WORMS ARE NATURE'S RECYCLERS

By Penny Pawl, UC Master Gardener of Napa County

WORM COMPOSTING

Worm composting (or vermicomposting) is a natural and efficient way to "recycle" your organic kitchen waste. Even in cool winter weather where outdoor compost piles lie dormant, you can compost your food scraps indoors with worms, and reduce the volume of your household garbage by as much as 25%. The end result is worm compost, unsurpassed as an organic soil builder and plant fertilizer. Worms will compose 90% of all the materials given to them.

BENEFITS

- Worm compost contains 5 times more nutrients than regular garden soil.
- Saves you money by lowering garbage bills and replacing store bought soil conditioners.
- Helps garden and house plants by improving the soil fertility and health of your soil.
- Benefits the environment by recycling valuable organic resources and extending the life of our landfills.

GETTING STARTED

To get started you will need a worm bin, bedding materials, water, food scraps and a crew of hungry red wiggler worms.

CHOOSE A BIN

Buy a bin, or build one out of wood, plastic, an old dresser drawer, shipping crate or barrel. Make ¼" holes in the sides and bottom of the bin so that air can circulate. Worms breathe through their moist skin. You may also use a large compost bin for outdoor composts. Your bin should be at least 10 to 16 inches deep. Because red worms are surface feeders, deep bins are not necessary. The rule of thumb for bin size is two square feet of bin surface area per person in your household. A 2' x 2' worm bin would handle the kitchen waste from an average two person household.

LOCATION FOR THE BIN

Locate your bin where it will not freeze or overheat; in a pantry, kitchen corner, laundry room, garage, basement, patio, deck or in your garden. During the cold winter months it should be out of the rain or covered with a tarp.

MAKE A WORM BED

Worms like to live under lots of damp paper and/or leaves. This helps keep them cool and moist, gives them fiber to eat and prevents fruit flies from getting to their food. To prepare bedding tear black and white newspaper into 1" strips, mix with equal parts of dry leaves and soak them in water. Wring out and let drip until they are as moist as a damp wrung out sponge. Other items which may be added to basic bedding are shredded, corrugated cardboard, compost, sawdust and straw. You may also sprinkle bedding with a few handfuls of soil or composted chicken manure. Do not use glossy newspaper or magazines.

FEED THE FIRST MEAL

Begin feeding your worms only a little at a time. As they multiply, you can add larger quantities of food wastes. Bury the kitchen wastes into the bedding regularly, rotating around the bin as you go. When you return to the first spot, most of the food you buried there should have been eaten. If not, just feed the worms less for awhile. Under proper conditions, two pounds of worms will process (eat) about seven pounds of kitchen scraps per week.

MAINTAINING YOUR WORM BED

FEED YOUR WORMS about a quarter (one pound) of fresh food scraps per square foot of surface area in your bin per week. To avoid fruit flies and odors, always bury food under bedding.
ADD FRESH BEDDING every 1-3 months. Always keep a 4" to 6" layer of fresh bedding over worms and food in your bin.
KEEP BEDDING SLIGHTLY MOIST as moist as a wrung out sponge. In a plastic bin, add dry bedding to absorb excess moisture. Wooden bins may require adding water occasionally.

HARVESTING WORM COMPOST

After a few months, you will notice that the bedding has been eaten. Used-up worm bedding is called worm compost or worm castings. This drops to the bottom of the container. You can begin harvesting the compost, which will look like rich, dark soil. Harvesting the compost and adding fresh bedding at least twice a year is really necessary to help keep your worms healthy. Here's how to harvest the finished compost and return your worms to the bin.
Using hardware screening, put the finished compost on it and place it on top of new bedding. Place the bin under a bright light or in the sunlight. Worms are light sensitive and will move down into the lower bedding. Pick out any wigglers or worm eggs and return them to the bin. If you plan to use the compost immediately, you do not need to dry it. However if you plan to store and use later, be sure to dry it so it will not mold.

Another method is to push the decomposed material to one side of the bin and fill the other side with new, moist bedding and fresh kitchen scraps. After a few days, the worms will move to the freshly filled side of the bin.

DO'S AND DON'TS IN WORM COMPOSTING

Worms are vegetarians who eat decaying plant material. Your kitchen scraps of vegetables, fruit, egg shells, coffee grounds, tea bags, clean paper towels, dead flowers and the manure of grain eating animals is the perfect diet. They do not eat seeds, cat and dog feces, meat, bones, and dairy products. If your delicious casserole was made with milk or cheese, the worms won't eat. Also, the smaller the food scraps the faster the worm will decompose them.

TROUBLESHOOTING

If your bin starts to smell, is too wet or there are many fruit flies then you need to correct this problem. Do not feed the worms; make fresh bedding and put it on top of the older bedding. Leave the bin for 2 weeks before you feed again.

USING YOUR COMPOST

After you harvest your worm bin and have nice compost, either wet or dry, you can begin to use it in many ways. You can add it to seed starter mix to give an extra boost to new seedlings. It can be dissolved in water with air and make a nice tea to feed your plants; it can be spread around your garden in a thin layer and then watered in. If you decide to store the compost, it should be dried first and kept in a container.

Additional Reading:

Rapid Composting Method, 1991, UC ANR Publication #21251.
Compost Production & Utilization, a Grower's Guide, 1995, UC ANR Publication #21514.
Backyard Composting, 1992 Harmonius Technologies, Harmonius Press, Ojai, CA., 96 pp.
Worms Eat My Garbage, 1982, Mary Appelhof, Flower Press, Kalamazoo, MI., 100 pp.
Let It Rot! The Home Gardener's Guide to Composting, 1975, Stu Campbell, Garden Way Publishing, Pownal, VT.
Organic Soil Amendments & Fertilizers, 1992, UC ANR Publication #21505

Web sites:

http://www.wikihow.com/Make-Your-Own-Worm-Compost-System
http://wormwoman.com/acatalog/index.html
http://dnr.wi.gov/org/caer/ce/eek/earth/recycle/compost2.htm
http://projectcompost.ucdavis.edu

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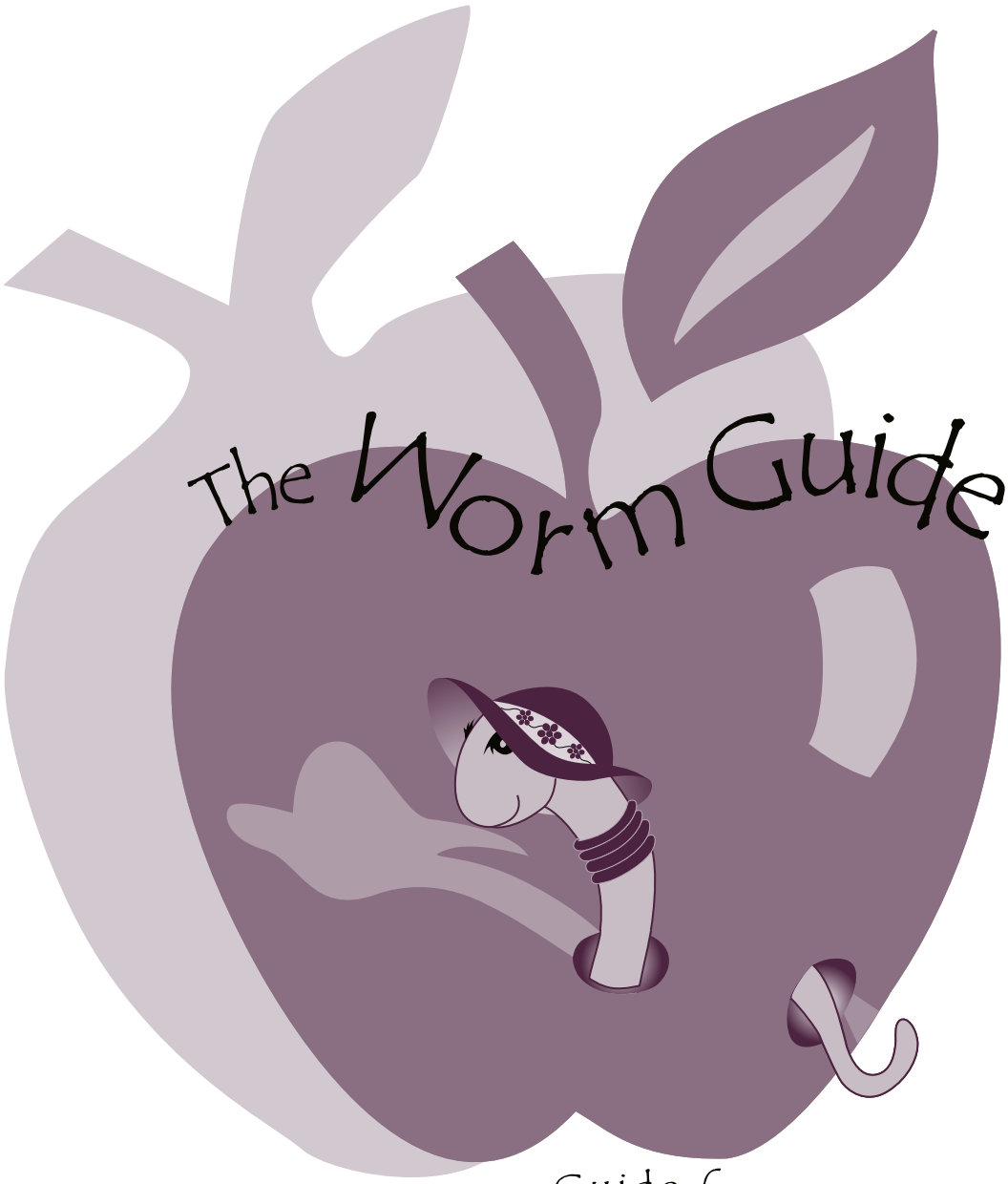

