a brief literature search uncovered little on the public's knowledge or attitudes toward marine reptiles specifically, references to reptiles in general were found. A common theme in this work involved the public's misconceptions about and even negative attitudes toward reptiles, as reflected in the following quote from Kaplan (1997) on the use of reptiles in public education: "*Wildlife educators who use reptiles, either solely or as part of a larger group of animal representatives, have a great opportunity to help individuals overcome fears and learn facts to replace myths.*"⁴² It is possible that the Dolly did not fit into viewers' pre-existing misconceptions about reptiles.

Other interpretations are possible, however, and might be looked at by the project team.

Question set 2: Other animals that lived during the late Cretaceous period:

Out of a possible score of 6 on the second question set relating to other marine animals that lived during the Late Cretaceous period, viewers significantly outperformed pre-viewers, with the viewing group averaging 5 correct responses, and the pre-viewing group averaging just 3. The effect size in this case was 1.20, generally considered a very large effect.

Looking across the 6 items, 4 of the questions were true/false items that asked about animals (other than the Dolly) featured in the film. The fifth question asked viewers a 2-part yes/no question about a) whether sharks lived during the age of the sea monsters and then b) to explain how/why scientists know this to be the case. The evaluation found that on the 4 true/false questions: 1) More than two-thirds of viewers (68%) compared to one-fifth of pre-viewers (22%) knew that the statement "*During the age of the sea monsters Ammonites were rare among the marine animals*" was false; 2) Three-fifths of viewers (60%) compared to two-fifths of pre-viewers (41%) knew that the statement "*Only the largest sea monster was safe from attack*" was false; 3) Four-fifths of viewers (81%) compared to two-thirds of pre-viewers (65%) knew that the statement "*During the age of the sea monsters dinosaurs roamed the Earth*" was true; and 4) Four-fifths of viewers (84%) compared to one-third of pre-viewers (36%) knew that the statement "*During the age of the sea monsters Tylosaurs were likely territorial with each other*" was true. Finally, on the 5th 2-part question that asked "*Did sharks live during the age of the Sea Monsters?*" a higher percentage of viewers correctly replied "Yes" to this question compared to pre-viewers (89% vs. 64%) and were then able to identify that scientists know this to be the case as a result of evidence obtained from the fossil record (76% vs. 42%).

Question set 3: The Earth during and after the Cretaceous period:

Out of a possible score of 4 on the third question set that related to the Earth during the Cretaceous period, viewers again significantly outperformed pre-viewers, with the viewing group averaging 3 correct responses and the pre-viewing group averaging 2. The effect size in this case was 1.39, generally considered a very large effect.

This question set featured 2 True/False questions and, like with Question set 2, a 2-point open ended question. On the first True/False question almost all of the viewers (94%) compared to less than half of pre-viewers (46%) correctly answered that the statement "*During the age of the sea monsters the states we now*

⁴² *Melissa Kaplan's Herp Care Collection: The Use of Reptiles in Public Education* ©1997 Melissa Kaplan
<http://www.anapsid.org/repsineduc.html>

know as Kansas and Texas were under water" was true. Similarly almost all of the viewers (96%) compared to two-thirds of pre-viewers (64%) correctly answered that "*During the age of the sea monsters most of the Earth was covered by land*" was false. The final 2-point question began "*Imagine...Millions of years ago a sea creature dies of old age and then sinks to the bottom of the sea*" and then asked respondents to identify the natural events that occurred over time to make it possible to discover the remains of this creature today. For this two-part question, one point was awarded for identifying either of two types of natural events presented in the film, summarized here as "fossilization" or "exposure." Fossilization was defined as the process of converting or being converted into a fossil (preserved from a previous geological age) where exposure was defined as a lowering or receding of the waters or uncovering through other natural forces such as through volcanic activity. Two points were awarded for identifying both types of events. The evaluation found that four-fifths (83%) of viewers compared to half (49%) of pre-viewers scored 1-2 points on this question.

Question set 4: The discoverers of fossil evidence relating to the Cretaceous period

Finally, out of a possible score of 8 on the fourth question set that related to the discoverers of fossil evidence from the Cretaceous period, viewers significantly outperformed pre-viewers, with the viewing group averaging 6 correct responses and the pre-viewing group averaging just 4. The effect size in this case was .93, generally considered a large effect.

This question set asked evaluation participants to identify, through a True/False question format (similar to that asked for Question Set 1), the various types of people who have been responsible for discovering the remains of sea monsters. The percentage differences between the two groups for the correct items were consistently fairly high, 38% on average. The differences spanned up to 45% in two cases for the items "hikers/campers" and "construction workers" where 90% and 91% of viewers knew this to be false, respectively, compared to 45% and 46% of pre-viewers. The differences were somewhat smaller for "miners" and "paleontologists," but were still between 11% - 20%. In the case of paleontologists, the smaller difference could be partly a function of viewers and pre-viewers having prior knowledge that paleontologists discover prehistoric remains and then extrapolating this definition to marine animals. In the case of "miners," viewers might not have recognized their role as discoverers given that the film briefly showed miners at a phosphate mine within an Israeli construction site. Some viewers may have assumed the miners were construction workers, which, as noted above, 91% of viewers correctly identified as a type of discoverer.

- Finally, viewers rated their knowledge of the age of the sea monsters significantly higher than did pre-viewers. When asked how much they felt they knew about the age of the sea monsters on a scale of 1 (know nothing) to 7 (know a lot) as a simple self-report measure, the mean rating for viewers was 4.2 vs. 2.2 for pre-viewers.

Part 3. Viewers' intentions of recommending *Sea Monsters* and seeking out information related to the film

- Viewers felt they were likely to recommend the film. Using a scale of 1 (won't recommend) to 7 (will recommend) the mean rating for the group was 6.3. Two subgroup differences were found for this question as adults were more likely to recommend the film than were youth (6.5 vs. 5.9) and viewers with an education beyond high school were more likely to recommend the film than were those with a high school education or less (means, 6.5 vs. 6.0).
- Viewers estimated they were somewhat likely to seek out information about the age of the sea monsters. Using a scale of 1 (won't seek out) to 7 (will seek out), the mean rating was 4.9. One subgroup difference was found as more frequent viewers of giant screen films (3+films) felt they were significantly more likely to seek out information than did less frequent or first time viewers (means, 5.2 vs. 4.6).

Phase 2: Focus Group Findings

This section summarizes the findings from 5 focus groups conducted with one-third (35%) of the viewers who completed a post-viewing questionnaire after seeing the film. Recruitment for the sessions focused on families because the project team expected that *Sea Monsters* would be a particularly appealing and effective learning tool for families. Among the 50 participants, there was an even split of males and females. About half of the participants (n=26) were 15 years or younger and half (n=26) were 16 years or older. The average age of the adults was 47 while the average age of youth was 12. As with the Phase 1 questionnaire evaluation, the majority of the participants were White (80%), with 8% Asian, 6% multiracial, 4% African-American, and 2% Native Hawaiian or Pacific Islander. On average, participants had previously seen 3 giant screen films and 3 3D films.

All 5 sessions were held in an open room located adjacent to the theater lobby and led by the same trained moderator and an assistant. The discussion sessions ran approximately 45-50 minutes, which included time for: recruiting and settling participants into the discussion room, introductions, an ice-breaker activity, discussion, wrap-up, and providing an honorarium.

The following summary identifies the major themes that were uncovered looking across the 5 groups relating to the following 4 issues:

Issue 1: What did participants notice about the Late Cretaceous marine animals?

Issue 2: How did participants respond to the 3D?

Issue 3: How did participants respond to the investigative storyline?

Issue 4: What remaining questions did participants have about the film?

Issue 1: What did participants notice about the marine animals?

To help break the ice and explore what participants noticed about the diversity and adaptations of the marine animals featured in the film, the moderator asked participants to draw as many as they could remember from the film, and to try to include features that helped each animal adapt to its environment. Participants seemed engaged in this drawing activity, with several commenting that they found it to be *amusing*, a *good ice breaker*, or a *useful way to think about what stood out* for them about the animals featured in the film. Although 8 minutes was set aside for this activity, most participants wanted additional time to work on their drawings. Given other priorities and time constraints, the moderator waited an additional 2-3 minutes and then asked participants to put their pencils down, which proved a challenge for some younger members in each group.

The major themes that emerged from the drawing activity and subsequent discussions are summarized below.

