Experiment

Overview

The experiment is an opportunity for your students to apply the information that they have learned about animal habitat, richness, and abundance. They will be given the opportunity to alter part of the habitat to see how this affects the richness and abundance of the animals seen.

Activity

Activity 7: Setting Up Our Own Biodiversity Experiment

The class will read a paragraph describing the class experiment. Following this, each team will choose an Experimental Question that they would like to learn more about. Each team will then work through some questions that will guide them with their experimental set-up and data collection. The class will go outside, set up the experiments, and collect initial data. A second data collection should occur following Part C. The final data collection and data analysis will follow Part D of the BioKIDS curriculum.

Teacher and Student To Do

Activity	Teacher	Student
7	• Have students read over the experiment description and aid them in choosing an experimental question. • Note what materials each group will need for their experiment. • Aid the students in setting up their experiment and taking initial data. • Give students the opportunity to collect additional data at the end of Part C and the end of Part D.	• Read over the experiment description. • Choose a question for investigation. • Use the worksheets to determine your experimental conditions and data collection methods. • Set up your team's experiment and take initial data. • Take additional data at the end of Part C and the end of Part D.

Time Estimates and Materials List

Time Estimates	This activity should take approximately three days including collecting initial data. Two other days later in the BioKIDS program are needed to collect data. Approximate times would be at the end of Part C and at the end of Part D.
Materials List	• Experimental Supplies

Learning Goals and Exploring Questions

Learning Goals	**Content Learning Goals**: • Explain how changes in the environment influence the richness and abundance of organisms.

	Inquiry Learning Goals: • Learner sharpens or clarifies question provided by teacher, materials, or other source. • Learner directed to collect certain data. • Learner guided in process of formulating explanations from evidence. **Technology Learning Goals**: • Students will use a PDA to collect experimental data, which will then be transformed into charts and graphs.
Exploring Questions	• By changing the environment, how has this changed the animal populations in the area?

Activity 7: Setting Up Our Own Biodiversity Experiment

To the teacher:

Choosing a Class Experiment
You may choose your class experiment, or have your students involved in making the choice. The possible Biodiversity Experiments are shown on three separate student worksheets. These include, "For the Birds!", "Who Lives in the Dirt?", and "Who Likes Flowers?". Following this *To the Teacher* section, there are detailed descriptions of each experiment.

Experimental Question
The Experiment offers students the opportunity to explore how changes in the environment influence the richness and abundance of organisms. As a class, read the description of the class experiment. Have each team of students read over the experimental questions that BioKIDS has supplied and choose one. We provided these questions as guidelines. If you are comfortable with it, you may have students modify them or come up with additional questions. The goal of this exercise is to examine the issues of abundance and richness. Make sure that the questions ask about one of these two concepts.

After the teams have chosen an experimental question, have them work through the experimental design worksheets to better define what type of experimental set-up they need, and what type of data they will collect.

Students will first determine if their question looks at the same experimental set-up at different time points. For example, you might examine "Does the time of day affect the abundance of animals using the bird feeder?". For these questions students will need to determine how many times they will collect data and when. The other set of questions compares two different experimental set-ups. For example: "Does the size of the flower patch affect the abundance of animals seen?". In this case, students will need two set-ups, a large and a small flower patch. For these questions students need to define what they will be comparing. Make sure that students only change ONE THING between the two different set-ups that they are comparing. In the flower example, they would need to use the same color and shape of flowers for both the large and small flower patches. The size of the patch would then be the only difference between the two set-ups. Students collecting data on two set-ups may collect data only once, or collect data from each set-up several times.

Depending upon your class schedule, it might be a good idea to dictate timing issues to the class so that they can use this information to design their experiments. For example: 1. We can only collect data at XX time of the day, 2. We will be able to collect data on three separate days, but only once a day, 3. We can collect data three times in one day, but only for one day. If possible, allow students to collect data at the time of experimental set-up, at the end of Part C and at the end of Part D.

The second determination that the students will make is if their question is about abundance or richness. Follow-up questions are on the worksheet to further define the information that they will need. In many of the experiments it will be possible to use CyberTracker as the collection

device. Discuss with the class this and other options (pencil and paper) for collecting the necessary animal data. Students examining both abundance and richness will be collecting data on the total number of animals present and the kinds of animals present. During the analysis it is important to distinguish which type of data actually answers their experimental question.