A Vermicomposting Guide for Teachers

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For additional copies of this publication, contact the California Integrated Waste Management Board (CIWMB), Office of Education and the Environment, at (916) 341-6769. You can download the entire guide from our website at www.ciwmb.ca.gov/Schools/Curriculum/Worms/.

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No worms were injured in the preparation of this guide.

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In addtion, this guide showcases a few ways to start and maintain a worm bin, but there are more options in vermicomposting than are included in this document.

The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption. For a list of simple ways you can reduce demand and cut your energy costs, Flex Your Power and visit www.consumerenergycenter.org/flex/index.html.

Mission

The mission of the California Integrated Waste Management Board (CIWMB) is to reduce the generation and improve the management of solid waste in California in order to conserve resources, develop sustainable recycling markets, and protect public health and safety and the environment. We do this in partnership with public agencies, industry, business, and the public we serve.

In pursuing the above mission, CIWMB promotes the utilization of recovered materials (materials that would otherwise have been discarded, such as paper or aluminum cans). Vermicomposting deals with one recovered material in particular: food waste.

Assistance

The CIWMB has representatives to assist schools with a variety of issues including vermicomposting, school reuse and recycling programs, and environmental curricula that focus on resource conservation and waste management.

If you are interested in recycling information or would like to start a school waste diversion program, please contact the CIWMB's Office of Local Assistance at (916) 341-6199. For education resources our Office of Education and the Environment can help you (contact information is below).

To contact the CIWMB's Office of Education and the Environment, call us at (916) 341-6769, or write to us at CIWMB / Office of Education and the Environment, Mail Stop #14-A / P.O. Box 4025 / Sacramento, California 95812-4025. We also encourage you to visit our website at www.ciwmb.ca.gov/Schools/ for more information about our programs.

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Integrated Waste Management

At the very heart of waste management is the integrated waste management hierarchy—reduce, reuse, and recycle. Many people have added a fourth component to the hierarchy—rot—in order to further eliminate waste from entering the landfill. The first, and most preferred, option is to **reduce** what you use. Buy items with less packaging, and only buy what you need. That's easy! When you reduce, you save landfill space, valuable agricultural land, natural resources, and money.

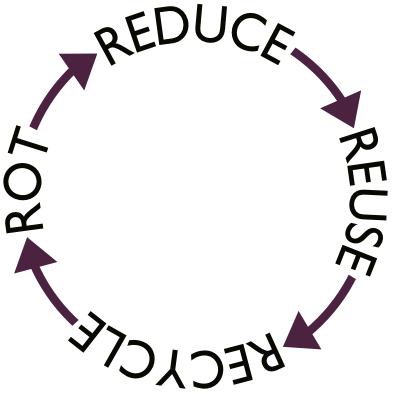
The second option is to **reuse** an item that you no longer use or want. The saying "One person's trash is another person's treasure" is true! Take items that are in good shape to a secondhand store or to other reuse organizations for someone else to use. If you have large quantities of items, you may want to place a free ad on CalMAX, a statewide material exchange program listing wanted or available goods (included in Appendix C). Many items destined for the landfill can easily be repaired or combined with other materials to make new, functional products.

Most of us are familiar with the concept of recycling, but as the third option in the hierarchy, **recycle** is less preferred than reducing and reusing. When materials are recycled, energy and resources are still expended, whereas with the first two options, they would not be. The good news is that when manufacturers use recycled materials to make a new product, they often use fewer natural resources and less energy than if they had used virgin materials. Recycling materials is definitely a better choice than sending them to the landfill. To support recycling efforts, buy back the materials you recycle by purchasing recycled-content products.

Rot refers to recycling food waste and other organic materials through composting or vermicomposting. In vermicomposting, worms do the "dirty work." The organic materials decompose and are transformed into a nutrient-rich material that can be used-or, in this case, "reused"-as soil amendments and fertilizer. Your plants will thank you!

By reducing, you decrease waste from the start. By reusing, recycling, and allowing food waste to rot into compost, you cycle materials back for another round of use instead of sending them on a one-way road to the landfill. Your solid "waste" has remained a resource.

Integrated Waste Management Hierarchy



Californians throw away more than 5 million tons of food waste each year! In fact, over 30 percent of California's waste stream consists of compostable organic materials such as wood scraps, yard waste, and food waste.

It is to our advantage to keep these materials out of our landfills, thus saving space and allowing these materials to be reused for other purposes. For example, many waste management facilities utilize organic materials that have been disposed of by turning it into compost. This concept can also be applied on a much smaller scale by composting food waste at school with the help of worms. Using worms to compost helps students understand the process of composting and their role in reducing food waste at their school.

Basics of Vermicomposting

Vermicomposting is the process of using worms ("vermi" is Latin for "worm") to process organic food waste into nutrient-rich soil. Worms eat decaying food waste and produce vermicompost, a very effective soil amendment.

Worm poop is the best compost! It is full of beneficial microbes and nutrients, and is a great plant fertilizer. Let's just use the fancy name for worm poop—"castings"—as we discover how you can teach your students about waste management by using worms.

As an educator, you are faced with the challenge of teaching various concepts to your students, like natural cycles and nutrition, while making it fun and interactive. If there is a compost pile at your school, you can teach these concepts in a visual, hands-on manner. If your school has a garden, you can take the lessons a step further. But, how can you take a hands-on approach to teaching cycles and nutrition if you don't have either of these? The answer is both easy and fun-make a classroom worm bin! Since a worm bin represents a small ecosystem, it is a unique teaching tool for you and an interesting way of learning for your students.

So, push up your sleeves and get ready to make some tiny new friends. Your worms will be the most quiet, well-behaved "pets" you have ever had!

Bin

Home Sweet Home

First thing's first. You need a bin! In selecting the right worm bin for your needs, you must first decide how much food waste you want processed and where you plan to store the bin. There are numerous sizes of bins to select from, and they can range from a small shoebox size to a large worm bin "estate."(Detailed bin assembly instructions are in Appendix D.)

For a classroom worm bin, a small storage container or a medium-size 12-gallon storage tub will do just fine. To process cafeteria food waste, you will need a much larger bin, which should probably be kept outside. Administrators, food service staff, and school grounds staff should all offer input on exactly how large an outdoor bin they are willing to help maintain. It may be best to start small and expand once you have the hang of it.

The options of materials you can use to make a worm bin are only limited by your imagination. Building your own bin allows more flexibility in size and appearance of the bin. It also gives you the opportunity to decorate! There may be a reuse center near you (check Appendix C) where you can buy inexpensive tile, paint, lumber, and many other unique items. Scrap lumber is fairly easy to come by and can be cut to size to build the bin. Wood pallets may be available free from your local grocery or hardware store to make an outside bin. Cinder blocks can also be stacked to form a bin with a piece of plywood used as a lid.

For an easy-to-make bin, use a plastic storage tub. Availability and types of tubs differ from store to store. The best times to find these storage tubs are at the beginning of the school year and during the December holiday season. From this point forward, a "standard bin" will refer to a 12-gallon bin or one that is approximately 21 inches long, 15 inches wide, and 12 inches high.

