Vermicomposting

in your classroom

Reduce, Reuse, Recycle

CITY of SPRINGFIELD

Department of Environmental Services

♻ printed on recycled paper
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INTRODUCTION

The City of Springfield Department of Environmental Services presents this guide in order to provide educators with the information and materials necessary to develop and maintain a vermicompost system in their classroom.

The City of Springfield utilizes an integrated approach to solid waste management providing multiple programs and services. This Integrated Solid Waste Management System (ISWMS) consists of these various components:

*__Curbside Recycling__ - Curbside recycling is the easiest, most convenient method of recycling. Simply set the recyclables curbside on your designated collection day. All licensed waste haulers offer this convenient service.

*__Household Chemical Collection Center__ - Springfield's Household Chemical Collection Center accepts household-generated chemical waste. This facility allows citizens to remain in their vehicle while technicians remove the items from their cars. Typically this can be accomplished in an average of five minutes or less.

*__Information and Education__ - This is an ongoing program that offers curriculum guides, presentations, brochures and other information including the Recycling Hotline.

__*Market Development__ - Ongoing efforts continue to develop new markets and to expand existing markets for recyclables.

__*Springfield Sanitary Landfill__ - Non-recyclable solid waste is taken here and disposal is monitored by sound landfill management.

__*Yardwaste Recycling Center__ - Yardwaste is composted and brush is chipped into landscaping mulch at this center. The facility is "one-stop-shopping" for your yard care needs. Drop off grass clippings, leaves, and limbs then take home some compost and wood mulch.

__*Recycling Centers__ - There are several convenient sites offered to Greene County residents where aluminum, tin/steel cans, plastics numbered 1 – 7, glass containers, cardboard, magazines, newspaper and mixed paper can be recycled..

Any one of these programs or services could not stand alone as the answer to the complex challenges facing today's municipal solid waste managers. Yet, when utilized as a part of the Integrated Solid Waste Management System, the combined effect on the reduction of our waste stream is significant. For more information, call the City of Springfield Recycling Hotline at 864-1904 or visit our website at www.springfieldmo.gov/recycling.

The revenue generated from tipping fees at the City Sanitary Landfill fund Springfield's Integrated Solid Waste Management System.

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WHY BOTHER WITH WORMS?

The idea of keeping worms in the classroom for composting food waste may seem like a science project, but it can be much, much more! Vermicomposting or vermiculture (composting with worms) in a classroom can be cross-curricular. Exercises using a worm bin and its lively inhabitants touch upon many of the Show-Me Performance and Knowledge Standards as well as adapt easily to all learning styles.

Activities utilizing vermiculture in the classroom could serve to meet "Show-Me Standards" performance within Goal 1 (1.1; 1.2; 1.5; 1.6; 1.8), Goal 2 (2.1; 2.3; 2.5), Goal 3 (3.1; 3.5; 3.6), as well as Goal 4 (4.1; 4.6).

With very few materials and a little bit of imagination, vermiculture in the classroom can enhance knowledge in communication arts (CA1; CA3; CA4; CA6), fine arts (FA1), mathematics (MA1; MA6), social studies (SS7), science (SC2; SC3; SC4; SC7; SC8), and even physical education (HP1; HP4).

From counting to measuring, graphing to drawing, singing to moving like a worm, listening to stories and writing them, worms in the classroom just may end up being something pulled out every day throughout the year – and not just for lunch leftovers *(which is still a very important reason to have them there in the first place).*

GOALS

1. The student will use inquiry to plan and conduct hands-on scientific investigations.

    ⇒ asks questions

    ⇒ makes predictions

    ⇒ observes, describes and classifies objects

    ⇒ employs simple tools and equipment

    ⇒ plans and conducts a simple investigation

    ⇒ gathers and records data accurately

2. The student will investigate matter and energy.

    ⇒ measurement (mass)

    ⇒ matter

3. The student will explore the interaction between organisms and the environment.

    ⇒ interaction between organisms and their environment

    ⇒ habitats

    ⇒ beneficial and harmful effects of humans on the environment

    ⇒ energy flow (food chains, food webs)

    ⇒ life cycles of organisms

4. The student will investigate the earth, its materials and natural processes.

    ⇒ properties of soils

    ⇒ natural resources

5. The student will recognize that science enables people to gain knowledge and create solutions to problems.

WHY SHOULD I COMPOST MY FOOD WASTE?

