Student Experience 04: Mammoth Hot Springs Photo Points

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2009

Developed by Ana Houseal for

E:Y! STaRRS

[MAMMOTH HOT SPRINGS PHOTO POINT PACKET]
Dear Expedition: Yellowstone! teacher or visiting volunteer,

Thank you for your interest in the Students, Teachers and Rangers & Research Scientists (STaRRS) project. One of the main objectives of the project was to introduce and integrate new science content and processes into the Expedition: Yellowstone! (E:Y!) program. During the 2008-2009 school year there were eight expeditions during which students worked on the three components of the STaRRS partnership. They were: 1) gathering photo point data, 2) gathering scientific data about the hot spring system from specific locations at two hot springs, and 3) developing and answering their own questions about a small aspect of the hot springs system.

The protocols and tools used for the grid/transect data collection as well as curriculum related to the development, experimentation, and presentation of student-driven research will be available on the Yellowstone National Park (YNP) website or through Bob Fuhrmann sometime in the spring 2010. In July 2009, the STaRRS team (including teachers, researchers, and scientists) gathered to work on an initial plan for integrating these three elements into the E:Y! choices of activities such that other teachers can take advantage of these lessons in the future.

Photo point data will also be gathered indefinitely. This is where you come in. The attached packet of information will give you some background on the set up of the photo points and details on photo point data collection using the designated camera, the P60 Nikon camera. There is an extra "cheat sheet" at the end of the packet, developed to help you get to know the camera better.

Currently, the photos are being uploaded to a private website associated with the STaRRS program. Soon, these photos will be shifted over to a site sponsored by the research division at YNP. Until this happens, any photos taken from the photo points should be emailed to Ana Houseal (anahouseal@gmail.com) or Bob Fuhrmann (bob_fuhrmann@nps.gov).

All photos from July 2008-May 2009 will be available at the National Park Service research website soon.

Happy data collection!

Ana Houseal
Photo Point Data Collection at Mammoth Hot Springs

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Mammoth Hot Springs Systems Background

When water flows under the Gallatin Mountain Range, it spends about 1500 years mixing and dissolving limestone from beds that used to be a part of a great inland sea. It is then heated by the hot spot under Yellowstone and it slowly moves upwards. By the time it reaches the surface at Mammoth Hot Springs (MHS), the water is super-saturated with calcium carbonate (CaCO₃). As it hits the air, the water goes through a chemical process in which some of the carbon dioxide (CO₂) leaves the water causing its pH to increase (become more basic) and leave behind (or precipitate) the calcium carbonate in the form of aragonite and calcite crystals. These crystals produce an environment conducive to heat-loving (thermophilic) micro-organisms, or microbes. These microbes have been found to be important in terrace formation. The rock as a whole is called travertine. In the locations where the water continually flows, the rock can precipitate at rates upwards of five millimeters per day. There have been occasions where rock has "grown" one to two meters in a single year. This is, in geologic terms, light speed! In contrast, it can take hundreds of years for mm of rock formation in other limestone precipitating locations such as stalactites and stalagmites in caves.

The flow of water in MHS is thought to be constant throughout the entire spring system, though in any given spring, it can fluctuate wildly in hours, days, weeks, and months. There are two current hypothetical explanations for why the springs "shut down" or undergo plumbing. One is that some type of ground movement, such as the thousands of earthquakes that occur in YNP each year, may cause underground plumbing to clog and/or reopen in other locations. Another hypothesis is that the weight of the travertine in any given spring succumbs to gravity, causing other shifts in the plumbing. An earlier hypothesis regarding the "clogging" of the vent (the opening where the water emerges) by the depositing travertine has recently come under question by comparing the pH levels needed for travertine precipitation (>6.1) and spring water emerging from the vent (6.0). The water is just slightly too acidic for deposition to occur, thus it is unlikely that it could clog the vent.

Photos taken over time from set photo points can help to increase understanding of terrace formation and concretely map the movement of microbial communities. Now, and in the future, researchers can use these high quality photos to help answer questions about things such as microbial mat migration, possible shifts in water flow, and formation of terracing through travertine precipitation/deposition. In the meantime, visitors and students will have access to these same photos and can compare visible changes themselves.