Have each team complete the summary sheet about their experiment and give you a copy so that you can acquire the necessary materials.

Data Collection

Before going outside, aid each team in assembling the supplies necessary to set up their experiment. In addition, remind students that they will be taking initial data so need to bring the appropriate data collection materials. When outside, help the students in finding appropriate locations to set up their experimental materials. Make sure that students' experiments are well labeled so that they remain undisturbed.

Initial data should be collected immediately after setting up the experiment. In some cases this may just be drawing the experimental set-up, where other teams may actually be logging animal sightings. Provide the opportunity at or near the end of Parts C and D for additional data collection.

For the Birds!

The Big Picture
The idea of this experiment is to attract a variety of birds to the schoolyard. Different birds can be expected depending upon a variety of differences such as the location of the feeder, type of bird seed, and the time of day.

Preparations
You will need a location in the schoolyard where students can place feeders and they will remain undisturbed. It is best to observe the birds from a little bit of a distance, so that they do not fly away. Therefore, if there is a location that can be seen easily out your classroom window (even if only with binoculars) it would be great. Make sure that each team labels their feeders. Remember that you may be able to use the same feeders to ask a number of Experimental Questions.

Materials
Feeder trays can be any flat tray or board. It will be necessary to weight down the trays with sand or a rock so that the wind does not blow them away when they are empty. Depending upon the questions that your class chooses, you may need more than one kind of birdseed.

Method Notes
You will need to decide if your bird seed trays need to be brought inside "after hours". This may minimize human and animal disturbance during the night. Birdseed needs to be added almost daily in order to make sure the birds know where to come for seed. It may take the first week to attract birds initially.

What To Expect
The time of day greatly affects the number of birds that will be at the feeder. Make sure that your class will be able to make observations during appropriate times.

Who Lives in the Dirt?

The Big Picture
The idea of this experiment is to create sheltered habitat for soil invertebrates in the school yard. By putting boards or other flat objects on the ground out in the schoolyard, you create refuges for small animals to stay hidden and avoid drying out. After some time has passed to allow the animals to find the shelters, students can look under them to find animals, and compare the abundance and richness under the boards to similar areas of open ground, and possibly under boards placed in other habitats.

Preparations
You'll need a place in the schoolyard where you can put down boards and marker stakes and have them remain undisturbed for at least a week. If possible, grassy areas are good, but keep in mind this will kill the grass underneath, so choose with discretion. Bare open ground makes for a good comparison to areas with more vegetation, but isn't good as the only choice, as animal life may be scarce.

You should also decide whether you want to use Berlese funnels as part of your data collection. See the optional data collection information at the end of this experiment description. The funnels are pretty easy to make and use, but do require some time and materials to prepare, and your students will need time to look at the animals they collect using the microscopes. You may not want to use it for all the teams. Below is a sample creature that you could see:

Labeling is important here, students need to keep track of which data are from which board locations. Each board and control area will need to be labeled, as will any samples of dirt or animals brought back into the class for further examination.

Materials
At least one board or other flat piece of weather-resistant material for every 2 student teams, more depending on the questions they choose to try to answer. This could be scrap lumber (avoid chemically treated wood!), plywood, sheets of stiff plastic, or anything else that will resistant rain and that is heavy enough to stay in one place. You could use lighter materials, even heavy corrugated cardboard, if you can weight it down. These sheets should cover at least 900 cm^2, but their shape is not important.

Marking stakes or other materials to keep track of the control areas. These could be wooden stakes, extra long nails, anything that will let you mark the corners of a board-sized area on the ground. If the ground is soft you could even use pencils and plastic flagging. You may also want the students to have rulers to measure the area of the boards and control areas.

The collecting materials used in earlier activities (magnifying boxes, forceps, plastic bags, etc.)
If you choose to use the Berlese funnel technique, you'll need at least one trowel or shovel to collect dirt, and some containers (paper bags are good) to put the samples in.

Method Notes
Depending on their question, each team of students will need to put down at least one board. Some will need to put down a board, and then mark an equivalent board-sized area nearby that will remain uncovered and be used for comparison. Others will need to put boards on different types of ground. Be sure all boards and areas are labeled!

Especially if the ground is wet, it would be good to put a small prop under one edge of each board. It should be small, raising the board no more than 2 cm off the ground on one side. This can be anything, a stick, a stone.

