Closing the Food Loop at School

An On-Site School Composting Guide

Cover Photo: NRRA

CLOSING THE FOOD LOOP AT SCHOOL: An On-Site School Composting Guide

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TABLE OF CONTENTS

Photo by NRRA. At the Maine Compost School.

"The soil is the great connector of lives,
the source and destination of all.
It is the healer and restorer and resurrector,
by which disease passes into health,
age into youth, death into life.
Without proper care for it we can have no community,
because without proper care for it
we can have no life."

— Wendell Berry
The Unsettling of America: Culture and Agriculture

ACKNOWLEDGEMENTS

The first edition of this Guide was written in 1997. It was made possible by the relentless dedication and enthusiasm of the Belmont High School and New Boston Central School students, staff (especially kitchen staff) and administrators. At that time, the NH Governor's Recycling Program and the NH Department of Environmental Services conducted a "Composting in Schools" pilot program to test whether backyard composting was possible for New Hampshire schools. (See Appendix C for a history of this project.) The pilot program was successful!

Special thanks go out to John Frick, Belmont High School Technical Education Teacher, and Dan Jamrog, New Boston Central School 6th Grade Science Teacher. Their hard work and commitment launched a "How to" Guide that has proven useful for decades; just by saying "yes" to school composting.

This Guide was made possible by the support and expertise of Nancy Adams, Rockingham County Extension, Bonnie Bethune (now with the Northeast Resource Recovery Association) and Debbie Smith, New Boston Transfer Station, and Tom Morin, Belmont High School. Thanks to Enid Kelly, Deerfield Central School, and Judy Engalichev, NH Office of State Planning (now office of Strategic Initiatives) for their attention to detail while reviewing, commenting and editing this Guide. It is essential to recognize Shelly Elmer, Portsmouth, NH, for the custom drawn graphics, Larry Green, San Francisco, CA, and the Indiana Department of Environmental Management's Office of Pollution Prevention for the use of their graphics. In addition, we'd like to thank The Center for Food Safety (https://www.centerforfoodsafety.org) for their image of the Soil-Climate Connection and VT Agency of Natural Resources for their graphics.

Now two decades later, the Guide is in its third edition (the second edition was printed in 2006) and continues to help schools implement their own on-site school composting programs. For this edition, NRRA recognizes the technical expertise of Cat Duffy Buxton of Grow More, Waste Less - Food Systems Consulting LLC, who runs the edible schoolyard and compost system at Thetford Elementary School, Thetford, VT. Her review broadened the scope of the Guide by enhancing the microbial ecosystem and reminding all of us that your compost is a living environment.

Permission for reprinting composting "Activities" was given by:

- The Cornell Center for the Environment, Cornell University, Ithaca, NY
- Patrick Cushing, New Rochelle, NY
- Association of Vermont Recyclers, Montpelier, VT
- Chadbourne & Chadbourne, Inc., Chargrin Falls, OH
- Cat Duffy Buxton, Grow More, Waste Less, Sharon, VT

Photo by Ben Laroche, Thetford Elementary School, Vermont

"It's much more than being a farmer… you're out to help people and make this little part of the world farmable and productive, make your little street or block a better place, make the world healthier."

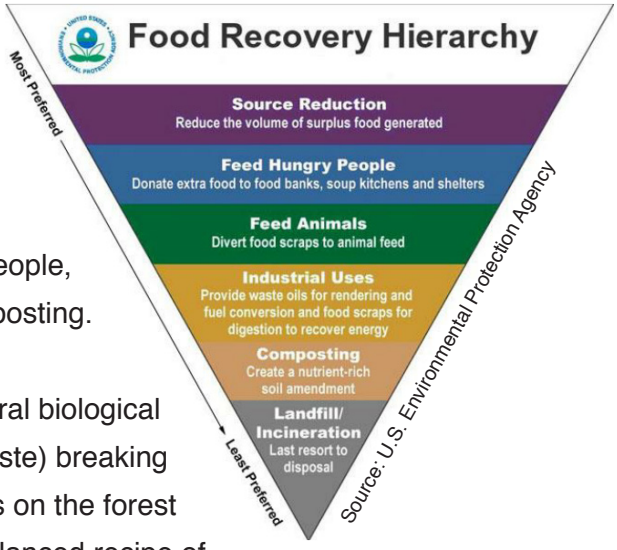
— A youth participant in GRuB (Garden-Raised Bounty, Olympia Washington)

INTRODUCTION

Students are great recyclers. They recycle their aluminum cans and they recycle their paper. But what about their food waste, those cafeteria leftovers from preparing the students' breakfast and lunch? This material can be recycled through composting!