- **Participants drew as few as 3 to as many as 11 different marine animals. On average though, participants drew a total of about 7 different animals.** Almost all of the participants drew Dolichorhynchops (93%) and Ammonites (91%). Between two-thirds and three-quarters of the participants drew pictures of Tylosaurus (76%) Styxosaurus (76%) Tusoteuthis (71%), or sharks such as Cretoxyrhina or Squalicorax (67%). Between one-fifth and two-fifths of the participants drew birds such as Hesperornis or Pteranodon (42%), little fish (36%), and/or sea turtles (20%).

- **Many participants, particularly adults and younger children, expressed surprise at how many different marine animals the film depicted and how big they were.** Participants' remarks about the diversity of marine animals shown in the film were often joined with exclamations of how big the animals were or how little they previously knew about them. Older youth were more divided on this issue, however, with some reasoning that it wasn't surprising that the marine animals were so large given the size of dinosaurs and others wishing the film had covered other animals that lived during the age of the sea monsters.
- **When invited to discuss anything else that surprised them about the animals featured in the film, participants most often pointed to similarities they observed between prehistoric and modern marine animals.** Adults tended to discuss the concept of similarities in general terms *while* youth were noticeably more focused on calling out specific similarities, and while they most often focused on comparisons between modern vs. prehistoric sharks, various other comparisons were also raised between animals such as: Tylosaurs and alligators, Hesperornis and puffins, Ammonite and nautilus, Dolichorhynchops and dolphins, and even *Styxosaurus* and giraffes.
- **Some participants expressed confusion over whether the Dolly was a marine reptile or mammal.** In one group, for example, a 13 year old girl's observation about the Dolly seeming similar to a modern day dolphin segued into a lively discussion about whether the Dolly was in fact a mammal or a reptile. When the girl elaborated that she was interested to learn that the Dolly was a mammal since it didn't lay eggs, another youth quickly countered a loud "No!" which led to a brief silence among the group members, followed by a collegial debate about whether the Dolly qualified as a mammal or reptile. In the process the group exchanged information they recalled learning about the Dolly from the film against any prior knowledge they had about what constitutes a mammal versus a reptile, with participants tending to focus on the significance of laying eggs vs. having a live birth, nursing, caring for young, and air breathing.

Issue 2: How did participants respond to the film's use of 3D?

- **Participants overwhelmingly agreed that seeing the film in 3D was central to their enjoyment of the film.** Many could not imagine watching the film in 2D, with one father and son pair going so far to say that the large group with whom they saw *Sea Monsters* would not have made the trip were it not for the 3D.
- **When characterizing the 3D's appeal, these participants and others most often described it as offering them *lifelike* or *realistic* views of prehistoric life that enabled them to *study* the marine animals up close or just *feel* that they were among them.** Youth tended to focus on how much they enjoyed the experience of *reaching out* or *grabbing* at the sea monsters that swam by them. Parents of younger children often chimed in that from their standpoint, the film struck just the right balance of being realistic but not *thrill-seeking* or *too scary* for young children. Frequent viewers of 3D films added that the quality of the 3D compared favorably to other 3D films they had seen because it was *more true-to-life* or *less cartoonish*.

Issue 3: How did participants respond to the film's use of an investigative storyline?

- **Adults and younger youth readily praised the film's investigative story for helping to *keep things moving, adding intrigue, or delivering science information in an interesting way*, but older youth were somewhat divided on this issue.** While some youth liked the investigative storyline, others felt it made the film seem too *chopped up* or at times *disrupted the action* scenes between the marine reptiles. Some of these youth wanted to see *more in-depth coverage* of the fossil discoveries while others wanted more time spent on the *raw animal action*.
- **Participants in all groups talked about the film's focus on fossil discoveries, with many participants expressing surprise to learn that the discoveries have taken place all over the world, and at different times, and by non-professionals.** Adults and older youth also tended to focus on the accidental or randomness of the fossil discoveries, or how fossils were often discovered by chance rather than someone specifically looking for them. Adults also frequently noticed the care with which discoverers handled the fossils they uncovered. Some older youth were more focused on the researchers portrayed in the film, or those who were seen making the discoveries and doing the work of sorting and interpreting the evidence that has contributed to our understanding of prehistoric marine animals. Most often these youth observed that they didn't generally find the researchers appealing as they either didn't look *scientific*, were *too old*, or weren't enough like *Indiana Jones*.
- **Many participants brought up the film's story around the Dolly family, and in particular the film's ending where the female Dolly dies of old age.** Several adults raised the point that they thought the story was *touching, human-interest oriented, sad, or sweet*. Some further observed that the Dolly story effectively communicated a *cycle of life* message, to which a few older youth disagreed, characterizing the death as *predictable* rather than compelling. Many of the youngest participants focused on the Dolly's death as being *sad*, with a few going further to say that they wished she had died from *being eaten* rather than old age, explaining that this would have been *easier to take*.

Issue 4: What kinds of questions did participants still have about the film?

- **Many participants indicated the film left them with any remaining questions.** Several different types of questions emerged across the groups, including those relating to: predator-prey relations, what you can or can't tell from fossil evidence, how prehistoric marine reptiles became extinct, what else lived at the time of the prehistoric marine reptiles, how the Earth has changed since prehistoric times and will continue to change, and the film's educational applications.

Phase 3: Follow-up telephone interview findings

This section summarizes the findings from telephone interviews conducted with 14 viewers of *Sea Monsters* within 2 to 2.5 weeks after viewing the film. A total of 14 interviewees completed interviews. Eight (8) interviewees were women and 6 were men. The average age was 47, with a range of 25-70. All of the participants were White.

The interviews explored the extended impact of the film in terms of the following 7 issues:

Issue 1: Did interviewees discuss Sea Monsters with others?

Issue 2: Did interviewees continue to think about Sea Monsters?

Issue 3: Were interviewees reminded of the film when encountering other print, visual, or audio media?

Issue 4: Did interviewees do anything new or different as a result of seeing Sea Monsters?

Issue 5: What did interviewees do with the Sea Monsters posters?

Issue 6: Did interviewees visit the Sea Monsters website?

Issue 7: Did interviewees have additional comments they wanted to share with the producers?

Issue 1: Did interviewees discuss *Sea Monsters* with others?

➤ All of the interviewees said they had discussed the film subsequent to their visit to the IMAX Theater.

The majority said they generally recommended the film to others, particularly the educational and 3D aspects, while a few described conversations that were of a more personal and/or analytical nature, as follows:

- Two-thirds (n=9) they said they had recommended the film to one or more people, including significant others, family members, friends, children or grand children, or colleagues. Their recommendations typically focused on one or two themes: the educational content, particularly the fossil evidence presented, or the 3D format, with one woman likening it to her experience of seeing fish swim around her in the large fish tanks at the neighboring Monterey Bay Aquarium.
- One-third (n=5) described discussions that indicated a connection with the film that was on more personal level. One man said he recommended the film to a relative who lived in Kansas as the film presented information about what the Earth was like in Kansas during the age of the sea monsters. One woman expressed her excitement about the film in the course of describing her satisfaction of seeing the IMAX Theater built on the site where a fire had destroyed the building the previous year.⁴³ A mother of a young child discussed with other parents the challenges she faced trying to settle her son down to watch the film after he became disturbed by a loud U23D preview to *Sea Monsters*. Two other interviewees discussed their reactions to the film's change over time theme from a Christian perspective.
- Finally, the remaining interviewees (n=2) had discussions of a more analytical nature, as they weighed the pros and cons of the film's use of the Dolly family storyline set against evidence from the fossil record. A father discussed the issue with his wife after having seen the film with their 7 year old son while a docent from a local museum had a discussion with two fellow docents about whether the film was too "Disneyish."

⁴³ According to the interviewee, a 100-year old building in the center of Monterey's downtown was destroyed by fire in February 2007 affecting more than 20 businesses.

Issue 2: Did interviewees continue to think about *Sea Monsters*?