Whichever size or type of worm bin you choose, there are a few details that must always be considered:

• **Location! Location! Location!** If you plan to keep your bin outside, make sure it is in a place that will not get too hot or too cold. Your worms will be most productive in temperatures between 55° and 77°F. Extreme temperatures below or above this range may be harmful to your worms, so take this into consideration when deciding where you will keep your bin. Generally speaking, your bin will be okay on a patio next to your classroom during the winter months. The bin should be kept in a shady, cool area during the summer months, or brought inside. Kitchens are a convenient place to keep worm bins. Do not place your bin in direct sunlight.

• **Don't forget to breathe!** Using a 1/4- to 1/2-inch drill bit, drill several holes throughout the bottom of the bin to allow for proper airflow. These holes will allow for ventilation and drainage. The worms will stay in the bin because they prefer dark, moist places to dry, lighted places. Vermicomposting is an aerobic activity, needing oxygen. If your bin becomes anaerobic due to insufficient airflow, you will most likely develop an odor problem.

• **Standing on four feet.** "Feet" are also used to prop up the bin for drainage and ventilation. Small wooden blocks or plastic soda-pop bottle lids perform this function well. You will need four of whichever item you choose. Secure each foot 2 to 3 inches from each corner of the bottom of your bin. If you use screws or nails to attach the feet, make sure they are short enough so they will not poke any fingers.

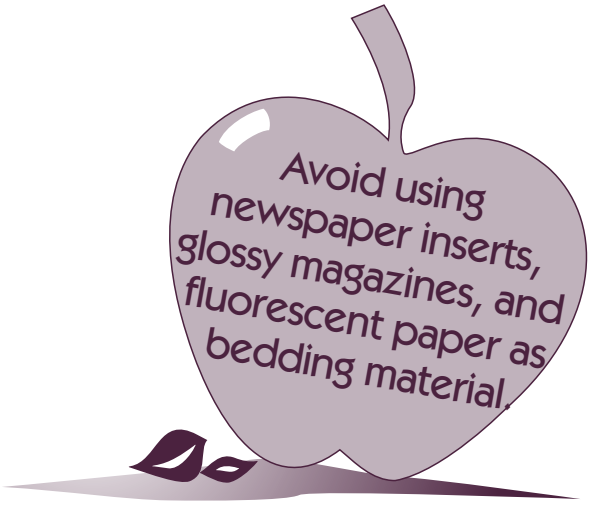
• **Worm Tea.** Place a tray underneath your bin to collect any drainage ("worm tea"). Aluminum oven pans work well and can be purchased inexpensively at your local grocery or discount store. Cafeteria trays also work. If you do not have a tray, you can use a couple of paper grocery bags or a piece of cardboard instead and replace them periodically, placing them into the bin as additional bedding. Any worm tea that may drain from your bin is very nutrient-rich and your houseplants and garden will love it!

• **It's too bright; keep out the light!** Red worms have no eyes and cannot see. They use light-sensitive skin cells concentrated at the front end of their bodies to sense light and move away from it. Choose a bin made of material that is not transparent. Keep a lid on your bin to prevent any light from entering. Your worms will feed on the surface and stay active. If you can only find a transparent bin, improvise by lining the outside of the bin with dark paper to keep any light out.

Bedding

Comfort Piled High

After a long day at work, it's nice to lie down on a comfortable bed, right? That's right! Your worms will agree.



They need bedding inside their bin to keep them comfortable and feeling safe. As always, there are many options for bedding material. One option is peat moss, which can be purchased at any local nursery, but must be leached or it will be too acidic for the worms. Other types of bedding include office paper, coconut fiber, or shredded cardboard or newspaper. When using some of these materials for bedding, you have the opportunity to apply the concept of reuse, instead of discarding the materials. In this guide we will use hand-shredded newspaper because it's easy to obtain and can cost nothing.

The one property the bedding material must have is the ability to absorb water. Worms need a moist environment—their bodies consist of 75 to 90 percent water. Moist bedding allows your worms to stay comfortable and maintain the moisture content inside their bodies. If you notice the contents of the bin tend to dry out, you may want to keep a squirt bottle filled with water near your bin and spray the contents as needed.

To prepare the bedding, collect a small stack of newspaper. Unfold and shred the newspaper into one-inch strips until the bin is approximately two-thirds full. Fluff the newspaper strips to avoid thick clumps. Initially, add several cups of water. Continue to add water and "stir" until all the newspaper strips are thoroughly moist and your bedding material feels like a wrung-out sponge-this is about a 3:1 ratio of water to bedding by weight. Be sure the bedding is not soupy or too dry because these extreme environments will serve as an eviction notice to your worms and they will start looking elsewhere for a new home. The bedding also serves as a medium in which to bury the food waste and prevent odors. Use your hands to "fluff" the bedding so your worms can move around and air can circulate freely. Now your bin is ready for worms!

Worms

Red Wigglers

You may have already noticed that worms have a lot of special requests. That is because we will be using a special type of worm—Eisenia foetida, otherwise known as "red worms," "manure worms," or "red wigglers." These worms are the perfect candidates to inhabit a worm bin, as their main goal in life is to eat decomposing organic matter. Red worms eat organic matter in mass quantities-up to their own weight each day.

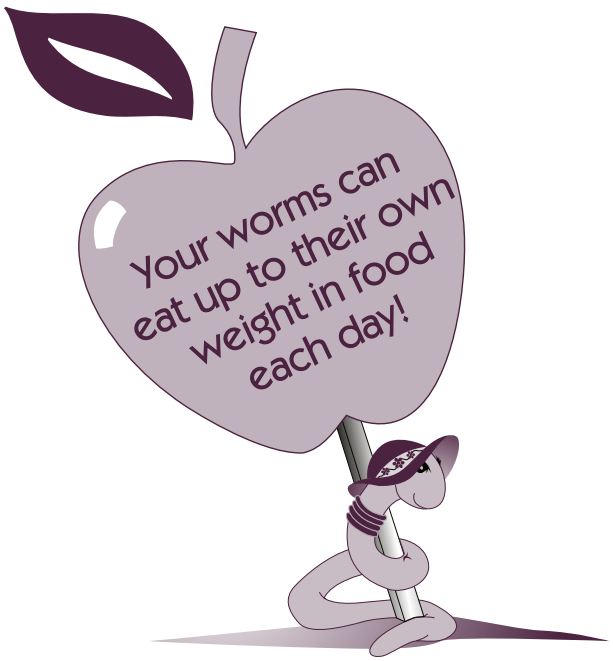
Don't mistake these little creatures for "night crawlers," as red worms and night crawlers are two totally different worm species requiring distinctive environments. Night crawlers need a large area in which to burrow; they are "deep dwellers" that aerate the soil by making tunnels. Red worms, on the other hand, live close to the surface of the soil and do not need a lot of space to burrow. Each worm species will not be happy in the other's environment, and may even die.

For the standard bin, we recommend starting with one pound of worms, equal to about 1,000 of the little wigglers!

You can start with fewer worms, but the quantity of food you initially add to your bin will need to be decreased. Worms in your yard, garden, and compost pile may be red worms, but it's not likely. Just to be safe, get your red worms from a friend who already has a worm bin or purchase them from a local worm grower. (See www.ciwmb.ca.gov/Schools/Curriculum/Worms/ for a complete listing of worm suppliers.)

Place your worms on the bedding you have prepared and watch them burrow away from the light, down into the newspaper. They should "disappear" in 5 to 10 minutes. If you are building a bin with your class, this may be an interesting feature for your students to witness.

A healthy worm bin should be able to supply enough worms to get another bin started, but wait a few months before you attempt to share worms from your new bin. After you divide the worms, both bins will eventually reach an optimal population level. Red worms also have the amazing ability to control their population growth, which means you don't need to worry about a massive worm population boom! Unless you have a major "tragedy," you probably won't need to replenish the amount of worms in your bin.



Feeding

Feed Me!

Worms are not picky when it comes to food, as they eat many of the same items you do. They especially enjoy vegetable and fruit peelings, grains, coffee grounds and filters, newspaper, and anything else that is organic.

Although worms eat fruit, be sure not to overload your bin with a high citrus diet. For example, if you are making a large amount of freshly squeezed orange juice, all of the remaining orange peels can introduce a toxic amount of d-limonene, a chemical that occurs naturally in citrus and other plants, into your bin. D-limonene is released as the peels are torn and broken down. So, you wouldn't want to pulverize the peels before adding them to your bin, as this would create a high d-limonene concentration. Due to the slow decomposition rate of citrus peels, however, it is okay to add small to moderate amounts to an established bin. If you add citrus peels to your bin and it begins to smell like a moldy fruit stand, then you may want to save it for a future feeding.