Why Compost at Schools?

One California waste generation study showed that students generate 37.3 pounds of organic waste per year, making it almost half of the total waste generated at a school (California Department of Resources 2014). There are other studies that examine why students throw away perfectly good food, but one thing is for sure; the United States has a school food waste issue. Food waste leads to increased waste disposal costs and wasted food budget funds, not to mention the environmental costs of sending food to sit in a landfill. States and organizations are considering this issue and coming up with a variety of solutions.



Composting is one such solution that can be combined with other food waste reduction techniques while enhancing school project-based curriculum. The U.S. Environmental Protection agency created the Food Recovery Hierarchy that shows multiple steps before composting; such as Source Reduction, Feed Hungry People, Feed Animals and Industrial Uses. The last step is Composting.

Decomposition is nature's way of recycling. It is the natural biological process of organic materials (i.e., food, leaf and yard waste) breaking down into a valuable soil amendment, just as a leaf does on the forest floor. Composting is managed decomposition using a balanced recipe of ingredients, water and lots of air to encourage aerobic microorganisms to break down organic matter quickly. Composting these organic materials not only saves money by reducing the school's disposal costs, the process can also strengthen an environmental science program with hands-on science activities and provide the baseline data for enhancing project-based math curriculum. Educators can play a major role in teaching students about the values of composting both in the school and at home, while providing a great example of a natural life cycle.

School Composting Can...

- **Re-use organic material**, a valuable natural resource.
- **Save money by reducing** the school's waste disposal costs.
- **Create a valuable soil amendment** for planting or mulching.
- **Provide an opportunity for students** to study the biology and chemistry of how the composting process works.
- **Provide students with an example** of a natural life cycle.
- **Restore biological soil health**, improving natural nutrient cycling.
- **Improve the way water functions** in landscapes, reducing the effects of flooding and drought.
- **Create a relevant entry point** into discussions of changing climate, carbon and nitrogen cycles, methane (CH4) and carbon dioxide (CO2) emissions, and the greenhouse effect.
- **Reduce greenhouse gas emissions** (C02 from trucking and CH4 from landfill emissions).
- **Catalyze a human understanding** of the role of soil health as a framework for functioning healthy ecosystems.
- **Empower students to feel** that they can help make a difference.

How Does Composting Work and Why Is It Important?

Compost is the result of managing organic waste material decomposing through the actions of soil microorganisms (microbes). The aerobic microbes that create compost need relatively large amounts of carbon material (leaves, wood chips, etc.), small amounts of nitrogen material (food waste, fresh manure, grass clippings, etc.), air and moisture to thrive and actively do their job.

Make the Most of Composting at School

The student experience is greatly enhanced with cross-cutting project-based learning that offers practical hands-on application of knowledge. Composting at school offers ample opportunity to dig into physical and biological sciences, mathematics, current and historical global studies, problem solving, public service, and environmental stewardship. There is a rich history of how humans have managed and recycled waste all over the globe with plenty of successes and failures to draw from.

Composting Addresses Global Problems

By composting food waste aerobically we are turning a problem of food waste, land, air and water pollution into helpful solutions like reducing landfilled waste, restoring soil health and improving water quality.

Soil Health

According to the Food and Agricultural Organization of the United Nation (FAO), more than half of the agricultural and forested land across the globe is severely degraded and in some cases has been turned from bio-diverse forest ecosystems into desert. Adding compost to landscapes can improve the overall biological function of ecosystems.


Photo by Ben Laroche, Thetford Elementary School, Vermont

Global Food Waste

Thirty to fifty percent (30 – 50%) of the food produced never makes it to the mouths of people and animals. It get wasted in farm fields, in food processing and distribution, in the retail environment and in homes all across the world. It is estimated that food waste generated in the U.S. alone could fill the Rose Bowl every day! *Source: American Wasteland: How America Throws Away Nearly Half of Its Food (and What We Can Do About It), by Jonathan Bloom*

When food waste ends up in landfills it becomes a pollution problem increasing methane production and decreasing water quality.

