
# Activity 4 - Mystery Box, Part 1 – Mapping the Unknown

## Overview:

When scientists first started trying to visualize and understand the ocean floor, they could not observe the seafloor directly. Initially, they believed that the ocean bottom was flat, but in 1855, U.S. Navy Lieutenant Matthew Maury created a bathymetric chart that revealed evidence of an underwater mountain range in the Mid-Atlantic. The bathymetric chart was made by dropping long weighted lines (i.e., ropes) to the ocean bottom. The lines were marked off at intervals to determine depth. These depth readings were called "soundings" because the leadsman – the person lowering the rope – would call out the depth intervals as the line was lowered.

In this activity, students will simulate "soundings" to visualize and map an unknown object using a Mystery Box, a cardboard box with a shoe or some other familiar object attached to the inside bottom. In Part 1, students will use "Sonar Sticks' to scan the box bottom surface and determine depths, and then construct a rough map of the bottom using color to indicate relative differences in depth. The resulting map will reveal peaks and valleys but not enough detail of the shape to determine the identity of the object. In Part 2, students will remap portions of the box bottom with higher resolution and work together as a class (i.e., a community of scientists) to share their data to determine the box contents.

## Background

Exploring the shape of the ocean bottom is absolutely necessary to understanding how the world's surface formed, but it was a daunting task initially. In order to map the ocean floor, weighted lines had to be lowered, measurements noted and then the lines hauled back on board at carefully recorded positions. Often early "soundings," as the measurements were called, were very sparse and with water depths of over a mile, the readings could be quite inaccurate. The advent of sonar, a system that sends sound waves instead of a weighted cable to the depths, significantly improved ocean bottom mapping.

## Development of Lesson

1. Explain that contour maps show the shape of a surface by joining points with the same elevation. Reading contour maps helps scientists visualize the ocean bottom and decide where to go to conduct their experiments. For a good graphic demonstration of how contour maps work, make a contour map of your hand. We suggest that you make your contour lines in advance on a snug fitting vinyl or latex glove. With a little finesse, it can be put on for a quick demonstration. Make a fist and, with a fine point sharpie marker,

## Essential Concept / Focus Question:

How do you map a surface that you can not see or touch?

## Learning Objectives:

Students will be able to

- explain how early maps of the ocean bottom were made.
- describe and execute a method for producing a low-resolution map of a surface that cannot be seen or touched.
- analyze the data from a mapping activity and identify areas of interest.
- Use color to enhance their sounding data..

## National Standards

- Unifying concepts and processes: Evidence, models and explanation
- Science and technology:
  - Abilities of technical design
  - Understanding about science and technology

**Time Frame:** 2 periods

## Materials:

- Copies of the *Mystery Box Sounding Activity Directions* and *Color Map of the Mystery Box* for each student.
- 2 (or more) Mystery Box Stations (see below)
- "Sonar Sticks" (one to use and one for back up incase!) Use shish kabob sticks. Mark off .25" intervals for 12" from the bottom of the stick with a fine point sharpie marker. Label the bottom interval 1, the next 2 and so on to the top.
- Sets of 8 color markers or pencils for map coding: blue, blue-green, green, yellow-green, yellow, yellow-orange, orange, red.

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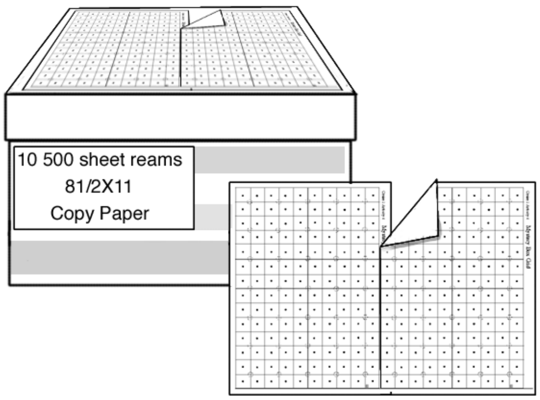
## Activity 4 - Part 1 (cont.)