Worms do not have teeth! They have a gizzard, similar to birds, that helps them grind small bits of food. Adding ground-up eggshells, oyster shell "flour," or a handful of gritty soil to your bin will help your worms with this process. Other organisms you will find in your bin, like springtails and mold, assist worms by breaking down the food waste first. Some foods take longer to break down because they are more fibrous, such as broccoli stocks, carrots, and potato peels. Some people like to puree their food waste first, thus allowing the worms to eat more quickly and process even more food. Worms in a standard bin can eat about a pound of food a day.

Contrary to popular belief, worms are not vegetarians. They will eat meat if you let them. However, we advise that you not add any meat, dairy, or oily foods because they form strong odors as they decompose, which attract undesirable visitors, such as mice and rats, to your bin. These critters may carry disease that you do not want to pass on to your garden or yourself! A word of caution: If allowed to, your worms will eventually clean meat bones so well that the bones' sharp edges would be a hazard to anyone burying food or harvesting castings from the bin (see "Harvesting" section).

Place the following in a worm bin:

- Shredded paper products
- Fruit and vegetable trimmings
- Grains, beans, or breads (without butter, margarine, or mayonnaise)
- Egg shells
- Fallen leaves
- Tea bags
- Coffee grounds and filters
- Lawn clippings and weeds

Do not place the following in a worm bin:

- Meat products
- Dairy products
- Oily products

Do not begin feeding your worms immediately after you introduce them to their new home. Give them a few days to a week to acclimate to the bin environment. At this point, their appetites will be in full force. In the meantime, reuse an old sour cream container or margarine tub to save your food waste for future feedings. (However, if you have asthma or allergies, feed the worms right away instead of storing food waste in a container, as mold spores will quickly result.)

Bury the food at least one inch deep to prevent odors and unwanted critters. Simply lift a bit of bedding, add the food, and put the bedding back into place. You can randomly pick spots to bury food, or set up a "quadrant" system. This system allows you to closely monitor the amount of food your worms are eating and also allows your students to practice fractions. Here's how it works:

Quadrants

1	2
4	3

The first time you bury food, bury it in quadrant 1. The next time you feed, a day or two later, bury in quadrant 2. Your worms will follow the food. Continue this pattern until you are ready to bury in the first quadrant again. If there is still food in quadrant 1, you are feeding your worms too much or too often. Give them a few days to eat what is already there and then start the process again, feeding them less food or less often. If your worms have already eaten through the food placed in quadrant 3 when you are ready to feed in quadrant 1 again, you may want to feed them more food or more often.

Your students can keep track of the feeding schedule by placing a laminated copy of your quadrant layout (like the diagram above) near the bin. Have your students use a nontoxic dry-erase marker to cross out each quadrant as they place food in it. You can also write the date of feeding for journal and record-keeping purposes. When all quadrants are crossed out, erase all of the markings and start over with quadrant 1.

Harvesting

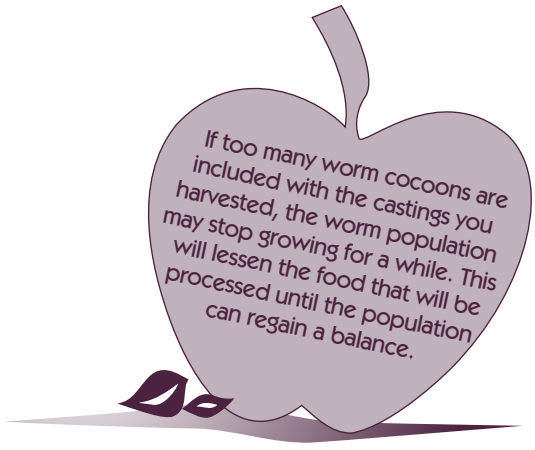
Reap the Rewards

Your worms have been busy eating, and the contents of your bin are looking more like soil than shredded newspaper. You have compost! Since it is not necessary to harvest right away, you can plan a harvesting time that fits your schedule. The amount of time you need depends on the harvesting method you choose:

• **Cone Method:** If you don't mind getting your hands a little dirty, this is a great harvesting method for your students. Find a work area, preferably outside in a shady area, during a period of moderate temperatures, and lay down a tarp or large piece of plastic. Carefully empty the contents of your bin, worms and all, onto the work surface. Separate this pile into "cones" of about six inches in diameter. Give the worms a fair amount of time (about 10 minutes) to burrow down, away from the light. After they have done so, sift through the compost from each pile, a handful at a time, until all you have left is a pile of worms. The harvested compost can be transferred to a separate storage container at this point, and your worms can return to their home with newly prepared bedding waiting for them.

• **Migrating Method:** This is a handy method for those who want to harvest fairly quickly, or not all at once. Open your bin and gently push the compost over to one side. Prepare new bedding and place it in the now empty half of the bin. From this point on, stop placing food in the compost side of the bin, and begin feeding in the new bedding area. Worms love your food waste, so it is the perfect bait for them to follow. Once most of your worms have made the journey over to their new bedding area, you can remove the compost. At this point, you will want to add more bedding to fill in the empty area of your bin. You can alternate your harvesting sides on a continual basis.

• **Scoop Method:** This is a perfect method for people who only need a small amount of compost at a time. Open your bin to allow light to penetrate the castings, thus gently forcing the worms to burrow away. Stirring the surface a bit will also encourage the worms to dive. After about 10 minutes, scoop off the top layer of castings. There should be few, if any, worms in the compost you have removed. If you still need more compost, continue to leave the lid off and wait another 10 minutes before scooping again.



Warning: Vermicomposting is not an exact science. Although red worms are small creatures that need your tender loving care, a successful bin is really based on one thing—observation! There are many variables from bin to bin, so take the time to get to know how your bin works. There is not one right way to make and maintain a worm bin. Use your own judgment and common sense. The troubleshooting information in this section lists problems you may encounter and remedies you may want to try. If all else fails, worm counseling is available! Call the Office of Education and the Environment at (916) 341-6769 and ask for assistance from your county representative.

Troubleshooting

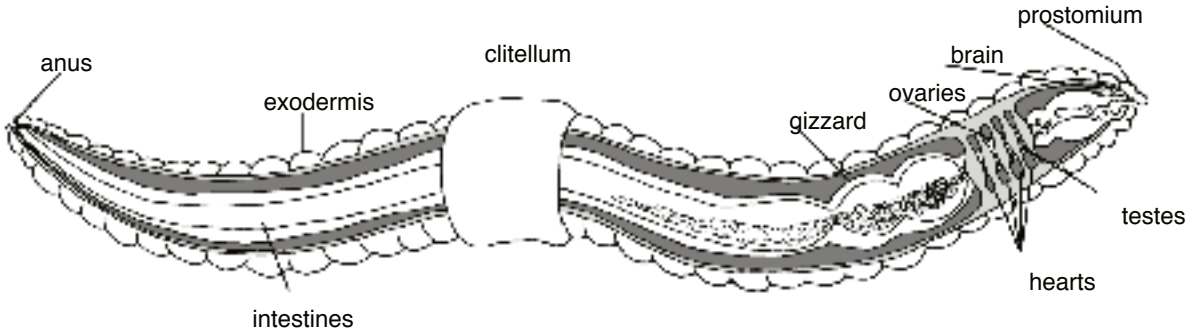
The Worm Doctor

Troubleshooting is based on experimentation, so getting to know your bin becomes very helpful when trying to remedy a problem. If a problem does occur and you think you've found a solution, don't stop there. Continue to give your bin daily check-ups until you see—or, in many cases, smell—an improvement. You may encounter some of the common problems listed below.

Symptom	Diagnosis	Remedy
Strong, Bad Smell	Not enough air circulation.	Fluff bedding. Make sure bedding or compost is not blocking the airholes.
	Too much food in bin.	Feed worms less food and/or less often.
	Improper food added.	Remove meat, dairy, and oily products.
	Food exposed.	Bury food completely.
	Anaerobic conditions.	Add bedding to absorb moisture.
Fruit Flies	Food exposed.	Bury food completely. Place bin outside in colder weather (temperature must not be below 50°F).
	Too much food.	Don't overfeed worms.
Ant Infestation		Place ant traps near, not in, your bin. Immerse bin feet in liquid. A barrier of chalk or petroleum jelly may repel the ants. If bedding seems dry, add water.
Mite Infestation	Mite population is high.	Avoid adding foods with high moisture content, such as fruits and vegetables.
Overly Moist	Too much water added to bedding.	Stop adding water. Add paper to soak up extra moisture.
	Too much food with high moisture content.	Put in less fruit and vegetable waste.