RESOURCE:

Project Drawdown is a world-class research and communication organization. They are a non-partisan, non-commercial, highly-trusted source of solutions to reverse global warming.

Their book and website list the top 100 global solutions; reducing food waste ranks as the 3rd most effective way to reduce greenhouse gas emissions and composting food waste ranks at #60. (https://www.drawdown.org)

What to Expect in This Guide?

The Guide was originally developed based on the knowledge gained from two pilot programs in New Hampshire with the NH Governor's Recycling Program (now NRRA) and NH Department of Environmental Services. Since then, many more schools have developed compost programs, while local, state and federal agencies have created guidance documents to help start programs. This guide is designed to provide users with background information to help decide if they want to start composting, as well as how to set up, operate and promote a school composting project. The appendices include information sheets, tracking forms and resources. We hope you find them helpful.

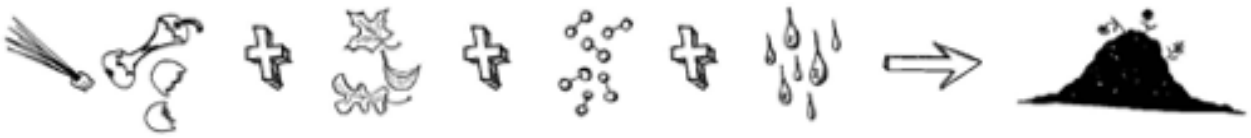
In addition, the Guide can assist teachers in educating students in science, math and solid waste issues. Sample lessons from NRRA's solid waste curricula, *3R's of the Common Core: Use it Up, Wear it Out, Make it Do, or Do Without: A Teacher's Resource Guide to Solid Waste and Recycling,* are available in the appendices.

As always, for any further questions, please do not hesitate to call The School Recycling CLUB at (603) 736-4401 or email theclub@nrra.net.

Photo by Ben Laroche, Thetford Elementary School, Vermont

THE COMPOSTING EQUATION

Think of your compost as a living organism – your new pet! Compost is very easy to manage when the right conditions are created. Microbes need a balanced diet and a safe place to work.



Microbes Need A Balanced Diet:

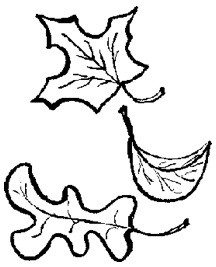
Billions of microbes are the unseen workers that are breaking down your food scraps into useful humus-like soil amendment. For optimal performance, the compost heap should have the moisture consistency of a wrung-out sponge. Aerated compost performs best with an ingredient ratio of 3:1, carbon-rich to nitrogen-rich materials. Think of the carbon materials as providing the carbohydrates (sugars) that give the microbes the energy they need to break down the nitrogen (protein). Carbon also provides a measure of air or void space in the compost pile, decreasing the bulk density of the compost, like the airspaces in a sponge.

Food Waste = Nitrogen

Most of a school's compostable food wastes are high in nitrogen and can include bread, fruit and vegetable scraps, coffee grounds and eggshells. Fresh green grass clippings are also a source of material high in nitrogen. Meats, dairy products, oils, fats and bones should be avoided when composting on a smaller scale or when ideal management for a hot compost pile cannot be met because they will take a long time to decompose and are likely to create odor and attract pests. If a school is hot composting, all meat, fat, bones and dairy can be included.

Hot composting means reaching pathogen kill temperatures of 131°F for three days in every part of the pile.
Hot composting requires regular turning in addition to a balanced recipe.

Bulking Agent = Carbon



Bulking agents are items that are high in carbon. They are also referred to as 'feedstocks' as they are feeding the microbes the energy they need to decompose the nitrogen-rich food scraps. These materials provide structure and air (void space), lowering the bulk density of the compost pile. Either wood shavings (available by the bag from a grain store) or fall leaves (keep in mind oak leaves decompose more slowly than maple leaves) are good materials to use as a bulking agent since both are high in carbon. Ensure you have access to enough dry bulking agent for the entire school year. If the plan is to use leaves, this may require stockpiling many bags. See if you can get your bulking agent donated either by a nearby wood processing plant or local farm. Free is always good but make sure the material is safe for your bin, meaning no synthetic chemicals, pesticides, fertilizers and other unknown chemicals, when accepting donated materials.