**Mystery Box Materials**

• "A cardboard box (e.g., a copy paper




carton works well)" You may choose to have just one box or to create more than one Mystery Box station.

• 2 copies of the Mystery Boxtop grid for the top of each box

• A familiar object to place inside in each mystery box—we suggest an athletic shoe or high top boot.

• Spray adhesive and a stronger glue or duct tape to hold the familiar object in place.

• Sharpened # 2 pencil for punching holes in the box grid.

**Preparation:**

• Use a copy paper carton with a lid for the “Mystery Box.” Decorate it with phrases and pictures encouraging students to map its contents and guess what is inside. Use spray adhesive to fasten 2 Mystery Box Grids to the box joining them on the longer axis. You will need to cut off the margin from one side of one of the grids to allow the grid to be continuous across the top of the box. Make sure that you line them up.

• Use a sharpened pencil to poke holes in the large circles for the low-resolution grid.

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draw a line around your knuckle connecting all of the points that are 1/8” inch below the highest point. Repeat for points 1/4,” 3/8,” and so on until you have drawn four or five concentric circles around one or two knuckles. Flatten out your hand and show the lines. Lines will be closer together where the angle of your hand was steeper and further apart where the angle of the slope was more gradual. (This demonstration is fully described and illustrated on the Dive and Discover website. See Resources)

2. Project the “East Pacific Rise Contour Map” and help students to identify the latitude and longitude markings, depth notations on the contour lines, steep areas and flatter areas. Explain that the negative numbers (e.g., -2650) represent depth in meters, or meters down from the surface of the ocean. Point out that -2650 is deeper than -2600.

3. Ask students how they think scientists get the data to make a contour map of the bottom of the ocean. Tell them about how sounding lines were once lowered to the ocean floor to make measurements. It was a lot of work and required a great deal of time. Today sonar and multi-beam sonar make the job much easier. Ask the students what measurements they would need to know to make an accurate contour map? (Longitude, latitude and depth) How many points would need to be mapped to get a good idea of what the bottom looks like? (*more points for higher resolution*)

4. Explain that the students will take “soundings” with a “Sonar Stick,” instead of a sounding line, from the Mystery Box to deter-


# Activity 4 - Part 1 (cont.)

mine what, if anything, is inside. Show the students the "Sonar Stick" and demonstrate how it is put into the holes on the box grid and read. Suggest that one person from each group do all of the soundings for that group. Ask the students why they think that might be important. *(Consistent technique is important . If you have the time and want to introduce the concept of "reproduceability," you can have several groups that are using the same Mystery Box compare their soundings.)* Students will take their soundings of the Mystery Box as a group, but each student will record the results on his/her own "Color Map for Mystery Box Handout."

5. Scientists often color code their ocean bottom maps to make them easier to read. They use colors ranging from blue for the deepest area, through green, yellow, orange and red for the highest area. Once the soundings have all been recorded, the students will color code each square on their grid handout for the mystery box as well.

6. Give each group a copy of the "Mystery Box Sounding Activity Directions" and each student copies of the "Mystery Box Grid Handout." Set up a sequence for groups to visit the Mystery Box to get their soundings.

## Discussion Questions:

1.Is the resolution of your "Mystery Box" map good enough for you to identify the object inside?
2. What can you tell about the inside surface of the bottom of the box?
3. How could you improve on the information you currently have? *(more holes)*
4. What would a contour map made from the data you have collected look like?

- Choose a familiar object with a distinctive high relief shape that the students will be able to recognize—we suggest a clunky sneaker or high top boot. Fasten it to the bottom of the container with duct tape or glue so that it does not shift position in the box.

**Teacher Tip:** If you create more than one Mystery Box for your class, all the boxes need to be clearly labeled. Students must record in their notebooks which Mystery Box they used because they will need to use same box in their continuing investigation in Part 2.

