Student Experience 10: Grid Protocols

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Field Science Lesson: Grid Protocols

**When**
Prior to, during, and after the expedition

**Disciplines**
Applicable to all sciences

**Description**
Students will use specific protocols and equipment to systematically collect comprehensive data from a single location at a single point in time.

**Learner Outcomes**
The student will:
- Use previously gained knowledge of tools and techniques to engage in the systematic collection and reporting of scientific data at Mammoth Hot Springs.

**Materials**
- P-60 Nikon Digital Camera* (set on the highest resolution for photos)
- extra camera batteries
- Kestrel 3000 pocket weather station*
- 50x50cm grid*
- Infrared (IR) surface temperature thermometer (set to Celsius)
- Stop watch (for flow rate calculations)
- Compass* (to determine wind direction and directions in photos and sketches)
- pH indicator strips and a cup to hold water*
- Fishing pole with cup* and 5cm “t” attached (for scale)
- Microbe wheel* (for basic microbial community identification)
- Measuring tape or meter stick,
- Protocol sheets, clipboards,
- Writing utensils (including colored pencils – browns, yellows, pinks, dark green, light blue/turquoise)
- Calculator (for averaging temps, flow rate, etc.)
- S’Cool Cloud Charts* (for cloud identification)

*Equipment may be available at E:Y!
Short Background Explanation

There are so many components to any system, it may seem impossible to gather all measurements in the same data gathering session. This set of protocols is designed to collect a full set of data from a single location that represents the environmental conditions at a specific point in time. However, because time may be limited, this lesson includes suggestions for an abbreviated data collection session. Conditions in the field and the state of the system usually dictate which sets of data can be collected. For example, during the winter, the weather may be too extreme to spend the hour it takes to collect the full set of data in the field, so the abbreviated version that takes 20-30 minutes would be more appropriate. Also, since the spring water flow fluctuates so dramatically, it is possible that you may arrive at a location where no data can be collected over water. Data collected over the dry travertine is as useful as data collected over the spring water, so do not let the lack of water stop the data collection. Without water, no flow direction or rate will be collected. However, it will be even more important to collect data on residual colors and shapes of the travertine or possible calcite ice at your location. These can be clues that help determine how long the water has been gone from that area. Two questions that have not yet been explored thoroughly include: How quickly do microbial communities migrate when the flow changes in a system? and How long it takes for the travertine shapes to be affected by meteoric (rain) water? Photographs and other data collected from these dry areas may help guide scientists towards ways of answering these and other questions.

If you are planning to have your students conduct their own research, it is critical that they practice these protocols prior to your expedition. This can be done by having students collect data with the grids set up in the classroom with familiar objects placed behind them. (See Figure 1) Next, have students take the grids outside to collect a set of data somewhere on the school grounds.

This will help students understand some of the difficulties inherent in collecting data outside. Finally, if there is a stream or body of water close to your school; have students collect data using the grids over moving water. This will give them further experience with the protocols and provide a better idea of how long it will take them to complete the various components of the protocols.

Groups of more than five students tend to be too large for this type of data collection, while groups of less than four typically will not have enough members to collect all the data in a reasonable amount of time. It is important to have the leader (clan leader) become familiar with the data collection procedures prior to the expedition. One way to do this is to provide a data collection training session during a chaperone meeting prior to the trip. Additionally, it is also possible to work some practice into the expedition schedule prior to leaving for the field either after the geology night classes or in the morning just before to heading out to the field. If you plan to do this, please let your rangers know so that the time can be allotted for this extra practice.
**Student Experience LESSON:**

**Grid Protocols**

Short explanation of the seven areas – including metadata:

1. **Photographs** – High quality close up and wide angle digital images are critical for this data set. Often, students need to be reminded to take the wide angle shots.

2. **Detailed sketches** – Even with digital photographs, colors and textures and details like flow direction and rate can be better recorded by a person sketching in the field.

3. **Surface temperature recording** – The grid provides a framework to collect surface temperature data across an area in a systematic manner.

4. **pH** – These data are collected from the area within the grid. Triplicate measurements help to eliminate variability in the pH strips or the reading of them.

5. **Flow rate** – This is a measure of the rate of flow over a specific distance.

6. **Atmosphere** – Air temperature, relative humidity, wind speed and cloud cover are gathered using the Kestrel 2000 and the S’Cool cloud cover charts.