How come some materials are not recommended?

Some trees (like walnut, oak, butternut, hemlock and pine), will take longer to break down because they contain anti-bacterial or anti-fungal properties, often referred to as allelopathy.

The same is true for citrus peels, barley or rye straw, sage, lavender, wormwood, sunflower hulls, and many other organic materials, to varying degrees.

That's why cleaning products are often made with ingredients derived from these species. All of these materials can certainly be composted but they'll take a little longer to break down. As the materials age, they will break down more quickly.

What Are Microorganisms?

Microorganisms (microbes) are extremely small critters, the smallest organisms on Earth. In fact, the term microorganism literally means "microscopic organism."

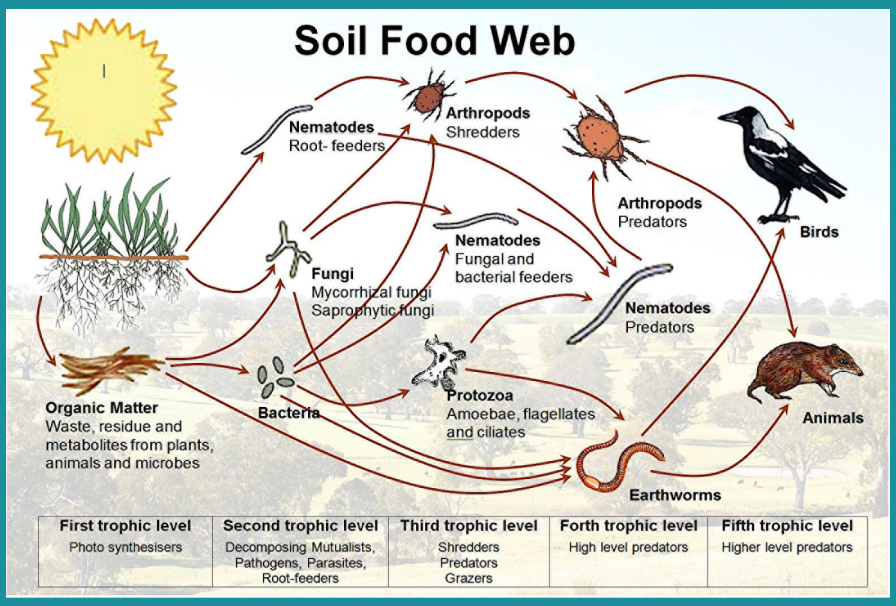
There are billions of kinds of microbes and they exist everywhere that the conditions are right for them: inside and on all living things, including humans! Microbes are very specific about the conditions they like and they can 'turn on and off' as conditions change.

Aerobic organisms, those who need air to survive, are the stars of a compost pile. The particular conditions they need to thrive are a roughly 3:1 carbon to nitrogen (C:N) ratio, water and air. When the conditions are right microbes will reproduce rapidly – this reproductive activity is what creates the heat inside a compost pile!

Some microbes prefer low-air or no air; these are anaerobic organisms such as those who live in a landfill or a septic system. Anaerobic organisms emit stinky gases like ammonia and sulfur as they slowly break down organic matter. They also emit methane, an odorless but powerful greenhouse gas.

