Title of Grant / Cooperative Agreement:	Laurel Clark Earth Camp Experience....
Type of Report:	Summary of Research
Name of Principal Investigator:	Debra Colodner
Period Covered by Report:	10/1/2010 - 9/30/2014
Name and Address of recipient's institution:	Arizona-Sonora Desert Museum, Tucson AZ
NASA Grant / Cooperative Agreement Number:	NNX10AK14G

Reference 14 CFR § 1260.28 Patent Rights *(abbreviated below)*
The Recipient shall include a list of any Subject Inventions required to be disclosed during the preceding year in the performance report, technical report, or renewal proposal. A complete list (or a negative statement) for the entire award period shall be included in the summary of research.

Subject inventions include any new process, machine, manufacture, or composition of matter, including software, and improvements to, or new applications of, existing processes, machines, manufactures, and compositions of matter, including software.

Have any Subject Inventions / New Technology items resulted from work performed under this Grant / Cooperative Agreement?	No ◉	Yes ○
If yes a complete listing should be provided here: Details can be provided in the body of the Summary of Research report.		

Reference 14 CFR § 1260.27 Equipment and Other Property (abbreviated below)
A Final Inventory Report of Federally Owned Property, including equipment where title was taken by the Government, will be submitted by the Recipient no later than 60 days after the expiration date of the grant. Negative responses for Final Inventory Reports are required.

Is there any Federally Owned Property, either Government Furnished or Grantee Acquired, in the custody of the Recipient?	No ◉	Yes ○
If yes please attach a complete listing including information as set forth at § 1260.134(f)(1).		

Attach the Summary of Research text behind this cover sheet.

Reference 14 CFR § 1260.22 Technical publications and reports (December 2003)
Reports shall be in the English language, informal in nature, and ordinarily not exceed three pages (not counting bibliographies, abstracts, and lists of other media).

A Summary of Research (or Educational Activity Report in the case of Education Grants) is due within 90 days after the expiration date of the grant, regardless of whether or not support is continued under another grant. This report shall be a comprehensive summary of significant accomplishments during the duration of the grant.

Laurel Clark Earth Camp Experience: Using NASA Data to Teach Teens, Teachers, and the Public about Planet Earth through Programs and Interactive Displays

Final Educational Activity Report

Prepared by
Debra Colodner
Project Director

December 2014

Based largely on interim evaluation reports (2011, 2012, 2013) by

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mindful planning for clear decision making

Earth Camp is supported by
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OVERVIEW

This final evaluation and program report presents a summary of the results for Earth Camp 2011-14 activities. Detailed results have been shared with project staff; therefore, the purpose of this report is to highlight the lessons learned from Earth Camp. Goals and relevant evidence are described below. Highlights of relevant Earth Camp survey results and journal entries are included throughout this report and summaries are included in the Appendices.

EVALUATION QUESTIONS

The evaluation design consisted of PROCESS (formative) questions that described the project planning and activities and OUTCOME questions that illustrated the changes that resulted from those activities. This report first covers process questions, followed by the third year report on outcomes (see also the Appendix for a chart that summarizes the goals, objectives, and results to date). The last section provides brief descriptions of the program components as well as photos of some of the activities.

PROCESS QUESTIONS

Did the project reach its intended audiences and conduct the proposed activities? YES

The Earth Camp project team delivered 3 successive years of teacher professional development to 3 cohorts of 16-18 teachers. Forty two teachers completed the year-long professional development program. The team incorporated additional and improved field experiences throughout the project and new opportunities to learn and practice with equipment, software and other technology. Although not all the teachers who initially enrolled were able to complete Earth Camp, the ones who participated created a full complement of posters and seven teachers organized Earth Clubs at their schools which continued for at least one academic year.

Teen Earth Camp successfully engaged 132 middle school and high school students over four years. Routinely high satisfaction rates from both youth and parents remained the best evidence for successful implementation of this activity. Reaching under-served students continued to be a valuable component of the program.

What were the successes and challenges for the implementation of the project?

The main successes centered on full engagement of three cohorts of teachers who provided useful feedback for the ongoing refinement of workshops, and assisted project staff in decisions on how to improve workshop activities that addressed the questions of the teachers and anticipated ways to meet the challenges of using satellite images for inquiry-based lessons. Program staff successfully implemented changes from Year 1 and 2 in Year 3 activities, based on prior feedback and will continue to refine the plans and activities as they seek continued funding for the program.

The biggest successes for the Teen Earth Camp are described below in the outcomes (see also the appendices for specific results from the post program surveys and examples from the student journals). Additional questions about attitudes and behaviors (e.g., in feedback forms and in the form of a focus groups and an alumni survey) were included and results are reported below and in the appendices. Review of student journals and student focus group reflections revealed both insights into their learning and showed results consistent with post program surveys.

What suggested changes for improvement can be incorporated into related future projects?

- Continue to incorporate feedback from each teacher workshop into the design of the future professional development workshops. Continue to be reflective and flexible in planning. Participants were consistent in their appreciation for the hard work, responsive planning, and solid decision making that went on behind the scenes and in real-time adjustments to accommodate unexpected events. They also truly valued the hands-on field work experiences.
- Continue to seek ways to provide follow-up support for all teachers as they implement their ideas of ways to use satellite data and images in their classrooms and with Earth Club activities. Several teachers expressed explicit need for having “booster sessions” or other reminders throughout the year.
- Continue to identify ways to craft open-ended/reflection questions to elicit insights and deeper thinking from the students. The third year journals for both the middle school and high school students showed more reflective writing than in years past. The open-ended questions used for program feedback also showed more ideas and reflections.

OUTCOME QUESTIONS

What evidence exists that the program achieved its goals and objectives?

The evidence for the achievement of the goals outlined in the NASA grant proposal is highlighted below and detailed examples can also be found in the Appendices that contain a chart of the goals as well as summaries of program surveys of youth and parents. In short, the program successfully met or exceeded nearly 100% of its goals and objectives.

I. Engage students in lifelong learning in STEM disciplines to inform their Earth stewardship practices, career decisions and capacity for innovation by:

- Introducing compelling inquiry questions that lead students toward their own discoveries.
  Staff revised and prepared detailed agendas for the Earth Camp participants each year that utilized field measurements and observations, visits, and "tours" of inspiring locations. Some of the most cited learning activities included direct experience and tracking results—for example, the “zero

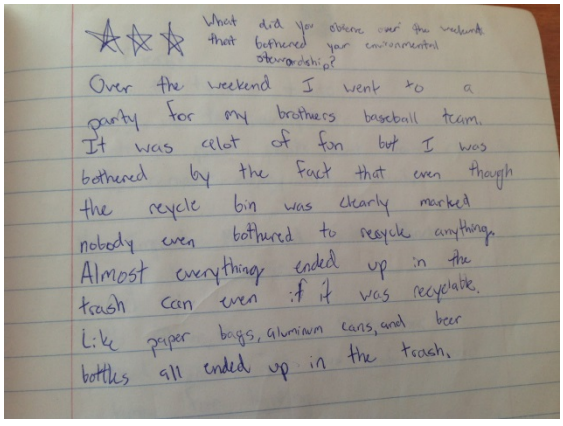
waste" lunch and tracking the exact amounts of trash/waste (the "Five Bucket System") throughout Earth Camp.

- Teaching mathematical and scientific problem solving skills necessary for critical thinking and STEM careers.

  Each of the hands-on activities required the participants to apply problem solving and critical thinking to accomplish. In addition, youth (and educators) used a team approach to the activities that furthered their learning and provided collaborative experiences all participants felt they could apply in the future. Additional evidence continued to be seen this year when the students shared potential impact analyses during the Learning Celebrations.

The objectives for *engaging students in real-world earth stewardship projects and scientific inquiries beyond the term of the camp and forming and sustaining multi-generational learning communities that galvanize broader community involvement* have been seen in the successfully implemented Earth Clubs (described in a later section and at http://desertmuseum.org/earthcamp/earthclub/). Many examples of changed practice and environments at these schools embody the purpose and intent of Earth Camp to open minds and encourage stewardship. Focus group questions included asking the students how they thought Earth Camp might have helped them to use science in the future and the following examples reveal the variety of ways:

- More aware of what I am doing.
- I'm looking deeper into things.
- Making more connections – how different things impact the world.
- More aware of my choices and how little things can help or hurt.
- Learned things like the dichotomous key and more about the stars and climate change.



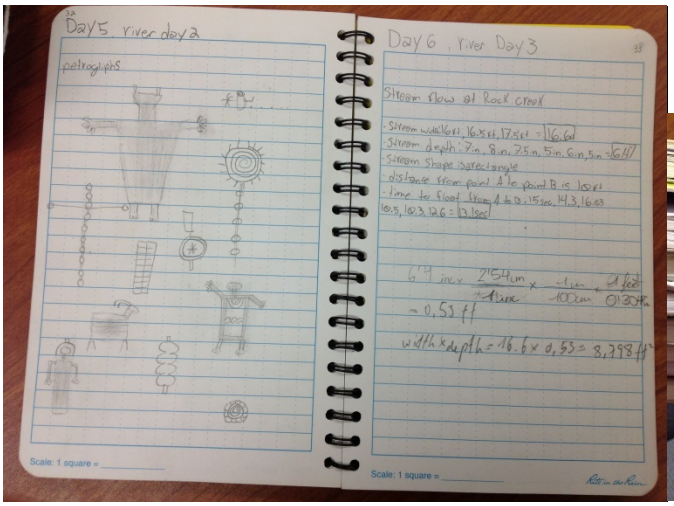
Additional outcome objectives for Teen Earth Camp included that *Campers make a commitment to do at least one thing to lessen their impact on the environment in the immediate future* and that *they are more interested in environmental science or technology careers than they were before Earth Camp.*

1) All Earth Camp youth participants committed, in front of their peers and parents during the final Learning Celebrations, to at least one thing that would decrease their impact on the environment. As noted above, the Learning Celebrations were enhanced during the second and third years to include specific rationales for these commitments and estimates for the potential impact of long-term follow-through on the proposed changes in their lifestyles.

2) Program feedback surveys (see appendix for detailed results) asked students to rate whether they are more interested in STEM-related careers. Three-quarters of the middle school students attending Earth Camp agreed with the statement. Furthermore, 80% believed there were more motivated to do well in their science classes as a result of Earth Camp.

3) Evidence from the journals and focus groups showed that detailed exposure to a variety of STEM Careers occurred during Earth Camp for Teens. Careers mentioned in the middle school journals included the following: sustainability, animals, forestry, paleontology, hydrology, marine biology, vet, geology, astronomy, designing things, herpetology, architecture and infrared technology.

The journal writings indicated exposure to science topics as well as reflections on their changing perspectives. Nearly all the students wrote paragraphs about how their eyes had been opened and how their attitudes had changed. They mentioned concrete ways in which they could make a difference in their homes, their schools, and their communities.



II. Provide teachers with tools and experiences to inspire students to discover the real-world relevancy of STEM disciplines and apply this learning to the pursuit of STEM careers and technological innovation by:

- Deepening teacher content knowledge in the environmental and earth sciences.
  The teacher feedback surveys after each workshop (see Appendices for specific questions) provided evidence for their learning and increased content knowledge. The Earth Camp Educators described how they will be able to use all their experiences in many aspects of their teaching. They noted specific ways in which the activities fit with the STEM standards of the grade levels in which they teach. Teachers appreciated in particular the "amazing" educators who taught Earth Camp and expressed deep gratitude for being treated with respect and feeling valued as teachers.

- Mentoring teachers in the use of innovative teaching methods that lead to student driven inquiry and problem solving.
  Teachers noted their appreciation for the "awesome" resources and example activities that provide more effective inquiry-based and problem solving activities in their classrooms. They also felt inspired to do more "field work" and independent projects with their own students. All (100%) of the teachers reported that would be more likely to offer independent projects to their students as a result of Earth Camp.

- Demonstrating the use and value of NASA resources for teaching Earth Sciences.
  Teachers noted in feedback surveys that they believed they gained exposure to the process and examples of resources they can use in their classrooms. Year 3 (the final teacher cohort) offered even more specific examples of how to use these resources and teachers continued to request

additional support throughout the school year as they continue to learn more about online resources, the processes of finding and downloading and using satellite data and images and additional ideas for Exhibit posters and projects for their classes and Earth Clubs. In particular, in Year 3, Google granted permission to sign up teachers as trusted testers of Google Earth Engine, which allowed lay users to access a wide variety of satellite imagery with minimal training. A majority of the teachers became quite adept with this tool.

- Translating the relevance of this field to their lives and the lives of their students through a compelling experience.
  All the teachers noted ways in which they would be able to use the activities and inspiration from Earth Camp in their classrooms. During phone interviews with past participants, the most frequently noted favorite memory and value of Earth Camp was the excitement of the hands-on, field-based experience and all of the teachers noted their ability to share this enthusiasm with their students.

- Creating a multi-generational learning community that informs teachers own teaching practice through their interactions with students, the public, and other educators.
  Reports from Earth Clubs show that these learning communities are happening. The continued follow-up and interactions from the Desert Museum and partner staff are noted as important to generate additional excitement and value for the clubs, but there are other examples of how schools generate their own enthusiasm. One of the challenges noted by the teachers implementing these activities is getting buy-in from other teachers who have not participated in Earth Camp themselves.

III. Enhance public awareness of environmental change in the southwestern United States and the importance of NASA satellite data for recording, tracking, understanding and predicting these changes by:

- Fostering and sustaining lifelong learning and community involvement through applied projects.
  Steps towards this goal have been described above and in the latter section on Earth Clubs.