7. **Metadata** – Metadata is the collection of any additional observations made that are not included in the protocol. Examples of meta data could include: observations of the areas around that site; challenges that affected the data collection; smells; unusual occurrences like low light due to thick cloud cover, or conversely, reflective light from a bright day; and seasonal information that is normal or anomalous.

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**EXPEDITION: YELLOWSTONE! STaRRS**

**Suggested Procedure**

Prior to the expedition the teacher will:

1. (Prior to first classroom session) Select sites for student groups to set up their grids and do a run-through of the protocol. This can be done initially in the classroom, using areas with interesting objects placed behind the grids. If the weather is inclement or very cold, it may be preferable to practice inside first. However, the outside practice will give students the best idea of what it will be like in the field. Locations near the school with moving water are ideal. If moving water near the school grounds is not available, consider using a stream table with sand. If there is no access to water, make sure the grids are placed over different types of surface areas so the students will be able to note differences in data to compare in their final discussion. The flow rate protocol is one of the most difficult to do in the field for the first time, so it is best to find a way to practice this ahead of time.

2. Review all the tools in the protocol, giving extra instruction for tools the students may not be as comfortable with such as the Kestral 3000.

3. Put students in groups of 4-5 and give each group a set of protocol sheets.

4. Review the protocol all together. This can be done the class period prior to the data collection. Either assign jobs for the students or have them decide their jobs within their groups. Explain that they will be conducting data collection using only the parts of the protocol that they can utilize at their designated sites.

5. Take students to their designated locations and monitor data collection and equipment sharing as needed. Set a time limit allowing for 5-10 minutes at the end for students to check for missing data. Data not filled in right away is often lost or unusable later.

6. Following the data collection, (this will probably need to be done the next class period) have students spend some time cleaning up their data. This could include eliminating data sets that are not complete for
some reason, calculating averages, identifying trends. An example of a trend they might explore: Were the IR temperatures all the same or were there warm or cool spots within their grid? Have students make a list of challenges they faced during data collection.

7. Lead a large group discussion in which:
   a. Students briefly share their data trends.
   b. The entire class spends more time discussing all groups’ challenges and work on solutions to these challenges.
   c. Students discuss how this will be similar and different to their data collection in the field. (Safety issues might be good to discuss at this point – review the Nuts and Bolts guidelines for keeping safe in thermal areas and how these guidelines will dictate how data are collected there.)
   d. Students discuss what would happen to these data if they had been collected in the field. (Data would have been put in legible order and matched with photos and sent to the partnering scientists – with any comments or questions the students might have about the data collected).

8. If you have time before your expedition to do this a second time, the time in the field will be much easier.

You will also want to do this same exercise with your chaperones prior to the expedition – Not so that they can participate in the data collection, but instead so that they are familiar with the equipment and will be able to facilitate their group during data collection.

During the expedition the teacher will:

9. Remind students of the fragility of the terraces and the importance of using care while collecting data.

10. Go with the rangers and students to an area where the small groups can set up their grids and collect data. It is important to remember that the rangers will be facilitating the location selection and safety of the students, but will not be in charge of any of the groups or the data collection.

11. Remind students to write everything down, take LOTS of photos, and gather as much data as they can, since they will not be able to return to this site.

Groups who finish early can gather and clean up their data in the field. If students are running out of time, review the Abbreviated Protocol and have them gather as much of that as they can.
Visual representation of the spring - 
Sketches and Photographs

Sketches:
While one-two students are holding the grid in place, two other students need to be sketching what they see within the frame of the grid. Use the grids provided in the packet:

1. Label the top with your school name, clan name, date and time of day
2. Sketch the main features and shapes you see within the grid
   a. What shapes do you see?
   b. What textures do you see? Add captions in the margins of shapes that are more difficult to draw
3. Add in colors (if you have colored pencils), use arrows and descriptions to give as thorough a picture as possible
4. Record the flow of water (if there is water). Use arrows to show the direction of the flow. Try to estimate the depth of the water in the four corners and the center of the grid. (Remember to use cm! 2.2cm=1 inch) DON’T TOUCH THE WATER!
5. Add in any living material you see – sometimes you have to look for a while to notice things like tiny bugs, grasses, twigs, etc.
6. Be sure to sign your work and put it in a safe place to take back with you.
Student Experience LESSON: Grid Protocols

#1 Sketches (PAGE 1):

School Name: 

Date: 

Time of day: am/pm (circle one) 

Where are you?