For further background on Mammoth Hot Springs, please consult the following resources:

Setting up the photo points

In July 2008, rangers and researchers set up eight photo point locations along the boardwalk near Canary Hot Springs, at Narrow Gauge, and Orange Spring Mound. During the winter when New Trail Spring began to show signs of picking up, we added two more spots along the boardwalk overlooking this spring. Because of these additions, the photo point numbers will seem to be out of order. However, the numbers are simply designations. Shifts in spring flow may necessitate that other numbers be dropped or added making switching these designations complex, whether done now or in the future. After discussion, and in spite of potential for slight confusion, the team has decided to retain the current numbering scheme.
The photo point locations were selected using the following criteria:

1. They are located in spots that are easy to get to and find (with the exception of two locations at Narrow Gauge).
2. Each of the photos has something in it (e.g. a tree, branches, boardwalk) that can be used to match photos and used for scale.
3. Each location (of the brackets for the camera) is discreet and will not detract from other visitors' enjoyment of the springs.
4. Many locations were selected with the understanding that the springs are unpredictable and that any given location may show little or no changes.

Cameras were selected using the following criteria:

1. Ease of use. Settings for the camera needed to be high quality, such that turning it on and setting it in the spot would produce a high resolution photo.
2. Ease of battery replacement (these cameras take 2 AA batteries and a set of high quality rechargeable batteries have worked well for many of the teachers).
3. Ease of uploading photos to a computer. Photos can be uploaded off the memory card or with a USB drive hooked to the camera.

Currently 10 E:Y! teachers have cameras. There is also one at the education office at the Albright Center at Mammoth, another at the Fouke Research Lab at the University of Illinois (which they bring on field expeditions to YNP about two times a year). I also have one, which I use to gather shots every time I at Mammoth Hot Springs.

With the addition of the STaRRS comparison groups, 10 more cameras will be in the hands of E:Y! teachers. We would like to encourage you to bring them with you on expeditions and possibly also with you on personal trips to Yellowstone, and that you will take photos at the photo point locations and add your photos to the data base.

We also hope that you will find the photos themselves appealing and come up with interesting ways to use them in your classroom. Many of the STaRRS teachers have used them to engage their students prior to and after their E:Y! trips. The following two photos, taken at PP7 at Narrow Gauge give an example showing the incredible growth that occurred in that spring in the 10 months of data gathering in 2008-09.
PP7 – July 2008 to May 2009

The lime green is a line drawn over two branches, one that was hanging down, and the other that was nearly horizontal to the top of the travertine terrace.

The same two branches are marked in this photo, taken about 9.5 months later. You can also see the incredible differences in the terraces of this side of the spring.
Maps of Photo Point Locations
**Last Minute Instructions**

*(Before giving out all the PP information)*

**Camera settings:** With the camera turned on, push the **Menu** button on the back of the camera. You will have two choices: **Image quality**, and **Image size**. Select **Image quality** – in that menu you will have three choices: Fine, Normal, and Basic. Select **Fine**. Press **OK** to go back to the main menu. For **Image size** the default is 8M – which you should be able to see from this screen. Leave it at this setting. If, for some reason it is on a smaller image size, select 8M from the menu under Image size. With the 4G card provided, you will be able to take over 1000 photos of this size 😊.

**Recommended order of PP shots:** Again, because the PPs have been numbered in the order they were set up, the number order is not necessarily the best order to use when taking shots. The best order for all three locations follows:

**Canary:** PP9 (panoramic view), PP10 (panoramic view), PP2, PP3, PP4, and PP1 on the way out of the boardwalk.

**Orange Spring Mound:** PP5

**Narrow Gauge:** PP8 (panoramic), PP6, & PP7

**THIS PACKET IS ARRANGED IN THE RECOMMENDED ORDER DESCRIBED ABOVE FOR EASE OF USE IN THE FIELD**
Photo Point #9 (PP9)

Description: This photo point is related to PP2 and PP10, as they all three are monitoring New Trail Spring. As mentioned earlier, this spring has picked up in activity over the past year, and these two points were added in the hopes of having more data on a spring throughout some (hopefully) significant changes. You will actually probably begin with PP9, and then proceed to PP10, before going below to do PP1-4. This is an overview of the spring at the first overlook on the Canary Boardwalk.