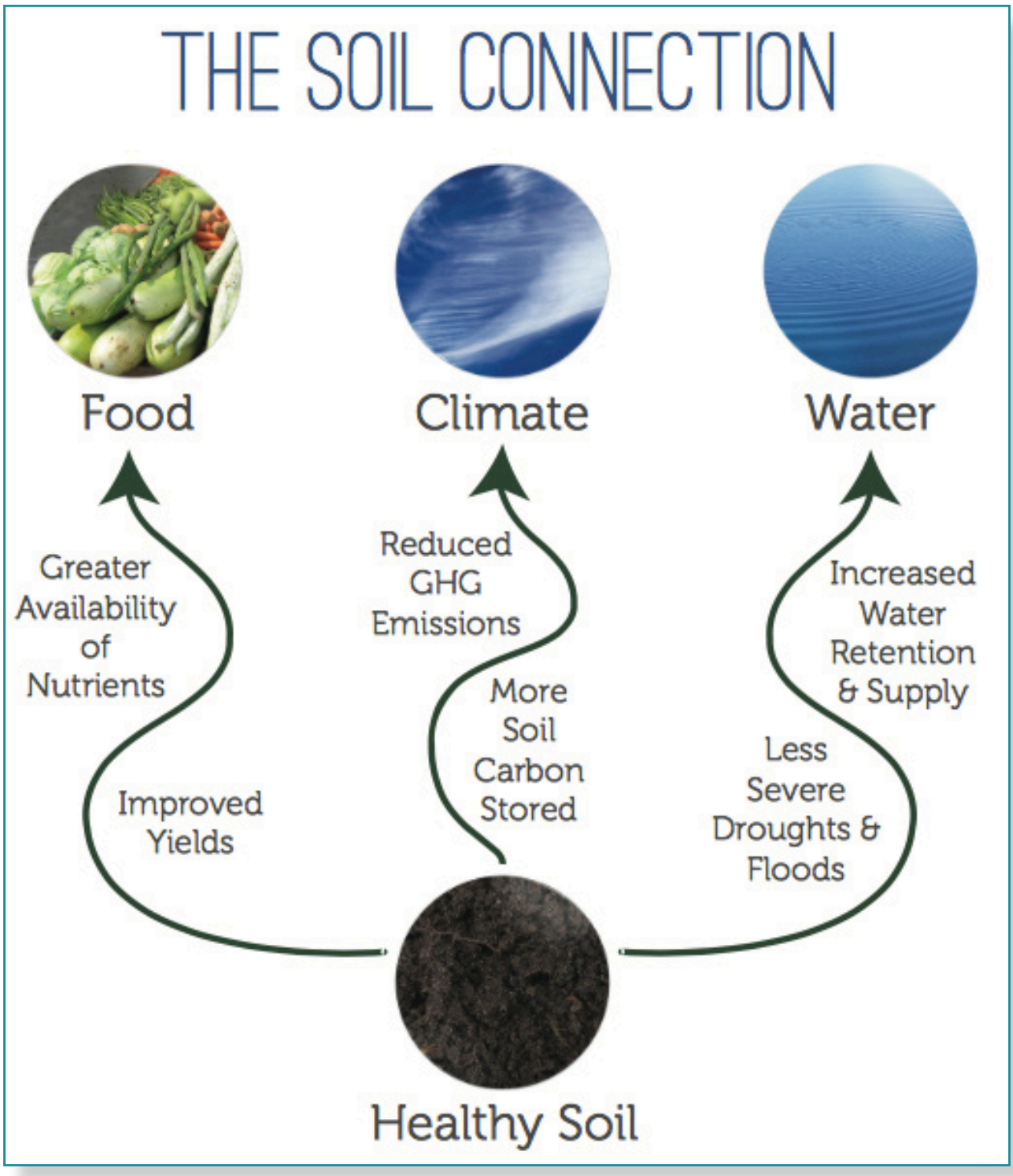
The Soil Food Web

An incredible diversity of organisms make up the soil food web. They range in size from the tiniest one-celled bacteria, algae, fungi and protozoa, to the more complex nematodes and micro-arthropods, to the visible earthworms, insects, small vertebrates, plants, rodents and birds. As these organisms eat, grow, reproduce and mobilize through the soil, they make it possible to have clean air, clean water, healthy plants and ecosystems.