If time allows, all teams should do a count of animals in the area where their board will go before they put the board down (this would be the initial data collection). This will be vital for those looking at changes over time, but would be good to do for all the different questions.

When lifting boards after some time has passed, students should be prepared -- some animals will move quickly. It's more effective to wait and watch were they go than to try to grab critters in motion, most moving things will do a very short dash and stop again.

What To Expect
Much depends on the wetness of the soil, and the amount of vegetation nearby. You will probably find earthworm tunnels, pillbugs, small dark ground beetles, and slugs or snails. Some spiders may be hiding there, and you may find small ant nests (look for white larvae and pupae!). Centipedes favor this situation too. Boards placed over vegetation are likely to attract more animals than those on bare ground. Larger boards will have more animals up to a point, but very large ones (over 2 m^2) may have fewer creatures near the middle.

If your schoolyard has seemed pretty barren in earlier collection efforts, then the Berlese funnels might be an especially good idea. It will help collect the little creatures that are present everywhere in soil and leaf litter, even if larger ones seem scarce.

Who Lives in the Dirt?: Alternate Data Collection Technique

If your class chooses the "Who Lives in the Dirt?" Experiment, they have two options for data collection. First is to use CyberTracker to log any animal sighting that they seen on or under the board. A second option is to use the Funnel described below. This allows investigation of the microscope animals living in the dirt. It produces some pretty amazing invertebrates to look at! Since these microscope invertebrates are not in CyberTracker, a paper log sheet would need to be used to log Abundance and Richness data.

Collecting Soil Animals With a Funnel
Here is an easy way to discover the amazing animal diversity that lives in ordinary leaf litter and humus. With this simple device you can extract many of the creatures that live in soil, helping students see that biodiversity is everywhere around them, not just in far away rain forests or coral reefs.

The funnel is called a "Berlese funnel, " (pronounced ber-laze-ee), after Antonio Berlese, a important entomologist from Italy who invented it in the early 1900's. Modified versions of it are widely used by entomologists and ecologists who study the small animals living in soil and leaf litter. Most of these animals need relatively moist and cool conditions to survive. The funnel works by trapping them as they move away from the dryness, light, and heat of the lamp.

Here is what you need:

- a one-gallon plastic milk container (empty)
- a medium sized empty jar with a tight lid (about the size of a 1 pint Mason jar is good)
- a stick -- about 25 cm long
- $1/8^{th}$ or $1/4^{th}$ inch mesh hardware cloth or aluminum window screen (15 X 15 cm)
- a pair of scissors
- masking tape or duct tape
- ethanal (aka ethyl alcohol, aka rubbing alcohol) -- available at drug stores
- a desk lamp or gooseneck lamp with a regular incandescent bulb (optional, but worth the effort)

Assembly:

1. Cut the bottom out of the milk jug (Fig. 1) and turn it upside down over the Mason jar to make a funnel.
2. Tape the stick to the handle of the milk jug (Fig. 2) so it is just long enough to reach the outside bottom of the Mason jar.
3. Bend down the corners of the hardware cloth so it fits snugly inside the wide end of the funnel. If using window screen, cut and pinch numerous slits so larger animals can crawl through.
4. Collect several handfuls of humus or leaf litter and put them on top of the wire mesh.
5. Pour alcohol into the Mason jar to a depth of 1-2 cm.
6. Carefully set the funnel on top of the jar and tape the stick to the jar so it won't tip over.
7. Leave the funnel in a warm, quiet place where it won't be disturbed.

8. Set a lamp over the funnel to speed drying (see Fig. 2). Keep the lightbulb at least 8 cm away from the funnel.

As the sample dries out, the animals will move down and fall into the alcohol. Check the funnel every day -- you may need to add more alcohol. After several days (maybe longer if the sample was quite wet), you can CAREFULLY remove the jar and screw on its lid. The alcohol will preserve the sample indefinitely.

The ideal material for this is damp humus: the upper level of soil that has lots of decaying plant matter in it. Very dry soil will be relatively empty of life (and lots will fall through the screen and clutter up the sample). Really wet stuff will take a long time to dry out (though may produce some interesting animals). You might also try handfuls of dead leaves, material from a compost heap (very rich!) or compare soil taken from underneath a board to soil from open ground.