Be sure to keep in contact with your school grounds staff. Let them know you have a worm bin and request they notify you ahead of time of any pesticide spraying that may take place, whether it is in the classroom or outside. If spraying will be done for ants or other reasons, remove your bin from the premises to avoid worm fatalities.

Take your bin home during extended vacation periods, unless you plan to visit your classroom at least every few weeks for feeding purposes. You may want to have a parent or another teacher adopt the bin while you are gone.



Biology

Annelid Anatomy

Annelids are segmented worms. The term "annelid" is derived from the phylum in which these creatures are classified—Annelida. This phylum includes marine worms, leeches, and earthworms, all of which possess the fundamental characteristic of soft, segmented bodies.

Anus

The end product can be found here. Worm castings are excreted through the anus, which is at the end of the intestine.

Intestine

A red worm's intestine is a long tube that extends from the gizzard to the anus. Food passes through this tube by peristaltic muscle movement (progressive waves of contraction and relaxation).

Exodermis

Unlike humans, worms do not have lungs. Instead, they respire through the entire surface of their bodies, the exodermis. Oxygen dissolves in the moisture on the worm's exodermis and then passes into their bloodstream. Worms need enough moisture to maintain their bodies' moisture content, which is similar to that of humans at 75 to 90 percent. If you remove the worms from their bin for an activity, make it easy for them to survive the experience: place them on moist paper towels or newspaper and only keep them out of the bin for about 10 minutes.

Ovaries and Testes

Red worms are hermaphrodites, which means each worm is equipped with both female and male reproductive organs (ovaries and testes, respectively).

Clitellum

The clitellum is the light-colored band visible on the outside of a worm's body. It plays a major role in the reproduction process of the red worm. Two worms join together so that each worm is in contact with the other's clitellum. Each clitellum secretes mucus, through which sperm are exchanged and then enter the opposite worm's sperm storage sac. After the worms separate from each other, the clitellum secretes another substance that hardens and forms a tiny, lemon-shaped egg case, or cocoon. As the worm separates from the cocoon, it deposits eggs from its own body along with its partner's sperm from its sperm storage sac and fertilization then takes place inside the cocoon. Two or more baby worms will hatch from the cocoon after a few weeks, looking small and transparent. These baby worms will become sexually mature when their clitellum appears. Although worms are extremely prolific, their numbers will be regulated by environmental factors. Cold weather tends to slow reproduction, while an increase in food supply will often increase your worm supply.

Gizzard

A red worm's muscular gizzard functions similarly to that of a bird. Small particles of sand and minerals lodge in the gizzard to aid in digestion. Muscular contractions compress the particles against each other and the food, mix it with enzymatic fluid, and grind the food into smaller particles. Undigested matter passes through the intestine as castings.

Hearts

Worms have five hearts that pump blood throughout the body. The blood carries digested food particles to whatever part of the worm's body needs them.

Brain

Red worms have a primitive brain—the size of a pinhead. This is where a cluster of nerves, which control the worm's actions, is located.

Prostomium

The prostomium is a small, sensitive pad of flesh that protrudes above a red worm's mouth. It stretches out to push soil particles out of the way as the worm moves along. When the prostomium finds a food particle, it pushes the food into the worm's mouth, where the peristaltic muscle action throughout the worm's body aids that food particle on its way to becoming a worm casting.

Other Worm Bin Residents

The Good, the Bad, and the Ugly

Ant

I am an insect with six legs. I am a decomposer because I break materials down into smaller particles. I create tunnels and move soil into clumps. Some people would rather not have me around their homes. I am black, brown, or red. Worms especially don't like me because I eat them.

Bacteria

I am so tiny that you can't even see me. I can eat almost anything. Some of us live together in groups and others of us don't.

Beetle

I am an insect with shiny, black, tough wings and am about 1/2 inch long. I am a predator and eat slugs, snails, and soft insects such as caterpillars. I live beneath stones, boards, and in other moist places.

Centipede

I move quickly on my many legs. I have 15 to 137 segments with a pair of legs on each. I am a fierce hunter and love to eat worms. I use my pair of poisonous claws to help keep my prey from getting away. I am about 1 to 2 inches long. I am usually reddish brown.

Collembola

I am a close relative of the springtail but can't jump like they do. I am tiny, less than 1/16 of an inch long. I eat molds and decaying matter. I am white in color.

Earthworm

I am a long, thin soft-bodied annelid that has many little segments. I do not have legs or eyes. I sense light and I breath through my skin. I eat bacteria, fungi, and decaying materials. I like dark, moist places.

Fruit Fly

I am a very small fly. When I fly around, I look heavy, as if weighted down by bricks. I don't bite, sting, make buzzing sounds, or harm worms. I tend to be brownish in color with black stripes on my abdomen, and usually have red or white eyes. Sometimes you will see me around a worm bin if a person forgot to bury my favorite food, fruit. I prefer to lay my eggs in fruit where it's moist and warm. I can lay thousands of eggs at a time.

Fungus Gnat 

I am a small, dark gray or black fly. I fly around like a paper airplane. As a larva, I feed on soil fungi and plant roots and often hang out around houseplants. I can infect houseplants easily, so it is hard to get rid of me. Sometimes my friends and I will occupy a worm bin, but only in small numbers.

Mite 

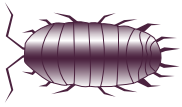
I am tiny. It would take 25 of us to cover an inch-long line. My body is round and fat, so it's hard to see my eight legs. I eat plant materials such as mold and soft tissues of leaves. Some of us eat the manure of other organisms. I am usually white, red, or brown.

Millipede 

I have so many legs you would have a hard time counting them. My name means "thousand legs," but I don't have that many- only two legs per segment. I am very shy and I roll up in a ball to avoid danger. I am a vegetarian and eat soft, moist, decaying plants. I am dark red to black in color and am 1 to 3 inches long.

Mold 

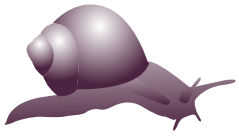
I am a fungus and related to mushrooms. In your bin, most of us live on old food.

Pill Bug or Roly Poly 

I am an isopod, which means my pairs of legs look very similar to each other. I eat old leaves and other stuff like vegetable scraps. I am about a half inch long and I roll up in a ball if I am disturbed. Some people think I look like a little armadillo. I am a dark, greyish color.

Slug 

I have muscular discs on my underside that are adapted for creeping and crawling. I lay egg masses that look like Jell-O. I eat living material but will make an appearance from time to time in your compost pile to eat fresh garbage and garden trimmings.

Snail 

Like my friend the slug, I am a mollusk and creep around on my muscular belly. I, however, carry on my back a spirally curved shell. I also have a broad retractable hood and a distinct head. Like slugs, I prefer to eat living material, such as leaves, but I will also show up in your compost pile or worm bin.

Soldier Fly 

I am usually black and look like a large wasp-like fly. I always breed in organic material that is damp and usually in an advanced stage of decomposition. I hang out around dumpsters, garbage receptacles, and compost piles to lay my eggs.

Soldier Fly Larva 

I have a flattened body. Generally, I range in color from dark brown to cream. I move fast from one place to another because I wiggle around aggressively. Since my appetite is huge, I can eat massive amounts of organic material. I don't eat worms, though. You can find me around dumpsters, garbage receptacles, and compost piles.

Sow Bug 

My pairs of legs look alike, and that makes me an isopod like my cousin Roly Poly. I eat vegetation and old leaves. My half-inch-long body is oval and flat with flattened plates, but I can't roll up into a ball like Roly Poly. I am related to crayfish and lobsters. I breathe with gills, so I must live in a damp, moist place. I am a dark, greyish color.

Spider 

I am related to mites and have eight nifty legs. I am one of the least appreciated animals in the garden and compost. I feed on other insects and work hard to help control pests that will hurt a garden.

Springtail 

I am a tiny insect less than one-sixteenth of an inch long. I eat molds and decaying materials. I have a little spring that helps me jump high into the air. I am white.

White Worm 

I look like a frayed piece of thread. I am a skinny, white worm, about an inch long. I like to eat rotting food after the other critters get to it. You might think of me as one who likes to finish off the job.

Text adapted from ***Do the Rot Thing: A Teacher's Guide to Compost Activities***, Alameda County Waste Management Authority and Alameda County Source Reduction and Recycling Board, San Leandro, CA, 1997. Used with permission.