- All but one interviewee said that they had continued to think about *Sea Monsters* in the weeks since viewing. Their thoughts tended to focus on one of three areas: (i) the kinds of information scientists can uncover about marine animals from the fossil record; (ii) the film's balance of presenting scientifically accurate information about the fossil record versus using a dramatic fictionalized storyline; or (iii) the lingering effects of the 3D presentation that created the sense of swimming amongst the marine animals featured in the film. In particular:
- More than one-quarter (n=4) found themselves thinking about how fossil evidence can be used to learn about life on Earth at an earlier time, with two wondering about connections that can be drawn to present or future day marine animals.
 - Another quarter (n=4) thought about the film's balance between a fictional storyline and the kinds of evidence scientists have actually uncovered about the Dollys from the fossil record. In this set of comments viewers wondered about the film's balance of science content vs. a fictional story and its likely goal of communicating to a family audience while accurately representing the fossil record, or at least what is realistically obtainable. Their comments included:
 - The final quarter (n=4) thought about the 3D presentation. While 3 of these viewers had reminisced about and stayed connected with the feeling of swimming amongst the marine animals, another had thought about the 3D quality not quite measuring up to other 3D films he had seen.

Issue 3: Were interviewees reminded of the film when encountering other print, visual, or audio media?

- All of the interviewees described at least one media experience that led them to think about the film. Most often they recalled connections that occurred through television or film experiences, followed by print media, and then radio. In particular:
- Two-thirds (n=9) said that they had seen something on television that reminded them of *Sea Monsters*. Two were reminded of the film while watching previews for other films such as the giant screen film *Wild Ocean*, while the remaining viewers were reminded of *Sea Monsters* while watching specific parts of movies they had viewed either on DVD, The History Channel or the Sci Fi Channel. Their viewing of programs like *The Naked Archeologist*, *The Water Horse*, or a Ray Bradbury time travel movie variously triggered thoughts back to scenes or themes from *Sea Monsters* such as: the ammonites shooting ink, how researchers use the fossil record for evidence of past life, the concept of change over time or the balance of nature, or the hope that "unseen" sea monsters still exist.
 - One-third (n=5) reported reading something that reminded them of the film. One grandfather visited his local library to research *Tylosaurus* with his grandson. One woman thought about the fossils shown in *Sea Monster* while reading a book about the skeleton remains of hobbits. Another woman who read and felt moved by the book *The White Bone* said she thought back to the story of *Sea Monsters* and how it also drew her in, yet qualified that she felt let down when the film ended on a visual fadeout rather than on a *punch*. Two others commented about print advertisements they had seen for the film with one being surprised about the lack of print advertisements they had seen for the *Sea Monsters* while another recalled an advertisement in a local area guide.
 - More than one-quarter (n=4) said they were reminded of *Sea Monsters* while viewing other theater-based films including *Journey to Planet Earth*, *Adrenaline Rush*, *Narnia*, and *Wall-E*. In these cases their connections related to the film's Dolly story, 3D, or change over time theme.
 - The smallest group (n=3) said that they had heard something on the radio about time travel, Bigfoot, or evolution that brought the film to mind, with the rest of the interviewees (n=11) qualifying that they rarely or never listen to radio.

Issue 4: Did interviewees do anything new or different as a result of seeing *Sea Monsters*?

- More than half of the interviewees reported that they had done something new or differently in the 2 to 2.5 weeks after seeing *Sea Monsters*, including seeking out additional information about topics in the film, keeping “an eye out” for the possibility of discovering potential fossils, or not eating sushi the night of viewing the film. In particular: Four (n=4) interviewees sought out additional information about topics in the film either at a local science center, a bookstore, the National Geographic website, a television documentary, or at a rock and mineral show. Three (n=3) more interviewees talked about keeping “an eye out” for the possibility of discovering potential fossils in a way they had never thought to do before. One interviewee noted something he did not do as a result of viewing, which was: I *didn't go for sushi that night*.

Issue 5: What did interviewees do with the *Sea Monsters* posters?

- Most of the interviewees said they had at least read or looked at the *Sea Monsters* poster they were given at the theater site after completing the evaluation. Nearly three-quarters (n=10) of the interviewees said they had read or looked at the poster and then actively did something with it after leaving the theater site. Three individuals, including one father, had tacked the poster on a wall at home and had referred to the sea creature names or activities, while two other had placed it on their desk and planned to use it in the fall with their students or with a scout troop working for geology badge. Another interviewee put it in a summer scrapbook with other memorabilia from the summer time he spent with his grandson and then gave an extra copy to a middle school teacher. A couple more interviewees said they reviewed it briefly before passing it on to grandkids or to friends with kids. Another interviewee said she had discussed the poster at dinner after seeing the film with friends. The remaining interviewees said they still had the posters and planned to do something with them, but hadn't to this point (n=2) or couldn't recall what happened to the poster or gave it away to a child or relative and hadn't followed up from there (n=2).

Issue 6: Did interviewees visit the *Sea Monsters* website and if so, what did they do?

- Most interviewees did not visit the *Sea Monsters* website, with at least one contributing factor being that they didn't know about it. About one-sixth (n=2) of the group reported visiting the *Sea Monsters* website. One interviewee read about the animals featured in the film and did some of the interactives while another tried to watch video clips but wasn't able to get them to work at her office computer. Among the remaining 12 interviewees who did not visit the website, 8 stated that they did not know there was a *Sea Monsters* website. Four more (n=4) stated that while they did know about the website, they either forgot about it, didn't have questions to pursue, or still planned to look at it.

Issue 7: Did interviewees have additional comments they wanted to share with the producers?

- Two-third of the interviewees offered additional comments that they wanted to share with the producers. One-third (n=5) took the opportunity to add additional praise for the film, focusing on the emphasis on the Dolly story, the storyline of the fossil discoveries, or the 3D element. More than one-quarter (n=4) also pointed out something they wish had been handled differently in how the film was produced or promoted, mostly focusing on their desire for more science and less story from the film, while one mother focused on the challenge she faced just getting her son to focus on and enjoy the film after having a negative experience watching a loud U2D preview.

Conclusions

The above findings show that *Sea Monsters* appealed to the Cannery Row IMAX viewers recruited for the evaluation and had a significant impact on their knowledge of prehistoric marine animals and the Late Cretaceous period during which these animals lived. Overall, viewers liked the film, thought the story was interesting, felt the film was visually exciting and clear, judged that the film struck the right balance in terms of the amount of information and science provided, and they expected to recommend it to others. While viewers were somewhat divided about whether they would seek additional information about the film's topics upon leaving the theater, the follow-up telephone interviews revealed that all those interviewed ultimately made some connection to or took an action related to the film within 2-2.5 weeks of viewing.

The role of subgroup differences

Only a few subgroup differences emerged across the evaluation findings, involving the variables of age, gender, educational level, prior giant screen film experience, and prior 3D film experience, but in each case only one or two differences were found. On the variable of age, adults were more likely to recommend the film than youth, yet there were no other significant differences in how youth versus adults responded to the film in terms of appeal or learning. For gender, females estimated they learned more from the film than did males, yet there was no significant difference in their scores on the 28 item content assessment. For educational level, two differences were found as more educated viewers were (i) more likely to recommend the film, and (ii) perceived that the film had a lower than desired amount of science, as compared to less educated viewers; here again though, there were no other significant differences in how viewers of varying educational backgrounds responded to the film in terms of appeal or learning. Finally, for each prior film experience variable, one difference was found. Frequent giant screen viewers were more likely to seek additional information in the future about the film's topics than were less frequent or first time viewers. Meanwhile, less frequent viewers of 3D films estimated they learned more from the film than did more frequent viewers. In both cases, though, there were again no other significant differences in how the subgroups responded to the film in terms of appeal or learning.

In sum, relatively few subgroup differences were found across the evaluation findings, indicating the film was well received by and successful with both males and females and with individuals of varying ages, levels of education, and giant screen and 3D film viewing experience.

The added context of the focus group discussions

The focus groups both shed light on viewers' questionnaire responses and provided further insight into their experience with the film within an hour of viewing. For example, the first 15 minutes of each discussion session revealed participants' fascination with drawing and talking about the Late Cretaceous marine animals that appeared in *Sea Monsters*. Participants consistently showed a high degree of interest in and capacity for visually representing the animals, and they were struck by the diversity of the Late Cretaceous animals as well as their resemblance to modern animals. While participants were impressed by many marine animals – such as Tylosaurus, Styxosaurus, sharks such as Cretoxyrhina or Squalicorax, and Tusoteuthis – they most frequently drew Ammonites and Dolichorhynchops. During the discussions, participants more often talked about the Dolly, tending to focus on the animal's survival habits, whether it qualified as a mammal or reptile, and the Dolly "story." Participants often characterized the Dolly story as *touching, human-interest oriented, sad, or sweet*. And yet, the story also generated areas of disagreement about whether the ending, which culminated in the death of the female Dolly, effectively communicated a cycle of life message. Where many adults characterized her death as a *sensitive and thoughtful* portrayal of the cycle of life, older youth tended to view it as a *predictable* ending, and the youngest participants often found it *hard to take or too sad*.