EXPEDITION: YELLOWSTONE! STaRRS
#1 Temperature Data Collection:

School Name: ________________________________  Clan Name: ________________________________

Date: ________________________________  Time of day: __________ am/pm (circle one)

Where are you?

Grid Protocols
Photographs:

Make sure the camera is set to the highest resolution possible. Since you are using a digital camera, take as many photos as you need, or even more than you think you need! It is very disappointing to return to the field and find out over half of your photos are blurry. It is hard to see the quality of the photos in the field, especially on sunny days, so if you think it may be the least bit blurry, take another. It is much easier to delete extras than get more after you get back. The latter is usually impossible.

1. **RECORD IN YOUR JOURNAL OR ON THIS PROTOCOL SHEET WHICH CAMERA YOU ARE USING! CAMERA NAME: Then:**
2. Begin by taking a photo of your name tag with your clan name on it.
3. Each time you start a new series of photos for data collection do this again!

This is **EXTRA ESPECIALLY important** if you are sharing a camera with more than one group. This makes it so much easier to sort photos later – when they look oh-so-much-the-same. As much as you think you will remember all the photos you take, you will probably not, so better safe than sorry!

4. **Take some WIDE angle shots of your grid, the people holding it and about 2m (~6 feet) on both sides of the grid.** It should look something like the following photo:

An even wider angle would have been helpful, as it would be nice to know, now, what was upstream (towards and behind the photographer) in the photo on the left, and what was beyond the grid above and to either side in the photo on the right.

5. **Take some photos of what you see looking through the grid.** Make sure the grid fills the frame and the pictures are clear so that shapes and colors can be seen when the photos are enlarged. Here are some examples:

6. **Take 6-12 more photos of things of interest you see in the grid.** Use the macro setting (a flower icon on the Nikon P60) and zoom for close-up shots. This works better than trying to get the camera close, which usually results in fuzzy photos. Here are some cool things students have taken photos of in the past:
Recording temperature:

While 1-2 students continue to hold the grid, two others will take water surface temperatures in triplicate (this means three times for each location) and record them on the temperature grid data sheet. One person will be pointing and gathering the temperature data, the other will be writing it down on the data sheet.

1. Stand at the front edge of the grid and extend your arm. Point to the center of each designated 10X10 cm section (where the strings cross) and take the temperature.

2. You will do this at each cross section by doing the following: Click and hold the thermometer – read the temperature aloud and wait for your group mates to record it. Undo your grip, re-align the thermometer with the location where the strings cross and click, hold and read the temperature aloud again. Repeat this process until you have done it three times for each of the 8 locations specified on the grid.

3. Start at A1 and work your way left to right, and top to bottom. Have your colleague record each measurement in the GRID # 1 form. It is also a good idea to have a back-up data collector recording the temperatures in the table also given.

Record grid surface temperature using the infrared thermometer gun (IR Thermometer). Make sure it is set to Celsius!
IR TEMPERATURE DATA TABLE:
You can record the temperatures on the Grid Temperature page or you can also record the temperatures in the following table:

<table>
<thead>
<tr>
<th>Location</th>
<th>Temp #1</th>
<th>Temp #2</th>
<th>Temp #3</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

School Name: ____________________________  Clan Name: ____________________________

Date: ____________________________  Time of day: ____________________________  am/pm (circle one)

Where are you? ____________________________
Recording pH (if there is water):

If your water is less than 2cm deep, tape the pH paper directly to the fishing pole and dip it carefully, directly into the spring water as close to the middle of the grid as you can. This will lessen the possibility of accidentally damaging the travertine while collecting water. Take care not to touch the underlying travertine with the fishing pole – it is very fragile.

If you have enough water, have a chaperone or ranger gather water from the area under your grid and pour it into your pH cup. Hold the pH paper in the water and count to five aloud. Remove the paper and match it to the scale that comes with the paper. Do this three times.