Worms promote a natural process of decomposition. Decomposition is the breakdown of material into a simpler substance. Their bodies are capable of converting this organic food waste into nutrient-rich compost material simply and naturally.

When food waste is thrown into landfills, this resource is wasted. Therefore, another reason to compost is to reduce the amount of waste that occupies space in landfills. Approximately 12% of our garbage is food waste. When organic material (material coming from living things) is buried in landfills, there is not enough oxygen to allow decomposition to occur.

Additionally, grinding food waste in garbage disposals produces organic waste and adds it to our wastewater. The garbage disposal waste in wastewater also produces more sludge at treatment facilities. This requires increased treatment by wastewater facilities including additional chemicals, the use of more fuel, energy and labor. Since food waste is so easily and naturally turned into high quality soil, it is a valuable resource.

While recently excavating landfills,
archeologists have found
hot dogs and lettuce
dating back to the 1960's that were
not decomposed.

Wildcat.arizona.edu

HOW DOES THIS REALLY WORK?

Soil is a very important natural resource because it is the basis for which vegetation and organisms grow and live, which, in turn, feeds humans and animals. Worms make tunnels in the ground, called burrows that allow rainwater and air to reach plant roots. This soil conditioning decreases the chance that the rainwater will erode the top soil. If the water is flowing into these burrows, less will be washed away.

As they burrow, earthworms take in organic material, pass it through their digestive system and deposit nutrient-rich soil. To help in the digestion of organic material, the earthworm uses stones in its gizzard that work to break down what was eaten. The material that leaves the earthworm's body is called castings.

WHAT ARE THE PHYSICAL CHARACTERISTICS OF A WORM?

Worms have soft bodies with no bones, legs or arms. They are an invertebrate, which means they have no backbone. Worms do not have eyes, ears or teeth. Their mouths are very muscular so that food can be easily swallowed and it is an opening located on their first segment. However, without teeth, they must eat food small enough to "suck" into their mouths.

The worms are made of rings and grooves called segments. Each of these segments has bristles called setae that help the worm move. There is a large swollen band around the worm called clitellum. (see "How do Worms Reproduce?" for more details on the clitellum.)

WHAT CONDITIONS DO WORMS NEED?

Temperature

It is very important not to let the worms freeze. The vermicomposting project works most efficiently at temperatures between 55-77 degrees F. If temperatures get beyond 84 degrees F, it could also be detrimental to the worms. Therefore, it is important to control the temperature by proper placement of the vermin-bin to keep conditions favorable.

Moisture

Worms require a moist environment. Since worms breathe through their skin, it is important that moisture be present to ensure proper air flow. Worm bodies consist of 75% water. Therefore, we must keep a moist climate in the bin by maintaining about 75% water content in the bedding. When you see a dead worm on a hot sidewalk in the summer, the worm's moisture content has dropped below 75%. However, it is also imperative that you do not water them too much. This could result in flooding and cause the worms to drown. We should remember to keep the

bin moist, not soaked. Ideally, the bin should rarely have to be watered. As the food waste decomposes, adequate moisture is generated naturally. However, if the bin is, for instance, placed in direct sunlight or near a heating register, these natural conditions will be altered. Properly moistened bedding in the vermin-bin should feel like a damp sponge.

Oxygen

Worms breathe in oxygen and produce carbon dioxide. Worms do not have lungs, but breathe through their skin. Proper moisture and oxygen flow is needed so that the worms can breathe. Allowing for the flow of oxygen in the bin is crucial to the success of vermicompost. Oxygen is needed to keep the worms alive so that they can do their job. To assure adequate oxygen flow, proper bedding (loose, fluffy shredded paper) and sufficient ventilation (see "How to Construct a Vermicomposting Bin") are two critical considerations.