Bracket location: The bracket this time is located on the corner post and on the second railing down on the outside of the hand rail. In this case, the camera is put flush right to the bracket (again with the back of the camera flush with the rail). You will not be able to see the photos as you take them, so it will be important to check them before moving on. Make sure the camera is set (on top) to the camera icon, and that it has not been zoomed in at all. If you are unsure, turn the camera off and then back on to reset it. Set up the camera and take at least three photos. The strap holder on the top right part of the camera may seem to be in the way when you set the camera in place. Make sure the back is flush with the board and the bottom is sitting straight on the bracket. The right side should be as close as possible without tilting the camera.

Latest PP shot (Date: September 2009):
Other photos showing location from different angles:

Bracket is located behind and below the snow-covered sunglasses.
Bracket, looking down

Don’t be fooled, there is at least one more railing beneath the snow! Photo taken March 2009.
Photo Point #10 (PP10)

Description: This panoramic view (again of New Trail Spring) is a little further down the boardwalk (but not much!). This view gives the resulting pictures a scale by including the lower boardwalk. It is possible that eventually the three photos could be used to triangulate and measure growth and space of the flow.

Bracket location: This bracket is also a right-hand bracket, so the camera sits on it flush right, like PP9. It is on the second post from the corner, second rail down on the outside. Again, make sure to line it up with the bottom, back and as far right as possible without tilting. Ranger Bob is pointing out where the bracket is located in one of the shots below. Look for the place on the boardwalk where there is a corner, and a tree to the left of the corner. (And, of course, the view looks like the one below!)

Latest PP shot (Date: September 2009):
Other photos showing location from different angles:

Ranger Bob Fuhrmann modeling bracket location for PP10. March 2009

Looking down at the bracket.
Photo Point #2 (PP2)

Description: This photo point is located overlooking New Trail Spring, which is located just above Canary Spring along the upper terrace boardwalk. This spring has a couple of trees in the foreground making it easy to identify. It has been active on and off over the past three years, but the flow has picked up quite a bit in the past year – coinciding with the increase in temperature at the spring at PP1. The vent for this spring has been an increasingly wide blue pool, easily identified from PP9 and PP10 – the two additional photo points set up to monitor this spring in the winter of 2008-09. It is probable that this spring will continue to have interesting flow changes over the next couple of years.

Bracket location: The bracket is located on the post, on the second rail down to the right side of the sign as you are facing the sign. As with the first PP bracket (and all the rest) you will need to look over the railing to see it. The camera sits on this bracket with the left side of the camera flush with the bracket, and the back of the camera against the railing. Turn the camera on, check to make sure the top dial is set to the camera icon, place it in the bracket and take three photos in succession. Again, you will not be able to see the photos you are taking as you take them, so it is a good idea to check them after you finish.

Special note for this location: This is a popular spot for people to take photos of each other. Often when I take photos here I have conversations with visitors about what I am doing and take the opportunity to give them some background on the springs. They are usually very interested in the colors (microbes) flow (temperature) and deposition rate. At some point we hope to have an interpretative sign in this location showing what the PPs are capturing: change over time!

Latest PP shot (Date: September 2009):
Bracket location

Other photos showing location from different angles:
This is actually the view from PP10, but it shows where PP2 is nicely. The red circle is around people who are standing near the sign where the bracket is located. The blue arrow is pointing at the tree that is in the foreground of the PP2 photos. The black arrow is pointing to the blue pool where, at the time of this photo, two vent openings were spewing out water. Some of the water was flowing to the left and under the boardwalk, but the bulk of the water (in this photo) is flowing off to the right and down towards Canary.
Photo Point #3 (PP3)

**Description:** The location of PP3 is at the top of Canary. This location has shown the least amount of change in the photographs throughout the year, except for the ones from last October (2008) when the spring completely drained for the second time in two years. Looking at the PP3 shot from October 27, 2008 will give an idea of what it looked like a week after it drained and before it refilled.

Canary had been a very active spring for a number of years until we set up this and the next photo point. More recently, a vent sprung up on the far left side of this pool, down the hill a ways. In May 2008, this vent was sending forth liters of water per second, noisily down the slope, too far from the current boardwalk location to take good photos.

**Bracket location:** This bracket is located on a post near the tree line near the top of the pool. It is on the post and third rail down on the outside of the railing. It is a little more difficult to find initially, but keep looking over the railing and walking down the boardwalk and you will eventually see it. The camera will again be flush on the left side and the back of the camera.

**Latest PP shot (Date: May 2009):**
Other photos showing location from different angles:

Location of PP3 taken from PP2.

