

## OVERVIEW

In two different habitats, youngsters raise earthworms to the soil surface using a non-lethal irritant (hot mustard slurry!), then count and compare worm numbers.



## BACKGROUND

Earthworms are everywhere ... or are they? A *habitat* is the place where a plant or animal, like an earthworm, lives. What is “good” worm habitat and how might we improve an area for these humble creatures? Despite their small size and inconspicuous colors, earthworms in large numbers can be a major force below ground. Scientists estimate that a healthy worm population of 50-200 worms per square meter of ground can “move” nearly 30 pounds of soil each year! Earthworms mix the soil, keep it aerated and speed the breakdown of dead material in the soil.

To study earthworms and their habitats, you have to find them! You can dig them up, but that destroys their habitat. As an alternative, you can force them to come to the surface. In

*Worm Worlds*, youngsters use a “slurry” made of hot mustard—an irritant that bothers worms a little but doesn’t harm them—to sample earthworms in two habitats within a study area. Teams count all the worms they find and see how many are juveniles to get an idea of what might be good or bad worm habitat.

Youngsters in *Worm Worlds* can join ranks with ecologists who study earthworms, trying to answer the question, *What environmental factors determine how many earthworms are found in different habitats?* Some of the factors ecologists have studied are how dense and moist the soil is, how much and what kind of organic matter the soil contains, whether there are transplanted trees nearby whose rootballs might have carried worms to the site, and the presence of animals that eat worms.





**CHALLENGE: COMPARE THE NUMBER OF EARTHWORMS IN TWO DIFFERENT HABITATS AND RELATE ANY DIFFERENCES YOU FIND TO ENVIRONMENTAL FACTORS IN EACH PLACE.**

## MATERIALS

**For each team of 2 or 3 youngsters:**

- 1 Quarter Square Meter Quadrat (See Equipment Card)
- 2 Mustard Slurry Jugs with 1 sprinkler head (See Equipment Card)
- 1 white basin, pan or bowl - 6" min. size (for holding worms)
- 1 pair of scissors or grass clippers (for clipping grass to see worms better)
- 1 pencil to record data
- 1 copy of the Action Card
- 1 Record Sheet on cardboard or clipboard

**For the whole group:**

- 1 extra jug with about 1/2 gallon of water (for wetting basins and rinsing worms)
- 1 Data Board and marker, or blackboard and chalk (for summing up the whole group's findings)

## PREPARATION

**Group Size.** 6 to 60 youngsters broken into teams of 2-3 each.

**Time.** Count on spending 50-60 minutes for the outdoor investigation:

- 10 minutes to introduce the challenge and choose the two habitats to compare,
- 5 minutes to distribute materials and explain the sampling procedure,
- 20-30 minutes for teams to set up quadrats, count worms, and complete record sheets at two spots and then to clean up, and
- 15 minutes for teams to summarize, compare and discuss their findings.

Also count on spending at least 30 minutes further analyzing, summarizing and interpreting the group's results back indoors.

**Site.** Survey the area a few days before going out with youngsters. Do a couple of trials with the mustard slurry to get an idea of how many earthworms your youngsters might find. Make sure there are at least two types of habitat in your study area for comparison of worm numbers, e.g., planted beds versus lawns, playing fields versus ornamental lawns, heavily trampled versus untrampled lawns, or plant beds with wood chips versus leaf mulch. Locate a convenient water tap, e.g., an outdoor spigot, where the Mustard Slurry Jugs can be filled just prior to use.

**Time of year.** This investigation works best when worms are active, that is, when soils are warm and moist. Frozen or exceedingly dry conditions should be avoided.