## Resources

**Dive and Discover**

http://www.divediscover.whoi.edu/

For the hand contour map activity, go to:

Expedition 7: Deeper Discovery: Activities: Reading and creating maps with contour lines

# Mystery Box Sounding Activity Directions

Your mission is to map the bottom of the inside of the "Mystery Box." Do not lift or move the box. Using your "Sonar Stick," you will measure the interior depth of the box at each of 70 points defined on the grid on the top of the box. The "Sonar Sticks" are marked with Mystery Box (MB) units – each unit equals _ inch. You will convert these numeric depth readings into a color coded depth to create a color map or bathymetry map of the box inside bottom.

## Instructions:

1. Starting at one corner of the box top, gently slide the Sonar Stick through one of the holes into the box, keeping the Sonar Stick as vertical as possible. REMEMBER, the surface below may have deep sediment or it may be pliable. As you slide your sticke into the box, try to stop as soon as you feel a surface inside.

2. Record the numeric depth reading from your Sonar Stick on your **Color Map of the Mystery Box (Low Resolution)** handout. The depth of the surface inside the box corresponds to the first number showing on the Sonar Stick above the lid.

3. Repeat steps 1 and 2 for all holes, or "sounding points" on the box lid.

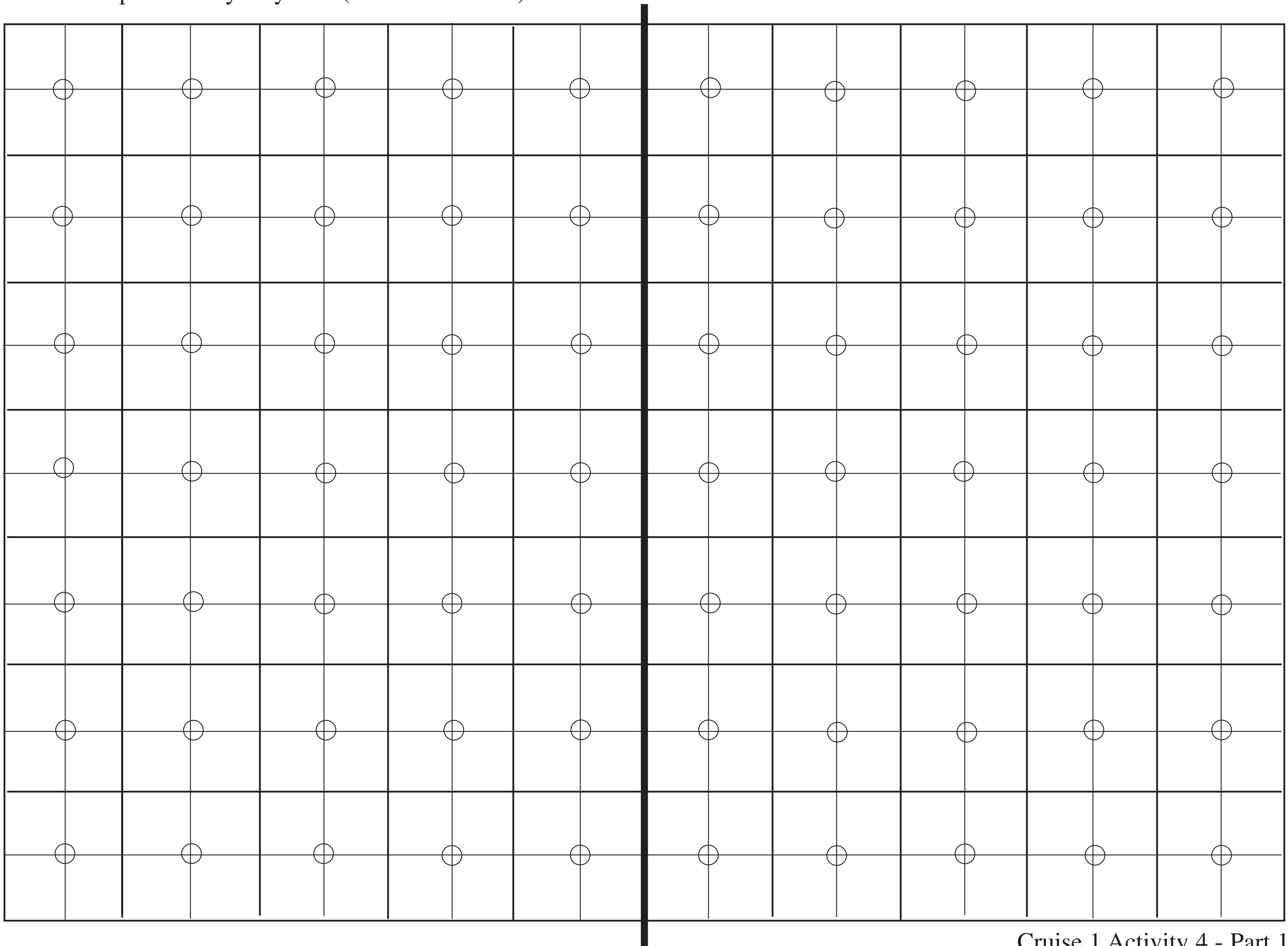
4. When you have recorded all the numeric depths on the map, determine a color code scheme for your readings. Scientists use a convention in which blue or purple is the deepest, green is more shallow, and then yellow, orange and red correspond to increasingly shallower depths. Red is typically the shallowest. The actual depths may vary from map to map but the order is the same. Study the numbers you have found and develop a color code for your depths, following the same order that scientists use.