The little creatures will die and be preserved in alcohol. If you would like to observe them alive, you'll need to put a damp sponge or wet paper towels in the container under the funnel, and you will probably want to remove some of the animals no more than a night or two after the funnel is set up. Don't worry about things getting out, these creatures are all so sensitive to dryness that they will stay in the jar where it is damp.

Figure 1

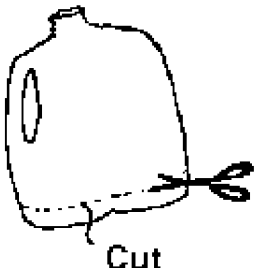
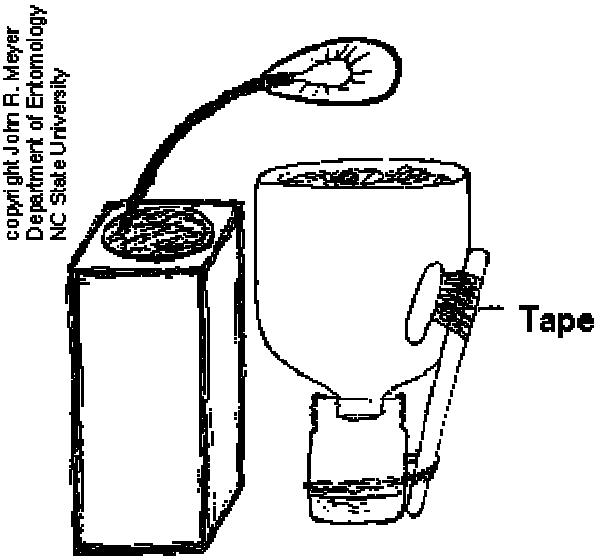


Figure 2



Milk Jug Set-up

Who Likes Flowers?

The Big Picture
The idea of this experiment is to attract pollinator insects with cultivated or artificial flowers. As various species of pollinators have co-evolved with species of flowering plants, the insects have developed preferences for color, scent and shape. We'll take advantage of those preferences and see if we can find patterns in visiting insects.

Preparations
Weather is an important consideration for this experiment. Pollinators only fly when there's no rain, and it is warm enough and not too windy. You'll need some flexibility to work around rainy days.

You'll need a lot of flowers, either cultivated flowering plants, or artificial ones. Either one will do, the two options allow for different questions, and you could even use both in a class. If you use living flowers, you'll need a place to put them out on the schoolgrounds, either planted or in pots or flats. You'll probably want to have them out for the duration of the experiment, so you'll need a protected place where they can be watered and tended. The point of having live plants out on the grounds the whole time is to allow insects and other animals to colonize the plants (e.g. aphids, ants, spiders, ladybird beetles).

The other option is to make artificial flowers. These can be very simple: flat disks or inverted cones of construction paper will be enough to attract insects, they should be at least 8 cm across. Bottle caps glued upside down in the disk or in the cone make good reservoirs for nectar. They'll need to be attached to something to get them at least a few inches off the ground. Higher is better, they'll be more visible from distance that way. You'll want at least 7 flowers per student, with colors and shapes depending on their questions. More flowers will always be better.

This experiment will require students to identify a number of flying insects, visually (very low accuracy) or by catching them and examining them up close (much better). The students will benefit from some practice at this, you might want to emphasize it in earlier collecting activities. Some of the pollinators (bees, wasps) that will come can sting, and some of the flies that will come are bee-mimics, with bright yellow and black stripes. Students can handle these insects safely in nets, but you should encourage them to work on quiet observation skills, so catching them will not always be necessary. Over enthusiastic netters are liable to wipe out flowers.

Students who are allergic to bee-stings should <u>not</u> be allowed to catch or handle any flying insects.

Materials
Whether living or artificial, you'll probably need more than one color of flower. The three best options are blue/dark purple, red/pink, and yellow/white. Any pair of these will have a chance of getting contrasting sets of visitors.

In addition to the flowers, insect nets and the other collecting gear used in the earlier activities will be used.

For "nectar," a solution made from one part sugar or honey to 6 parts warm water will do. If you want to vary it, this concentration can be halved or doubled.

Method Notes
On a day of suitable weather, each team should set out their arrays some distance from the others.

If examining live plants for inhabitants, encourage close up observation with the magnifying lenses, looking under leaves and among the petals.