Participants' discussions about the Dolly also offered further insight into the questionnaire findings on viewers' learning from the film, as it highlighted a possible source of confusion underlying viewers' assessment of whether the Dolly was a marine reptile. While this wasn't a planned topic of discussion, some participants voiced their uncertainty about whether the Dolly was a marine reptile or mammal. One group even had a collegial debate about this issue during which group members examined information presented in the film against their prior conceptions of each animal group, weighing the relative significance of the physical attributes and behaviors of laying eggs, having a live birth, nursing, caring for young, and air breathing.

While both the 3D and storyline emerged as the most frequently praised aspects of the film in the questionnaire findings, the group discussions helped illustrate how these features were central to viewers' enjoyment. The 3D was repeatedly praised for the *lifelike* or *realistic* glimpse it afforded into prehistoric life that in turn enabled viewers to *study* the marine animals up close or just *feel* that they were among them. The 3D film enthusiasts within the groups were quick to compare the film favorably to other 3D films because it was *more true-to-life* or *less cartoonish*. Youth were more focused on expressing how much they enjoyed the chance to *reach out* or *grab* at the marine animals that swam by them, while parents of younger children appreciated that the film struck the right balance of being *realistic* but *not too thrill-seeking* or *scary* for young children. In terms of the investigative storyline, adults and younger youth readily praised it for helping to *keep the narrative moving*, adding *intrigue*, or *delivering science information in an interesting way*, although the group discussions also revealed some nuances about it appealing less to some older youth, who felt that the technique made the film seem too *choppy* at times or *disrupted* the animal action scenes they liked watching.

Finally, the group discussions were also useful to uncover questions that viewers were left with after viewing, questions that involved: predator-prey relations, information that researchers can reasonably decipher from fossil evidence, how Late Cretaceous marine reptiles became extinct, what other animals lived during the Late Cretaceous period, how the Earth has changed since the Late Cretaceous period and will continue to change, and the film's educational applications. These questions provide clues as to unresolved issues viewers take away from the film, topics they may choose to research on their own, and opportunities that the *Sea Monsters* project may consider for providing follow-up outreach salient to viewers' interests.

The extended influences of the film

Beyond the immediate impact of the film at the theater site, the evaluation also found that *Sea Monsters* continued to influence viewers more than two weeks later. During the telephone interviews, most of those interviewed reported that they: were still thinking about some aspect of the film; had discussed the film with friends, family, or co-workers; and had seen something on TV, read something in a magazine, book, or online, or heard something on the radio that reminded them of *Sea Monsters*. Most had also done something new or different after seeing *Sea Monsters* – ranging from seeking additional information at local science centers, bookstores, or rock shows, to keeping “an eye out” for the possibility of discovering fossils in a way they had never thought to do before. Since the film addressed topics that are not frequently in the news or affect most people's daily routine, the fact that all of the interviewees subsequently found ways to make connections to or take actions related to the film on their own accord is notable.

While the interviews gathered feedback from a fairly small group of viewers, this qualitative method uncovered a diverse set of connections 2-2.5 weeks after viewing that could be explored more closely, particularly to inform the development of other informal science education film projects focused on similar topics. As it turned out, few interviewees reported doing anything that specifically involved the project's formal companion materials, with the exception of looking at or reading the poster/activity guide they were given, and few seemed aware that there was even a *Sea Monsters* website. Yet viewers talked at length about personal

connections they had experienced with *Sea Monsters*, when, for example: visiting museum exhibits at institutions ranging from the Smithsonian to the Egyptian Museum, watching IMAX films from *Wild Ocean* to *Adrenaline Rush*, watching other theater-based movies from *Narnia* to *Wall-E*, watching television programs from *The Naked Archeologist* to *Bambi*, reading books from *The White Bone* to the works of Ray Bradbury, listening to radio programs on topics such as Bigfoot to evolution, visiting local businesses from sushi restaurants to rock and mineral shows, and fossil hunting in places as close to home as the backyard garden to nearby lakes and canyons.

One potential theme reflected in viewers' *Sea Monsters* connections is the incidence of connections that occur, even spontaneously, when viewers are interacting with entertainment media, pursuing hobbies, and going about the business of their daily routines. Further exploring the often idiosyncratic paths viewers arrive at in making these film connections may help future projects (i) tailor, and make more relevant, the traditional companion books, educational guides, and websites offered by ISE film projects, and (ii) consider new avenues for outreach, possibly through synergistic relationships with other film, television and radio projects, as well as museum exhibits and programming.

The film's broader informal science education implications

The findings from *Sea Monsters* also offer broader implications for other giant screen film projects aiming to informally educate the public about science facts, concepts, or research. Although the evaluation was conducted at only one theater site due to budget constraints and to allow for in-depth focus group discussions, the findings add further support to a conclusion reached in a review of 10 giant screen films funded by the NSF (Flagg, 2005):⁴⁴

Summative evaluations of 10 giant screen films indicate that the NSF's grants have been well spent. Viewing these films significantly increases the science knowledge base of adults and students; improves interest in and attitudes toward science content; broadens viewers' understanding of what scientists do; and positively impacts viewers' actions after a museum visit.

While the evaluation did not measure viewers' science attitudes or understanding of what scientists do, it did assess: their scientific knowledge of prehistoric marine animals and the Late Cretaceous period in which they lived; their expectations of seeking out additional information about the film's topics; and the extent to which a subgroup of viewers ultimately pursued actions subsequent to their theater visit. In each of these areas, the film was found to be successful.

Beyond confirming these findings, the evaluation also raises new issues for consideration around three aspects of the giant screen viewing experience that have received little or no evaluation attention to date: the use of 3D, the use of a dramatic and investigative storyline, and the role of the theater viewing context.

First, in terms of the film's use of 3D, viewers clearly applauded not only that the film used 3D, but how it used 3D. Viewers often praised the 3D for offering an *engaging, lifelike*, and yet *non-scary* view of the Late Cretaceous period, and some couldn't imagine *not* seeing the film in 3D. Future research might explore the relative value of 3D, given the kind of appeal it generated in this context, as weighed against its cost and feasibility. Whether viewers would have experienced the same level of enthusiasm or fascination with the

⁴⁴ Flagg, Barbara, Beyond entertainment: Educational impact of films and companion materials, *The Big Frame*, Spring 2005, pps. 51-66.

Late Cretaceous marine animals like Dolly without the 3D element, for example, is uncertain since the evaluation was not designed to address this question.

Second, the film's dramatic and investigative storyline was also generally well received and viewed as an effective way to communicate science information about the marine animals that lived during the Late Cretaceous period. Yet a number of issues could be explored more closely in this case as well. For example:

Why did some youth in the focus groups feel that interspersing the investigative-style footage of the fossil discoveries with the dramatic animal action scenes disrupted their enjoyment of the film, yet adults tended to like the technique for creating intrigue, for moving the narrative forward, and for imparting science information in an interesting way? How does this style of storytelling enhance or detract from a film's appeal and learning value with different audiences?

Why was it that youth and adults generally grasped the main facts about Late Cretaceous marine animals assessed in the evaluation, yet some viewers in the follow-up telephone interviews were concerned about a "Bambi" type blurring of fiction and fact within the Dolly story – a blurring that they queried could lead to incomplete or inaccurate knowledge about marine reptiles like Dolly and what the fossil record has *actually* told us about the Dolly family portrayed in the film. Here again, the larger issue to explore might be how the juxtaposition or weaving of scientific fact and an investigative fictional storyline lends itself to enhance or detract from a film's appeal and learning value with different audiences. Other similar questions could be asked of both the film's 3D and storyline features.