The Garden Connection

A garden can be a food source, an outdoor classroom, a place of rest, a habitat for endemic flora, or all of the above. Whether you grow flowers, herbs, vegetables, or a little bit of everything, gardens are a place for learning. They are perfect for getting your hands dirty and your mind engaged in exploring the world that surrounds you.

Learning by doing often allows students to succeed academically, because they can touch and see the concepts they are being taught. Hands-on activities are engaging and fun for everyone. It is exciting when students who are normally quiet or have difficulty learning in a formal setting take an active role and show leadership qualities. With a school garden, students learn to nurture, wait patiently, become responsible for part of a project, and claim ownership for their success. Being involved in these activities helps create self-esteem and pride for both individual and team accomplishments.

A school garden is an outdoor classroom. Basic science and mathematical concepts are automatically associated with gardens, but other concepts are explored as well, such as nutrition and agriculture. Nutrition education plays a large part in garden learning and, ultimately, in the health of the students. Some of the most finicky eaters, students who were once completely opposed to eating certain fruits or vegetables, discover that their garden harvest is quite tasty! For some students, a school garden provides the opportunity to eat fruits and vegetables they have never tried before. A school garden, on a small scale, demonstrates how the agricultural sector of California, and the world, ties into our daily lives. Students can discover with their own eyes and hands what makes a seed grow, what is needed to prepare soil, how to maintain a healthy crop, how to harvest crops, and what it takes to get food from a farm to our tables.

Other topics, such as economics, cultural diversity, language arts, music, and art are often overlooked but are wonderful avenues to tie into lesson plans. Instruments used for rhythm can be made by putting seeds in a sealed container. Language art lovers can write to their heart's content through poetry or creative writing about the garden. Endless art pieces can be inspired by a garden, whether it is a flower petal mosaic or a painting of a favorite flower. Once students get hooked, it's hard to stop them! School gardens are an endless source of learning and fun.

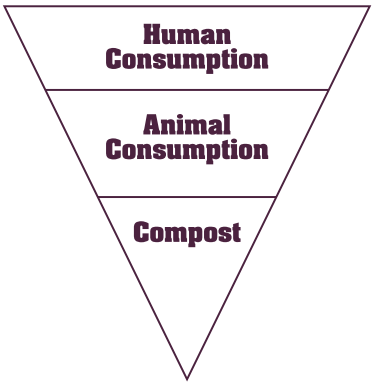
Closing the Food Loop at Your School

If you have a school garden, a vermicomposting system is likely to follow. Fruit and vegetable waste from the garden or cafeteria are a valuable resource for your school. These materials can be cycled back to the garden as compost through vermicomposting, instead of being wasted and sent to the landfill. In addition to the integrated waste management hierarchy, your school can also utilize the food waste hierarchy.

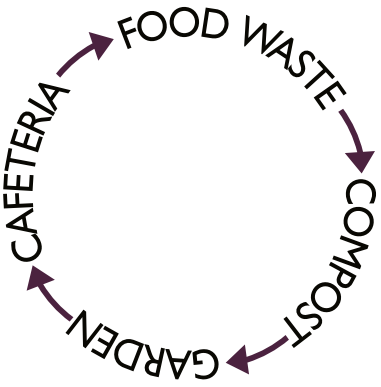
There are several methods schools can use to "reduce" food waste. One such method is "offer vs. serve." This option empowers students to reduce the amount of waste they create by allowing them to select which food items they prefer, rather than being served something they may not want. Food items that are slightly stale, irregular, or past the due date are often thrown away. Wait! This food can be donated to a local food bank to provide meals to people in your community. Food items that are very old and not suitable for human consumption may be useful as animal feed for a local farmer. With these kinds of partnerships, everyone wins. Your school reduces disposal costs, people are fed, the farmer has free animal feed, landfill space is saved, and natural resources are cycled for reuse.

If there are large amounts of food waste from the school, ask your local public works department if services are available that allow you to have the food waste composted at a local composting facility. This process cycles the decomposing materials back to the earth. You can also save energy and gas by keeping the food waste at your school and composting it yourself. School staff and/or students may be willing to maintain a compost pile or large-scale vermicomposting bin.

Food Waste Hierarchy



School Food Cycle



How to Get Started

Be assured there is no one way of setting up a food diversion program at your school, but there are a few key ideas to keep in mind as you get started.

1. First and foremost, obtain the full support of your administrators before doing anything. They can help to institutionalize the program as a normal function of the school rather than a pet project that will likely fail once the key facilitator leaves the school or is no longer involved.

2. Next, develop a plan. Writing out objectives ensures that the project stays on target. Objectives outline the purpose of the project and spell out the roles of each individual. It is a good idea to include food service and custodial staff in the planning process to foster program ownership. Start out small to ensure a solid foundation for your program, and then build on your successes.

3. Once you have established your program goals, start developing the basic structure of the program. A collection system to separate the food is first on the agenda. Determine how much food you want to collect to feed the worms. Ask the key players for their thoughts on possible problems they foresee. Take the time now to work out the issues before they become problems! All involved will have different and valuable insights based on their own perspectives gained from working on different parts of the program.

4. Build a large enough vermicomposting system (or outdoor compost bin) to accommodate the amount of food waste determined necessary for the program.

5. Clearly mark containers "Garbage" and "Compost" so it is easy for students to separate their food. Before the initial start date, it would be helpful to go through the collection process as if you were a student yourself so you can make adjustments as necessary.

6. Before implementing the program, review the information in this guide and plan to present key points to the faculty, staff, and students. This outreach is critical, as it will teach the whole school what can be collected as compost and what must be thrown away. Keep this review simple and repeat it several times before the start date of the program, reminding everyone what is happening and what their roles are.

Many programs throughout the state have trained students to become "worm experts" who then help make the program successful. They are responsible for teaching other students, ensuring that food is properly separated at the bins to minimize contamination, and then placing the food in the worm bin. Their role lightens the load for custodial and food service staff. Whether staff or students place food waste in bins, be sure they do this soon after collection, rather than store the food waste in a container for a few days.

You will need to make adjustments along the way, so be flexible. Keep the program simple and build on your successes!

Fundraising

Making Money Worm-Style

Here are a few ideas for raising money for your program.

- Package and sell worm castings to parents and community gardeners.
- Establish a partnership with a local bait shop to sell red worms.
- Grow plants with worm casting-enriched soil and host a plant sale.
- Create a worm starter kit, which could include worm bedding, red worms, and an instructional packet on how to get started. Sell the kits at Open House, Back-to-School Night, a science fair, or a PTA event.
- Make planter containers out of recycled paper to sell at your plant sale. Instructions for this project are included in the "Making Recycled Paper by Hand" lesson in the CIWMB curriculum, **Closing the Loop**—call (916) 341-6769 to request a copy.
- Make a calendar or poster to promote your school garden and recycling efforts to reduce food waste. You can include some of the worm facts found in this guide (use nontoxic markers.) Sell the calendars or posters at Open House or Back-to-School Night.
- Host a puppet show! Make worm puppets by stuffing pantyhose with cotton balls or dryer lint and reusing other items to embellish the puppets' worm features. Collect donations to view the puppet show at Family Night.
- Facilitate a student-run vermicomposting mini-workshop to promote food waste reduction in your community. The students can build the bins on site and sell them at the workshop.
- Wood shop classes can make wooden worm bins to sell to interested members of the community or donate to your school's program.
- Have students approach businesses and local organizations that may offer community assistance in the form of funding and/or resources for your school's vermicomposting program. Students should be prepared to share program goals, projected outcomes, how the company will benefit from contributing to the program, and what is needed in order to accomplish program goals. Some possible businesses or organizations to contact are:
  - Local hardware, lumber, and nursery stores.
  - Local chapter of the Association of Nurserymen.
  - Certified master gardeners.
  - Kiwanis, Rotary, and other service organizations.
  - PTA and booster clubs.
  - Conservation corps.
  - Recycling, composting, and waste hauling companies.

Composting with Redworms

Many homeowners have some kind of home composting system in operation. However, people living in condominiums, apartments and other residences don't have a suitable place to start a compost pile. These people feel left out on a worthwhile cause, and need alternative ways to be part of the composting program.

There is a solution! Kitchen wastes can be converted to a rich humus with the help of redworms. Children find worms fascinating. They are very well behaved "pets," and also help with household chores!

What to Call It

It is called a "home vermiculture system" or "worm box system."

The system contains

- A **physical structure**: a redworm box or container
- **Biological organisms**: redworms and microorganisms & macroorganisms
- A **controlled environment**: temperature, moisture, acidity
- A **maintenance program**: bedding preparation, food waste burying, separating redworms from compost and using compost

Where to Put It

Consider the needs of redworms and needs of the owner. Redworms need controlled temperature, contolled moisture content, controlled aeration and proper pH.