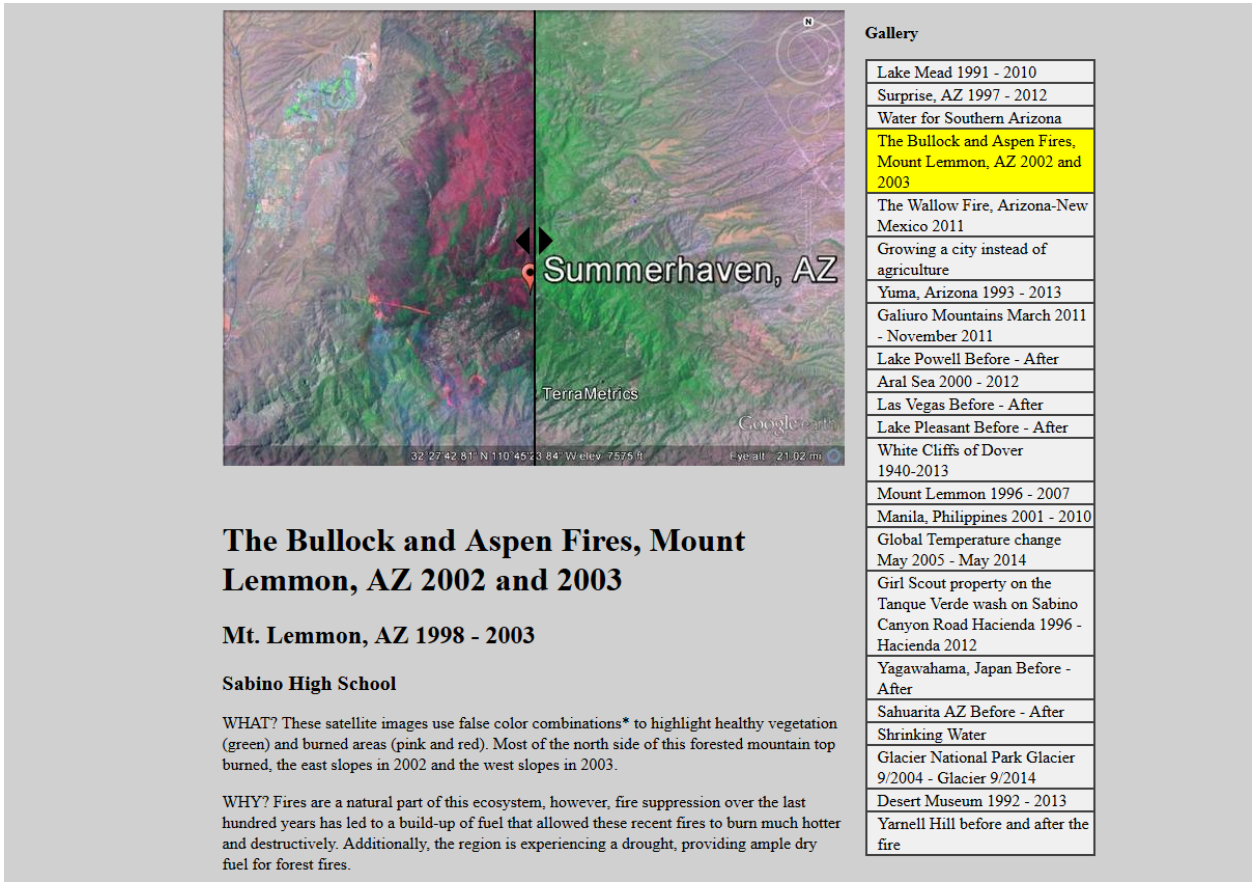
- Intergenerational problem-solving and community communication through:

  - Traveling poster exhibits and simple games that share the inquiry work of Earth Camp students and teachers, introducing the public to the relevance of NASA data to environmental questions
    Posters were created and shared at the Desert Museum and other regional sites (e.g., Water Resources Research Center, Arizona Science Teachers Association meeting, National Science Teachers Association Regional meeting). The last set of posters were on display at the Desert Museum from Nov 1, 2013 – Jan 15, 2014. All teacher posters from the three years of the program can be viewed and downloaded here: http://desertmuseum.org/earthcamp/stories.php.

  - Online exhibits using NASA images and inquiry questions allowing deeper exploration of the data.
    The Earth Stories from Space website allows students to create before and after comparisons of the Earth's surface using Google Earth historical imagery, research the changes they see and report on their conclusions. Their "stories" are uploaded by teachers to share with others. Please see: http://www.desertmuseumdigitallibrary.org/ecweb/home.html.

    The website was designed with significant input from teachers. Twenty three teachers were trained to use the site, including Earth Camp Teachers, and teachers in a Desert Museum Green STEM workshop, and 15 created accounts and their own stories. One museum, and fellow CP4SMP-

grantee, the Montshire Museum in Vermont, demonstrated the site in teacher workshop as well. Teachers and students in Desert Museum programs have created over 89 “Earth Stories”, 23 of which are shared on the project’s Gallery.



Earth Stories from Space Gallery: http://www.desertmuseumdigitallibrary.org/ecweb/home.html

Although teachers expressed interest in and positive feedback about the site, in the end, they did not have the time or reason to use it. Only one teacher used the site with her high school students. Students who used the site in Desert Museum programs also provided feedback that they enjoyed using it, learned a lot about the resources available from NASA satellites, and would like to do something like this in school because it allowed them to explore real data (images). All of the ten students in the test class were able to list more global issues that can be studied with satellite data after the activity than before. However, given the slow adoption rate by test teachers, the Earth Camp team did not devote further time to dissemination of this website beyond summer of 2014.

- Kiosk-style exhibits for the ASDM’s Earth History Room, featuring the on-line exhibit on both small and large screens.
  Our original vision was that the teacher and student posters would provide the content for the public exhibit, however, this turned out to be unrealistic due to several factors:
  a. the image quality available to teachers and students is not adequate for this application

b. the limited exposure of students to remote sensing data and Earth Systems concepts, and therefore their limited ability to properly interpret earth changes from space
c. the limited availability of computers, bandwidth and even Google Earth software for students in many of our participating schools.

Based on these findings we revised our approach. Instead, we produced an exhibit (with a local company, Earth Knowledge) on **Earth Change from Space** with an interactive kiosk and large screen that allows visitors to choose to view short videos about a variety of global change topics. The video content is drawn from existing NASA visualizations and videos, as well as a couple of custom-made slideshows. Each video/slideshow has been edited to about 1-1.5 minutes to accommodate the museum environment. Topics include:

Landsat mission
Las Vegas urbanization
Tucson urbanization
Earth at night
Yellowstone fires
Oceans and climate
El Nino
Hurricanes
Water availability
Water on Earth
Extreme weather
US drought

Evaluation of the exhibit during this year focused on its "draw" relative to other static exhibits in the room, and to visitors of different generations. A timing and tracking study of 569 visitors revealed that the classic natural history exhibits which line the walls of this oval shaped room (static displays of fossils and models with explanatory text and images illustrating the "Sonoran Desert" region over geologic time) attracted more visitors than the large video screen. We did not compare the time spent at the natural history exhibits to the time at the video screen, but more people looked at the older exhibits than at the video. About 34% of visitors watched at least one video, whereas 61% looked at the natural history exhibits. This result surprised us, but perhaps is due to the fact that these exhibits make up most of the room, and include fascinating real objects, including a NASA moon rock, meteorites, a variety of rocks and fossils, models and one live animal. Of those that stopped to watch the Earth Change from Space videos, the average number of videos watched was 2 per person. The most popular topics chosen by visitors were: Earth at Night (28%), Yellowstone Fires (13%) and Extreme Weather (10%). The least popular topics were Las Vegas growth and Water on Earth, each at 2%. There was some differentiation among groups with or without children. 62% of groups with children interacted with the kiosk and chose videos, whereas 50% of groups without children stopped at the kiosk. The effect was stronger for the groups containing teens. 80% of groups with teens stopped to choose and watch the global change videos.

What other changes occurred that were not anticipated at the onset of the grant?

Practical realities about ease of use of satellite images has caused staff to reassess some of the activities and resources to be used to support the teachers. Teachers in the last cohort again expressed concern about the availability of technology for their students. Examples of these challenges are: access related to bandwidth and other technical limitations of teacher/school computer and internet resources, availability of images able to address the types of questions teachers and students initially ask, levels of conceptual background needed to explore inquiry-based activities using satellite images and the lack of time for activities outside of the curriculum. The changes made to address these challenges in year 3 were: more emphasis was placed on using easily accessible web programs such as Google Earth and Google Earth Engine; and more complex data downloads and images were created by Planetary Science Institute staff that were relevant to the topics of teacher projects and based on requests from the teachers themselves. These images are stored on a website that the teachers can access as they design their lessons and exhibits.

Incorporating ways to demonstrate differentiated instruction would both model for teachers ways they can engage a diverse array of learners in the own classrooms and would maximize the value of the highly varied backgrounds of the participating educators. Some of the teachers have strong math/science backgrounds and some do not. They expressed interest in being in mixed groups to better use their individual areas of expertise. This may also assist them as more schools adopt the new Common Core.

Ongoing learning about assessment and documenting outcomes.[1] Alternative ways to document change continue to be sought and the journals, drawings and reflections continue to be used. We continued use of new elements of the Learning Celebrations this year, including asking students to think about and connect rationale and analysis of the potential impact of their chosen commitments. Other "embedded" opportunities to teach and show the change are well worth the effort. For example, the following drawing shows the "power of perspective" as a way to help participants observe the world around them. Each year, youth revealed changed perceptions in their "before" and "after" drawings of native fauna (see below).

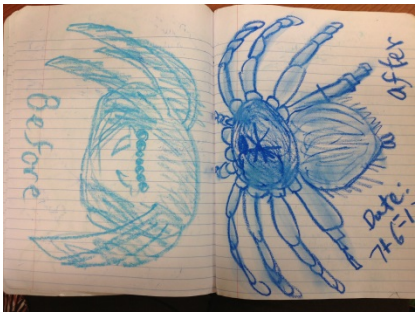


Figure 1 Sample "Before" and "After" journal illustration. Students learn to draw what they see, not what they believe.

[1] An existing survey used by other environmental education programs was tried as pre/post assessment of attitudes and beliefs about the environment. Some of the results are reported in a later section on outcomes for the Teen Earth Camp. Opportunities to observe and elicit insight from students continues to be refined.

HIGHLIGHTS FROM EARTH CAMP ACTIVITIES

ECE Component 1: Informal Educator and Master Teacher Training

Workshop and field trip themes scheduled and conducted in Year 3 (final year) included the following:

Workshop 1: Power of Perspective: January 26, 2013
Workshop 2: Power of Perspective: Biodiversity- ASDM--February 16, 2013
Workshop 3: Power of Perspective: Water- PSI-- March 30, 2013
Workshop 4: Power of Perspective: Investigating Earth Change- Univ. of Ariz. Biology Learning Center May 4, 2013
Mt. Lemmon Trip- May 28-31, 2013- Mt. Lemmon Sky Center

Surveys in Year 3 continued to show high satisfaction as well as specific learning: In addition to open-ended questions about what they learned, the questions they still had, and suggestions for future sessions, each workshop was rated by the teacher participants on a 0-10 scale with 10 being "one of the best professional development experiences I have ever had." The average rating for the workshops was 9, showing that the teachers valued the workshops very highly. Other results from workshop feedback are included in the appendices.

Figure 2 Teachers learned about satellite images, data from satellites, and some of the value and limitations of using satellite images.

ECE Component 2: Teen Earth Camp

As seen in the summaries of responses and sample journal entries (please refer to the appendices for details), there continues to be high satisfaction reported by both participants and parents. Teens consider it to be fun and value the knowledge, confidence and perspective they've gained from Earth Camp. Parents and teens continued to describe the value of the experience in their feedback surveys (see appendices for more examples). Many considered it life changing:

"It changed my point of view of life and everything!"
"The gorgeous places make me want to make a change."
"Best experience of my life."
"She was exposed to several fields of science, not previously available to her. She got additional experience working with peers on projects and sharing responsibilities.

After both the Middle School and High School Earth Camp, participants and staff shared slide presentations as part of a Learning Celebration about their activities, commitments and analyses of potential impacts. Preparation of these visual strategies allowed shared learning and required close collaboration among the staff and participants. Student stories from earlier Earth Camps can be viewed at: http://desertmuseum.org/earthcamp/stories.php.

Figure 4 Amy Orchard introduces a Harris Hawk to the parents and students at the Learning Celebration. Harris Hawks hunt collaboratively in family groups, an inspiring symbol of the teamwork students learned in Earth Camp

Alumni Survey- STEM Careers and Conservation Behaviors

In 2013, an Earth Camp alumni survey obtained perspective from 49 past participants (60% response rate based on 82 valid email addresses). Students reported that Earth Camp did influence their choice of study/career (84%) and 71% indicated long-term career goals related to science, engineering or environmental studies. Eighty percent (80%) indicated that they try to stay informed about environmental issues as a result of Earth Camp.

When asked, "Did Earth Camp increase or maintain any of your conservation behaviors?" survey participants noted high levels (80% and over) in the following areas:

- ✓ Not running water while brushing teeth (100%)
- ✓ Recycling appropriate household trash items (98%)
- ✓ Turning off "ghost power" when not in use (88%)
- ✓ Using less water (85%)

Over half of the respondents also reported continued conservation behaviors: using non-disposable containers for lunches (79%), bringing reusable bags when shopping (79%), reducing length of showers (77%), carpooling (68%), and shopping for local foods (60%).

ECE Component 3: Teacher Earth Camp Experience

The Earth Camp for Educators in 2013

As in the first and second years, teachers valued the hands-on field investigations the most. In Year 3, discussion centered around application of activities with STEM standards. Some examples of the ways they anticipate using the ideas from Earth Camp workshops with their students included the following:

STANDARD	Ideas Inspired by Earth Camp
Using mathematics & computational thinking	*Comparing measurement from data* *Calculating permeability of soil in burned and non-burned areas* *Measuring crawfish & sexing them as citizen scientists for Game & Fish* *Graphing & averaging data sets on Mt. Lemmon* *Mean, median, mode, range from large data set for predictions of future land usage*
Analyzing & Interpreting Data	*Graphing exercises* *Google spreadsheets to organize, manipulate & display Mt. Lemmon data* *Compare findings to other (past) finding* *Inferring cause/effect from images, graphic results*
Planning & Carrying Out Investigations	*Teacher putting together data sets for student investigations* *Mt. Lemmon Investigations & collecting data* *Yuma East/West Wetlands Investigation & Comparison* *Land Use Changes* *Assign specific tasks/jobs to students and make a schedule of time to do investigations* *Testing physical and chemical properties of soil samples on Mt. Lemmon*
Developing & Using Models	*Wind Turbine* *Ecosystems (Biomes)* *Climate models from presentation* *Water distribution activity w/ measuring cups*
Asking Questions/Defining Problems	*Mt. Lemmon investigations* *Giving students data sets & they form questions/define the problems* *Giving 2 pics and have students form questions based on what they see* *Have open-ended questions that relate to the students*
Obtaining, evaluating and communicating information	*Using Landsat images & data* *Creating posters* *Powerpoints of DATA collected on Mt. Lemmon* *Collecting field data, graphing, making connections, sharing findings*
Engaging in argument from evidence	*Philosophical chairs* *Discussion boards* *Discussion intergroup analysis of Mt. Lemmon data* *Have students justify response to their viewing 2 pic questions* *Global warming- causes and effects*
Constructing explanations and designing solutions	*Use images & other data to draw conclusions & then solve problems*

ECE Component 4: Student Earth Clubs

Earth Clubs that were started prior to the NASA grant will continue and new Earth Clubs have formed as a result of the Teen and Educator Earth Camps and workshops. For Year 3, Earth Club reports were received from 6 of 8 active sites. One of the teachers noted the value of an Earth Club: The students discovered "a new found passion for the outdoors and previously unrealized personal connections with a non-urban environment and desire to help preserve what is remaining."