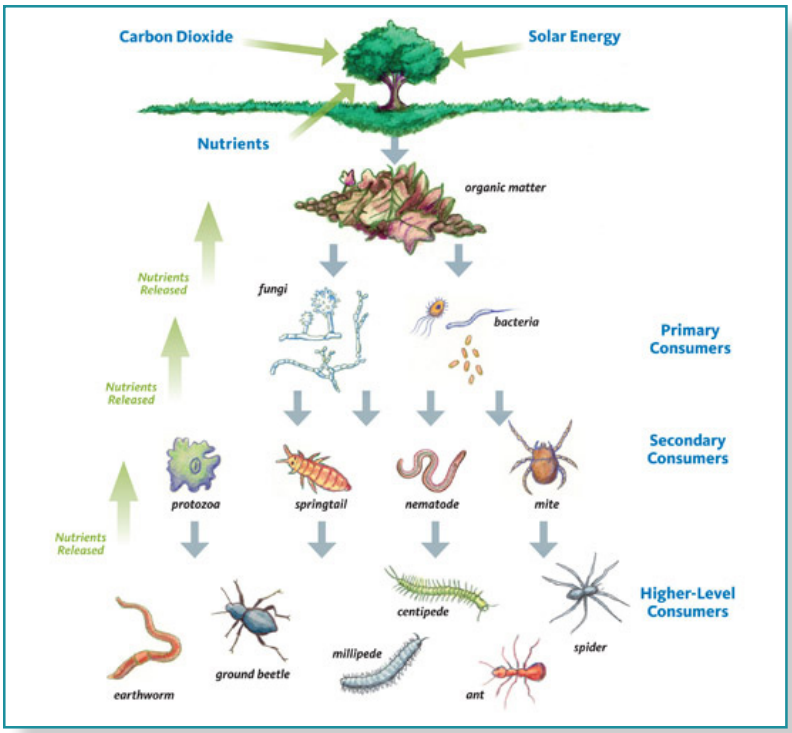


Microbes are tiny! 1 teaspoon of healthy soil can have as many as 75,000 species of bacteria, 10,000 protozoa, a few hundred nematodes, a micro-arthropod and a mile of fungal hyphae!

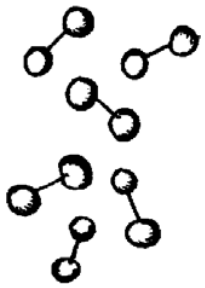
Soil organisms play many integral roles in the function of ecosystems including the formation of soil aggregates that hold our landscape together, water cycle moderation, sequestration of essential gases like nitrogen and carbon, nutrient cycling from rocks to plants, filtration of pollutants such as pesticides and chemical fertilizers, and are essential for decomposition of organic matter that ultimately returns as nutrients to our farms, forests, fields and backyards.



Sources for this image and the images on pages 15 and 17 are noted in Appendix E



A well-managed compost pile can provide habitat in which billions of diverse organisms can thrive. Adding finished compost to a garden not only provides some nutrients but, more importantly, it serves as an inoculum to restore biological diversity and food for soil organisms in our landscapes promoting natural nutrient cycling.



Compost's Microorganisms Need Air!

As with all living things, the compost's microorganisms need oxygen to survive and do their work. Turning a pile from one bin to another is one way to aid in ventilation.

The compost bin must be able to supply plenty of air. If a pile is larger than four square feet, the material in the center will be too compressed to allow air to reach the middle. Adding plenty of carbon-rich materials with a variety of particle sizes and from a variety of sources helps to ensure the organisms have enough air.

What Happens When There is No Air?

When food waste decomposes in the absence of oxygen, such as in a landfill, the greenhouse gas methane, which is up to 34 times more powerful than carbon dioxide over a century, is produced, as well as stinky gases like sulfur and ammonia.

Feedstocks: Size and Shape Matter

Using a variety of different particle sizes of carbon feed stocks (for example leaves, wood shavings and hay or straw) provide natural void spaces where the materials touch each other. These built-in air pockets are an important part of a compost pile structure.

Moisture Is Important!

The microorganisms in a compost pile work best when the pile is as moist as a wrung-out sponge. Sitting in direct sun all day may dry out the pile and the microbes will die of thirst. However, during heavy rains, too much water may make it too soggy, preventing oxygen from reaching the whole pile, and ultimately drowning the microbes.

Photo by Cat Buxton, Thetford Elementary School, Vermont

Check the pile moisture regularly with a simple “‘squeeze test” (see Appendix D).

Won’t it Smell? And Attract Flies and Pests?

Healthy compost does not omit odor. If the compost pile smells that is an indicator that the pile has gone anaerobic. (The air has left!) The same is true if there are lots of flies present as they prefer to lay eggs in stinky, wet places. To prevent odors, flies and other pests, use the right recipe to create the perfect conditions for air-loving aerobic microbes to thrive.

The Relationship Between Air and Heat

When a compost pile gets hot it is an indication that the microbes are happy and are reproducing rapidly. The more microbes there are, the quicker they use up the air. When the temperature drops its an indicator that it’s time to turn the pile. Fluffing the pile up or turning the compost pile from one bin to another, mixing and blending materials as they’re transferred, will refresh the air in the pile sending the microbes into a feeding frenzy. You can track the level of available air in a compost pile by using a compost thermometer regularly and tracking the temperature patterns.