   • First make a list of the readings from your soundings from the most shallow to the deepest.

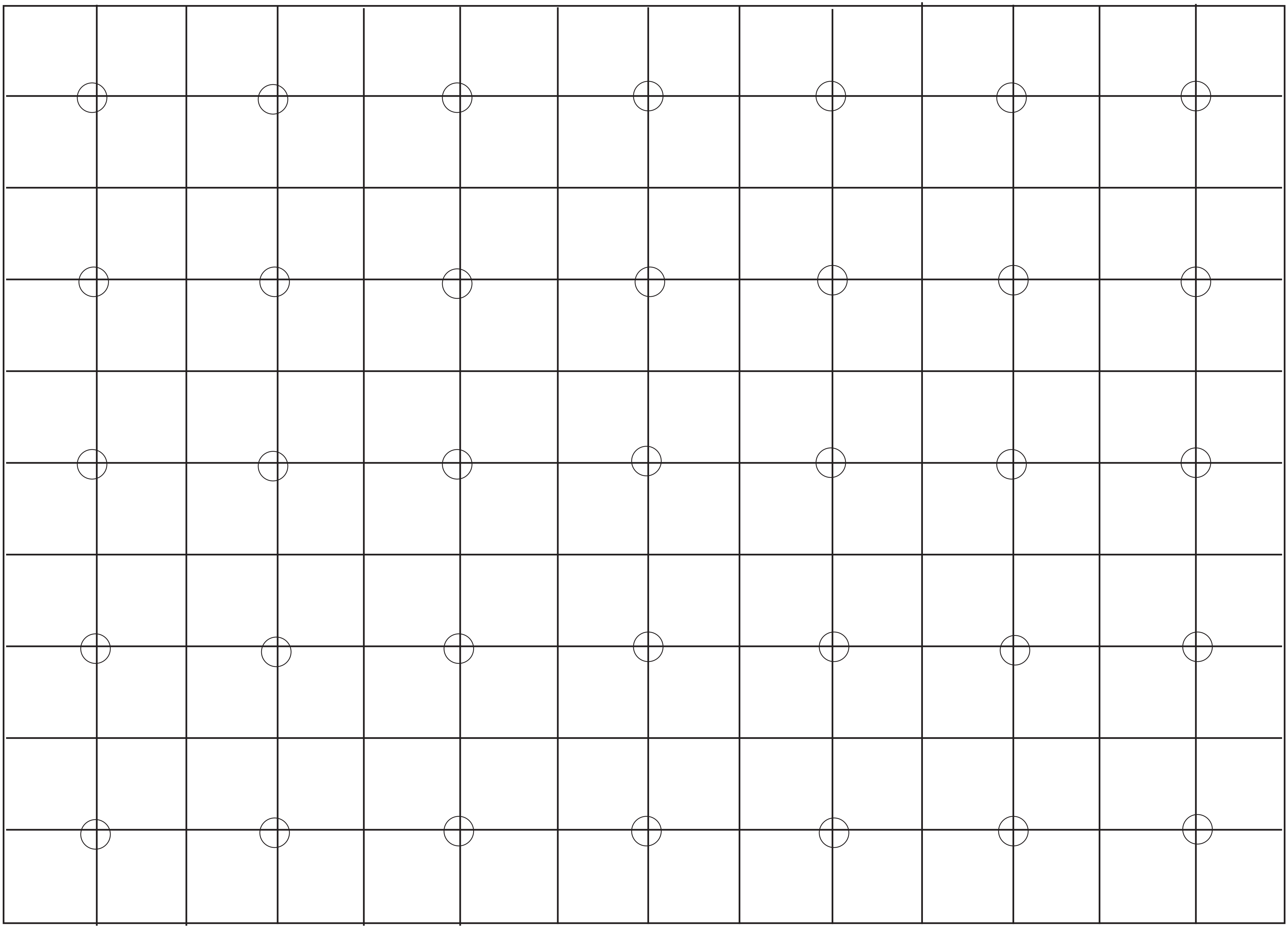
   • Decide which numbers will be represented by which colors.
      o Will each color represent 1 unit or more?
      o Will you use all 8 colors?
      o If you have no numbers 1-5, you may want to start the color code at 6.
      o Take some time to figure out what will help you most to read your grid efficiently.
      o List your color key below (i.e., 1-2= Red, 3-4= Orange, etc.)