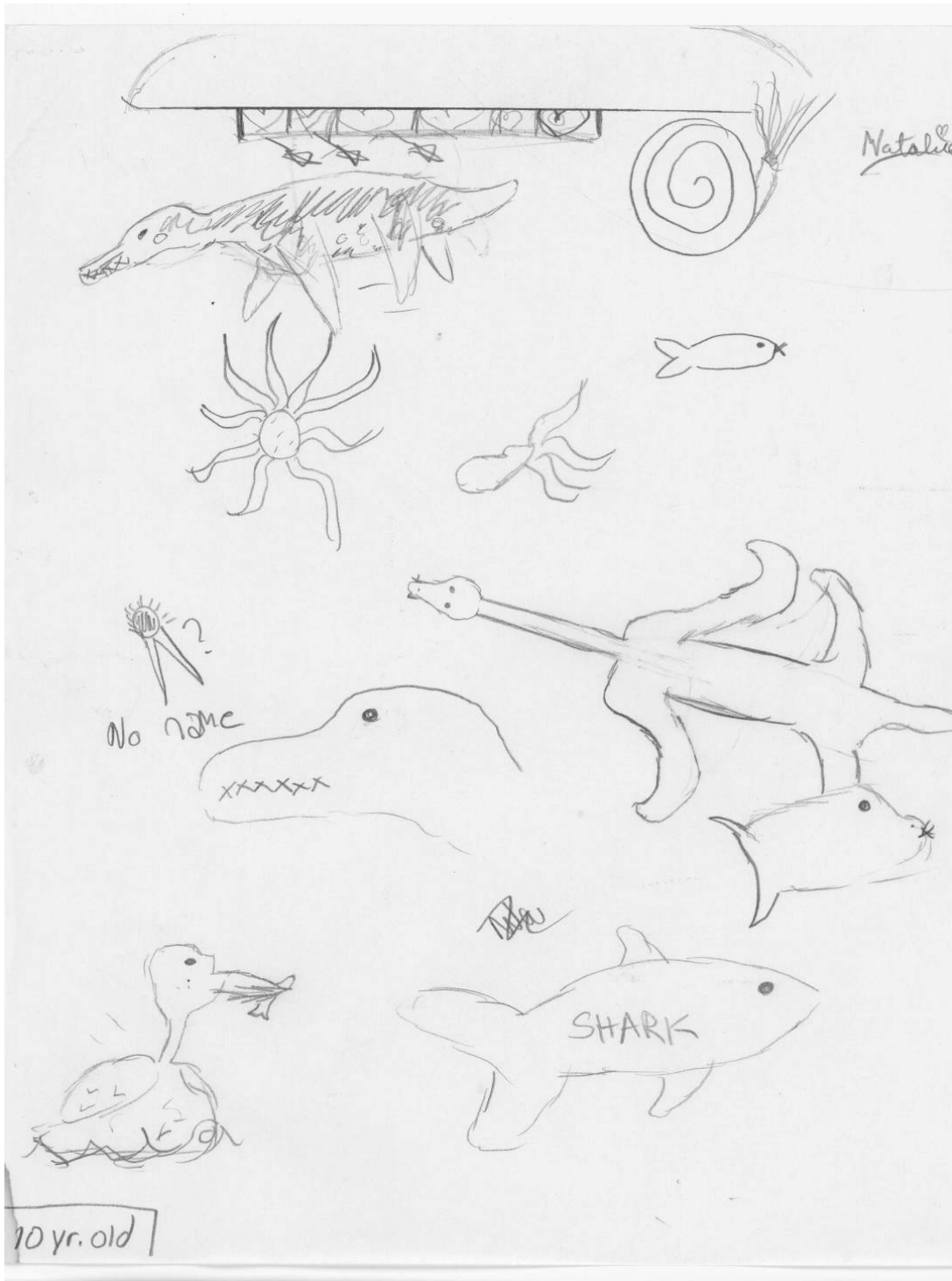
Finally, viewers participating in the evaluation watched the film in a commercial theater setting, not a science center or other museum-based theater setting. Although a preeminent aquarium is located within walking distance of the theater and is often visited in tandem by theater-goers, the viewing setting was still within a commercial theater institution. By contrast, most, if not all, of the previous summative evaluations of informal science education giant screen films have occurred within informal science center or museum settings. What is the significance of this difference?

Future studies might look at this issue of viewing context in greater depth, both in terms of the physical setting of the theater, and the role of supporting exhibits or programs in priming or extending viewers' film experience. Looking more closely at the types of viewers who frequent each type of theater also seems an area ripe for further investigation. For example, if commercial theaters draw a somewhat different or broader audience than may be typically seen at museum-based theaters, what are the implications of this difference to how films are distributed, marketed, and supplemented with outreach programming? Given that the NSF seeks to invest in projects that increase interest, engagement, and understanding of science and other STEM disciplines by *individuals of all ages and backgrounds*, research on audiences that experience NSF supported films in different theater contexts could contribute to this "broader impact" goal.⁴⁵

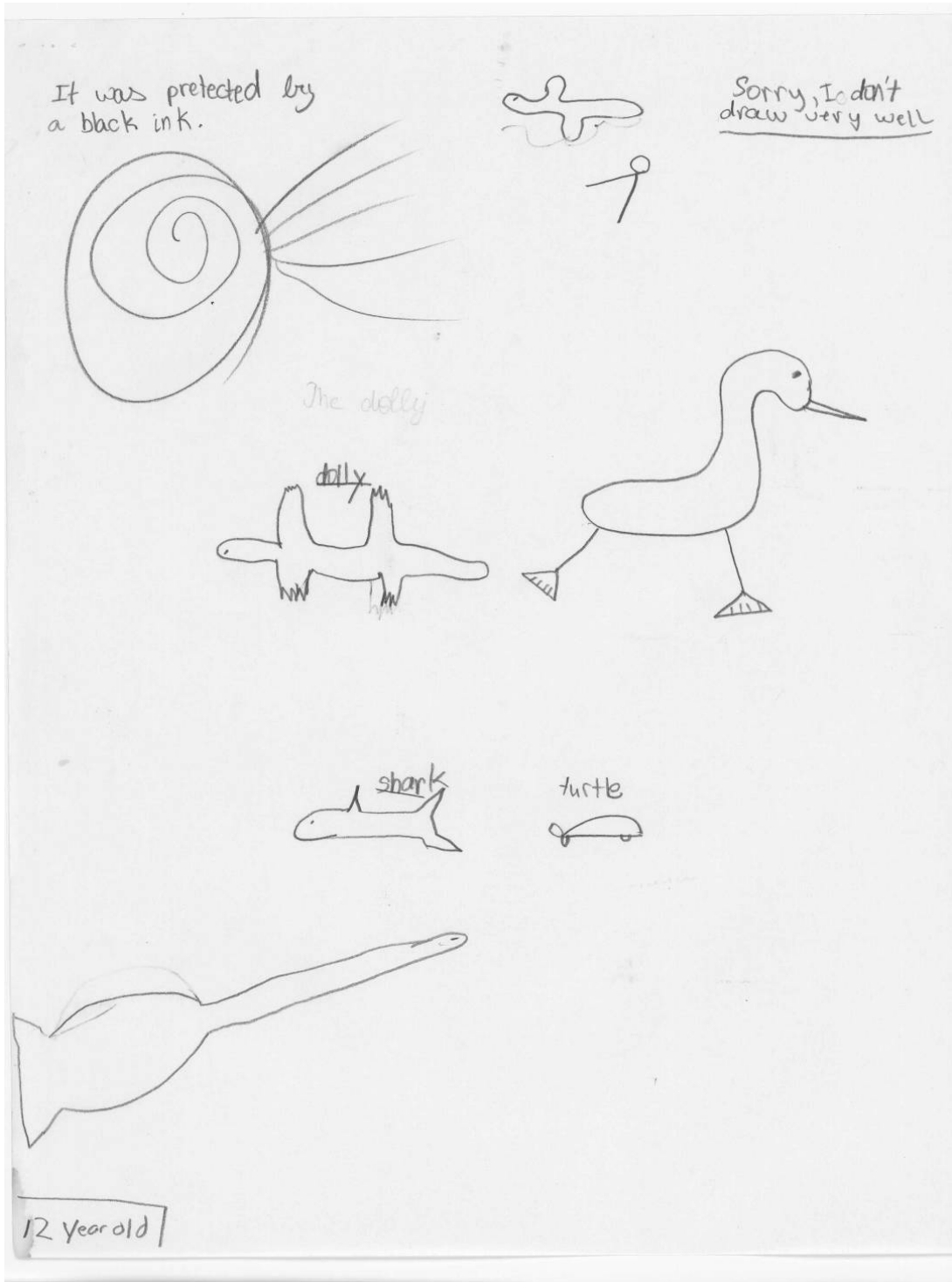
⁴⁵ As stated on the NSE ISE program web page: "*The ISE program invests in projects that develop and implement informal learning experiences designed to increase interest, engagement, and understanding of science, technology, engineering, and mathematics (STEM) by individuals of all ages and backgrounds*" http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5361&org=DRL&from=home