The following table summarizes some of the key activities from each school, as well as the number of students who participated. These are also described on the website: http://desertmuseum.org/earthcamp/earthclub/



Earth Club Site and Location	Number of Students Reached/Participating	Sample Activities (favorite activities noted in student surveys listed in italics)
Salpointe High School Tucson, AZ	10-45	The science club at this school used Earth Club funding to add environment-related activities, including, astronomy lectures and star party, a night-time light audit, zoo scavenger hunt, and a visit from Desert Museum staff and animals.
Hendricks Elementary School Tucson, AZ	10	Most of the activities were related to their outdoor garden classroom: planting and observing plant growth, making garden benches, observing mammals, birds, reptiles and insects that visited the garden, and making plant models. Next year they will be setting up water harvesting the garden to catch runoff from the basketball court.
Flowing Wells High School Tucson, AZ	8-45	Planned and held star party, hosted presentation about Desert animals with live animals from the Desert Museum, planned and implemented fundraising for trips, worked with Zoo Club to create enrichment items for Desert Museum animals, toured behind the scenes.
Monterey Park School Phoenix, AZ	30	The club did a scavenger hunt at a local park using satellite imagery, planted a vegetable garden and did student-led experiments with the plants, they donated vegetables to a shelter, and completed a school water audit. They also took an overnight trip to Tucson to visit the Desert Museum and Biosphere 2. During their water audit, they replace the aerators on most of their school faucets and calculated the water savings. They also worked with the district to change light bulbs and collected cans as a fundraiser.
Utterback Middle School Tucson, AZ	15-25	The Utterback Earth Club was an official club at the middle school. It met approximately 8 times during the year. We had 2 visits from The Arizona-Sonora Desert Museum using live animals from the Sonoran Desert Bio region and one visit from Tucson Project WET in which we investigated the Colorado River Watershed. We using 2 meetings to plan and implement a challenging hike up Wasson Peak in the Tucson Mountains with students and families. The hike took place on a Saturday. After the hike we created a bulletin board in the school using the photographs from the hike.

Nash Elementary School Tucson, AZ	20	The Earth Club met twice a month after school. They started a school garden, worked with AZ Project WET to do a school water audit, attended a water festival, hosted scientists from the Planetary Science Institute for astronomy activities, hosted live animal presentations, and visited the Desert Museum

The biggest challenges noted by Earth Clubs this year related to funding. Some of them started activities, such as planning for water harvesting, for which they were not able to raise sufficient funds. Others spent a significant amount of time and effort raising funds for their field trips.



ECE Component 5: Exhibit Design Workshop: The Power of Perspective

The exhibit posters and website became reality in Year 2 of the grant. Specific opportunities for design and an opening exhibit day were scheduled and conducted with the teachers again in Year 3 and culminated with the opening of the Earth Change from Space Exhibit in the Earth Sciences area of the Desert Museum.

Educators Workshop 4: Design Workshop for Teachers

Teachers shared with each other and with project staff a lesson plan that described activities/lessons/assignments they have used with their students that incorporate satellite images. Alignment with Education Standards and refined implementation plans was also discussed. Draft posters created by the Desert Museum based on the teacher presentations during the summer were reviewed and feedback on a website prototype was elicited as well.

Design Workshop June 10-13, 2013

Figure 3 The Design Workshop offered time for creation and review of the Poster Exhibit previous finished version and drafts.

At the end of the design workshop, a focus group with the teachers explored their perspectives on the value of Earth Camp for Educators, what changes they had started to implement, and their projections about future use and challenges. The following summarizes key points from the focus group:

Teachers noted that what has worked well for them thus far include the "pre-canned lessons," science notebooks and other easy-to-implement activities. Their challenges with Earth Engine revolved around the steeper learning curve (than they expected) and access issues with their schools—either bandwidth or blocked sites. They have clear plans to use ideas for data analysis, blending the activities with other curricula, graphing change, and doing more project-based activities with "students owning" the projects. They also plan to do more outside, especially in partnership/collaboration with other teachers at their school or in their district. The felt their "depth of knowledge" increased from their participation in Earth Camp. Topics of particularly valued learning included: phenology, all systems and connections, critical thinking and problem solving, and climate change.

The teachers felt the value of the program was "tremendous" and "huge." They especially valued their changed perspective of "seeing the big picture" and "not just reading about dynamic change from a book." When asked about their changed practice, they stated that they have become more "inquiry focused" and more science and math based. They also feel they have and will continue to use more technology so their students will have access to data. They feel there are now more options for kids to do meaningful investigations "for themselves." Several made a point of saying they will ask more "where is the evidence?" questions of their students.

On the topic of independent investigations, teachers noted that they had more "content and procedures" that they did not have before, as well as new examples and ideas. "This is HUGE toolset on how to get 150 teenagers to think critically about a topic." They said their backgrounds on how to develop independent thinking have been strengthened. Sharing the enthusiasm and excitement of the applications with kids was one of the most valued promising parts of the experience.

At the end of the focus group when asked if there was anything else they wanted to share, teachers noted how extraordinary they found the experience:

"This was the best PD class I have ever been to—such incredible resources."
"Field trips kept the momentum up."
"An engaging spectrum of speakers.

Staff were very helpful and their support has been amazing:

"I appreciate that they (staff and guest scientists) are interested in us being successful."
"We feel valued and treated well—high quality field experiences."

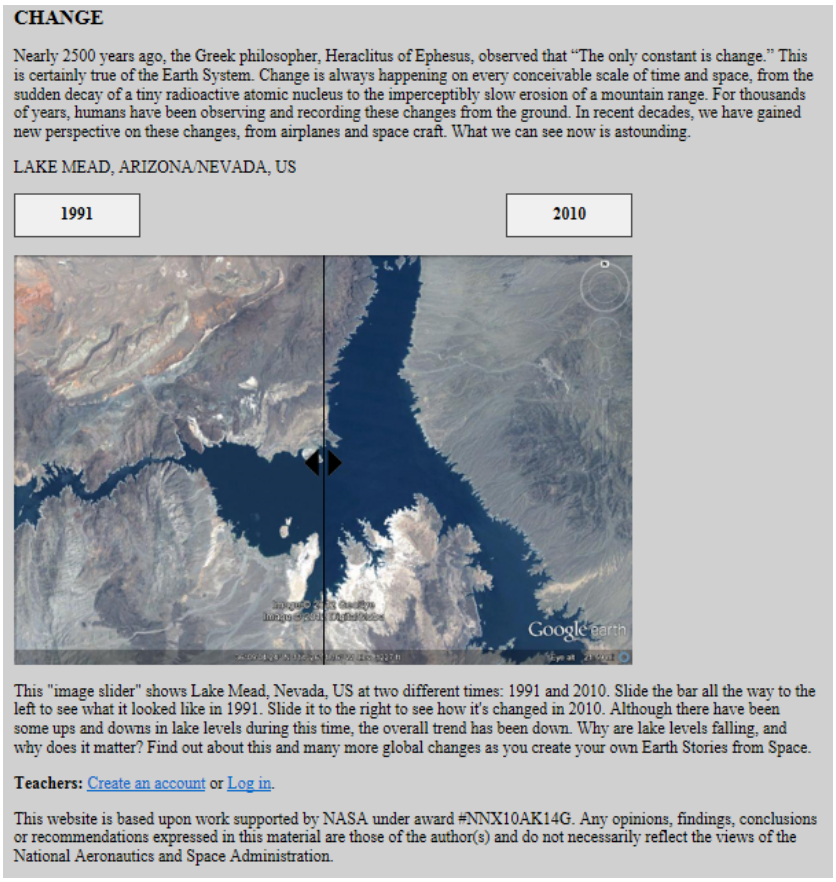
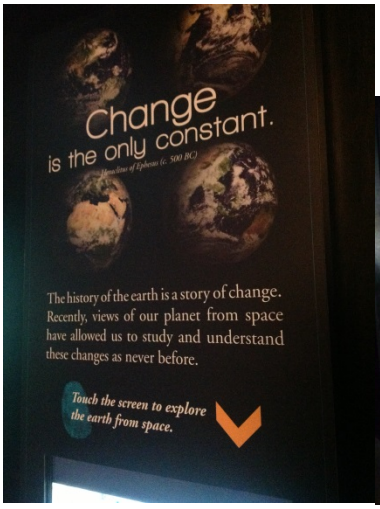


Figure 4 Earth Stories from Space allows teachers and students to create their own ways to show change over time through satellite images.

Exhibit Opening for Educators August 17, 2013



FUTURE PLANS

The success of the program in achieving its goals provides support for the value and impact of the program. The high regard with which all the components are held by teachers, youth and parents echoes the evidence of the changed practice and behaviors, enthusiasm for learning more about the topics, and commitments to stewardship in the classroom and beyond. With additional funding, Earth Camp can continue its trajectory of engaging educators and youth and inspiring future leaders of a shared planet.

The Earth Camp team is continuing to seek funding to sustain the teen and teacher programs, and to make them available to the most diverse audience possible, regardless of financial means.

Figure 5 Presentations about Earth Camp shared on a staff/docent bulletin board in the education building.

APPENDICES

GOALS and OUTCOMES from NASA Proposal

Goal I. Engage students in lifelong learning in STEM disciplines to inform their Earth stewardship practices, career decisions and capacity for innovation by:

	Proposed outcomes	Results
Target Audience	1. 20 Middle and 20 High School students per year. 2.75% students from under-represented groups.	1. 20 students in each group were accepted each year. 2. Of those reporting ethnicity, 55% of the middle school students (n=20) and 50% of the high school students (n=18) were from under-represented groups. Alumni follow-up survey respondents reported ethnicity included 25% Hispanic (12), 10% Asian (5) and 13% two or more races (6).
Activities/ Outputs	1. Middle and High School Earth Camps with new NASA satellite-based water and climate modules. 2. Exhibit Design Project. 3. Earth Steward cohort activities and community education in subsequent years.	1. Teachers created lesson plans and presented on inquiry projects during the workshops. Follow-up in Year 2 of past participant teachers showed over ¾ of the teachers reporting use of water and climate modules in their classroom (82%) and over half mentioned direct use of Google Earth or Google Maps to use satellite images in their teaching. 2. Teachers completed Poster Exhibits that have been shared with students and parents during Earth Camp activities and are available on the website. 3. Earth Clubs at Arizona schools included activities and used resources from Earth Camp.
Short-term Outcomes	Students will demonstrate improved: 1. understanding of global and regional water issues. 2. ability to compare the impacts of conserving. *3.* ability to interpret and apply NASA data.	1. Embedded in the Earth Camp experience were activities and reflection questions that highlighted perspectives on water issues. Students made personal commitments to behavior change including those related to water conservation. Journal reflections, focus group interviews and parent surveys provided additional evidence for students improvement in their understanding and applied actions related to water issues. 2. Consistent with results from prior years, impacts of conserving were embedded in inquiry activities during Earth Camp. Students had hands-on experiences and conducted real-time data collection on the results of conservation (e.g., hauling and packing their own trash throughout, minimizing waste during a lunch "competition"). Learning Celebration presentations included analyses estimating the potential impact of the individual commitments made by each student. 3. Students used satellite images during Earth Camp to look at rocks and debris flow for change-over-time comparison with their direct observations. 3D images were used to show large geologic concepts related to the Colorado Plateau. Satellite photos were consulted along the way to check out anticipated camp sites.
Medium-term Outcomes	Students will be able to: 1. Translate and illustrate what they learned into an exhibit. 2. Form cohorts to maintain communication during the year. 3. Engage in deepening their understanding of earth science. 4. Discuss STEM careers. 5. Decrease their water use and become active water stewards.	1. In addition to their Earth Camp commitment and impact analyses, students completed Public Service Announcements and stories about their changed perspective to be included on the Earth Camp website. 2. Students committed to starting or joining Earth Clubs experience the opportunity to continue their learning and connection with Earth Camp throughout the year. An annual “reunion” at the Desert Museum offers additional opportunity to reconnect with cohort members. 3. High school students mention water, geology and the environment when asked what they learned the most about during Earth Camp. When asked an open-ended question about what they would like to know more about, over 90% of the Earth Camp High school students wanted to know more about STEM-related topics. 4. Evidence from the journals and final surveys showed the detailed exposure to a variety of STEM Careers during Earth Camp. In the middle school survey, 84% report that Earth Camp has increased their interest in STEM careers. The most frequently mentioned careers learned by the high school students include hydrology, geology, and astronomy. 5. All students expressed intent to decrease water use and some selected a water-related commitment for their final presentation. Alumni survey results noted 77-100% reporting continued or maintained conservation behaviors related to water use (e.g., 100% turn off water when brushing their teeth, 85% use less water, and 77% report reducing length of showers).
Long-term Outcomes	1. Students pursue a career in a STEM discipline (not measurable in this time frame)	NA (An alumni survey of past participants note that 71% report continued interested in STEM-related careers based on their experience in Earth Camp)

Goal II. Provide teachers with tools and experiences to inspire students to discover the real-world relevancy of STEM disciplines and apply this learning to the pursuit of STEM careers and technological innovation by:

	Proposed outcomes	Results
Target Audience	1. 20 middle to high school teachers per year. 2. >50% teachers reach high numbers of underrepresented students.	1. For Year 1, the final group of enrolled teachers was 16. Although 20 teachers were enrolled for Year 2, 12 completed the program. In Year 3, 20 were enrolled and 16 completed the program. 2. Teachers represented a diverse array of schools, at least half which serve underrepresented students (e.g., Arizona School for the Deaf & Blind, Teenage Parent Program, Ha:san Preparatory & Leadership School, Altar Valley Middle School, Baboquivari Middle School, Cesar Chavez High School, La Paloma Academy, and others.)
Activities/ Outputs	*1. Series of four teacher workshops over a school year.* *2. Field studies.* *3. New NASA satellite-based water and climate modules.* 4. Exhibit Design Project.	1. Four successful teacher workshops a year have been offered. 2. Field studies conducted during river trip, Mt. Lemmon explorations and other field sites to accommodate state-wide participation (e.g., Yuma). 3. Water/climate modules drafted by teachers during summer workshop and used in their classrooms (82% reporting use from phone interviews). 4. Teachers completed Poster Exhibits and Change is the Only Constant exhibit opened in August 2013.
Short-term Outcomes	Teachers will demonstrate improved: 1. understanding of global and regional water issues. 2. ability to interpret and apply NASA data . 3. ability to develop grade appropriate curriculum integration for Earth Camp materials. 4. ability to understand and communicate the value and relevance of STEM education to students in their classes and schools.	1. Teachers reported increased understanding in post-workshop and field trip surveys. The posters created by the teachers focused on water issues and other systems/environmental/climate change issues. 2. Teachers completed projects and demonstrated their interpretation of data during end of workshop presentations. 3. Plans created during the workshops and ongoing examples of how teachers have incorporated Earth Camp materials revealed their ability to develop curricula--- the challenge with sustained implementation of these ideas relates to school/district requirements and limitations, decreased resources from state and federal funding, and needs for ongoing implementation support. 4. Earth Club reports from the schools show the commitment and demonstrated value teachers have for sharing STEM topics, activities and opportunities with the students.
Medium-term Outcomes	Teachers: 1. collaborate with students to translate and illustrate what they learned to an exhibit for the general public. 2. analyze topics via email groups. 3. engage in deepening their understanding of earth science. 4. discuss STEM careers and assist students and parents. 5. decrease their water use and become active water stewards.	1. Teacher posters have been created and the Change exhibit is on display at ASDM. Online resources for teachers and students are being tested. 2. Teachers access the people resources of Earth Camp through email and share with each other their ideas for implementation in the classroom. 3. Earth Club reports show that teachers have worked closely with students in their schools. Topics and activities have included water audits, installation of solar panels and community gardens, composting and recycling projects, guest visits from Desert Museum staff, field trips and camping trips, and use of images from the Earth Camp and Desert Museum website for presentations about earth science and environmental topics. 4. Some of the Earth Clubs have incorporated guest speakers or field trips related to STEM careers (e.g., one school attended Arizona State University's Earth & Space Engineering Day as part of their all-8th-grade Earth Club. 5. Teachers report being more conscious of their own water use (in part encouraged by students who talked about their learning at the end of Earth Camp). Earth Clubs report water audits at some of the schools that preceded water-conservation changes at the schools.
Long-term Outcomes	1. Teachers prepare students for STEM careers and graduate more students who move in to those careers (not measurable in this time frame)	NA (During focus groups in Year 3 and follow-up phone interviews with past participants, teachers report increased enthusiasm for and ability to describe STEM careers both more broadly (e.g., areas of study and work they did not know about before Earth Camp) and more specifically (e.g., "real" scientists and other examples) based on their experience with Earth Camp.