Light

Although worms do not have eyes, they are light sensitive and prefer dark places. This is why they stay in soil or bedding or under logs, to avoid light.

WHAT DO I FEED THE WORMS?

A worm's favorite food is coffee grounds. Coffee grounds are small enough that worms can easily eat and digest them. However, any organic waste can be given to the worms. Potato peels, lettuce, celery ends, spaghetti, orange peel rind, banana peel, bread crust and dry oatmeal are a few foods that can go into the worm bin. (If you have questions on other specific items, please refer to additional resource materials). Tea, tea bags and coffee still in the filter can be added to the bin. This is because the filters are organic material; they are made from paper. Meat, dairy and oils should not be put into the bin.

HOW MUCH DO I FEED THE WORMS?

The general rule of food ratio is 2:1 (worms to food). For example one pound of worms will eat approximately one-half pound of food. You will however become familiar to the eating habits of your worms and adjust feeding appropriately. They do not require daily feeding. Feeding the worms too much may result in excessive bin moisture. Should this occur, simply add more bedding until it is absorbed.

HOW DO I DELIVER THE FOOD?

For classroom feeding, the recommendation is to number the four corners, (1, 2, 3, 4), to represent Monday thru Thursday. The center of the bin will represent Friday. This number system will help in identifying feeding history. Should a feeding be missed, do not panic, worms will chew on the bedding. They easily can be fed a minimum of twice weekly.

Food is to be presented to the worms by lifting the bedding, near the selected corner or center location, and burying the food approximately two inches below the surface. Food should always be covered to prevent fruit flies.

For a classroom bin, there are a few precautions:

1. Do not feed the worms citrus fruits. This could cause fruit flies, unwanted pests and offensive odors.

2. For purposes of this project, use only leftover food from the cafeteria serving line. This would be the food that has been prepared but never served. Do not allow food that has come into contact with human hands or mouth to be fed to the worms.

3. Use rubber or nitrile type gloves (no cloth gloves) when feeding the worms or handling the compost.

4. ALWAYS wash hands after feeding the worms or handling the compost.

Responsibility!

If the students are required to feed and care for the worms they learn to appreciate that the worms are living, breathing creatures. The worms must have their needs met in order to survive. Students also become aware of how important worms are to our environment. This is why when worms are brought into the classroom, student responsibility for their well-being is imperative.

ADDITIONAL INTERESTING NOTES

- Our classroom bins, available for checkout, are specifically designed for vermicomposting, therefore they will not have drilled holes on the bottom and sides. Notice the apples on the upper sides and top, these serve as ventilation.

- Since there are no drain holes with this bin design, should the bedding become too wet, simply add more bedding until it is absorbed to proper moisture.

- If the bedding remains wet too long, white mites may develop. Should this occur, consider the type and amount of food that has been fed to the worms. Foods with considerable water content should be held off for awhile. Also consider reducing the amount of food offered to the worms. It may also help to place toilet paper tubes or sheets of newspaper in the bin to absorb excess moisture, change these daily until you see the mite population diminish.

- The typical duration for worms to digest and turn over food scraps and bedding into soil is approximately four to six months. You will however be able to follow the progress and witness the transformational process.

- Worms, like humans, prefer familiar surroundings and when they are placed into their new bin, they will wander searching for what feels like home. Therefore, the first week you have worms in their new bin; a light source should be kept on near the bin throughout the night to condition them to remain in the dark surroundings. If the entire room is dark the worms may escape and wander at first until they are accustomed to their new home.