Temperature:

Redworms tolerate a wide range of temperatures, however, the ideal temperature is between 55 – 77 degrees F. Bedding with a temperature above 84 degrees F. is harmful, sometimes fatal, to redworm populations. The temperature should be measured inside the box, because the temperature in the moist bedding is usually lower than the outside air.

Redworms should be protected from freezing temperatures. Temperatures below 50 degrees F. slow down worm activity.

Moisture Content:

Redworms need a moist environment. Worms breathe through their skin. Skin must be moist in order to breathe.

Aeration:

Redworms need oxygen to live. They produce carbon dioxide. Air circulation is a must in and around a worm box.

pH level:

Redworms do best if the pH is around 7.0, however, they can tolerate levels from 4.2 to 8.0 or higher. Lime (calcium carbonate) may be mixed with the bedding material to correct acidity or to maintain a more favorable pH. Pulverized edd shells also correct acidity. (**Warning**! Use only limestone and never hydrated lime. The wrong kind of lime will kill the worms!)

Owner Needs

1. **Convenience** for maintaining the wormbox
2. **Aesthetic preferences**: Kitchen? Garage? Basement? Or Bedroom??

What Kind & Size Container?

Shape:
The box or container should be shallow, not more than 1 1/2' deep. Redworms tend to feed in the top layers of bedding. Materials may pack down if spread too deep.

Size:
Size depends on the average pounds of kitchen waste per week. A box measuring 1' by 2' by 3' can handle 6 pounds of kitchen waste, which is the average for families from 4 to 6 people. A smaller sized box, 1' by 2' by 2', can handle kitchen waste for 2 people.

Material:
Never use a recycled container that might have been used for chemicals! Treated wood could be harmful, also. Some examples of good materials to use might be:

- Wooden pallets
- Old Rubbermaid containers
- Old ammunition boxes
- Go to the Re-store for ideas!

Bedding:

1. **Corrugated cardboard** is an excellent material for bedding. Be careful not to breathe in the dust if you shred it. Corrugated cardboard holds moisture better than any other material. Some people use a piece of corregated cardboard to cover their bedding. In a "wet" environment, it can help to absorb some liquid, and will eventually disinegrate.
2. **Shredded newsprint** and computer strips can be used. The papers should be shredded in long lengths of ¼" wide strips. It's easily moistened, but the strips don't keep the moisture as well. Strips provide more surface area from which the water can evaporate. They require frequent moistening. The black ink used for printing the newspaper is not toxic to redworms. The main ingredients of black ink are carbon and some oils. Colored ink should be avoided. There used to be heavy metals, such as lead and chrome, in colored ink. US Government regulations now forbid the use of heavy metals in colored ink for printing newspapers.
3. **Shredded newspaper** is the most economic material. Make the strips from one to two' long by ½ to 1" wide. Redworms will eat the paper after it has softened.
4. Some people may object to the initial odors of animal **manures.** It is not recommended to use manures if the box will be located in your living area! Animal manures have other organisms such as mites, sowbugs, centipedes or grubs that you wouldn't want in your home. But if the box will be outside or in a garage, manures would be fine. Worms really like manures. Reminder—no pet, people or pig manures!

5. Old decaying **leaves** are a good source of bedding. Some leaves are better than others are. For example, maple leaves are preferred over oak leaves, because the latter take longer to break down. Leaves from trees growing along heavily traveled roads could be dangerous because of possible lead accumulation on the leaves.
6. **Peat moss** can be used if mixed with other bedding materials. It has an excellent moisture holding capacity, however it provides no nutrients for the worms, and can be expensive.
7. A handful of **soil** provides the grit worms need for breaking down food particles within the gizzard. Since worms don't have teeth, their food must be broken down by muscle action in their gizzards.

Worms With "The Right Stuff"

REDWORMS:

Eisenia Foetida

This variety is the best redworm for home composting. They produce a large amount of compost in their natural habitats of leaves, manure, compost piles and in many other decaying organic materials.

Lumbricus Rebellus

This variety will adapt to the worm box environment, but they are really a soil earthworm. Their natural habitat is in soils which contain a lot of organic matter. Redworms are on the market under many different common names. Some people call them "red wigglers," or "manure worms." Fishing suppliers may call them "red hybrid," "dungworm," or "striped worm." All these names are for the same kind of redworms. If you order from commercial breeders, your best choice is Eisenia Foetida. This variety is used by many for worm composting projects. The Cooperative Extension office has names of suppliers.

OTHER WORMS:

Worms NOT to use:

Lumbricus terrestris

This is the night crawer. This variety is the most studied of all earthworms and most sold to farmers and gardeners. They are very important for soil improvements and are widely raised for that purpose. They like to tunnel in the soil, sometimes 3 feet deep. They come to the surface foraging for organic matter, which they take into their furrows. They mix sub-soil with their food and deposit their castings on the surface. Their burrows aid in soil aeration and allow for better water penetration. Nightcrawlers have a very important role in our ecosystem but don't adapt to the shallow worm box environment.

Garden worms:

There are more earthworm varieties that might show up in somebody's garden. To identify worms you have to count the segments, study their sexual organs and their behavior. It's best to stay with redworms for your worm box.

The Sex Life of a Redworm

Hermaphroditic:
Redworms have both sexes, but mating is still necessary. If the worm has a swollen band, called the clitellum, at about one third between head and tail, this means that the worm is sexually mature. Redworms mate in their bedding at different levels, sometimes even on the surface. They may mate at any time of the year. They are attracted to each other (maybe for their beautiful body face, or other irresistible qualities.) They find each other and lie with their heads in opposite direction, bodies closely joined. They produce a secretion and secrete this through their clitella, a mucus that forms a band around each of them. Sperm from each worm move down a groove into receiving pouches of the other worm. The sperm enters in a storage sac. Some time after the worms have separated, the clitellum secretes another substance called albumin. This material forms a cocoon in which the eggs are fertilized and baby worms hatch.
Redworm cocoons are round shaped and small. They change color during their development, first white, becoming yellow, later brown. When new worms are ready to emerge, the cocoons are turning red. It takes at least three weeks for the worms to develop in the cocoon. Temperature and other conditions are factors in the development of the hatchlings. Although a cocoon might hold as many as 20 eggs, usually only 3 or 4 worms will emerge. The young hatchlings are whitish with a pink tinge showing their blood vessels.

Population Control

Conditions that determine Redworm population:
If worms have to compete for food, the population will go down. If there is a lot of food available for a time, then worms multiply at a high rate and more young worms then compete with their parents. Then this greater population produces more castings. To solve the problem you can feed them more food, but you might also need a larger box for the greater numbers of worms. It's important to note that castings are toxic to their own species, so it is advisable to harvest the castings regularly.

How many worms to start with?
The number of redworms needed depends on the daily food waste. There is a worm to daily food ratio. The ratio is 2 pounds of earthworms for each pound of food, in short: 2:1.
For example, 1 lb. Worms can eat 3.5 lbs. Food waste per week, or .5 lb. per day.
How many redworms there are in a pound of worms depends on the size of the worms. Commercial growers estimate that there are 1000 breeders (sexually mature) in one pound of worms. A dealer in baits for fishermen expect not more than 600 worms per

pound, otherwise his buyers might complain. New hatchlings are very small, and sometimes 150,000 are needed to make one pound. If you order pit-run worms (worms of all sizes and ages) by the pound, you will have lots more worms than if you should order breeders by the pound.

Setting up a Worm System

You need:

1. A worm box
2. Bedding
3. A couple of handfuls of soil or sand
4. A scale, if you want to know how many pounds of food waste you have.
5. Moisture. Worms' bodies & the bedding should have the same amount of moisture content. This amounts to 75% to 90% moisture content.

Water: Bedding ration = 3:1 by weight. Three pounds water to one pound bedding. If using dry bedding such as shredded paper, newspaper strips or cardboard, you need to wet it. One way is to put the material in a bucket and add water to it, until it is saturated. (That would be about a minute or two.)

Manure bedding:

If using composted manures, it is more difficult to determine moisture. Be careful not to make the manure soggy! If the manure is too soggy, add some dry material to it, such as shredded paper cardboard or leaf mold. The goal is to keep your worm bin under aerobic rather than anaerobic conditions.

Moisture & Temperature:

A few drops of moisture released by squeezing could be a guideline for the right amount. If five or more drops are produced the material is too wet. The ideal temperature for worms is between 55 and 77 degrees Fahrenheit.