Goal III. Enhance public awareness of environmental change in the southwestern United States and the importance of NASA satellite data for recording, tracking, understanding and predicting these changes.

Target audience	*1. ASDM visitors (400,000/yr), ASDM web visitors (1 million unique hosts/yr), and exhibit visitors at community sites, including parents of teen participants.*	**1.** Exhibit has been installed and will be evaluated during Year 4 – no cost extension.
Activities/Outputs	*1. Lifelong learning community fostered and sustained.* *2. Posters and Interactive game to be displayed at regional sites.* *3. Kiosk exhibit is installed at ASDM.* 4. On-line exhibit is created and maintained at ASDM website.	**1. Exhibit has been installed and will be evaluated during Year 4** 2. Posters have been displayed at Regional sites (e.g., Water Resources Research Center). 3. **Exhibit has been installed and will be evaluated during Year 4** 4. First, second and third year posters, and website resources have been created and shared with Earth Camp participants, ASDM visitors and others.
Short-term Outcomes	1. Parents of participants attend presentations and engage in learning through interactive exhibits. *2. ASDM on-site and on-line site visitors increase understanding of the importance of NASA satellite data for recording, tracking, understanding and predicting environmental change.*	1. Parents attended the Earth Camp for Teens Learning Celebrations and completed post-program surveys (see Appendices for summary of results) **2. To be addressed in Year 4**
Medium-term Outcomes	1. Teachers, educators and students form community learning groups dedicated to earth and community stewardship. 2. Teachers use on-line exhibit in their classrooms and in their work with Earth Clubs on their campuses. *3. Visitors to poster exhibit at community sites increase awareness of NASA's contribution to Earth Sciences.*	1. Earth Clubs have formed. Reports from 6 sites were received in Year 3 with over 450 students participating. Most are small clubs (approximately a dozen student attending regularly). Some schools implemented school-wide Earth Clubs (e.g., reaching nearly 200 students each). Additional teachers and students from Earth Camp 2012 have committed to creating Earth Clubs at their schools in 2012-2013. 2. Teachers from the Earth Clubs and year 2 Earth Camp educators report using resources from the website and ideas from Earth Camp for the activities and projects. Additional examples will be reported in Year 4. **3. To be addressed in Year 4**
Long-term Outcomes	*1. Graduates in STEM disciplines increase in numbers, fill the professional positions available and provide the innovation of the future (not measurable in this time frame).*	*NA*

Teacher Workshops Feedback Summaries

Post-workshop surveys were conducted for each of the teacher professional development experiences. The responses to these questions were used for staff feedback and planning. In addition, teachers rated each workshop on items related to the learning goals for the workshops overall. Note that some workshops directly addressed a subset of the learning goals.

Each of the workshops was rated on the following items on a 5 pt Likert scale (5= Postive).
The average for all items for all workshops were rated very consistently between 4 and 5.

1. This workshop was excellent—one of the best I have ever attended.
2. The objectives of the workshop were stated and fulfilled.
3. I intend to become a better water steward as a result of this workshop.
4. The materials can be adapted to fit in with what I'm teaching.
5. The workshop activities were relevant and improved my knowledge.
6. The resource materials provided will be helpful for teaching about (topic of the day).
7. The facilitators were well prepared.
8. The facilitators were enthusiastic and pleasant.
9. The workshop was well organized.
10. The information, strategies and instructional methods presented during the workshop were helpful to me.
11. The facilities and amenities (setting, breaks, etc.) were suitable for the purposes of the workshop.
12. The workshop met my expectations and had an impact on me.

Specific topics were rated using a pre/post scale on the day of the workshop. Items showed consistent gains throughout. The following are examples from two of the workshops.

Rank your level of understanding with the following subjects before (and after) the workshop (1-10, 1= Low, 10=High)	**Pre** Average Rating	**Post** Average Rating
The Properties of Water that enable it to transform and move in the water cycle	7.8	8.9
Watersheds that are part of Arizona's Water Supply	6.4	9.3
Remote Sensing	3.8	7.8
Use of satellite imagery to investigate earth changes	4.6	7.4
The appropriate tools to study change over time and space at the appropriate scales	4.4	6.8
Rank your level of understanding with the following subjects before (and after) the workshop (1-10, 1= Low, 10=High)	**Pre** Average Rating	**Post** Average Rating
The tools available to collect biodiversity data at different scales	5.0	8.3
The methods used to compare the biodiversity at different sites	5.0	8.6
The methods used to analyze biodiversity data at different scales	3.9	7.8
Remote sensing	4.3	7.3
Use of satellite imagery to investigate earth changes	4.6	7.4
The appropriate tools to study change over time and space at appropriate scales	4.5	7.3

Teacher Design Workshop June 2013

The survey completed at the end of the design workshop served as an end of program survey and asked a more extensive set of questions.

Because of this program, how confident do you feel in teaching the following science/engineering practices to your students: N=16	**Much less confident**	**Less confident**	**About the same level of confidence**	**More confident**	**Much more confident**
Asking questions (for science) and defining problems (for engineering)	**0**	**0**	**6% (1)**	**44% (7)**	**50% (8)**
Planning and carrying out investigations	**0**	**0**	0	**31% (5)**	**69% (11)**
Analyzing and interpreting data	**0**	**0**	0	**62% (10)**	**38% (6)**
Using mathematics and computational thinking	**0**	**0**	**31% (5)**	**31% (5)**	**31% (5)**
Constructing explanations (for science) and designing solutions (for engineering)	**0**	**0**	**6% (1)**	**56% (9)**	**38% (6)**
Engaging in argument from evidence	**0**	**0**	**12% (2)**	**38% (6)**	**50% (8)**
Obtaining, evaluating and communicating information	**0**	**0**	**12% (2)**	**31% (5)**	**56% (9)**
STEM Integration	**0**	**0**	**6% (1)**	**31% (5)**	**62% (10)**

Comments:

Lots of great examples demonstrated and modeled that helped a lot.
I love the program but would have like more direct application for math-engineering
This helped me move from a good teacher status to a great teacher!
I liked all the hands-on investigations we did during the first 3 or 4 sessions to model lessons for students
This has been extremely helpful for me and STEM Integration
I am very excited to be able to incorporate many of these "tools" with my students.
What an amazing experience! Thank you for all the fabulous resources.

Before this program, did you teach about Earth/Environmental Change? If yes, please provide some examples.

No (5)

Yes, but… (4)

- *Not very much unless asked about something*
- *Used google earth on a limited basis*
- *Very basic though. This was my first year teaching 7th grade science. This workshop really helped my confidence for the coming year.*

Yes (7)

- *Using images from Alaska—website that has old and new images.*
- *It was more on a geologic time scale and not recent years.*
- *We talked/taught about urban planning & development*
- *Global climate change, Ecosystem change/invasive*
- *In 7th grade Ecology and Global Warming*
- *Weather/climate/seasons; some forest fire and flood*
- *Renewable resources, fossil fuels*
- *We do population modeling and talk about human and natural changes in habitat as part of our ecosystems unit. We cover 1 week of climate change. We study volcanoes and earthquakes.*

How does Earth Change fit into your subject area(s), if at all?

- *Change = slope, y=mx+b, rate/ratio all math*
- *It will fit in this coming year when I teach integrated science*
- *One of my goals is to write a STEM class for high school. I would like to integrate an Earth change section.*
- *I integrate all subjects so this is perfect*
- *It is directly tied into the NGSS standards for 4th grade!*
- *Perfectly aligned with environment, weather, habitats, ecosystems…*
- *It fits exactly into the standards that I teach.*
- *It fits right into ecology- I only teach it fall semester so looking forward to revamping curriculum*
- *I want to incorporate recent earth climate change, looking at water, geology and vegetation*
- *Al of my subjects can relate to Earth change. Ecology, Evolution, and the environment.*
- *It is a cornerstone of my subject*
- *It works well with the 6th and 7th grade science curriculums*
- *It fits w/ geology & ecosystems in 7th grade. It fits w/climate change & weather phenomena in 6th*
- *Climate change in ocean depth, drying of river systems, renewable energy*
- *Ecology- so many ways, fits in quite well, EQ & Volcanoes—satellite images are great*

Are you more likely to give your students more independence in developing their own investigations after doing this program?

Much LESS Likely	LESS Likely	About the same likelihood	MORE Likely	Much MORE Likely
0	0	0	62% (10)	38% (6)

What questions do you still have?

~ *Navigating earth engine now that I have access*
~ *Earth Engine- student logins? Maybe?*
~ *Who will support as a classroom teacher in implementing lesson plans?*
~ *I would like more follow up on implementation, for example, support in my classroom over the school year.*

Any other suggestions for ways to improve the workshop/program experience?

✓ *Keep the monthly meetings—they keep me focused.*
✓ *Create a blog or sharing space to keep in touch w/ our fellow campers and share how we are using these tools.*
✓ *With more experience in Earth engine I will feel more confident with it.*
✓ *Have previous Earth Camp Educators tell us how they use it in their classroom.*
✓ *Get people on Earth Engine within 2 classes!*
✓ *Get rid of the U-table configuration.*
✓ *It would have been helpful to have started the posters earlier.*
✓ *Provide a binder or have people bring their own for putting all papers.*
✓ *Everything was amazing and really well done!*
✓ *No, it's great!* ☺
✓ *Keep doing what you are, it was GREAT!*
✓ *It was very well organized, professional, engaging, and interesting.*
✓ *It has been VERY well run and directed with great speakers, resources, and advice providing excellent activities and modeling processes.*

Please rate your satisfaction with this program as a professional development opportunity for teachers.

0	1	2	3	4	5	6	7	8	9	10
0	0	0	0	0	0	0	0	6% (1)	0	94% (15)

0= Not at all Satisfied

⇧

5= This was an average workshop based on my experience

10= This was one of the most outstanding workshops I have ever experienced.

High School Earth Camp 2013 Camper Evaluation
Summary of Responses (N=20)

List three words that describe your experience at Earth Camp:

Amazing (40%), Life Changing (30%), Exciting (25%) and Fun (25%) were the most frequent words mentioned. More than one student also wrote Memorable/Unforgettable (20%), Inspiring (15%), Exhausting, Learning and Perfect.

What are you going to tell your friends about Earth Camp?

- *I am going to tell my friends that it is an amazing experience that could change your life.*
- *That it changed my life. I have gained so much more of an understanding about my role in this world.*
- *That it has been an amazing experience because you do science, friendship, and you travel in the same time.*
- *They should apply if they want an incredible experience.*
- *That it will change your life for good, because Earth Camp takes your vision and removes the blinders.*
- *That it's a bonding experience that teaches leadership as well as how we affect the environment.*
- *It was awesome! I went to a place many people don't even know about.*
- *It is one of the greatest experiences that you could ever have from the learning to the views and friends.*
- *That it was the best experience of my life, I met amazing new people, and I learned new things that I'm ready to bring home.*
- *I am going to tell them it was the best experience of my life.*
- *Earth Camp taught me how to be a leader for a shared planet and taught me not to be shy to express who I am.*
- *A camp where you can enjoy the nature while learning new things. Things about the environment and science.*
- *I will share the information and skills I learned during camp. I will also encourage them to try this camp for themselves.*
- *That I had an unforgettable experience and learned unforgettable skills and knowledge.*
- *I'll tell them all that I learned and how much fun I had*
- *I am going to tell them that I had the time of my life and that they should all consider going at one point.*
- *I will tell my friends that if you want to take a stand and want to be involved with helping the planet, then you should go*
- *It was a place where I felt happy*
- *I am going to tell them that it was well worth it and to encourage their own earth-y things.*
- *That it was the most amazing, phenomenal thing that has ever happened to me and that they <u>have</u> to go and see these amazing sights and go have fun!*

List five new things you learned at Earth Camp:

- *Hydrologist, Astronomers are awesome, the big dipper is connected to lots of stars, how to measure stream flow, the names of many planets.*
- *There are amazing friends and people out there, we <u>must</u> conserve water, Planet Earth is a beautiful place that we must do everything in our power to preserve it, you must be a leader and a follower.*
- *Amount of drinkable water, river guiding, duckying, camping on my own skills, how to rig an overnight pack.*
- *Debris flow, how to measure stream flow, about John Wesley Powell, new constellations, how to row a kayak.*

- *How rapids form, how to raft, names of star constellations, how to make rope, how to create no waste when I eat out.*
- *How scarce our water source is, how much a dam or something like it can change an ecosystem, how to help reduce our output of waste, how to save more water, what a great experience it is to be cutoff from the rest of the world.*
- *Hydrology, geology, the creation of a simple object could take up an immense amount of resources, astronomy, survival skills.*