What To Expect
We're not sure what will be flying during the time of the experiment, but bumblebees, other small solitary bees, honeybees, many kinds of flies (including some bee-mimics), small stingless wasps, ants (crawling up from the ground) and butterflies are all possible.

Bees tend to favor blue/purple and yellow flowers, and aren't sensitive to red. Flies are attracted to white, yellow, or pink, but some will land on any flower. Some butterflies also are broad-minded, but many are prefer yellow or blue flowers.

Activity 7: Setting Up Our Own Biodiversity Experiment

Team Name: _____

1. Read the following description of your class experimental setting:

For the Birds!

Your class experiment will allow you to get to know one animal group better – THE BIRDS! Across the country, people use birdfeeders to attract interesting species of birds. While the birds are eating, it is possible to get a peek at many aspects of their lives. These include what they eat, what other animals they associate with, what they are scared of, exactly what they look like and much more. As you will learn in Activity D, many other animals also like to eat seeds. So don't be surprised to find species from other animal groups chomping up your birdseed as well. Your class will be using bird feeders to change the abundance and richness of animals in the schoolyard.

2. Read the following experimental questions that match your experimental setting.

   A. Does the richness of animals using the feeder change with the time of day?
   B. Does the time of day affect the abundance of animals using the feeder?
   C. If a bird feeder is left in one place for a long time, does it attract a greater richness of birds that a feeder that has been in place for only a short time?
   D. Is the abundance of birds at a feeder affected by how long the feeder has been in a specific location?
   E. Does the location of the feeder affect the abundance of animals seen?
   F. Is the richness of animals at the feeder affected by its location?
   G. Does the height of the feeder affect the abundance of animals seen?
   H. How does the height of the feeder affect the richness of animals seen?
   I. Does mixed birdseed attract a higher richness of birds than a single variety?
   J. Between two types of seed, which birdseed attracts a higher abundance of animals?
   K. Can you measure a difference in animal richness between feeders with different types of birdseed?

Activity 7: Setting Up Our Own Biodiversity Experiment

Team Name: _____

1. Read the following description of your class experimental setting:

Who Lives in the Dirt?

In this class experiment you will learn more about a whole world of animals that live beneath your feet. These animals are the INVERTEBRATES that live on the ground and below. The invertebrate groups are the most diverse and abundant animals in the world, over 90% of all animal species are invertebrates! They may be small but they do the most amazing things, and we couldn't live without them. Just like other animals, invertebrates need shelter. Because they are small, a leaf on the ground often offers enough shelter for several animals. By looking under an object that has been sitting on the ground for several days you can get an idea of what types of invertebrates live in the area. Observation of this small area can tell you a lot of information about the invertebrates such as who likes to live on top of the dirt, who likes to live in the dirt, how many species can live together in the same space, and much more. Your class will be using boards on the ground outside to change the abundance and richness of animals in the schoolyard.

2. Read the following experimental questions that match your experimental setting.

   A. Does the ground under the board have a higher abundance of animals than a similar area with no board?
   B. Does the ground under a board have a higher richness of animals than a similar area with no board?
   C. Does a different size of board attract a higher richness of animals?
   D. Where under the board (the edges or the center) do you find a greater richness of animals?
   E. Where under the board (the edges or the center) do you find a greater abundance of animals?
   F. If you place a board in two different microhabitats of the schoolyard, is there a difference in animal richness?
   G. Does the location of the board affect the abundance of animals seen?
   H. Does the kind of board used affect the richness of species seen?
   I. If you use two different kinds of boards, is there a difference in animal abundance?
   J. Does the amount of time the board is on the ground affect the abundance of species seen?
   K. Do you see a change in species richness over the amount of time the board is on the ground?

Activity 7: Setting Up Our Own Biodiversity Experiment

Team Name: _____

1. Read the following description of your class experimental setting:

Who likes flowers?

Your class experiment will allow you to get to know one animal group better – THE INVERTEBRATES! Flowers are loved by many species of invertebrates for the sweet nectar inside. While they are eating, it is possible to get a peek at many aspects of their lives. These include what they eat, what colors they like, what other invertebrates they associate with, what they are scared of, exactly what they look like and much more. Look closely, some invertebrates are not there to eat the nectar – but to eat other invertebrates. As you will learn in Activity D, many other animals also like to visit flowers. So don't be surprised to find species from other animal groups flying around your flowers as well. Your class will be looking at how real or student made flowers affect the abundance and richness of the animals in the schoolyard.