Data: The Lifeline of the Compost Pile at Schools

Regular data collection of temperatures, moisture and other observations can serve as the basis for project-based math education, exploring the scientific principles to solve problems, and collecting student feedback to improve the school-wide materials collection and compost system.

	Number of Buckets	Outside Temp.	Left side Temp	Center Temp	Right Side Temp
Range	2.5 - 0.5 = 2	82°F - 0°F = 82°F	150°F - 60°F = 90°F	150°F - 60°F = 90°F	150°F - 60°F = 90°F
Mode	1	40°F, 50°F	140°F	100°F	140°F
Median	1	26°F	142°F 124°F	122.5°F 118°F	134°F
Mean (Average)	1.22	39.12°F	122.11°F	118.42°F	123.97°F
Overall Compost Temp Mean					121.5°F

Photo & chart by
Ben Laroche, Thetford
Elementary School,
Vermont

Heat Means Compost Action!

Microorganisms generate heat as they reproduce and decompose organic material.

Pile temperatures between 90°F and 150°F indicate rapid composting. Temperatures consistently above 131°F indicate pathogen kill. A composting thermometer is the best way to keep track of the temperature deep inside the pile to indicate whether the compost pile is active.

Temperatures below 90°F indicate the pile is not actively composting. This may be because . . .

1. **The pile needs to be turned** to get more oxygen into the center.
2. **The pile is too wet or too dry** for the microorganisms to do their work.
3. **The pile needs more nitrogen material**, i.e., green grass clippings, food waste, and manure to feed the microorganisms.
4. **The pile is done composting** and is now "finished" compost.


Photo by Ben Laroche, Thetford Elementary School, Vermont

Temperatures above 150°F indicates the pile is too hot and should be turned to avoid burning up the big and little microorganisms. Turning adds oxygen and it also cools the pile.

Refer to 3R's of the Common Core 9-12:
How Can We Recycle Organic Waste?
(Appendix F)

Refer to 3R's of the Common Core 4 - 6:
How Can We Recycle Organic Matter?
(Appendix F)

THE COMPOST BIN

NRRA Photo: Kenneth A. Brett School in Tamworth, NH

The needs of a school compost bin are a little different than the needs of a household's backyard compost bin. Issues to consider when deciding what type of compost bin are right for a school include: the quantities of food waste generated, attracting wild animals to the school and extra finances to buy or build a compost bin.

Ready-made and easy-to-assemble bins can be purchased at local hardware and garden supply stores. Keep in mind that these bins are typically used by single households, therefore, depending on the amount of food waste the school produces, you may need multiple bins, which can be expensive. Multiple small bins will also require more time to manage than appropriately larger bins would (more turns), so consider that in your cost planning.

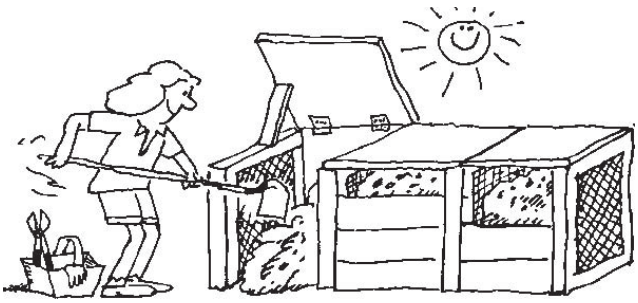
When constructing compost bins, there are a number of designs which can be easy and fun to build. There are "holding units," such as snow fencing, wire fencing or hardware cloth tied in a circle to contain the compost pile. However, for the larger quantities of food waste a school generates, a "turning unit," a series of three or more bins that allows wastes to be turned regularly from one bin to the next, may be more appropriate.

Use a 3- & 4-Bin Turning Unit

The successes and failures of other school composting programs throughout the United States were researched. Some schools had tried using the ready-made bins, however, they were unable to handle the large quantities of food waste. Others built elaborate multiple bin units with buildings around them, however, that required a large financial investment. ***A three- or four-bin "Turning Unit" made from re-used wooden pallets and lined with hardware cloth would best address a school composting program's needs because...***

- **it can handle the large quantities of food waste** and, if necessary, can be easily expanded by adding another bin
- **it is easy to line the pallet bins with hardware cloth** to keep out unwanted animals
- **reusing wooden pallets to make the bins** keeps the composting program's costs down and is a form of recycling!