Appendix 1

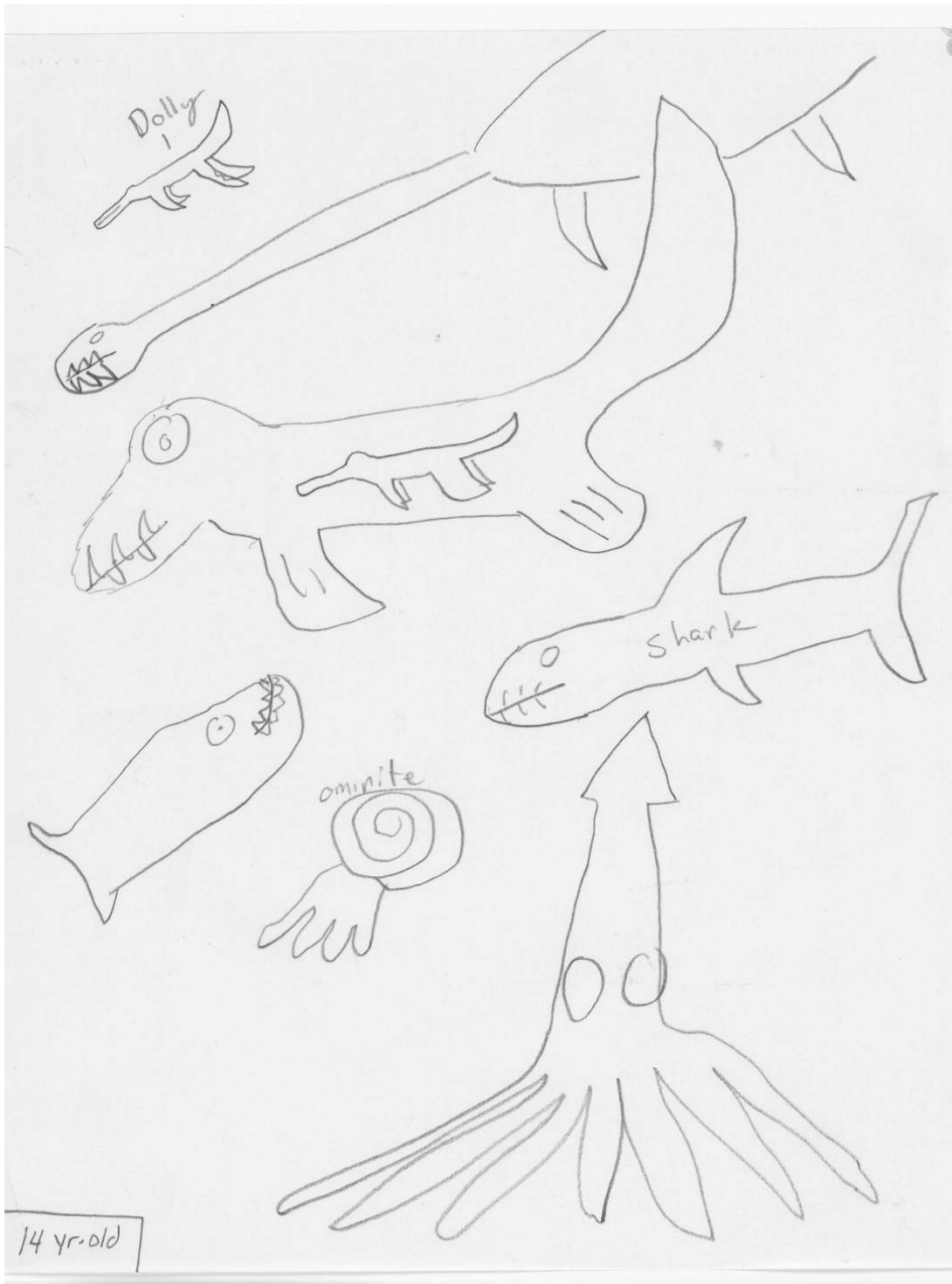
Sample drawings of marine animals by youth and adult focus group participants