5. Using the color key you have created, color your map.

Color Map of the Mystery Box ( Low Resolution)



# Mystery Boxtop Grid - Low Resolution




# Activity 4 - Mystery Box, Part 2 – Improving Resolution

## Essential Concept/ Focus question:

Using the data we have already collected and cooperating with other researchers, how can we optimize our data collection in order to get the most detailed and useful results from a mapping expedition even when facing considerable limitations?

## Learning Objectives:

Students will be able to:

- Analyze their existing data to determine how best to complete their inquiry.
- Cooperate with other students to create a system that will allow them to share data.
- Make qualitative and quantitative observations and inferences.
- Describe the shape of an unseen surface using depth readings.
- Present their data and the conclusions they draw from it.

## National Standards:

Unifying Concepts and Processes:
- Systems, order and organization
- Evidence, models and explanation.
- Change, constancy and measurement.

Science as Inquiry:
- Abilities necessary to do scientific inquiry

Science as Inquiry (cont.):
- Understandings about scientific inquiry.

## Overview

In Part 2, students return to the Mystery Box to identify the object in the box. Identification must be made with hard evidence produced through careful mapping. Like the scientists working on deep-sea explorations, students in this activity are limited in their access to "research site." They will only have time to map a small area in detail. By sharing data between student groups, the whole call will develop a high-resolution map of one Mystery Box.

Each group must use the data collected by the entire class to identify the contents of the box. Groups will present their arguments for the identity of the box contents. Their presentations will include a color-coded copy of a detailed version of the Mystery Box Grid Map.

**Teacher Tip:** If you have provided multiple Mystery Boxes, you will need to choos one for the whole class to work with in this activity. Also, you will need to increase the resolution on the Mystery Box top by making a new box top and using the higher resolution BoxTop Grid. Punch out the solid circles in the center of each box on the grid (total = 280 holes).

Investigating a remote environment requires special equipment and ship access. Scientists must find funding to pay for their research. They write detailed and compelling proposals outlining what they want to accomplish at sea. They often must compete with each other for limited funding and ship time. Out of a hundred or more proposals for any cruise as few as three to five may be funded. Scientists must pay attention to which projects have already been funded and show that their work is relevant, not redundant. They work together as a scientific community to optimize their findings—building on each others' data.