- *Geology, hydrology, astronomy, skills to survival, reuse a lot of quotidian things.*
- *How to reuse items and create something completely new, like a rope made paper towel, how to find constellations by using other constellations as a guide, how to find new ways to use less waste, how to make the best of limited resources, how to survive in the wild.*
- *American culture, new animals and plants, utilize paper towels to make rope, how to make compost, using napkins.*
- *A new way to see the world, how to make connections, how to more fully love the natural world, how to make better friends, how to make the best of the time we have.*
- *Magnesium [sic] is often the darker desert varnish in the Desolation Canyon walls, the rest of the Colorado River is cold beyond Lake Powell as a result of the Glen Canyon Dam, few native fish are able to survive now because of these changes in their ecosystem, Canyon de Chelly is about 700 feet high, stryofoam is spelled E-V-I-L.*
- *How the clouds can tell you it's going to rain, that the Glen Canyon Dam supplies water to Page, even though it might seem like we have a lot of water we only have a drop, No Impact Man—to make the least amount of impact on Earth, spread the words of Nature.*
- *Dams hurt, and help, how to make friends, geology and hydrology, that I am in love, that I matter.*
- *How we affect water thousands of miles upstream, how precious water really is, how to reuse what we think is unreusable, how to look at the bigger picture of the world, the mechanics behind the resources used to create something.*
- *How to make rope, how to live without running water, how to bathe in a stream, how to make a tent, how to keep dry under rain.*
- *Signs in relation to stars, how rapids form, how calcium carbonate is formed on rocks, how Powell sailed the Green River, the formation of Snowflake, Arizona.*
- *That we only have a "drop in a bucket" left of water that we can use, learning about the environment even more, that leadership from one person can spread to many people, Desolation Canyon is one of the most beautiful and relaxing places ever, it's easy to help the environment in many ways.*
- *That Canyon de Chelly's native people are getting pushed over and the government's taking over.*
- *I learned the humpback chub used to live in the Colorado River, I learned only 0.03% of water is accessible to us, I learned how much is wasted by humans, I realized my potential as a leader, I discovered a love for Desolation Canyon.*

What leadership abilities and qualities did you learn about or practice during Earth Camp?

~ *Be a more positive person*
~ *Being positive, collaboration, cooperation*
~ *Be thoughtful, motivated, tolerant and persistent*
~ *Persistence, hard work, charisma, trustworthiness, responsibility, respectfulness*
~ *Perseverance, positivity, responsibility and patience*
~ *Persistence, wisdom, cautiousness and unprejudice*
~ *How to be patient, inspiring, intelligent and thoughtful*
~ *How to be patient, respectful, knowledgeable*
~ *Not to give up, hard work pays off*
~ *How to encourage others and be a strong leader*
~ *You must be a leader and lead by example, at the same time be a follower and open to new ideas*
~ *To expand my teamwork skills and practice taking responsibility*
~ *Take action on our dreams and make the world a better place*
~ *How to work together and get something done instead of waiting 'til the last minute.*
~ *Able to take action where it is needed*
~ *Take part I any activity that is happening*
~ *Talking as a leader isn't enough—you need to act upon what you say*
~ *Teamwork—through the hardship of the rafts and how to better demonstrate confidence*
~ *Be myself and how to trust others*
~ *How to speak my mind!*
~ *Loving the people you lead/follow*
~ *As a leader you must be a follower*

- *Sensitive, taking responsibilities, be a good communicator*
- *Practice being outgoing, kind, caring and helpful*
- *How to be confident, humble, understanding, and trustworthy*
- *Care more about others and not just think of myself*
- *See the world from a new point of view, see all situations from different perspectives*

What does sharing the planet mean to you?

- *We are all part of it and we have to work together to make sure we are taking care of it*
- *Keep the peace and let us all be equal amongst each other*
- *This world belongs to everyone not just me*
- *The earth is a place filled with many different spaces and resources and it's not just about humans- we share this planet*
- *It is our planet and it takes care of us so we need to take care of it*
- *Sharing the planet with every other living thing and keeping Earth whole and beautiful*
- *Leaving nature as I found it, respecting the wilderness, and helping the world stay amazing*
- *We have limited resources and we need to learn how to save these and share them equally*
- *A responsibility for all human beings to be able to love and care for the planet*
- *We each have a certain amount of resources and we all need to work to conserve it*
- *To live peacefully with the other humans, animals and plants without harming our environment*
- *Living in part of a system where we have a role that adds to the others in that system*
- *The world is not only for us, is for other animals and plants and for the next generation*
- *Doing my part as a community, helping as I can, and as much as I can; others will follow*
- *Everything that I do not only affects me, but other people as well*
- *Each person lives here like you; we all feel like we need a part of it; if everyone would share, the world would be better*
- *Finding a balance between technology and nature*
- *Letting everyone live right now, but also keep the population of the future able to live*
- *Sharing the earth with everyone, whether by recycling or conserving natural resources or by just not wasting so much*
- *We have to conserve our valuable resources to go around for every living organism, and we can't always soley think about ourselves*
- *We all share this amazing planet and we must take care of it together*
- *What things are you doing now to be a leader for a shared planet?*

What things would you like to do in the future to be a leader for a shared planet?

- *Be a leader of a club like Earth Camp*
- *Start a water conservation club at my school to help people*
- *Teach others about it, encourage others to do it*
- *Teach many others about being eco-friendly and continue to advocate for a shared planet*
- *Expand my knowledge of ways to make Earth a better place. I will also spread the word to family and friends so we can lead by example*
- *Start leading by example, more often instead of just talking about it*
- *Start a small garden in my backyard*
- *Help protect the Earth's precious resources more by taking shorter showers, reusing or refusing to use waste, and using less*
- *Discover or improve the renewable energies, mainly solar energy. I also will take care of my actions to protect our planet*
- *Let others have similar experiences*
- *Explain other people what nature means and why we have to respect it*
- *Pick up trash as I see it and make as little of an impact as I can*
- *Not be afraid to speak my mind*
- *Show people to speak their minds*
- *Help people see the bigger picture of our world instead of a tiny pixel*
- *Start a compost when I'm older, start recycling, and grow my own food*
- *Maybe teaching, doctor, camp leader*
- *Use less water, produce less waste, & encourage people to do the same*
- *Share the ideas of earth camp with people I know in order to create a mass impact*

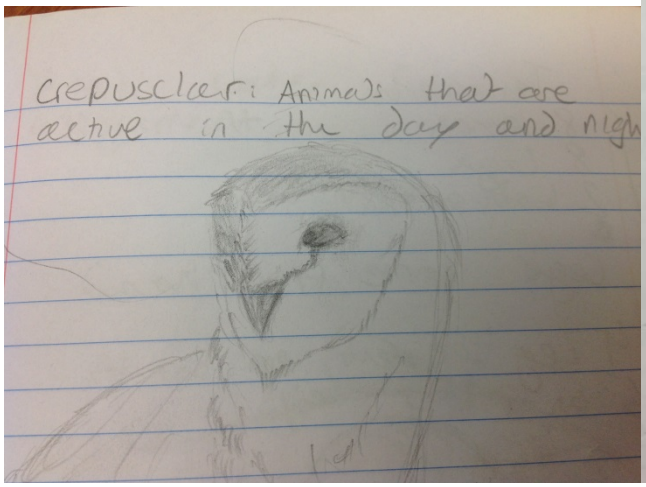
Quotes from High School Earth Camp Student Journals and Learning Celebration

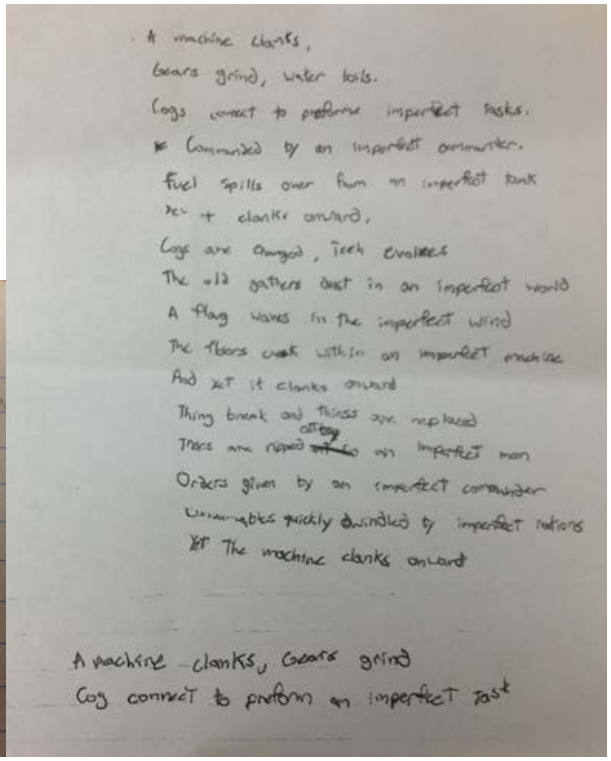
The following quotes from student journals and Learning Celebration presentations show explicit examples of the value and learning students gained from participation in Earth Camp:

- *It's like a whole other world!*
- *I can't remember the last time I was this tired.*
- *What I learned from this was how easy it is to do such simple things (e.g., bring own napkins, reject styrofoam cups)*
- *Ultimately, I decided to drop my anger and just move on (regarding frustration with unexpected rain)*
- *Listening and paying attention is imperative.*

Key ideas noted in journals include:

- ✓ *Observations and descriptions*
- ✓ *Data*
- ✓ *Summaries*
- ✓ *Qualities of a leader*
- ✓ *Earth Camp waste data*
- ✓ *Stream flow data*
- ✓ *Self improvement ideas and reflections*
- ✓ *The Story of Stuff- planned and perceived obsolescence*
- ✓ *A drop in the bucket activity*
- ✓ *Aspects of change through the canyon*
- ✓ *Debris flow data*
- ✓ *Rain experience*
- ✓ *Feeling connected to the land*
- ✓ *Sky quality meter measurement*
- ✓ *New terms like "crepuscular"*
- ✓ *A poem*





High School Earth Camp 2013 Parent Evaluation

Results N= 16

Please rate your satisfaction with the following aspects of High School Earth Camp 2013:

Information provided **before** camp	6% (1)Not enough	6% (1)Enough	88% (14) Answered all my questions- Useful & Helpful
Pre-Camp Meeting at Desert Museum Did not attend (4)	0Not helpful	6%(1)Somewhat Helpful	69% (11)Very Helpful
Variety of activities offered **during** camp	0Unsatisfied	12% (2) Satisfied	88% (14)Very satisfied
Helpfulness of staff **to you as a parent**	0Unsatisfied	12%(2) Satisfied	88% (14) Very satisfied
Learning Celebration Presentations	0Unsatisfied	15% (4) Satisfied	75% (12) Worthwhile- I gained insight into their activities and learning

Comments:

- *Thank you for providing this outstanding experience!*
- *Amazing opportunity for my son—a life changing experience for him. I am certain it will change his life forever. THANK YOU! (The learning celebration was beautiful, just long enough.)*
- *Thank you for ALL your amazing effort*
- *I do not know how to thank enough all the staff that make it possible. Many changes have been made in my house and my life thanks to my daughter attending camp for several years.*
- *Very well done—heartfelt. Is there a certificate to show accomplishments as a reference?*
- *The learning experience he had could not be had anywhere else. I know this will be in his heart for the rest of his life and impact his path in the future.*
- *Well done! Thanks so much for your dedication to the students and Earth Camp.*
- *Didn't realize the presentation at end would last so long and had appointments that ended up missing.*

Please rate your overall satisfaction with Earth Camp as a learning opportunity for students.

0	1	2	3	4	5	6	7	8	9	10
0	0	0	0	0	0	0	0	0	31% (5)	69% (11)

0= Not at all Satisfied

⇧

5= This was an average opportunity based on our experience

10= This was one of the most outstanding opportunities my daughter/son has ever experienced.

How did you hear about Earth Camp? *Prior attendance by family member (3), teacher (3), school (2), Website, UA, Amy/Naomi Orchard (2), Brookfield Zoo, ASDM newsletter*

How did your son/daughter benefit from attending Earth Camp?

- *Knowledge, Awareness, Friendships; Excellent ESL opportunity (I think Brazil has a program similar to Spain's)*
- *Seems like he left "bored" with life—He seems to be confident, happy and he seems to have learned a lot*
- *They been so much changes on her prospectives of what the earth is and what is needed to help the environment. We are very happy having camps like this and people that make it happen.*
- *Made new friends; new experience for water rafting.*
- *She learned about nature and more about outside.*
- *Haven't talked to him yet.*
- *He has a closer relationship with nature. He has a commitment to preserving nature and conserving resources. He has learned how he can be the change maker and make a difference.*
- *Help focus her commitment on the Earth; Help her grow, mature & gain confidence. Thank you X 10^9*
- *Learned a lot about the environment and being aware.*

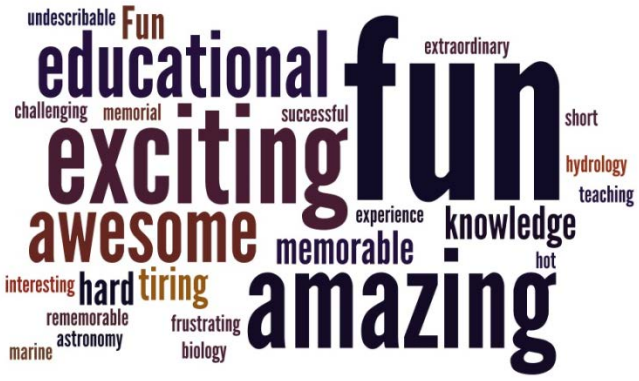
- *She seems happy and very informative*
- *I think it's an outstanding experience for my son. My son learned a lot, and he matured too. He became a different person.*
- *Sharing/Community/Friendships/Conservation/humility*
- *New friends, new perspectives, hands-on education; EC is an adventure that will forever impact my daughter*
- *Became more mature and aware of environment*

What changes would you suggest for next year's Earth Camp?

- *Have international students arrive several days prior to EC.*
- *The end presentations were wonderful and I think next year parents should go! (Kidding)* ☺
- *All is GREAT!*
- *None, I think it is great.*
- *Change nothing it was great.*
- *All sounds great.*
- *None, Thank you. (4)*
- *Just keep it going!*
- *I don't think they should have any changes. I will send my younger son next year!*
- *Suggest kids wear their hiking boots for at least 2 weeks before leaving so they won't get blisters. Check tents beforehand so they have all the parts.*
- *Tell us how long send off/return home presentations will be*

Middle School Earth Camp 2013 Camper Evaluation
SUMMARY RESPONSES (N=19)

1. **List three (3) words that describe your experience at Earth Camp:**
   Fun, amazing and exciting are the most frequent words students used (each mentioned by 32% of the students). Other frequent words included **awesome, educational and memorable** (each mentioned by 21% of the students).