Interestingly, this location has completely drained two times in recent years. The first time it happened in October 2007, and the second time in October 2008. Both times, the pool where the vent is located refilled in time. Here is a photo of what the vent looked like without any water coming out. Photo taken by M. Keffer, Cody, WY.
Ranger Bob Fuhrmann is installing the bracket (July 2008)
Bracket location looking towards viewing area at the top of Canary, the boardwalk turns to the left if you go forward, and goes back around the corner behind the photographer. Sometimes the water is up to and/or underneath this part of the boardwalk.
Photo Point #4 (PP4)

Description: This photo point was selected partly because this spring had been so active for the previous few years. In 2006, the water was running over the top of the pool that contained the vent (PP3) so forcefully, and travertine deposition was so rapid in areas that the boardwalk had to be shortened twice. Just weeks after this location was set up, the water nearly completely shut down. However, it has been an interesting site to watch, especially in the winter as the animals have begun to retake the area (as evidenced by tracks in the snow).

Bracket location: This bracket is located at the top “pull out” which is on the left as you travel towards the dead end of this boardwalk. Again, the bracket is on the outside (spring side) of the railing, on the third rail down attached to a post. See photo of Ranger Bob installing bracket below. The camera, again, will be flush on the left and back sides on the bracket and railing.

Latest PP shot (Date: September 2009):

This area was covered in water and colorful microbial communities in 2005, 2006, and most of 2007. The vent in the pool above it (the one from PP3) stopped and the pool drained completely in October 2007 and 2007. As you can see from this image, there has been no water here for a while, but it hasn’t been long enough for the travertine to turn grey, yet.
Other photos showing location from different angles:

As you can see from this photo, taken July 2008, there was still some water flowing over the top. The colors indicate active microbial communities, which tend to disappear about 72 hours after flow ceases.

Installing bracket
Photo Point #1 (PP1)

**Description**: This spring is as of yet unnamed. It is just below the upper terrace large parking lot, and started in the spring of 2006. It has been a relatively cool spring and therefore very slow growing over the past three years. This spring has produced some beautiful formation in travertine-covered grasses each fall. This past winter the water began to heat up, and some pond formation has started. In addition, on the left side, from the PP bracket, not visible from the photo, some of the travertine has caved in. In March 2009 two holes appeared, approximately ½ meter in diameter each.

**Bracket location**: The bracket is located on the left side of the boardwalks (on the spring side of the railing) on the second post as you move up the incline. It is an L-shaped bracket, connected only on one side to the post. The camera sits in it with the left side of the camera flush with the bracket and the back flush with the railing. Turn on the camera, and make sure it is set to the camera icon on the top. Do not zoom. Take three photos in succession. You will not be able to see the photo being taken. Check the photos to make sure they are all clear and in focus before leaving the spot.

**Latest PP shot (Date: September 2009)**: [Image]
Another photo showing bracket location (circled in red):
Photo Point #5 (PP5)

**Description:** This PP is located facing the new (since 2007) vent on the side of Orange Spring Mound. It is easy to get the view in the off-season, but harder to get it without people from June-September, as this is a popular spot for visitors to stop vehicles to take pictures.

**Bracket location:** The bracket in this case is an “L” shaped piece of metal screwed to the top of a post with the sign saying “Keep Off - Re-vegetation Area”. There are two such posts. The bracket is located on the one closer to the parking lot. Turn on the camera. Make sure it is set on top to the small camera icon. Set the camera on top of the post with the back and right side flush with the bracket. Without changing the view by zooming, take three photos in succession.

**Latest PP shot (Date: May 2009):**

![Photo Point #5 (PP5) at Mammoth Hot Springs](image-url)
Other photos showing location from a different angle:
The correct post will be identifiable by the “L” shaped bracket screwed into the top of the post. You can use this to place the back and right side of the camera in order to line it up for the perfect shot!
**Photo Point #8 (PP8)**

**Description:** This photo point is a panoramic view of Narrow Gauge from the Howard Eaton Trail. It is in a natural spot for picture taking, as many of us have been taking photos at this spot for a number of years. The location for taking this shot is right on the trail, in an opening near a cut log. I align my back with a dead, short (approximately two meter tall) pine tree a ways up the hill. Holding the camera just above my waist, I make sure the sky is in view on the top, and the dead tree (which has fallen into the spring below) is fully visible. The trees on either side of the clearing frame the photo. Look closely at the photos in this section and match yours as closely as possible. I often take five to eight photos at this location in hopes of matching one with a previous one more closely.