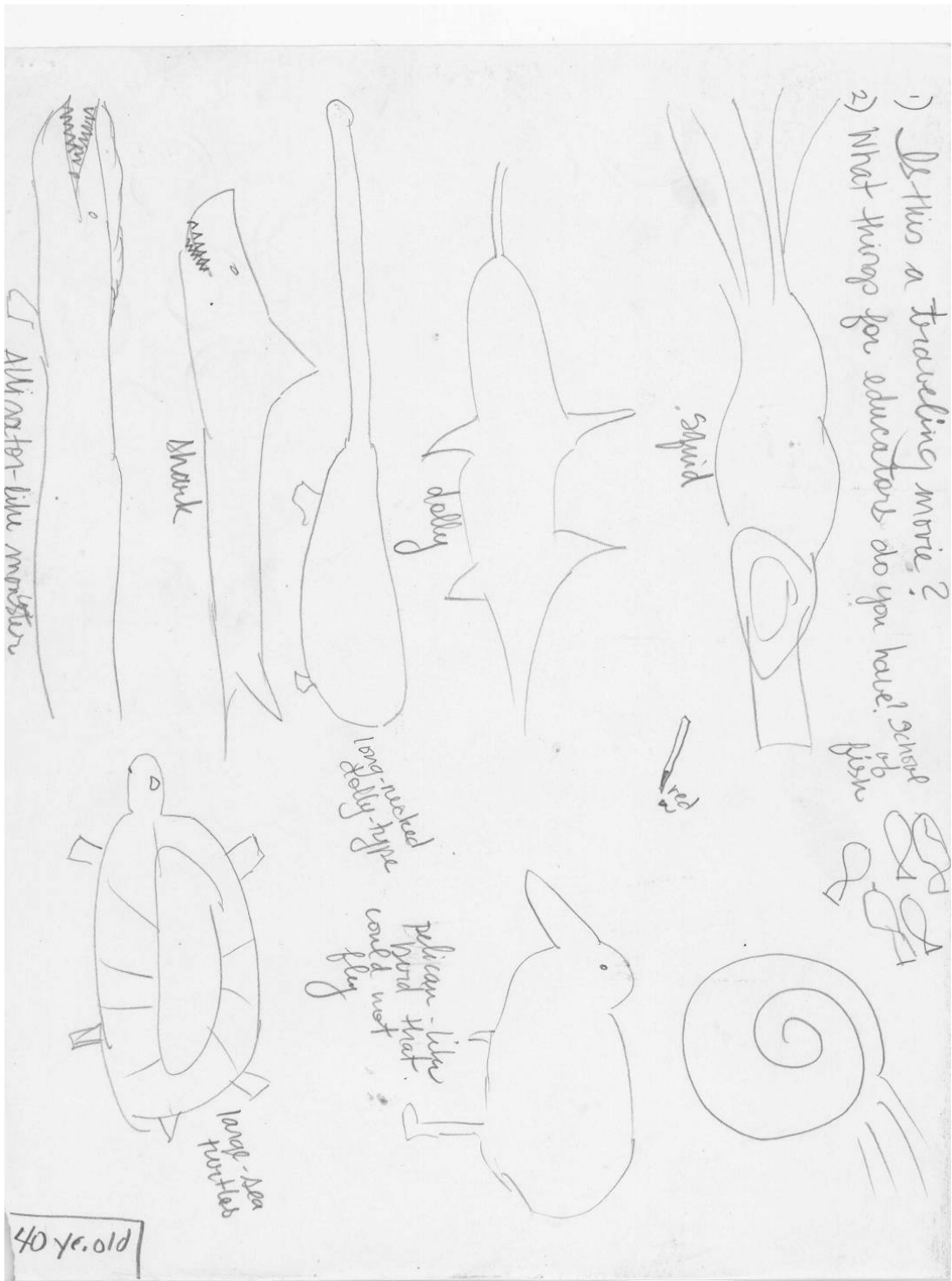
Drawing from 10 year old



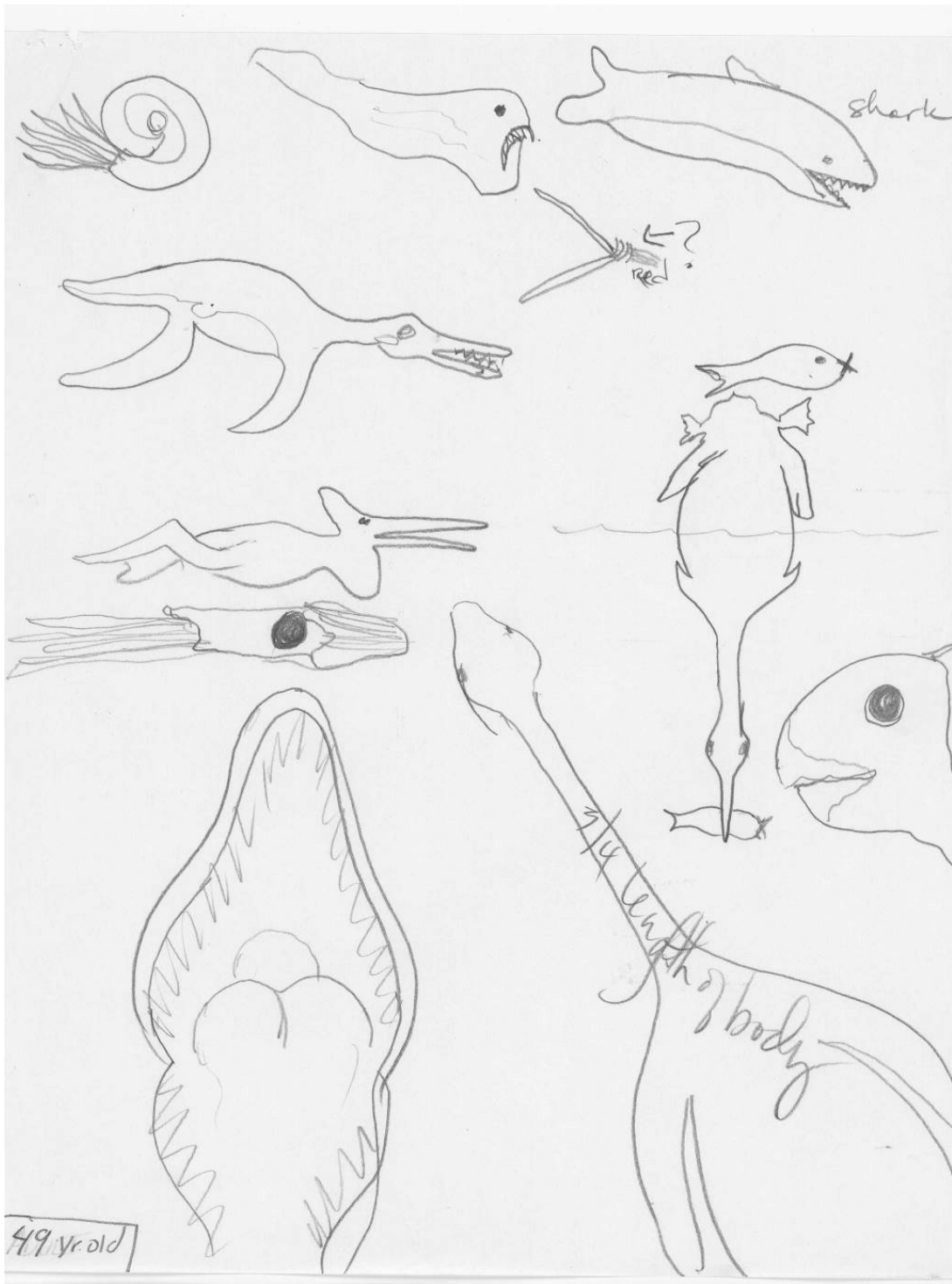
Drawing from 12 year old



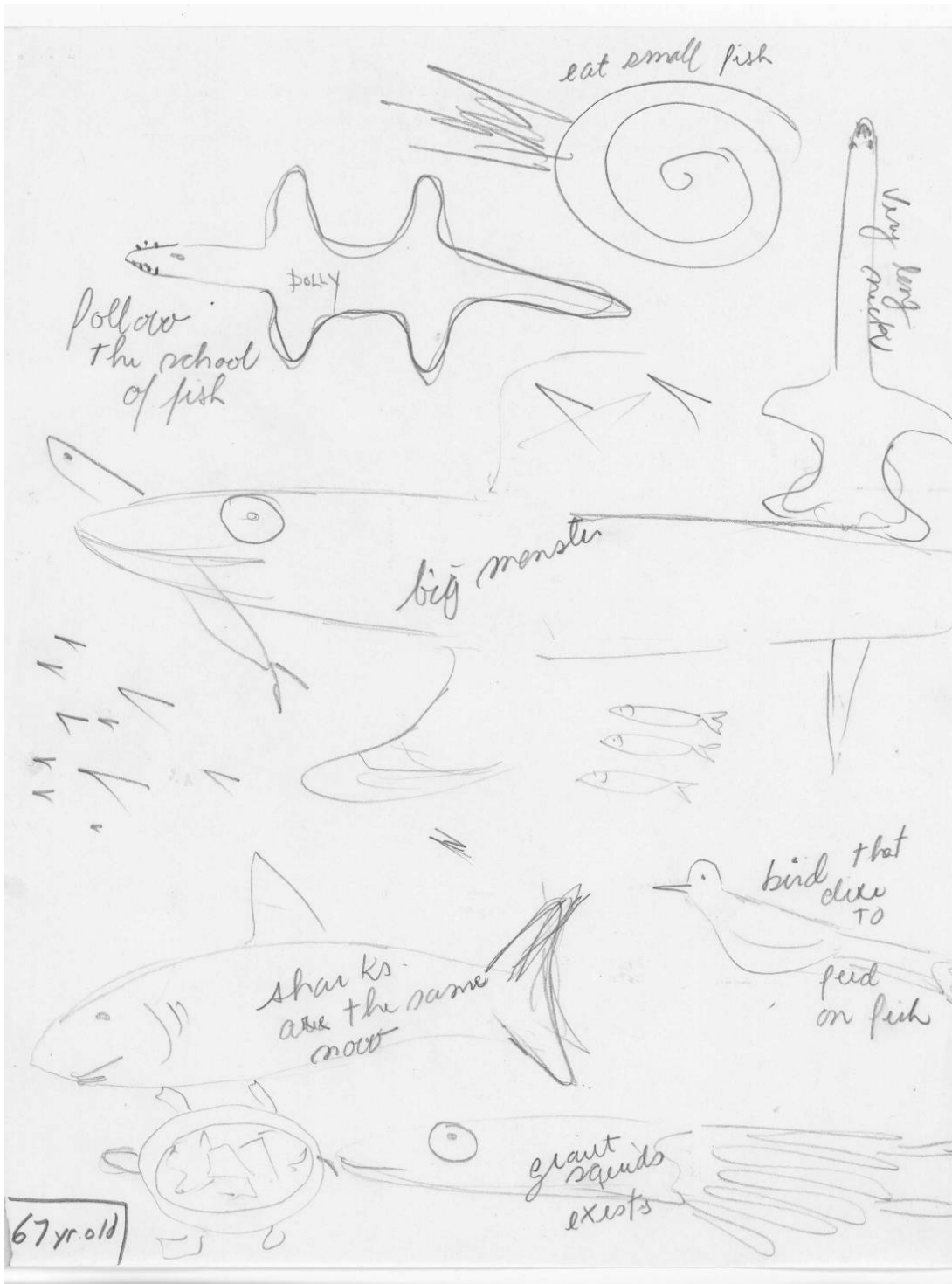
Drawing from 14 year old



Drawing from 40 year old



Drawing from 49 year old



Drawing from 67 year old

Appendix 2⁴⁶

Background information about *Sea Monsters*

Courtesy of National Geographic Cinema Ventures

Sea Monsters: A Prehistoric Adventure **The Storyline**

Film Setting

The film is set in what is known as the Western Interior Seaway 82 million years ago. During the Late Cretaceous period, when our story takes place, the Sea spanned the length of North America, from the Arctic Circle to the Caribbean, and was warm, shallow and tropical. The film takes place in the American Midwest, predominantly Kansas, which was once covered by the sea.