2. **What are you going to tell your friends about Earth Camp?**

- *It was fun and I learned so many new, amazing things! It was an eye-opening experience.*
- *I'm going to tell them that it is an awesome camp, it's helpful, also that Earth Camp is an eco-friendly camp. I will also tell them that there is a lot of learning and that it is a great experience to have.*
- *Though you'll get tired out, you should try it out. You learn so much and make such good friends. The experiences are amazing. It's worth it.*
- *It was a good camp to have fun in however you have to behave.*
- *That it's awesome and they should attend Earth Camp.*
- *It was really amazing and a once in a life time chance.*
- *That is was a lot of fun and a great experience.*
- *I would tell my friends that Earth Camp combined the perfect amount of fun and education. It motivated me to change things when I go home.*
- *That it is one of the most extraordinary experiences EVER.*
- *Everything.*
- *That I had a really fun and interesting time and met a lot of new friends.*
- *You guys should have applied because that was probably the best camp I've ever been to.*
- *That it is an amazing experience and everyone should apply.*
- *I had an awesome time. I met a load of new people and make a lot of friends. The whole camp was really exciting.*

3. On a scale of 0-10, how would you rate your overall experience?

0	1	2	3	4	5	6	7	8	**9**	**10**	**8-10**
0	0	0	0	0	0	0	0	0	**32%**	**68%**	**100%**
									(6)	**(13)**	**(19)**

0= Not at all Satisfied

5= This was an average opportunity based on my experience

10= This was one of the most outstanding learning experiences I have ever had.

4. **Please review the Earth Camp activities listed below and answer the questions for each**

(% YES Reported Below)

Earth Camp Activity	Did you ENJOY this activity?	Did you LEARN new things during this activity?	Should we include this activity in next year's Earth Camp?
Calculating ecofootprints	79	100	95
Crayfish Eradication	95	100	100
Dendrochronology & Tree Coring	90	95	90
Hike to the Fire Tour Overlook	95	100	100
Telescope Observing at Sky Center	100	100	100
Aquatic Insect ID on Hike	68	95	90
Re-Photography Activity in Wash on Mt. Lemmon	90	84	90
Biking in Tucson	100	95	100
Live Animal Presentations	100	100	100
Climate Change Lectures	68	95	90
Ground Water & Aquifer Model Exploration	95	90	84
Ant Collection and ID Activity at Museum	84	90	90
Building Tools for Use at the Biosphere 2	100	100	100
Biosphere 2 & Activities at the Ocean & Marsh	100	100	100
Light Audit & Light Pollution Activities at Biosphere	100	100	100
No Impact Man Presentations	95	95	95
Story of Stuff Movie	74	95	95
Tour of the MERF (Recycling Center)	90	100	84
Eco-Quest at the Mall & Second Hand Stores	100	84	100
Bright Solutions Presentation (TEP & Energy)	95	100	95
Waste-free Lunch Challenge	100	95	100
Saguaro Harvest Campout	100	100	100
Final Presentation for Learning Celebration[2]	NA	NA	NA

Any activities not listed above on which you would like to comment?

Team Building was the most frequently mentioned "other" activity (e.g, "really brought me closer & helped me make friends). Specific activities included web the board, capture the flag, chocolate river game. One person mentioned that the underwear game was awkward. Most had nothing else to offer: "Everyday was perfect," wrote one student.

[2] Students completed the evaluation just prior to the Learning Celebration

5. Think of all the experiences you had at Earth Camp. What did you learn that will help you be a leader for our shared planet?

- *I learned many ways to conserve water which is a big problem in TX so I plan to take these skills home and help lead.*
- *I learned about how the climate is changing and how it's affecting <u>everything</u> around us. I'll help lead by reducing my eco-footprint to help the environment.*
- *I learned that even though you don't think you contribute to pollution you actually do!*
- *I learned so many ways to get around using less and refusing things we don't need.*
- *Reduce, reuse, recycle, refuse; cooperation with others is key; how much plastic really does affect us; 1 person really can make a difference ("Be the change you wish to see in the world.")*
- *You need to work together for a common goal to help preserve are planet.*
- *You must cooperate with other people, even if it is hard too. You also have to communicate efficiently.*
- *How to compost.*
- *Every person needs to do what they can to help the environment. It isn't up to just 1 person- it's up to all of us. I learned that we can <u>all</u> do something, even if it's small. We can make a difference, and even the little changes have BIG Impacts.*
- *I learned all about techniques I can use and share with people. I also learned how to speak to shop keepers and strangers and just people in general without sounding like I am judging them for not being completely eco or eco at all. I learned that if we all work together we CAN help this planet.*
- *That we should take shorter showers.*
- *Earth Camp opened my eyes to environmental problems that I didn't even know existed, like light pollution, & taught me more about things I already knew about, like climate change.*
- *Well, I learned about the environment and to be more aware of things around me.*
- *A lot of things we do daily are polluting and there are ways to stop it.*
- *About the pollution that we put into the air, and how we need to stop all the pollution.*
- *Tell people at bathrooms not to use paper towels; explain to younger generations on how to limit how you use plastic*
- *Nature is not to be messed with*
- *I learned that it's up to you. Be the first one to start an environmental "uprising" in your community. Encourage others to bike to school, conserve water and energy, and plant their own gardens. I learn just how important one person changing their own habits can be. You can influence others to do the same.*
- *I learned that all the activities were fun to do and helpful for me in the future. I can help the planet by doing everything I learned at Earth Camp.*

Please circle the word that best matches your HONEST opinion about your Earth Camp experience:

6. Because of Earth Camp, I feel closer to nature.

100% AGREE

Strongly Agree	*Agree*	*Neither Agree nor Disagree*	*Disagree*	*Strongly Disagree*
63%	*37%*	*0*	*0*	*0*
(12)	*(7)*			

7. Because of Earth Camp, I intend to work harder to conserve nature and reduce my "ecofootprint."

100% AGREE

Strongly Agree	*Agree*	*Neither Agree nor Disagree*	*Disagree*	*Strongly Disagree*
74%	*26%*	*0*	*0*	*0*
(14)	*(5)*			

8. I learned how to be a better team-member in Earth Camp.

100% AGREE

Strongly Agree	*Agree*	*Neither Agree nor Disagree*	*Disagree*	*Strongly Disagree*
37%	*63%*	*5%*	*0*	*0*
(7)	*(12)*	*(1)*		

9. I am more interested in a career in science, technology, engineering or math as a result of Earth Camp.
74% AGREE

Strongly Agree	*Agree*	*Neither Agree nor Disagree*	*Disagree*	*Strongly Disagree*
53%	*21%*	*21%*	*5%*	*0*
(10)	*(4)*	*(4)*	*(1)*	

10. I am more interested in a career in an environmental field as a result of Earth Camp.
68% AGREE

Strongly Agree	*Agree*	*Neither Agree nor Disagree*	*Disagree*	*Strongly Disagree*
23%	*42%*	*21%*	*5%*	
(5)	*(8)*	*(4)*	*(1)*	

11. I am more motivated to do well in my science classes as a result of Earth Camp.
84% AGREE

Strongly Agree	*Agree*	*Neither Agree nor Disagree*	*Disagree*	*Strongly Disagree*
47%	*37%*	*16%*	*0*	*0*
(9)	*(7)*	*(3)*		

12. Any suggestions for next year's Earth Camp?

Full tour of the Biosphere (2)
More hands-on (2)
More star gazing
More stuff involving reptiles
Less desert hiking, more Mt. Lemmon
More team building
No more scrubbing bean pots!!
1 pair of binocs & star guide for each group
Have more fun
Let campers who don't want to do stuff with bugs just stand back and take notes
Do a game at the end of day if time
Tool building was too easy—real scientists have to improvise in emergency situations
More creative, technical, inventive skills activities
Be creative for everything you do!
2nd bike day

Middle School Earth Camp 2013 Parent Evaluation

Results N=16

Please rate your satisfaction with the following aspects of Middle School Earth Camp 2013:

Information provided **before** camp	0 Not enough	6% (1) Enough	94% (15) Answered all my questions- Useful & Helpful
Pre-Camp Meeting (5 NA/did not attend) *(Notes were good, one person said)*	0 Not helpful	0 Somewhat Helpful	63% (11) Very Helpful
Helpfulness of staff **to you as a parent**	0 Unsatisfied	0 Satisfied	100% (16) Very satisfied
Learning Celebration Presentations 1NA	0 Unsatisfied	6% (1) Satisfied	88% (14) Worthwhile- I gained insight into their activities and learning

Comments:

Please rate your overall satisfaction with Earth Camp as a learning opportunity for students.

0	1	2	3	4	5	6	7	8	9	10
0	0	0	0	0	0	0	0	7% (1)	0	88% (14)

0= Not at all Satisfied

⇧

5= This was an average opportunity based on our experience

10= This was one of the most outstanding opportunities my daughter/son has ever experienced.

How did you hear about Earth Camp? Website (4), school (3), teacher (3), UA Book Festival (3), email, grandparent, friend, Alex Sandoval, David, Amy

How did your son/daughter benefit from attending Earth Camp?

Positive Role Models, Educational, hands-on experiential learning that was engaging and encourage thoughtful insight about your place in the world.

She learned a lot in the area of her interest.

Very happy—Very interesting, she made a lot of friends; she got a lot of information and she wants to apply in all moment and place.

Meet people from different backgrounds; better understanding of what astronomers do; learn how to study environmental impact; learn benefit of solar/see it in use.

For the most part that remains to be seen. I know he received an excellent and fun education and has already tried to lesson his environmental footprint.

Learned the concept of eco-friendly, learned friendship, learned caring others.

Kindle passion for taking steps to participate in an effort to care for the planet and a community of peers who do

She formed some wonderful friendships. She got excited about Conservation and by being around enthusiastic people.

Learned so much about how to save the planet; compost she now wants to start at home; also wants to plant a garden. Great Idea! Thank you for a great two weeks for my daughter.

Being exposed to several types of people to obtain information. TEP, MERF, etc. Great opportunities for her to learn new things. I'll let you know in a week.

He was introduced to so many experiences and fields of study that he never would have known existed without Earth Camp. Interactions with the other kids. Learning in an environment other than formal classroom. Given good reasons to consider items about water, land and animals previously not seriously thought about.

She was exposed to several fields of science, not previously available to her. She got additional experience working with peers on projects and sharing responsibilities.

What changes would you suggest for next year's Earth Camp?

None (3), none that I can think of.
Not one, wouldn't change a thing. Thank you all- your positivity cause us all!
More campings, more days, more time. Thanks!!
It would be great if the daily photos could be uploaded to a secure [sight] so the parents could see more of what their children are doing daily.
Organize reunions for the Tucson based kids?
Contacting solar electric international for some hands-on workshops could be interesting.
More opportunity for parent/family involvement OR offer a Parent Earth Camp!
I would suggest more field investigation technique time.

Earth Camp Evaluation Summary
Middle School Earth Camp 2014

Words used by students to describe their Earth Camp experience:

On a scale of 1-10, how would you rate your Earth Camp experience? Average 9.6

Think of all the experiences you had at Earth Camp. What did you learn that will help you be a leader for a shared planet?

- *I can be a lot more active than I thought.*
- *New simple ways to conserve resoures and lead*
- *Responsibility*
- *Everything*
- *Be someone that listens to a good leader or be that leader*
- *Eco-Footprint*
- *I learned that patience is key and listening to ideas is helpful*
- *That landfills are bad and you should be careful what you throw away*
- *Learning how to get a message into a persons head*
- *Everything because I can talk about my experience and tell people we need to change to share this for longer*
- *I learned that people really don't know about how much they actually hurt the planet which will make me speak up*
- *a lot*

Rate the following:	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Because of EC, I feel closer to nature	7	5			
Because of EC, I intend to work harder to conserve nature and reduce my "ecofootprint"	7	5			
I leanred how to be a better team-member in EC	7	4	1		
I am more interested in a career in science, technology, engineering or math as a result of EC **	5	5	2		
I am more interested in a career in an environmental field as a result of EC	3	4	4	1	
I am more motivated to do well in my science classes as a result of EC**	5	6	1		

(**Some noted that they were already in the strongly agree or agree categories before Earth Camp)

From parents: How did your son/daughter benefit from attending EC?

- *Many projects that they wanted to do*
- *They said they learned every day*
- *Wanting to share new things at home*
- *Increased awareness & ownership of their own choices and lifestyle*
- *Became more aware of our planet and what we can do to improve things*
- *He has a better attitude*
- *It gave her confidence, developed her environmental ethics and behavior, team work skills, camping skills and outdoor skills and analytical skillls!!*
- *Made friends while learning*
- *He's a new man! (10 years older)*
- *It grounded things he already knew or suspected by growing his knowledge of issues and connecting them to the real world and his community.*
- *I am sure there is lots, but she has not been home enough for us to see it.*

Scientific Investigation Guide
for Incorporation in Science Notebooks

1. TOPIC OF STUDY

Also include the date and the name of people in your group.

2. FOCUS QUESTION (Big Idea)

- What will you investigate or figure out?
- What will be the main testable question or questions that will guide your learning?

3. PLANNING (Materials & Methods)

- List all materials you need for the investigation.
- Write step-by-step procedures so that someone else could repeat the investigation.

4. DATA COLLECTION/OBSERVATIONS

Create a Data Table, may include written observations and drawings.
NOTE:

- Use correct units of measurement & label your units
- Measurements should be specific and accurate

5. DATA ANALYSIS

Create a visual representation of the data (graph, chart etc.)

- Title and label all diagrams and pictures
- Include units

6. CLAIMS AND EVIDENCE

Claims	Evidence
I claim that...	I know this because...

- What do you claim to be true?
- How does your data and research prove your claim?

6. CONCLUSION

- Restate the focus question.
  In this investigation...
  In this inquiry....

- How do your claims and evidence relate to the big idea?

- How would you revise or change your thinking based on the evidence?

- What did you learn that was new?

7. NEW QUESTIONS/REFLECTIONS

- What could you have done differently to improve your experiment?

- What applications could your conclusions have in the "real world"?

- What new questions do you have now that your investigation is done or what next steps would you take?

Laurel Clark Earth Camp for Educators
Power of Perspective: Biodiversity
February 16, 2013
Arizona-Desert Museum – Baldwin Education Building

Agenda

Overarching Question: What tools can we use to explore/study biodiversity?