GETTING TO KNOW YOUR WORMS

ACTIVITY: Before any discussion of the worms, have the students get into pairs. Give each group two worms. Have the students get a damp paper towel and a dry paper towel and lay them side by side. Place a worm on each towel. Give the students magnifying glasses and have them observe and discuss the following:

1. Which towel do the worms prefer? What does this tell us about the kind of environment they need?

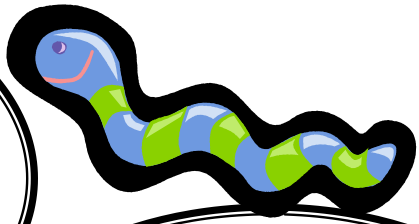
2. Draw a diagram of the worm and label: front, back, segments, clitellum

3. What does the worm's skin feel like?

4. How can you tell which is the front-end and which is the back?

Learning Extension:

Have students create an obstacle for the worms to work through. Students can show their obstacles and tell how their worms reacted.



Learning Extension:

Have the students write a short story, from the worm's point of view, based on what they have observed about the physical characteristics and preferences.

HOW DO WORMS REPRODUCE?

The reproductive system of a worm is very fascinating. Worms are both male and female. This means that they produce both eggs and sperm. If the worm has a large swollen band, this is indicative of a mature worm. This large, swollen area is called the clitellum. The clitellum produces mucus that allows for two worms to join. Once joined, the worms pass sperm from each other to a sperm storage sac. After they detach and a few days later, a cocoon begins to form on the clitellum. The worm then backs out of this hardened cocoon and during this process, deposits sperm and eggs into the cocoon to be fertilized. Cocoons look much like a small grain of rice. It is at least three weeks before any of the several babies hatch. Although each cocoon has potential to hatch 20 fertilized eggs, most cocoons only hatch two to three. Worms usually live about a year. However, because of the fast rate in which they reproduce, there is no fear of a limited worm population.

LIGHT OR **DARK**?

ACTIVITY: Have the students get into groups and construct some sort of "tent" (for instance, two small boxes with a piece of paper or cloth draped over the top). Give each group a flashlight and a few worms. The students are to decide if worms like dark areas or lighted areas by shining the flashlight on them and seeing where they go, in the tent or toward the light? Have the students guess (hypothesize) what they think will happen, and then test their hypothesis.

A little more light fun ……

Give each group two different jars each with a different type of soil in them (i.e. sand, potting soil, etc.). Have the students put a few worms in each jar and observe the following:

1. Do they go into the soil or stay on top of the soil?
2. Which soil do they seem to prefer?

*This would be a good time to introduce the term **burrowing**. Have students observe if this action takes place in their jars.*

ADDITIONAL CROSS-CURRICULAR SUGGESTIONS

Mathematics/Science

1. Students gather, measure and record all material fed to the worms.

2. Students record observations such as; food preferences, percent of food consumed, changes in worms etc.

3. Students extend their measurement findings by calculating averages of worm population, worm growth, weight of enriched soil produced by worms, creating growth graphs and charts etc.

4. Students conduct experiments to determine sensitivity to light by placing colored cellophane over flashlights to observe how the worms respond. Colors could include: Blue, Red, Green and Clear.

Language Arts

5. Have students write an anthology of poems about worms incorporating facts learned about the worms

6. Have the students create a story (from a worm's point of view) about life in a worm bin.

Literature Connection

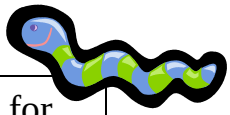
Wonderful Worms by Linda Glaser

Worm's Eye View by Kipchak Johnson

The Magic School Bus Inside the Earth by Joanne Cole

Diary of a Worm by Doreen Cronin

HOW TO CONTRUCT A VERMICOMPOSTING BIN



The vermicomposting project is very versatile. The directions for constructing the bin can be used for a classroom bin or a home bin. The following pages are designed so they can be used as a separate document from this guide. This enables teachers to copy it for any interested parents, colleagues, etc.

When building the bin, there are precautions that should be taken.