Record it in the space below:

<table>
<thead>
<tr>
<th>Trial #1</th>
<th>Trial #2</th>
<th>Trial #3</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH measurements</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

School Name: ____________________________________________  Clan Name: ____________________________________________

Date: ____________________________  Time of day: ____________________________ am/pm (circle one)

Where are you? ____________________________________________
Recording Flow Rate (if there is water and sufficient flow to gather data):

1. Measure the distance along the spring flow path across which flakes will be timed. A distance of 20 – 50 cm, may be sufficient. Record the distance in the second column of the flow rate data table.
2. Sprinkle a few flakes (seeds or pine needles from near the measurement spot will be appropriate to use) into spring water slightly upstream from the point where you want to begin your measurement.
3. Start timer as soon as flakes reach the starting point. The observer should call out “Start” as the timer begins timing.
4. Stop timer as soon as flakes reach the ending point. The observer should call out “Stop” as the timer stops the timer.
5. Record this number (time in seconds) in the third column of the data table.
6. Repeat the measurement two more times, recording the numbers in the proper places.
7. Calculate the rate by dividing the “time of flight” by the distance traveled to obtain the flow rate of the spring water. For example: if your distance was 50 cm, and the time it took the flakes to travel that distance was 12 seconds, you would take 50 divided by 12 and your answer will be 4.16 cm/sec.
8. Figure out the averages for your trials, and make sure to fill in all the other information.

Flow Rate Table:

<table>
<thead>
<tr>
<th>Distance (in cm)</th>
<th>Time (in seconds)</th>
<th>Rate = distance/time m/s</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trial #1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Trial #2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Trial #3</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Averages</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

School Name: ___________________________________________ Clan Name: ___________________________________________
Date: ___________________________________________ Time of day: ______ am/pm (circle one)
Where are you?
Atmosphere Data:
Using the Kestrel 3000, record the following information:

1. Turn on the Kestrel. You want to hold it up so the wind can flow through it while you take the air temperature. You will eventually record the AVERAGE wind speed after at least 5 minutes (Generally this is the amount of time it takes to record the temperature and humidity in triplicate - remember, that means 3 times each).
2. Make sure the temperature is set for °C, find the air temperature – which is a tiny thermometer icon [i], read it out loud and have a colleague record it.
3. Next, find the symbol for relative humidity, which is a small raindrop followed by a % sign [i]. DO NOT USE THE ICON WITH THE ADDITIONAL i - This is the measurement for Heat Stress, not relative humidity. Read the number aloud for your colleague to record.
4. Repeat steps 2 and 3 two more times
5. Now, check the wind speed AVE – record this in the space provided

Atmosphere data table:

<table>
<thead>
<tr>
<th></th>
<th>Trial #1</th>
<th>Trial #2</th>
<th>Trial #3</th>
<th>Averages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air &lt;Temperature</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative %∑Humidity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AVERAGE wind speed</td>
<td>(Record this AFTER you collect all the temperature and humidity data!)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cloud Types (check all that you see – Use the S’Cool cloud chart for reference):

_____Stratus (low & blanket-like) _____Cirro cumulus (very high, cottony-puffy)

_____Alto Stratus (higher & blanket-like) _____Cirrus (high, wispy “mare’s tails)

_____Cirro Status (very high and blanket-like) _____Nimbostratus

(blanket-like with rain/snow coming down)

_____Cumulus (cottony-puffy) _____Cumulonimbus (puffy with rain or snow)

_____Altocumulus (medium to low, cottony-puffy)

How much of the entire sky is covered (check one)?

___________<25% ____________ Between 26-75% ____________>75%

What is today’s date? ______________ What time is it right now? ______________
Metadata:

Location:

Where are you?

Describe this spot in as much detail as you can (so that someone else can find it later)

What are some things you notice? Use these questions to get an idea of what sort of metadata you can add:

- Is it really windy?
- Is it really cold or warm?
- Is there any evidence that other animals have been hanging out (tracks, bedding, etc.?)
- How does it smell? What does it smell like?
- What is the season? Are there leaves on the trees, bushes, plants? Flowers? How much snow is on the ground?

Add as much as you can in the space below:

_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________
Protocol Checklist:

- Sketches (2)
- Photographs (20 or more)
- Surface Temperature (8 points, 3x each = 24)
- pH (3xs)
- Flow Rate (3xs)
- Atmosphere
  - Air Temp (3x)
  - Relative Humidity (3xs)
  - Average wind speed (1x after 5 minutes)
  - Cloud types and cover (1 entry)
- Metadata (1 set of data - entry)
- Sent data to scientists on _________________________ (date)

Abbreviated Protocol – Use if you are short on time:

- Photographs
- Surface temperature
- Sketch flow direction (and record rate, if time)
- Atmosphere – Air Temp and Wind Speed
- Metadata (1 set of data - entry)

- Sent data to scientists on _________________________ (date)