In this activity the students are given limited resources to collect the information that they need to achieve their goal. There are a total of 280 possible measurement points defined on the high resolution Mystery Box lid (five times that if the students decide to go with an extremely detailed reading at all of the grid line intersections). Each group is limited to only 60 sonar stick readings. This simulates the limitations of time and available resources.

Students will work in their own groups using the data they collected in the first Mystery Box activity to define what areas they most want to study and how to identify those areas (develop a grid labeling system).

Together, all of the groups in the class must not only choose which areas they will measure, but they must devise and agree upon a system for locating those areas so that they can share their data and work as a larger community. In a full class meeting, they will work out a system to cooperate and bring back the most information possible. The goal is to make choices that will give the entire class the most relevant data possible.

Each group must use the data collected by the entire class to identify the contents of the box and present their theory, explaining their systematic meth-


## Activity 4 - Part 2 (cont.)

ods, which data they used and how the data supports their conclusions. ("It feels like a shoe" doesn't cut it). Part of their presentation must include a color-coded copy of a detailed version of the Mystery Box Grid Map.

### Development of Lesson (Steps):

1. Tell the students that they will return to the Mystery Box and identify its contents. They must provide hard evidence for their identification in the form of a color-coded map. Ask them to bring out their original sounding results and discuss what they need to do to collect the information necessary to accomplish this task. (Higher resolution mapping).

2. Explain that this time each group will be allotted only 60 sonar stick measurements. Encourage the class to think of ways to cooperate and use each other's data. They can break into their groups, discuss the problem for 5 minutes, and then meet again as a whole class to work out a method for cooperating.

In a meeting of the whole class the students must decide:
1. If there is more than one box, which Mystery Box to use?
2. What areas need to be mapped? (all, some?)
3. What method for labeling the Mystery Box grid will allow them to share results?
4. Which sections will each group investigate? (These may overlap.)
5. In what order will they take their measurements?

3. Each group will take their measurements and share them with the rest of the class. Have one student record "soundings" on an overhead transparency as her/his group takes their readings. Other students will record these soundings on their own maps. Each student should:
- complete a map with the entire class' data.
- use the color scheme presented in Cruise 1 Activity 4 in which blue is the deepest, followed by blue-green, green, yellow-green, yellow, yellow orange, orange, and red is the most shallow.
- complete the worksheet.

4. Have the student groups discuss their observations and complete the worksheet, "Mapping the Mystery Box."

5. Each group will choose a representative to present their arguments for the identity of the box contents. If the students are able to identify the item, show them the contents. If not, ask them how they can proceed to identify the object and challenge them to continue to investigate.

### Discussion Questions:

1. How did you determine which features were the most important to map?

2. Did you have a hunch about what the object was before you completed the mapping process?

### Extension:

Challenge students to build a 3-D model of the mystery box contents. They will need to consider scale. The sonar stick units are .25 inch but the grids used for mapping are reduced.

### National Standards(cont.):

Science and technology:
- Abilities of technological design.
- History and Nature of Science:
- Science as a human endeavor.

**Time Frame:** 1-2 periods

### Materials:

- Two sets of 8 markers or colored pencils for map coding: blue, blue-green, green, yellow-green, yellow, yellow orange, orange, red for each group
- Mystery Box and sonar stick
- New Boxtop Grid with higher resolution
- Copies of Mystery Box Map - High Resolution (extras may be a good idea)
- Copies of Mapping the Mystery Box worksheet for each student
- [Optional] Prizes for identifying the Mystery Box contents.

# Mapping the Mystery Box

**Community decisions:**

1. Since no one group was able to map the whole box, how did your community of scientists decide to optimize data collection?