1. Wear Safety Goggles

2. Be aware of the drill. Keep hands, arms, etc. away from an active drill.

3. When children are doing the constructing, make sure there is an adult to assist them with the equipment.

How to Construct a Vermicomposting Bin

Step 1:

*The first step of construction is to select **two**, 8-10 gallon, plastic storage containers. (Dark and not see-thru)*

Step 2

*Number the corners of **both** bins to designate feeding cells or areas.*
This will allow rotation of the feeding areas and tracking of optimum feeding rates.
Number the corners; 1, 2, 3, 4 and the center will represent day 5

Step 3

*Drill twenty evenly spaced ¼" drain holes in the bottom of **each** bin*

Step 4

*Drill 1/16" ventilation holes approximately 1 – 1 ½" apart around the top of **each** bin*

Step 5

*Drill approximately 30, 1/16 ventilation holes in the top of **one** lid.*

Step 6

*Prepare the bedding with approximately 3-5 pounds of shredded paper or newspaper in **one** bin only. Use a spray bottle to moisten bedding. Work and fluff the paper, while spraying, until the moisture level makes the paper feel like that of a wrung-out wet sponge.*

Step 7

The completed bin!
Place bin with bedding inside of the other, to allow for ventilation, raise the bin assembly by inverting four plastic cups or using blocks. Use the second lid, without holes as the capture tray at bottom.

Once the upper bin is completed and turned into compost, switch positions of the two bins, place new bedding in the "new" upper bin and start the feeding process. Worms will eventually follow the food and crawl from the lower bin, thru the ventilation holes on the bottom to the food source above. Once all worms have migrated to the new bin, proceed to remove and use the compost from the first bin. (Return the bin back to the lower position and the process repeats)

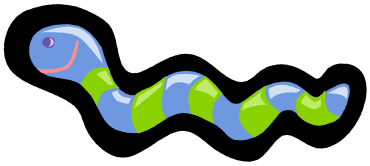
CLASSROOM VERMICOMPOSTING LOG SHEETS

Set up date _____

Initial weight of worms _____

Type of bedding _____

Number of cells in bin _____



Date	Day	Cell #	Ounces food added	Total # oz. to date	Ounces water added	What did you feed the worms?

Date	Day	Cell #	Ounces food added	Total # oz. to date	Ounces water added	What did you feed the worms?

WHEN I'M READY TO EMPTY MY BIN…

When you are ready to discontinue the project, you may want to stop or decrease the amount of food you are feeding the worms about 30 to 40 days before you plan to empty the bin. This will allow the worms to decompose the bedding. The worms and the end product, nutrient-rich compost, can then be used as a fertilizer or amendment for plants, areas around trees, etc. The class can decide the most appropriate placement for the worms and compost by using their knowledge of the worms' habitat preferences and needs. The soil should be well drained and loose when released into the selected area. If no suitable area is available, call the City of Springfield's Recycling Hotline at 864-1904 and an appropriate home will be found. You may keep the bin and accessories to be cleaned and prepared for the next group of students.

GLOSSARY

Bedding	moisture retaining medium, such as shredded paper, used to house worms
Burrow	a tunnel made in the ground by worms
Clitellum	the swollen region of a worm where the cocoon is formed
Decompose	to break down into a simpler substance
Organic	coming from living organisms
Segment	one of many rings and grooves that make up the worm's body
Setae	bristles on the segments of a worm that aid in worm movement
Vermicomposting	to compost with the help of worms
Worm Castings	material deposited from a worm's anus
Sludge	solids created during treatment of wastewater

SOURCES

Worms Eat My Garbage by Mary Applehof

Earthworms, Underground Farmers by Patricia Lauber

Break It Down! The Compost Connection by Missouri Department of Natural Resources

Washington State University Extension, Whatcom County

City of Springfield
Integrated Solid Waste Management System

Curbside Recycling
(provided by private haulers)
Household Chemical Collection Center
Information and Education Program
Springfield Sanitary Landfill
Market Development
Recycling Centers
Yardwaste Recycling Center

Programs and activities of the Integrated Solid Waste Management System are funded by the tipping fees generated at the Springfield Sanitary Landfill.

City of Springfield
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Environmental Resource Center
290 E. Central St.
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Recycling Hotline 864-1904
www.springfieldmo.gov/recycling
www.OzarksEnvironment.com

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