	TEAM	# WORMS	# JUVENILE WORMS	ENVIRONMENTAL FACTORS
HABITAT # 1				
	AVERAGE			
HABITAT # 2				
	AVERAGE			



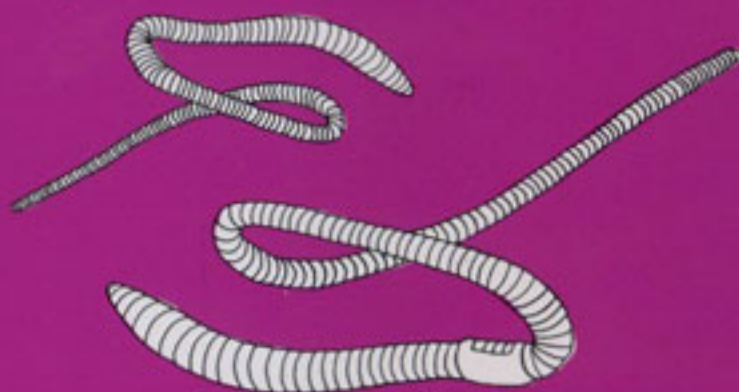
## Materials

1. **Quarter Square Meter Quadrats.** The quadrats can be used again and again (pencils or stakes need occasional sharpening).
2. **Mustard Slurry Jug.** Each team will need 2 jugs with caps and, if available, one sprinkler head (see Equipment Card). It is best to mix the slurry just before use so that the mustard is most potent. REMEMBER: rinse and air dry the jugs after use so they can be reused.
3. **Worm Worlds Record Sheet.** Mount each team's Record Sheet on a clipboard or piece of cardboard to make writing easier.
4. **Worm Worlds Action Card.** Copy the card for each team.
5. Assemble each team's materials into a sack, box, etc.
6. Duplicate the Summary Chart on the Data Board or blackboard, as shown, with one line for each team's results in each habitat.

## ACTION

1. Gather the whole group and show them the general study area. Introduce the challenge by telling the youngsters that there are worms here and that they'll actually be figuring out how many and where they are.
2. Have the youngsters look around the area and imagine what it's like below-ground in different places. List the different places and point out that all of these are potential *habitats* for worms.
3. After they've named 3 or 4 habitats, have them agree on 2 to compare. Help them come up with a reasonable comparison, such as healthy grass versus heavily trampled grass, or bare soil in the open versus under shrubs.
4. Divide the group into teams of 2-3. Outline the boundaries of the 2 habitats. Point out that since the habitats are too big to count all of the worms there, each team will take a *sample* or a count in a small area within each habitat.

5. Show the teams how to set up their uniformly sized sampling areas or *quadrats* and how to sample earthworms (see Action Card). Distribute materials (1 set/team), set a time for getting back together, then let the teams go.
6. Allow teams to select their own sampling sites, but stress the need for all teams to follow the same procedures so that their results will be comparable.



7. Circulate among the teams, helping them pick places to sample (random is best), set up their quadrats and sample worms. Things to look out for:
  - a. Crooked quadrats (make sure quadrats are straight so that samples are comparable).
  - b. Pouring slurry too fast (make sure all the slurry stays in the quadrat so they sample all the worms there).
  - c. Injured worms (avoid unnecessary harm).
  - d. Too much grass or leaf litter on ground (remove it so they get an accurate count).
  - e. No observations made of environmental factors (coax youngsters to fill in their entire Record Sheet).
  - f. No worms (help them see that this is an interesting result and ask them to explain it based on their procedures or the habitat).
8. Ask the teams to clean up and come together at the appointed time.
  - a. Return worms to the quadrat or an adjacent spot (not in direct sunlight).
  - b. Rinse mustard slurry jugs and let air dry.
  - c. Wrap quadrat twine carefully around stakes and store properly.





9. Have each team fill in its findings—worm numbers and environmental factors for the two habitats—on the Summary Chart. Then, calculate the average number of worms (both total and just juveniles) per quarter square meter quadrat: *average # worms per quadrat = total # worms from all teams ÷ # of teams*, e.g.,  $(18+12+9+21 \text{ worms per quadrat}) \div 4 \text{ teams} = 15 \text{ worms per quadrat}$ .

## DIGGING DEEPER

Display the Data Board so all the teams can see it. Encourage youngsters to compare their findings. Allow plenty of time for thoughtful discussion.

1. Which habitat had the most worms? The most juvenile worms? Why do you think this was so?
2. In what ways did the environmental factors in the two habitats differ? Which differences do you think might explain the differences you found in worm numbers?
3. Did each team find the same number of worms within each habitat? If not, why do you think worm numbers differed?
4. Now that you know how to sample earthworms, the sky's the limit for the questions you might ask about these fascinating creatures. What would you like to find out next?