Character Background

The film opens as a *dolichorhynchops* – who we call ‘Dolly’ for short, gives birth to two pups; a male and a female. At only three feet long these pups are clearly at the bottom of the food chain. As they leave the protected area of the shallow breeding ground to follow their migrating food, the audience sets out with them on a prehistoric adventure.



Through their eyes, the audience meets a variety of interesting creatures, the majority of which – like the Dollys themselves - are warm blooded, air-breathing reptiles, which makes them different than the cold blooded reptiles which live today. Further, these creatures gave birth to live young, unlike modern, oviparous reptiles.

The Dolly’s Storyline

The film follows the story of Dolly, the baby female, from birth to death. Dolly is only about the size of a modern day dolphin and like a dolphin appears very non-threatening. The female Dolly – our ‘Bambi’ of sorts - survives to have pups of her own before dying naturally at the end of the film.

Antagonists

The *tylosaur*, *cretoxyhrina* and *squalicorax* sharks, and *xiphactinus* are the antagonists of the story. The female Dolly loses her mother at an early age to a *cretoxyhrina* shark attack. Later, a *tylosaurus* (“killing machines of the sea”) launches an attack on both the female Dolly and her brother; in the end the female Dolly is unharmed but her brother is not so lucky. The enormous *Xiphactinus*, a carnivorous fish which can grow to 20 feet long and weigh more than half a ton, is another major predator, but preys on fish and not reptiles.

⁴⁶ Provided by National Geographic Cinema Ventures

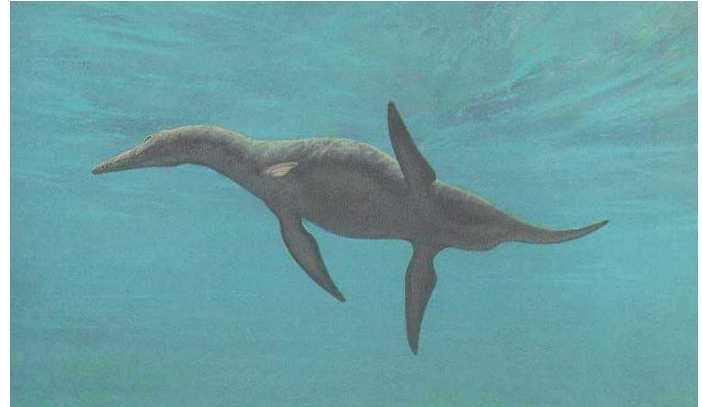
Sea Monsters: A Prehistoric Adventure

The Characters

Dolly (Dolichorhynchops)

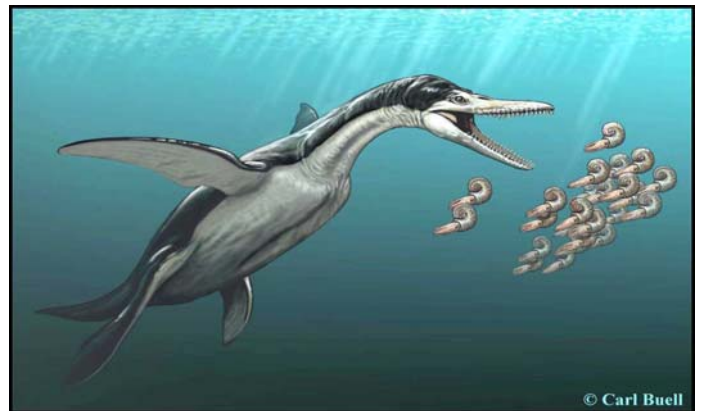
Statistics and Characteristics

- Averaged 6 feet long – about the size of modern day dolphins with 4 flippers
- Dollys have very long snouts and prey on squid and other living creatures
- Dollys are relatives of the styxosaurus and kronosaurus
- Dollys are reptiles with very small scales giving a smoother skin look, similar to the underarm of a sea turtle.
- Dollys are very fast and speedy, darting through schools of fish.



Dolly's Children

- In the film, the mother Dolly gives birth to two pups (one male, one female), each less than 3 feet long.
- The pups have proportionately bigger eyes and shorter jaws than their mother.
- The pups stay around and behind their mother and the Dolly group.
- The female pup has a wounded flipper from a dangerous encounter with a Tylosaurus in which her brother did not survive.
- Her mother dies, and the story follows the baby female Dolly from birth to death



Sea Monsters: A Prehistoric Adventure

The Characters

Tylosaurus (Vicious Mosasaur)

Statistics and Characteristics

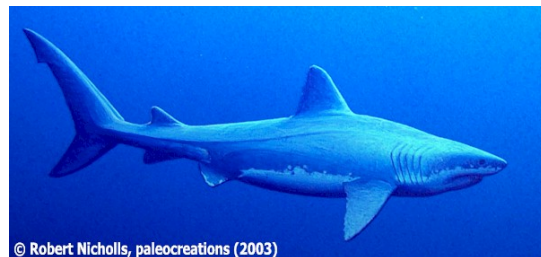
- The tylosaurus was the largest predator of the age and a distant relative of present-day snakes. They evolved as ambush predators and attacked with brute force, swallowing their prey whole and head-first (like a snake).
- Tylosaurs preyed on just about any other creatures they encountered: squid, turtles, sharks, fish, plesiosaurs, ammonites, and even other mosasaurs.
- Tylosaurs had visible scales, like modern snakes and lizards. A good example of skin texture is a modern-day Monitor Lizard, with the scales being different shapes in different places on the body. As with other marine reptiles, it's likely they would have been dark on top and light on the bottom.
- Tylosaurs had a huge head and jaws and could grow to a maximum of 40' – dimensions that still allowed it to hold its own in an environment where other would-be apex predators vied for territory.
- In general, tylosaurus would have moved slower than a Dolly, except when attacking, when he would have had a short burst of speed.



Shark (Cretoxyrhina & Squalicorax)

Cretoxyrhina

- The Cretoxyrhina Shark is the largest of the late-Cretaceous sharks. He is also called "The Ginsu Shark" – because it slices its victims up into bite-sized chunks using razor sharp teeth.
- The Cretoxyrhina Shark grew to 20 feet (3x the length of a Dolly, which he hunts) and was one of the top predators
- They are similar in appearance to the modern Great White Shark, and probably in behavior as well, but were not closely related.
- The teeth are large, triangular, knife-like and 2-inches long; each of these teeth had a smooth-edged blade and resembled those of a mako, but were much broader and more massive with an unusually thick enameloid coating.



Squalicorax

- *Squalicorax* can grow up to 6-8 feet long and are best known for its distinctive teeth, which have a rectangular root crowned with a graceful, finely serrated blade.

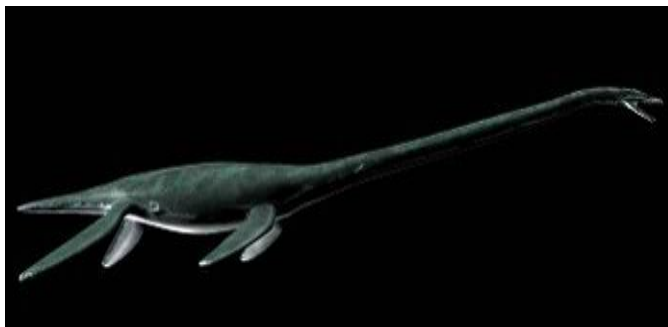
Sea Monsters: A Prehistoric Adventure

The Characters

Styxosaurus (Long Necked Plesiosaur)

Statistics and Characteristics

- Belongs to a large order of “lizard like” marine reptiles and is most similar to the iconic Loch Ness Monster
- Noted for extremely long necks and small delicate heads with sharp, pointed teeth. Styxosaurs grow to 40-foot in length with more than half made up of neck and head.
- Any scales would be small enough so that from a distance, Styxosaurus would have appeared to have smooth “skin.”
- When hunting, they quietly close in on their prey. Its small head would enter a school of fish long before its distant bulky body would be detected by the fish. With a quick sideways dart of the head, the hunter is able to quickly grab a few fishes before the school scatters.



Xiphactinus (Huge Fish)

Statistics and Characteristics

- Xiphactinus are vicious predatory fish that could grow up to 20 feet long and weigh up to 1.5 tons.
- They swim in schools and prefer to eat fish over other reptiles.
- Large, silvery scales, with visible cross-hatching, like a carp.
- Could move very fast, similar to modern day tuna – about 34mph.