8:30 **Homework Debrief**

- Share any insights you have from the last workshop.
- Share what you have tried with your students and report how it worked.
- Share lessons learned and challenges after playing with Google EarthEngine

8:45 **Properties of Light Relevant to Remote Sensing**

Focus Question: How can remote sensing be used to explore biodiversity?
Engage and Explore: Light Activity Stations
Explain: Overview of the basic properties of light
Discussion: What are the properties of light that make it useful for remote sensing (with satellites)? How can I uses this lesson as a STEM exercise for my students?

9:45 **Biodiversity and Remote Sensing**

Focus Question: How can remote sensing be used to explore biodiversity?
Explore: Exploring changes in vegetation using GoogleEarth Engine (NDVI)
(take a break as needed)

10:45 **Explain:** A real-world example of using remote sensing to study biodiversity
Discussion: How can remote sensing be used to explore biodiversity? How can I use this lesson as a STEM exercise for my students?

11:15 **Biodiversity in the Sonoran Desert**
Engage and Explore: Plant and Animal adaptions to the Sonoran Desert

12:00 **Lunch**

12:45 **Biodiversity** Field Study

Focus Question: What scientific methods can we use to study biodiversity in the field?
Explain: Introduction
Explore: Field data collection – transects, square meters and insect traps
Discussion: How might you adapt one or more of these tools for studying biodiversity for use with your students?
Explore: Data Analysis
Discussion: Why do we care about and therefore study biodiversity? How can I use this lesson as a STEM exercise for my students?

3:45 **Homework and Evaluations**

1. Record one or two insights you gained from today's workshop that you would like to share with group.
2. Design an adaptation to one of the exercises we have done today that you could try with your students.
3. Think about an investigation that you would like to conduct using the tools we explored today.

4:00 Thanks for being a part of the Earth Camp for Teachers cohort!

Exploring Changes in Plant Coverage using Google EarthEngine

NDVI Normalized Difference Vegetation Index

The NDVI takes advantage of how light interacts with green plants. In this activity we will look at some uses of NDVI satellite images.

Task 1:

1. Find the Chiricahua National Monument on the map and zoom in so that it fills the height of your screen.
2. Load the Landsat 7 32 day NDVI Composite data and jump to August 12, 2012.
3. Notice the different shades of green yellow and orange across the screen. How does the color vary across the mountains from west to east?

In your notebook, record the following:

a) What is your interpretation for this change?

b) What are the circular shapes that occur surrounding the Monument? How does their color compare to the color at the top of the Chirucahas?

c) Record your interpretations for the difference between the circles and the top of the Chiricahaus.

Task 2:

1. Load another Landsat 7 32 day NDVI Composite layer and jump to March 5 2012. Toggle back and forth between the March data and the August data. Describe at least 3 ways these two images are different.

In your notebook, record the following:

a) Describe at least 3 ways these two images are different.

b) Record any explanations could you give for these differences?

Task 3:

1. Change the top data set to August 1999. Toggle back and forth between the two images (August 2012 and August 1999).

In your notebook, record the following:

a) Describe the similarities and differences between these two dates.

b) What explanation can you give for any similarities you see?

Light Stations

Hitting the target

Directions – Your goal is to use the 5 mirrors to direct the light from the laser to the target. Arrange the mirrors in any way to achieve this task mirror to help you.
Notebook question: Describe in your own words the property of light that allows it to be directed by mirrors in this way.
Materials – laser, small mirrors, and a target.

Light in milk

Shine the light through the cups with different liquids and record what you see.
Record the color of the light through each cup.
Notebook question: Describe in your own words the properties of light that causes it to appear differently through these different liquids.
Materials – bright light, clear plastic cups, water, milk, etc.

Gummy Bears

Shine the different colored laser pointers and the LED light through the gummy bears.
Record what colors you see going through the gummy bears.
Notebook question: Describe in your own words what the gummy bears are doing to the light.
Materials - Red and green laser, gummy bears

UV Beads

Take one or two of the beads and describe how they look initially (these are yours to keep).
Now, take them outside and record what happens.
Notebook question: Describe in your own words what you think is happening when the beads are exposed to sunlight. How are the beads and sunlight interacting?
Materials – UV beads (Edmund Scientific) and sunlight

Seeing hidden light

Use the camera provided (or the camera on your cell phone) to "view" the light coming from the end of the remote (you need to hit button on the remote to activate the light on the remote). What do you see?
Now use the different materials to see how the light from the remote control interacts with each:
Record what happens to light when you try to see it through:
the black trash bag.
the plexiglass.
the piece of paper.
your hand.
Notebook question: Describe in your own words the properties of light that causes it to appear the way it does.
Materials – Remote control, digital camera, other materials to test such as a trash bag, paper etc

Laurel Clark Earth Camp for Educators
Power of Perspective: Water Quality
March 30, 2012
8:30 am to 4 pm
Christopher Columbus Park (Ramada #3) and Planetary Science Institute

Overarching Question: What tools can we use to investigate environmental issues at different scales?

8:30 Welcome and overview of day

8:35 Water: On-the-Ground Studies

Focus Questions:

- What can macroinvertebrates tell us about water quality?
- What does dissolved oxygen in water have to do biodiversity?
- Does conductivity, pH and turbidity change at different locations in a lake system?
- What soil differences can we detect closer to the water compared to further away from the water?

Explore: Water Investigations

8:45 Conductivity and pH meters and other equipment

9:00 Four station rotation (1/2 hour each)

11:00 Report out on results

11:30 Lunch - Homework Report: Think/Pair/Share

- What insights did you gain from the Biodiversity workshop?
- What exercise were you able to adapt and use in your classroom?
- What investigation would you like to conduct using on-the-ground measurement and/or satellite images.

12:15 Travel to PSI

1:15 Introduction to Electromagnetic Spectrum and Mulitwavelength Imaging

Focus Question: How do multiwavelengths of light help us see different things in satellite images?

Engage and Explore: Working with filters – what can we see?
Explain: Review of electromagnetic spectrum and imaging, introduction to Landsat Bands
Explore: Google Earth Exercise looking at vegetation, fires, and mineralogy
Discussion: How do different wavelengths of light help us investigate different phenomenon?

3:15 Water Lessons?

3:45 Homework and Evaluations

- Record one or two insights you gained from today's workshop that you would like to share with group.
- Try something we've done so far with your students and write a reflective summary in your notebook.
- Research a topic that you are interested in exploring on Mt. Lemmon

To check out water testing kits or for more information about Arizona Project WET and Water Education contact:

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Arizona: http://cals.arizona.edu/arizonawet/

Teaching Support Center: http://cals.arizona.edu/arizonawet/teachersupport/

Guide to Landsat Bands and Band Combinations

Landsat 7 (ETM+ sensor)	Wavelength (micrometers)	Resolution (meters)	Wavelength
Band 1	0.45 - 0.515	30	Blue-green
Band 2	0.525 - 0.605	30	Green
Band 3	0.63 - 0.69	30	Red
Band 4	0.75 - 0.90	30	Near Infrared
Band 5	1.55 - 1.75	30	Mid Infrared
Band 6	10.40 - 12.5	60	Thermal IR
Band 7	2.09 - 2.35	30	Mid Infrared
Pan Band	.52 - .90		

Guide to Landsat Bands: http://biodiversityinformatics.amnh.org/tool.php?content_id=141

Band 1 (0.45 – 0.52 um, blue-green):
Since this short wavelength of light penetrates better than the other bands it is often the band of choice for aquatic ecosystems. It is used to monitor sediment in water, mapping coral reefs, and water depth. It is the noisiest of the Landsat bands since short wavelength blue light is scattered more than the other bands. For this reason, it is rarely used for "pretty picture" image types.
Band 2 (0.52-0.60 um, green)
This has similar qualities to band 1 but not as extreme. The band was selected because it matches the wavelength for the green that we see when looking at vegetation.
Band 3 (0.63 – 0.69 um, red):
Since vegetation absorbs nearly all red light (it is sometimes called the chlorophyll absorption band) this band can be useful for distinguishing between vegetation and soil in monitoring vegetation health.
Band 4 (0.76 – 0.90 um, near infrared):
Since water absorbs nearly all light at this wavelength water bodies appear very dark. This contrast with bright reflectance for soil and vegetation so it is a good band for defining water/land interface.

Band 5 (1.55 -1.75 um, mid-infrared):
This band is very sensitive to moisture and is therefore used to monitor vegetation and soil moisture. It is also good at differentiating between clouds and snow.
Band 6 (10.40 – 12.50 um, thermal infrared)"
This is a thermal band, which means it can be used to measure surface temperature. This is primarily used for geological applications but it is sometime used to measure plant heat stress. This is also used to differentiate clouds from bright soils since clouds tend to be very cold. One other difference between this band and the other multispectral ETM bands is that the resolution is half of the other bands (60m instead of 30 m).
Band 7 (2.08-2.35 um, mid-infrared):
This band is also used for vegetation moisture although generally band 5 is preferred for that application, as well as for soil and geology mapping.

GoogleEarthEngine Guide to Landsat Bands

80 - band 8 which is a 15m/pixel band
70 - band 7 - IR
61 – band 6 - low resolution bands
50 – band 5 –mid infrared

40 – band 4 Near Infrared
30 – band 3 red
20 – band 2 green
10 – band 1 - blue

Common Uses for Each Band: Landsat Thematic Mapper (TM)

Band 1 (0.45 - 0.52u m): provides increased penetration of water bodies and also capable of differentiating soil and rock surfaces from vegetation and for detecting cultural features.

Band 2 (0.52 - 0.60u m): it is sensitive to water turbidity differences; it highlighted the turbid water in the Barkley Lake. Because it covers the green reflectance peak from leaf surfaces, it has separated vegetation (forest, croplands with standing crops) from soil. In this band barren lands urban areas and roads and highways have appeared as brighter (lighter) tone, but forest, vegetation, bare croplands, croplands with standing crops have appeared as dark (black) tone. Also the Kentucky Lake has appeared as black tone.

Band 3 (0.63 - 0.69u m): senses in a strong chlorophyll absorption region and strong reflectance region for most soils. It has discriminated vegetation and soil. But it cannot separate water and forest. Forest land and water both have appeared as dark tone. This band has highlighted barren lands, urban areas, street pattern in the urban area and highways. It has also separated croplands with standing crops from bare croplands with stubble.

Band 4 (0.76 - 0.90u m): operates in the best spectral region to distinguish vegetation varieties and conditions. Because water is a strong absorber of near IR, this band has delineated water bodies (lakes and sinkholes), distinguished between dry and moist soils (barren land and croplands). In this band croplands and grasslands have showed higher reflectance (brighter tone) than the forest. This band has also separated croplands from bare croplands. Since standing crops (vegetation) has higher reflectance in the near IR region, they have appeared as brighter tone and due to presence of moisture content in the bare croplands, they have appeared as darker tone. In the band 4 barren lands, urban areas and highways have not been highlighted and they appeared as dark tone. Band 4 is useful for crop identification and emphasizes soil-crop and land-water contrast.

Band 5 (1.55 - 1.75u m): is sensitive to the turgidity or amount of water in plants. Band 5 has separated forest lands, croplands, water body distinctly. Forests have appeared as comparatively darker tone than the croplands (light gray).Band 5 has separated water body (dark tone) from barren lands, croplands, and grass lands (lighter tone). Since urban area and croplands have responded almost in same spectral reflectance band 5 could not be able to separate these areas.

Band 7 (2.08 -2.35u m): has separated land and water sharply. Band 7 has strong water absorption region and strong reflectance region for soil and rock. Urban area, croplands, highways, bare croplands have appeared as bright tone and water body, forest have appeared as dark tone.

Extra Information

Land Cover Type	Spectral Band Combination
Water	Band 1, 4 & 7 / Band 1, 2 & 3
Urban	Band 1,4 & 7
Farmland	Band 1, 2 & 3
Forest	Band 1, 4 & 7
Salt Scald	Band 1, 2 & 3
Remnant Vegetation	Band 1, 4 & 7
Irrigated Vegetation	Band 1, 4 & 7

Terrain Feature	Reflectance Response
Water Bodies	Generally reflect high in the visible spectrum, however, clearer water has less reflectance than turbid water. In the Near IR and Mid-IR regions water increasingly absorbs the light making it darker. This is dependent upon water depth and wavelength. Increasing amounts of dissolved inorganic materials in water bodies tend to shift the peak of visible reflectance toward the red region from the green region (clearer water) of the spectrum.
Soil	Northern latitudes have black soils and tropical regions have red soils. Soil reflectance decreases as organic matter increases. As soil moisture increases, reflectance of soil decreases at all wavelengths. Texture of soil will cause increased reflectance with decreased particle size, i.e., the bigger particles (rocks, sand, and soils) basically cast a larger shadow.
Vegetation	The spectral reflectance is based on the chlorophyll and water absorption in the leaf. Needles have a darker response than leaves. There will be various shades of vegetation based on type, leaf structure, moisture content and health of the plant.
Man-Made Materials	Concrete and asphalt both display spectral curves that generally increase from the visible through the Near IR and Mid-IR regions. However, as concrete ages, it becomes darker and as asphalt ages it becomes lighter.
Snow and Ice	Old snow may develop a compacted crust and the moisture content increases which make it less reflective in the Near IR and Mid-IR region. It is possible to compare old and new snow by its Mid-IR reflectance.