## MORE WORM WONDERINGS

Encourage the youngsters to continue analyzing and displaying their results back inside. For example:

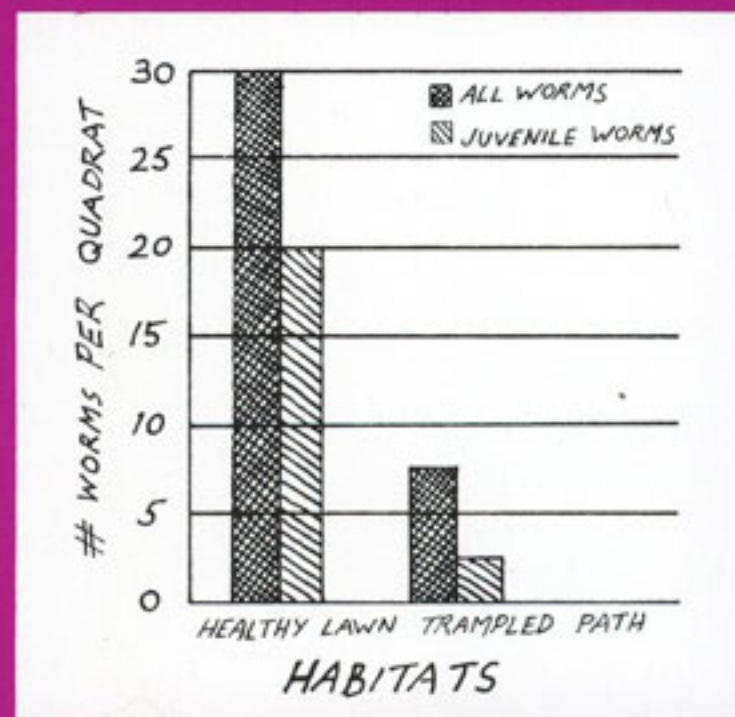
For more worm information and activities, here are some useful resources:

Earthworms. Teacher's Guide. Robert C. Knott, Kimi Hosoume & Lincoln Bergman. Great Explorations in Math and Science (GEMS). Lawrence Hall of Science, Berkeley, CA.

Earthworms. Dirt and Rotten Leaves. Molly McLaughlin. 1986. Avon Books, New York, NY.

Worm Digest. A quarterly publication of the Edible City Resource Center, Box 544, Eugene, OR 97440.

1. Have each team design a graph that will show others what they discovered. Here's an example:



2. Estimate the *population*, or total number of worms in one of the habitats in the study area:
  - a. Measure the dimensions of the habitat then calculate its area, e.g., for a 3m by 5m rectangular area,  $\text{area} = 3\text{m} \times 5\text{m} = 15\text{m}^2$ .
  - b. Multiply the average number of worms per quadrat in the habitat by 4 to get the number of worms per square meter, e.g.,  $15 \text{ worms/quadrat} \times 4 = 60 \text{ worms/m}^2$ .
  - c. Multiply the habitat area by this number to get the estimated number of worms in the entire area, e.g.,  $15\text{m}^2 \times 60 \text{ worms/m}^2 = 900 \text{ worms!}$

## BETTER WORM WORLDS?

Discuss with the youngsters how they might improve part of the study area as worm habitat. What changes would they make? How would they test whether their actions worked?

Try these other activities from Outdoor Biology Instructional Strategies (OBIS) related to *Worm Worlds*:

Super Soil  
Terrestrial Hi-Lo Hunt

Litter Critters  
Bean Bugs

For information on these, and other NAAEE programs & resources, call (937) 676-2514.