2. Read the following experimental questions that match your experimental setting.

A. Is there a higher abundance of animals attracted to red flowers than blue?
B. Do red flowers attract a higher richness of animals than blue flowers?
C. Is there a higher abundance of animals attracted to paper flowers with "nectar" than paper without "nectar"? (paper flowers only)
D. Is there a higher abundance of animals attracted to paper flowers with "nectar" than paper without "nectar"? (paper flowers only)
E. Is there a higher abundance of animals attracted to paper flowers with a "nectar" of high sugar concentration compared to one with low sugar concentration? (paper flowers only)
F. Does the sugar concentration of the "nectar" affect the richness of animals visiting? (paper flowers only)
G. Does the size of the flower patch affect the abundance of animals seen?
H. Is there a higher richness of animals attracted to a larger patch of flowers?
I. Is there a difference in the richness of animals attracted to flat versus funnel shaped flowers?
J. Does the shape of the flowers (flat versus funnel shaped) affect the abundance of animals seen?
K. Is there a change in the abundance of animals that visit the flowers over the course of the experiment?
L. Does the amount of time the plant is in the schoolyard affect the richness of animals that visit the flowers?
M. Does the kind of plant affect the richness of animals visiting?
N. Is the abundance of animals affected by the kind of plant you are observing?

3. With your team and the help of your teacher, choose one of these questions for your team to study in your schoolyard. Write your question here:

4. Your experimental question is one of two types. Circle A or B for your question below.

   A. Does your experimental question look at changes over time?

   B. Does your experimental question compare two set-ups?

If you chose A, answer the questions in A below. If you chose B, answer those questions.

A	**B**
How many times will you collect data?	What will you compare?
When will you collect data?	What is the goal of making this comparison?
What materials do you need to set up the experiment?	What materials do you need to set up the experiment?
Where will you set up your experiment?	Where will you set up this comparison?

5. You will be either counting numbers of animals (Abundance) or identifying kinds of animals (Richness). Circle the type of data you will be collecting:

Abundance: Counting numbers of animals
Richness: Identifying kinds of animals

If you chose Abundance, answer those questions below. If you chose Richness, answer those questions.

Abundance	**Richness**
What will you count?	What type of things will you identify?
What is the goal of counting?	What is the goal of identifying?
What equipment will you use?	What equipment will help you?
How will you record the data that you collect?	When you identify something, how will you record that information?
In addition to counting, you will need to	

identify the animals that you are counting. What equipment will you use to do this?	In addition to identifying animals, you will need to count them. What equipment will you use to do this?

For your planning, your team also needs to consider the following:

6. Is your experiment something that can be left outside overnight?

Why or why not?

7. Is there any daily/weekly maintenance you need to do to keep your experiment running?

8. How will you make sure that other students in the schoolyard do not disturb your experiment?

9. On the next page, write up a summary of your detailed experimental plan.

Our Biodiversity Experiment Set-up

Team Name: _____

Write this information in TWO notebooks.
One is for your team to keep and the other copy is for your teacher.

Our Experimental Question is:

Experiment set-up

1. Materials Needed:

2. Location where we would like to set up our experiment:

3. Daily/weekly maintenance necessary to keep the experiment running:

Data collection

1. Data Collection Device Needed:

2. Times/days we would like to collect data:

Activity 7: Setting Up Our Own Biodiversity Experiment

Team Name: _____

1. Prepare any materials that you will need for your experiment while in the classroom. This includes materials to set up the experiment, and measuring devices for initial data collection.

2. Go outside and set up your experiment.

3. Take a picture of your set-up, or draw a picture here.

4. As a team, take the initial data on your experiment using the data sheet on the next page.

Biodiversity Experiment Data Sheet

Team Name:_____

(make copies of this form for each time you will collect data)

Our Question:

Date:_____ Time:_____

General Observations:

Describe any changes that you observed or made to your experimental set-up from your initial observations (not needed for initial data collection):

Data: Number of Animals or Number of Kinds of Animals: (if you are using CyberTracker to collect data, make sure at least one member of your team attaches a printout of the data to this sheet.)