Adding worms to bedding:

When bedding is ready for the worms place the worms on top. They will disappear in a short time in the bedding. They don't like light. By keeping some bright light close by the box the worms will disappear faster in the bedding. If some stay on the surface after some time, assume that they are unhealthy or maybe dead, and remove them.

Food:

Most kitchen waste or table scraps, any vegetables, grapefruits, orange rinds, apple peels, lettuce and cabbage, celery ends, spoiled food from the refrigerator, coffee grounds, tea bags, egg shells are all suitable worm meals. (**Remember**, no meat or dairy products belong in a worm bin.)

Don't use meat or milk products in the worm bin. Mice and rats could be attracted to the odors!
Also, non-biodegradable materials don't belong in a worm box.
Cat litter should not be used, either. The odor of cat urine is intolerable to worms, plus the ammonia in the urine could kill the worms! Cats can carry the disease Taxoplasma gondii. This can transfer to humans. For example, a pregnant woman could inhale some of the protozoan and pass the disease on to her fetus, causing birth defects.

Burying kitchen waste:

One way to manage a worm box is to pick a different spot to bury kitchen waste in the box. A 2'x2' box has approximately nine locations where you can bury wastes. That gives you nine feedings before you have to repeat the cycle.
You need some air circulating in the box, or bad odors could occur.
Worms will usually like the earlier buried food wastes. They like decaying organic wastes best. They do not always wiggle to the newly added fresh food waste. They like the bacteria, fungi, and protozoa to break it down first! Worms help keep the decaying material aerobic and help keep conditions free of odors. They produce castings at the same time.
There are many other techniques for adding kitchen wastes, which vary with owner preference and the type of box or container. Some people may just have worms in a garbage can with holes drilled on the sides for aeration. Some bury this foot deep in the back yard, and worms can come in and out as conditions vary. They just throw the kitchen wastes on the surface. (Make sure you have a tight lid that is racoon proof!) They may add some materials such as sand, soil or peat moss on top. Just be sure not to fill it too high with food and bedding, or it will pack down and may become anerobic. Whatever works for the specific situation is fine—provided there are no odors or other problems.

Grind food waste?

Grinding food waste is extra work. These kitchen wastes break down in a very short time. Eggshells should be pulverized. Although redworms have very tiny mouths, and ground food would be easier for them, we want them to help us with kitchen waste! Too much time and energy spent preparing their food can be discouraging.

Overloading the system

The size of box and amount of worms are deciding factors for how much food should be put in the box. Remember the 2:1 ratio for worms. Two pounds of worms is needed for one pound of food per 24 hours. The surface area of the box should be 7 square feet if 7 pounds of waste in one week is consumed.
If too much kitchen waste is produced on certain occasions, the wastes could be temporarily stored in another container for use later. An overloaded worm box can become anaerobic, and stinky! If that happens, don't add any fresh kitchen waste. If you leave it alone for a while, the situation will correct itself.

Do I need a worm sitter?

If you're going on a vacation, you could feed the worms a little extra just before you leave. This is the best part of having worms as pets! Feed them and leave them

undisturbed. This way, you can go away for weeks. If you leave for longer than 3 weeks, it might be good to have a worm loving friend come and feed them once.

Observe the worms

The less you disturb worms, the better off they are. However, you should make regular observations to know what is going on in the box. The best time to do this is at feeding time. Is the bedding still moist? Is the temperature inside the box between 55-77 degrees? Sometimes you find many worms at one spot in a feeding frenzy. Note what they like and don't like. Look for worm eggs and baby worms. Are there any mating worms? Worms usually fascinate children. It is a good science project for children. However, point out to the children that the worms don't like to be too much or too often disturbed. They can't tolerate bright light. A red light could be practical for observations of the worms.

Different foods for different worms

Younger worms often are all congregated by a certain food item. Older worms sometimes are feeding on another. Older worms love to fill up the inside from halved grapefruits or oranges.

Recording observations

You can keep records of your experiences and improve your skills by sharing knowledge with others. Many people are interested in "vermiculture." You may be called on for information on composting with worms.

Harvesting castings and changing bedding

After weeks of adding food wastes the bedding goes down. This is a combination of worm activity and the microorganism activities. Decomposition and composting are taking place. The color of bedding becomes darker. The favorable environment for the worms decreases. The large amounts of castings might become harmful to the worms. Castings of one worm are toxic to another worm.

When to change the bedding depends on the bedding used, the quantity of the earthworms in the box, temperature and moisture conditions. Four to six months is a good guess for keeping the same bedding, if the worm boxes are correctly maintained.

Let the worms do the sorting

If you prefer only to add some new fresh bedding, carefully move the old bedding to one side of the box. Add the fresh bedding in the open space and start feeding in the new bedding.

Divide and dump technique

To divide the worms from the old bedding, dump the contents of the worm box on a sheet of plastic or a table. The worms will go down in the pile if you expose them to light. After a short time remove the top layer of the bedding up to the point you encounter worms. Wait a short time, and continue removing the bedding. You will end up with lots of worms in a small pile. If too many worms are left, some could be supplied for starting another box.

Frequently Asked Questions

Can they see?

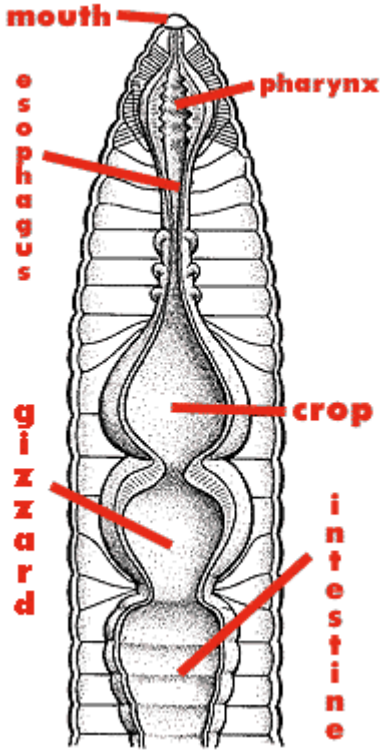
No, worms don't have eyes. However, they must have some kind of light sensor. They are very sensitive to bright light. They will try to hide as soon as exposed. It's odd that anglers use a flashlight to catch night crawlers, since they retract in their burrows if you shine lights on them. Worms are less sensitive to red light. You can observe worms with red light. Placing a red cellophane between the light source and the worm box allows you to watch the worms.

Where is the mouth?

The worm's mouth is in the first anterior segment. There is a small protruding lip just over the mouth, called prostomium. When the worm is foraging, this lip is stretching out. The prostomium is for sensing food.

Do they have teeth?

Worms have no teeth for chewing food. They grind food in their gizzard by muscle action



How do they grind food?

Worms can only take small particles in their small mouths. Microorganisms soften the food before worms will eat it. Worms have a muscular gizzard. Small parts of food mixed with some grinding material such as sand, topsoil or limestone is ingested. The contractions from the muscles in the gizzard compress those particles against each other, mix it with fluid, and grind it to smaller pieces.

What happens to food once it leaves the gizzard?

The ground up food is mixed with enzymes in the worm's intestine. This mixture breaks down the food, molecules pass through the intestine wall into the bloodstream for use where needed. Undigested material, including sand soil, bacterial and plant residues passes out of the worm as a worm casting.

If a worm is cut in to, will it grow back?

It depends on where the cut took place. If a worm is cut at the posterior end, sometimes a new tail will grow back on. Sometimes a second tail will appear next to a damaged tail. However, the posterior half of the worm can't grow a new anterior (head.)

Do worms die in the box?

It's hard to find dead worms in a worm box, but they do die in the box. Dead worm bodies decompose very quickly, because their bodies are between 75%-90% water. If you find many dead worms you should find out the cause. High heat (above 84 degrees) is fatal to them. Too much salt or acidic food waste can kill them. It's best to change the bedding with fresh materials to solve the problem. Sometimes, partially replacing bedding may solve the problem.

How long do worms live?

Often, worms live and die in the same year. They are exposed to hazards, dryness, too hot or too cold weather. Eisenia foetida can live for as long as four years.

Do worms need air?

Worms need oxygen to live. The oxygen diffuses across the moist tissue of their skin, from the region of greater concentration of oxygen (air) to that of lower concentration (inside the worm.) Carbon dioxide produced by the bodily processes of the worm also diffuses through skin. Moving from higher concentration to lesser concentration, carbon dioxide moves from the inside of the worm's body out into the surrounding bedding. A constant supply of fresh air throughout the bedding helps this desirable exchange take place.