## Worm Worlds

### QUARTER SQUARE METER QUADRAT and MUSTARD SLURRY JUGS

#### Equipment Card

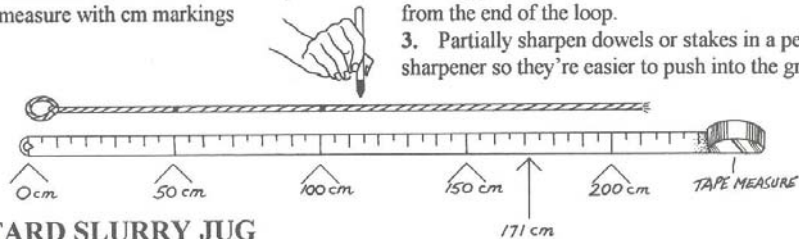
#### QUARTER SQUARE METER QUADRAT

##### MATERIALS FOR ONE QUADRAT:

- 1 2.5 meter piece of nylon twine
- 2 permanent markers (different colors)
- 4 5" stakes - pencils, tent or surveying stakes, or 3/8" wooden dowels - for corners of quadrat
- 1 tape measure with cm markings

##### MAKING THE QUADRAT:

1. Make a loop at the end of the twine.
2. Permanently mark the twine at 50 cm, 100 cm, 150 cm, and 200 cm, with an additional distinctive marking precisely at 171 cm. Be sure to measure from the end of the loop.
3. Partially sharpen dowels or stakes in a pencil sharpener so they're easier to push into the ground.



#### MUSTARD SLURRY JUG

##### MATERIALS FOR TWO JUGS:

- 2 plastic 1 gallon jugs with lids
- 1 sprinkler head for jug, available from NAAEE at (937) 676-2514.
- 4 T (about .88 oz.) dry mustard powder (try Colman's™ or bulk mustard from organic grocer—it MUST be FRESH)
- 2 empty film canisters with lids (optional)

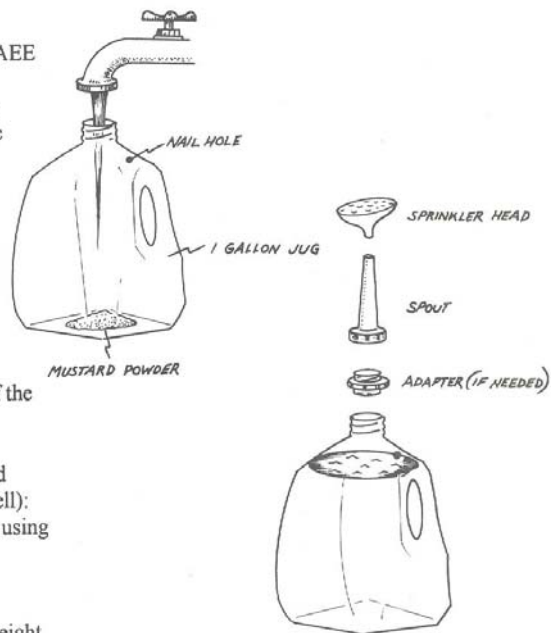
##### MATERIALS FOR PREPARING JUGS:

- 1 nail
- 1 funnel or rolled up piece of paper
- 1 tablespoon measuring spoon

##### ASSEMBLING THE SLURRY JUGS:

1. Make a small hole with a nail at the top of the handle to let air into jug as slurry is poured.
2. Put 2 T mustard into each film canister.
3. Immediately before using it, make mustard slurry (a large sink or outdoor faucet works well):
  - a. Add 2 T dry mustard powder to water jug using a funnel or rolled up sheet of paper.
  - b. Add 1 gallon of water.
  - c. Shake vigorously and cap.

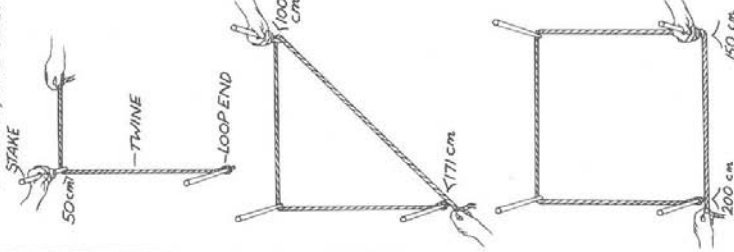
This makes a 0.33% solution of mustard by weight. Higher concentrations might harm the worms.