2. How did you label the grid in order to standardize the location of your data?

**Your Map of the Mystery Box:**

3. Explain your color key choices.

4. How many colors did you use? ____________

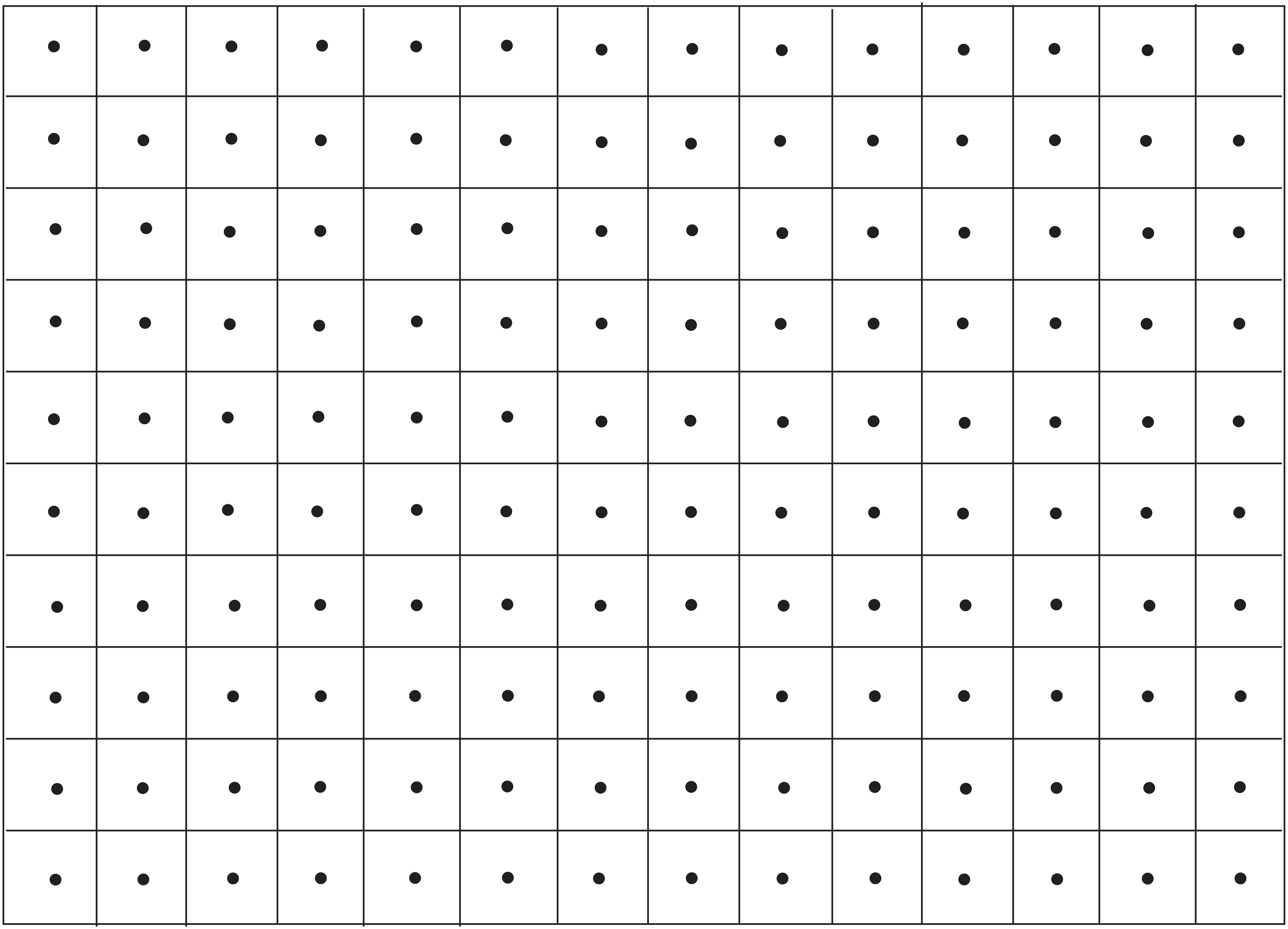
5. How many Sonar Stick units did you have per color? _______

6. Do you think that your data is sufficiently complete to identify the contents of the Mystery Box? Why or Why not?

7. If you were allowed to take another set of readings what location would you measure? Why?

8. What do you think is in the Mystery Box? What is your evidence?

# Mystery Boxtop Grid High Resolution



Color Map of the Mystery Box Map (High Resoultion)