Band Combinations

R, G, B	Potential Information Content
3,2,1	The "natural color" band combination. Because the visible bands are used in this combination, ground features appear in colors similar to their appearance to the human visual system, healthy vegetation is green, recently cleared fields are very light, unhealthy vegetation is brown and yellow, roads are gray, and shorelines are white. This band combination provides the most water penetration and superior sediment and bathymetric information. It is also used for urban studies. Cleared and sparsely vegetated areas are not as easily detected here as in the 4 5 1 or 4 3 2 combination. Clouds and snow appear white and are difficult to distinguish. Also note that vegetation types are not as easily distinguished as the 4 5 1 combination. The 3 2 1 combination does not distinguish shallow water from soil as well as the 7 5 3 combination does.
7,4,2	This combination provides a "natural-like" rendition, while also penetrating atmospheric particles and smoke. Healthy vegetation will be a bright green and can saturate in seasons of heavy growth, grasslands will appear green, pink areas represent barren soil, oranges and browns represent sparsely vegetated areas. Dry vegetation will be orange and water will be blue. Sands, soils and minerals are highlighted in a multitude of colors. This band combination provides striking imagery for desert regions. It is useful for geological, agricultural and wetland studies. If there were any fires in this image they would appear red. This combination is used in the fire management applications for post-fire analysis of burned and non burned forested areas. Urban areas appear in varying shades of magenta. Grasslands appear as light green. The light-green spots inside the city indicate grassy land cover - parks, cemeteries, golf courses. Olive-green to bright-green hues normally indicate forested areas with coniferous forest being darker green than deciduous.
5,3,1	This combination display topographic textures while 7 3 1 may display differences in rock types.□
4,3,2	The standard "false color" composite.□ Vegetation appears in shades of red, urban areas are cyan blue, and soils vary from dark to light browns.□ Ice, snow and clouds are white or light cyan.□ Coniferous trees will appear darker red than hardwoods.□ This is a very popular band combination and is useful for vegetation studies, monitoring drainage and soil patterns and various stages of crop growth.□ Generally, deep red hues indicate broad leaf and/or healthier vegetation while lighter reds signify grasslands or sparsely vegetated areas.□ Densely populated urban areas are shown in light blue.□ This TM band combination gives results similar to traditional color infrared aerial photography.
4,5,1	Healthy vegetation appears in shades of reds, browns, oranges and yellows.□ Soils may be in greens and browns, urban features are white, cyan and gray, bright blue areas represent recently clearcut areas and reddish areas show new vegetation growth, probably sparse grasslands.□ Clear, deep water will be very dark in this combination, if the water is shallow or contains sediments it would appear as shades of lighter blue.□ For vegetation studies, the addition of the Mid-IR band increases sensitivity of detecting various stages of plant growth or stress; however

	care must be taken in interpretation if acquisition closely follows precipitation.• Use of TM 4 and TM 5 shows high reflectance in healthy vegetated areas.• It is helpful to compare flooded areas and red vegetated areas with the corresponding colors in the 3 2 1 combination to assure correct interpretation.• This is not a good band combination for studying cultural features such as roads and runways.
4,5,3	This combination of near-IR (Band 4), mid-IR (Band 5) and red (Band 3) offers added definition of land-water boundaries and highlights subtle details not readily apparent in the visible bands alone. Inland lakes and streams can be located with greater precision when more infrared bands are used. With this band combination, vegetation type and condition show as variations of hues (browns, greens and oranges), as well as in tone. The 4,5,3 combination demonstrates moisture differences and is useful for analysis of soil and vegetation conditions. Generally, the wetter the soil, the darker it appears, because of the infrared absorption capabilities of water.
7,5,3	This band combination also provides a "natural-like" rendition while also penetrating atmospheric particles, smoke and haze. Vegetation appears in shades of dark and light green during the growing season, urban features are white, gray, cyan or purple, sands, soils and minerals appear in a variety of colors.• The almost complete absorption of Mid-IR bands in water, ice and snow provides well defined coast lines and highlighted sources of water within the image.• Snow and ice appear as dark blue, water is black or dark blue.• Hot surfaces such as forest fires and volcano calderas saturate the Mid-IR bands and appear in shades of red or yellow.• One particular application for this combination is monitoring forest fires.• During seasons of little vegetation growth the 7 4 2 combination should be substituted.• Flooded areas should look very dark blue or black, compared with the 3 2 1 combination in which shallow flooded regions appear gray and are difficult to distinguish.
5,4,3	Like the 4 5 1 combination, this combination provides the user with a great amount of information and color contrast.• Healthy vegetation is bright green and soils are mauve.• While the 7 4 2 combination includes TM 7, which has the geological information, the 5 4 3 combination uses TM 5 which has the most agricultural information.• This combination is useful for vegetation studies, and is widely used in the areas of timber management and pest infestation.

Using different wavelengths of light in satellite images

Investigation of Fire

The Stations Fire, north of Los Angeles, was a large and deadly wildfire, burning 160,577 acres (251 sq mi; 650 km^2) and killing two firefighters. It ranged from August 26 – October 16, 2009.

1) Go to http://earthengine.google.org/#workspace/UwSPx3amZa1
   The top layer is showing red, green and blue wavelengths (3,2,1)

   Record what you see:

   The second layer is showing IR, NIR, and Green (7,4,2)

   Record what you see:

2) Shift the dates to before and after the fire both layers. Record the changes you notice in each image

3) Discuss/record: How can we use these two images together to understand what is happening?

4) Add the NDVI layer Landsat 7 8-day NDVI –

   Predict what it will look like when you go back to August 29, 2009

   Go to the correct data and record what you see.

Investigation of Land Use

1) Go to http://earthengine.google.org/#workspace/5PZO2K4pDxd

The top layer is showing red, green and blue wavelengths (3,2,1)

Record what you see:

The second layer is showing MIR, IR, and Blue (5,3,1)

Record what you see:

2) Change the band combinations under “visualization”

   What do you notice when you change band combinations?

Views of Tucson

1) Go to Tucson, AZ
2) Add a Landsat 7 8-Day Raw DN Composite Layer
3) Try out several different band combinations from the suggested list.

Working with Filters

1) Take a look at the image(s) before you. Make note of the range of colors and features that you can make out in the image.

2) Use the red filter to cover the image. Make note of the range of colors and features that you can make out in the image.

3) Use the green filter to cover the image. Make note of the range of colors and features that you can make out in the image.

4) Use the blue filter to cover the image. Make note of the range of colors and features that you can make out in the image.

Questions for discussion/notebook

1) What does each filter do?

2) How does a filter impact what you can see in an image?

Laurel Clark Earth Camp for Educators
Power of Perspective: Investigating Earth Change
May 4, 2013
8:30 am to 4 pm
University of Arizona, Biology Learning Center, Rm. 209 Koffler Bldg.

Overarching Question: How can different tools help us study changes on Earth?

8:30 Welcome and overview of day

8:35 Homework Report: Think/Pair/Share

1. Share one or two insights you gained from the last workshop that you would like to share with group.
2. Share something you've done with your students and how it went.
3. Share the topic you have researched for exploring on Mt. Lemmon/in your own community for May.

9:00 Understanding the resolution of images (Alice)

9:15 Exploring Sky Islands and the Southwest Using Google Earth Engine

Focus Question: How can we use satellite images (Earth Engine) to investigate earth change?

Group Investigations

11:00 Planning Investigations for Mt. Lemmon

12:00 Lunch at the Student Union

1:00 Tour of the Tree Ring Lab: Don Falk and Paul Sheppard
Focus Question: What can tree rings teach us about climate and fire?

Engage, Explore, and Explain: Applications of tree rings to ecology and cross-dating

2:40 Reading the Rings Activity: Applications of tree rings to the classroom (Kerry)

3:00 **Presentation:** Using Remote Sensing to Study Changes in Southwestern Landscapes, Guest Speaker: Jelena Vukomanovic

3:45 Field Trip info and Evaluations

Homework:

1) Record one of two insights from today's workshop.
2) Further investigate what you plan to study on Mt. Lemmon, collect relevant data and plan out your investigation.

Cheat Sheet for working the Google Earth Engine

1) Use Google Chrome browser
2) Go to earthengine.google.org and make sure are logged into the workspace
3) Use Landsat 7 images (latest satellite for most investigations)
4) If you want to play with different band combinations choose either Landsat 7 32-day Raw DN Composite or Landsat 7 8-Day Raw DN Composite (this data may be incomplete)
5) Once you have added this layer, you can choose different band combinations under "visualization"
6) Decide on a question – decide which band combinations/data sets are appropriate (see guide to landsat band combinations)
7) You may also choose to use one of the following image sets

NDVI – The Normalized Difference Vegetation Index is generated from the Near-IR and Red bands of each scene, and ranges in value from -1.0 to 1.0. NDVI = (NIR - RED) / (NIR + RED). In general, the deepest (darkest) shades of green indicate areas of abundant healthy vegetation, whereas shades of brown, orange, and yellow indicate areas of barren to sparsely vegetated Earth.

EVI - The Enhanced Vegetation Index is generated from the Near-IR, Red and Blue bands of each scene, and ranges in value from -1.0 to 1.0. In addition to the traditional visible light-infrared light comparison common to previous vegetation indices, this index helps to reduce common problems with vegetation indices. In tropical areas, where biomass burning often creates thick smoke, the EVI should reduce smoke's interference. It also reduced the effect of saturation. Saturation occurs when the all values of greenness above a certain threshold appear as the highest possible number on the index's scale; it's common in areas of extremely high vegetation like rainforests. In semi-arid places on Earth where the vegetation is thin and widely spaced, the EVI minimizes the influence of background interference caused by bare soil reflecting off the ground. The deepest (darkest) shades of green indicate areas of abundant healthy vegetation, whereas shades of brown, orange, and yellow indicate areas of barren to sparsely vegetated Earth.

NDWI - The Normalized Difference Water Index is sensitive to changes in liquid water content of vegetation canopies. It's derived from the Near-IR and short wave IR bands, and ranges in value from -1.0 to 1.0. NDWI=1−SWIR/NIR1+SWIR/NIR. Normally on a grayscale, here the brighter colors indicate more water and blue indicates no water.

Earth Camp for Educators Design Workshop
June 10-13
Arizona-Sonora Desert Museum
Baldwin Education Building

Monday June 10

8:30 – 9:30	Poster Project introduction and discussion
9:30 – 10:30	Additional technology tools
10:30 – 12:15	Poster project research and development
12:15 – 1	Lunch
1:00- 1:45	Gregg Garfin, Institute of the Environment, University of Arizona Climate Change in the Southwest
2:00 – 3:00	Behind the scenes tour of Herpetology, Icthyology and Invertebrate Zoology
3:15 – 4:00	Climate Change teaching resources share-a-thon

Tuesday June 11

8:30 – 10:30	Poster Project work
10:30-12:00	LoriAnn Barnett, National Phenology Network Phenology research with your students
12:00-12:45	Lunch
12:45 – 1:30	Live animal presentation
1:30 – 4:00	Poster work

Weds June 12

8:30 – 9:00	Poster work
9:00 – 10:00	Brian Powell, Pima County Office of Conservation Science and Environmental Policy The Sonoran Desert Conservation Plan
10 – 12	Poster work
12 – 12:45	Lunch
12:45 – 1:30	Live animal presentation
1:30-3	Poster work
3 – 4	Earth Camp Evaluation Group Discussion

Thursday June 13

8:00-9:00 am	Desert Museum Guided Tour (optional)
9 am – 11 am	Poster presentations and feedback session
11 am – 12	Poster work
12 – 12:45	Lunch
12:45 – 1:30	Live animal presentation or poster work
1:30 – 3	Finish posters
3 – 4	Written evaluation and Graduation

Earth Engine Investigation Guide

1. **TOPIC OF STUDY**
   - Topic should be something that you can use with your students

2. **FOCUS QUESTION (Big Idea)**
   - What question would you like to investigate?
   - Is it investigable in the time frame within which we have satellite imagery?
   - Is it investigable within the resolution of satellite imagery?

3. **NEED TO KNOW**
   - What will you need to know to answer your question?
   - Make a list of what you will need-to-know

4. **RESEARCH**
   - Conduct the research needed to answer the question

5. **DATA ANALYSIS**
   - Decide on which visual representations of satellite data suit your inquiry the best (which bands will you use?)
   - Label and date all images

6. **CLAIMS AND EVIDENCE**

Claims	Evidence
I claim that…	I know this because…

   - What do you claim to be true?
   - How does your data (satellite images) and research support your claim?

7. **CONCLUSION**
   - What do you know based on your claims and evidence?
   - Does the evidence cause you to revise your thinking?
   - What did you learn that was new?

8. **NEW QUESTIONS/REFLECTIONS**
   - What could you have done differently to improve your investigation?
   - What applications could your conclusions have in the “real world”?
   - What new questions do you have now that your investigation is done?

Google Earth Engine Timelapse

Making a Timelapse Movie: Lake Mead example

- Go to http://timemachine.gigapan.org/wiki/EarthEngineTourEditor
- We will fly into our site from the global view, so start by hitting "+Add"
- Pan and zoom to the Northwest corner of AZ – put Lake Mead in the middle of your screen and zoom in to the desired picture. Click on "+Add"
- You have the option of letting the scene loop as you fly in (Loops), or just fly in (Duration). For now, hit the duration option. Set the duration to 5 secs.
- Now we want to stay on Lake Mead for a bit and see how it's changed. Click on "+Add" again. This time choose "Loops" for the transition, type in 5 loops and 50% speed.
- Now let's move the scene a bit and head over to the west of Lake Mead to Las Vegas. Put Las Vegas in the middle of your screen and zoom to the desired level. In the transition box, click duration and 2 seconds.
- In order to now watch the changes in Las Vegas, hit "+Add" again, and choose a looping transition of 5 times at 50% speed.
- You can add titles by clicking on the small call-out image at the bottom of each in the bottom film strip. Click on the call-out in the first Lake Mead scene and type in "Lake Mead". Click on the call-out in the first Lasa Vegas scene and add "Las Vegas"
- Play your movie by clicking "Play" (to the left of "Add")
- Share your tour by hitting share, giving it a title and copying the url where it can be found.

Earth Change Poster Guidelines

What is Earth Change?

- Change over space and/or time
- On any scale
- On any part of the globe
- Can be caused by humans or other natural forces

For the purposes of this poster project…

- Use satellite imagery to demonstrate the change
    - Must be big enough to see from space
    - Must be recent enough to see from space
- Find a topic you can relate to next year's teaching
- Use other imagery to help viewers/readers understand and relate to the story
- Use text to further explain the story

Writing Guidelines:

- Audience: general public
- Style: Active, engaging. Relate to everyday life. Pose a question if you like. Find a hook.
- If you want to, you can make it personal - use first person.
- Explain (in text) what you're trying to show with the satellite images.
- Stay away from jargon and write at about a seventh grade level. If you want to use an uncommon word, define it.
- Avoid statements that you can't support with evidence.
- Check your facts. Recheck your facts.
- Cite your sources in the Powerpoint notes – not on the poster.
- Image credits can be included in captions or superimposed on images.
- A picture is still worth a thousand words!

Technical Specs:

- Create your poster in Powerpoint
- Design>Slide Orientation>Portrait
- Design>Page Setup –width: 18", height: 24"
- Font: Candara
- Font sizes: Title – around 50; Text boxes – 16-20; Captions – 12-14
- You can use the zoom slider at the bottom right of your screen so that you can see your text.

Useful Resources:

Global Change, an Overview: Written summary for teachers
http://www.nature.com/scitable/knowledge/library/global-change-an-overview-13255365

A Student's Guide to Global Climate Change: comprehensive web resources for students
http://www.epa.gov/climatechange/kids/

Climate Change: Wildlife and Wildlands: Youtube video exploring impacts on wildlife
https://www.youtube.com/watch?v=drINEQFXbPY

Google Maps Education: Tutorials, ideas and links to training workshops for teachers
http://maps.google.com/help/maps/education/learn/index.html

NASA Earth Observatory World of Change: http://earthobservatory.nasa.gov/Features/WorldOfChange/

NASA Earth Observatory: http://earthobservatory.nasa.gov/