## Worm Worlds

### Action Card - MAKING YOUR QUADRAT

1. Choose a spot to sample in the habitat you want to study.
2. Create a quarter square meter quadrat using the twine and 4 stakes, like this:



a. Loop the twine on a stake and push it into the ground. Push the second stake into the ground at the 50 cm mark on the twine.

b. Gently place the third stake at the 100 cm mark and then bring the twine across the diagonal so that the special mark at 171 cm is at the first stake. Move the third stake so that it is precisely at the 100 cm mark and push it into the ground.

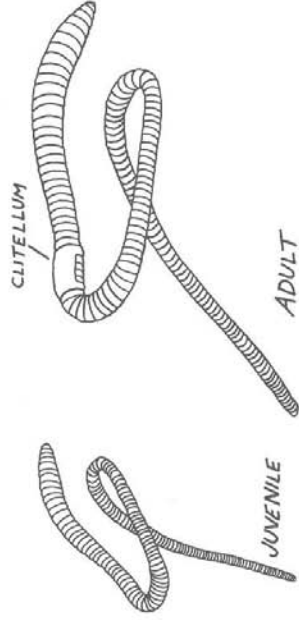
c. Place the fourth stake gently at the 150 cm mark and then complete the square by bringing the twine to the first stake at the 200 cm mark. Move the fourth stake so that it is precisely at the 150 cm mark and push it into the ground.

3. Remove everything loose from the soil surface. If the grass is not already quite short, clip it as close to the ground as possible so you'll be able to see even very small worms. Try not to disturb the soil itself.

## Worm Worlds

### Action Card - SAMPLING EARTHWORMS

1. Get ready by adding a little water (1/4") to the white basin, bowl or pan for rinsing and holding your worms.
2. Shake the slurry to make sure all the mustard is dissolved. Put on the sprinkler head.
3. Slowly pour all of the slurry onto the ground evenly within the quadrat. Go slow! Don't let the water run out of the quadrat. This should take 2-5 minutes.
4. Look for earthworms right away! Wait until the worms are all the way out of the ground, then carefully remove them from the quadrat and place them in the white bowl or basin.  
**CAUTION:** Do not try to remove earthworms until they are completely out of their holes—otherwise, they will pull back or hold on and will be impossible to get.
5. Count the worms and write the number on Record Sheet. You can count worms that you don't manage to pull out if you are careful not to count them twice.
6. Count the number of juvenile worms (clitellum absent - see drawing) and write it on the Record Sheet.



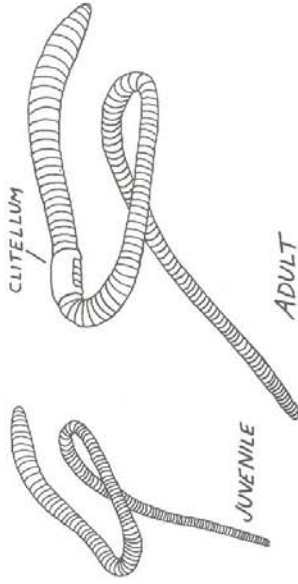
7. Fill out the other parts of the Record Sheet.
8. Return the worms to the quadrat when you're done.

# Worm Worlds RECORD SHEET

Team Members: \_\_\_\_\_ Time and Date: \_\_\_\_\_

**WORM COUNTS:**

	Habitat #1	Habitat #2
Number of all worms		
Number of juvenile worms		



**ENVIRONMENTAL FACTORS**

**Ground cover** (check all that apply):

dense grass	Habitat #1	Habitat #2
sparse grass		
wood chips or "hard mulch"		
dead leaves or other "soft mulch"		
none, bare ground		

**Soil** (check all that apply):

packed, hard to push in stakes, slurry went in slowly	Habitat #1	Habitat #2
loose, easy to push in stakes, slurry went in quickly		
dark in color, rich smell, much organic matter		
soil dry		
soil damp		
soil very wet		

**HABITAT** (check one):

bare ground	Habitat #1	Habitat #2
athletic field		
lawn		
garden bed		
shrub area		
tree area		
other, describe:		

**Other factors** (check all that apply):

bright, much sunlight	Habitat #1	Habitat #2
shaded, little sunlight		
ground very warm or hot		
ground cool or cold		
birds, other worm-eaters observed		
other, explain:		