**Bracket location:** There is not bracket at this location. Camera is hand held.

**Latest PP shot (Date: May 2009):**

![Photo to help locate the spot](image)

**Photos to help you locate the spot to stand:**
The small dead tree, which is also visible in the winter, (circled) should be lined up directly behind the photographer.

In the photo below, the backpack is located in the spot where the photographer should stand. This panoramic distorts the view somewhat, as it shows approximately a 180° view of this spot in the trail.

Other photos from the same location:
Photo Point #6 (PP6)

**Description:** This photo point is located at Narrow Gauge, which is on the Howard Eaton Trail (See map of Narrow Gauge on pages 5 and 7). At the base of the trail on the SE side of the spring, there is a tree with a V located a slight distance up the hill. In the notch of this V there is a piece of wood wedged in. The camera sits on this piece of wood. Please see the photos of the location for help finding this photo point location.

**Bracket location:** There is not an official “bracket” at this location; there is only the stick, which will probably eventually become dislodged. When taking this photo, it would be good to compare it with former photos shot at this location to make sure it is framed similarly enough for use. When I take pictures at this location, I line the back of the camera even with the stick, centering the camera. Be sure to take at least three shots at this location. People standing in front (below) of the tree will end up in the pictures, so it is important to check the photos before leaving the location.

**Latest PP shot (Date: July 2009):**
Other photos showing location from different angles:

The tree in question is actually behind and above this group of students (about 5 meters).

Here is a group of students setting the camera on the photo point wedges stick.
Another student showing off the location of the photo point.

Teacher Tiffany modeling PP6’s location.
Photo Point #7 (PP7)

Description: For several reasons this photo point location is by far the most difficult one to. For one, it is located in a tree with a notch cut out of it about half way up the slope on the western side of the spring. Secondly, the travertine has built up so much on the front side of the tree that the photo point must now be approached from the back. Finally, it is located above the eye level of most children and many adults. Studying the more recent photos will help you find the location. More pictures will be added to this section to help with location.

Bracket location: There is no bracket at this location, instead, a notch is cut into a branch (see photo below). Line the right side of the camera flush with the notch. Try to line the back of the camera up evenly while framing the two trees on the left side of the view to about 1/10 of the frame of the final photo. It is easier to see through the camera while this shot is being made, so it is somewhat easier to line up the shot.

Latest PP shot (Date: July 2009):

![Photo Point #7 (PP7)](image-url)
Other photos showing location from different angles:

View from where you would set the camera – from behind the tree

Looking at the branch from the front side of the tree – up the trail a tad bit.
P60 “cheat sheet”

How to...

1. **Change the batteries and SD cards**- Slide the lock to the unlocked position. One battery is positive up, the other negative up. The SD slips into the slot behind the batteries. To eject it, press down, and it will eject halfway, remove the rest of the way manually.

2. **View the pictures**- press the playback button, from here you can delete pictures, and zoom in and out to check for detail

3. **Change from optical to digital viewfinder**- press the silver button above the digital viewfinder to toggle

4. **Zoom**- W button zooms out, T zooms in. Can be used in both optical and digital viewfinder, and during playback.

5. **Change the focus**- press the Focus menu button (flower). Switch from AutoFocus (AF), Macro (flower), or Macro (Mountain)

6. **Change Image Quality**- Press Menu button, Image quality, right arrow, up arrow → FINE

7. **Change the flash**- Press Flash Menu button, toggle through until desired flash setting. No flash, lighting with arrow through it.

8. **Format the memory card**- Use dial on top of camera, SET UP. Scroll down to Format memory. Press right arrow. When asked all images will be deleted, check that you have downloaded all previous pictures to your computer, and that you aren’t missing any data. Once assured, scroll down to format. Memory card is then completely EMPTY.

9. **Use the framing grid**- Use dial on top of camera, SET UP. Scroll down to Monitor settings. Press OK, Scroll down to framing grid. Press OK, choose ON or OFF. Use dial to go back to taking photos.

10. **Download pictures**- Use USB cable provided, plug into camera and computer. Turn camera on. Download should start immediately through iPhoto. When prompted, keep originals and format SD card as shown in step 8.