How Many Compost Bins Will Be Needed?



Depending on the size of the school and the type of food served, most of these schools will need a turning unit with at least four bins. The first bin will be used for "new" food waste, the second bin will hold actively composting food waste, the third will contain finished compost, and the fourth can be used for extra capacity during winter months. Additional bins may be added for bulking agent storage.

Schools with more than 800 students should plan on a five- or six-bin turning unit in order to have space to compost the extra amount of food waste generated. However, to see if your school has more than an average of 30 pounds per day, you may want to do a school food waste audit by collecting and weighing "prep scraps" for one week before building the compost bins. You should also consider space for storage of finishing compost, plenty of bulking agents to sustain the system through winter and an area to store finished compost in windrows (long, short piles) as noted below at Mansfield Middle School in Mansfield, Connecticut. A very small school with less than 100 students can use a turning unit with three bins instead of four.

After the first year, it was determined that four 4' x 4' x 4' bins did not accommodate both active composting and storage of bulking materials for a school of 650 students. Three wider, stronger, steel-framed bins measuring 4' x 4' x 6' were built to allow for mechanical turning with a skid-steer loader. Two of the narrower bins are still used for composting and are turned by hand. The other two are used for storage of wood chips and leaves, keeping the area tidy.

original 4' x 4' x 4' bins

with wider bins added

It saves time in the beginning to determine what size bin system you will need but every school is different, and adjustments will need to be made throughout the process.

Compost Bin Size By School Size (FT³)

# of Students in the School	Elementary School	Middle School	High School
50	60	39	N/A
75	90	58	28
100	60	77	37
150	90	58	56
200	120	77	74
250	150	97	93
300	180	116	56
400	240	155	74
500	299	193	93
600	359	232	111
700	419	271	130
800	479	310	148
900	539	348	167
1000	599	387	186

The chart to the left will help you determine the size, number of bins, and total cubit feet of space you will need to manage your compost and be able to turn piles as needed.

3 Bins & 3 Month Fill Time/Bin

4 Bins & 2 Month Fill Time/Bin *

4 Bins & 2 Month Fill Time/Bin (Not Recommended w/Out a Bucket Loader)

*** Should Consider Using a Bucket Loader**

From Highfield's Institute, now Sustainable Jobs Fund of VT.

Where Should the Compost Bins Be Placed?

Compost bins should be placed on a flat grass or soil surface. To assist with keeping the compost moist, but not too moist, it is best if the bins are partially shaded to keep the compost from drying out. For convenience, being close to the lunchroom and/or kitchen exits and a water supply, without being disruptive to the human flow of the school, is ideal. Remember that access to the bins in the winter and snow plowing requirements should be considered. If at all possible, covering the compost bin area with a roof will keep the snow out, shade the compost, and provide shelter for the people managing the system year round.

The amount of space needed for composting depends on the size and number of bins used. Generally speaking, the four bins (each four feet square) in the pallet system need an area at least 20 feet across by eight feet deep for bins, and additional space for ample bulking agent storage, as well as maneuvering with tools, wagons, wheel barrows and a tractor (if your school is lucky enough to have access to one). If placing the bins near a wall or fence, be sure to leave enough space for a person to walk behind the bins to keep the area clean.

Before making any decisions as to where to locate the bins, the most important step is to check with the food service, custodial and grounds keeping staff, and the teaching and administrative staff, to be sure that the chosen spot is not in conflict with other needs or plans for the space.

Storage for Feed Stocks

Large thirty-five gallon plastic trash cans with lids and handles are excellent storage containers for dry bulking agents. They are easy to move around, stack when empty and are lightweight and watertight. Depending on the volume of food waste you are composting you may need space for five to fifteen barrels.

How to Avoid Attracting Animals

Using the proper ingredients ratio of food scraps, carbon materials and moisture is the very best pest protection. If they can't smell it they won't come investigate! Whenever composting food waste, and especially in a situation where there will be children around, additional care should be taken to avoid attracting animals.

Some suggestions for accomplishing this are to...

- **Line bins** on sides, top and bottom with hardware cloth or chicken wire.
- **Stay clear of food wastes that are high in protein** and fat such as meats, oils, fish scraps and dairy products.
- **Place food wastes** into the center of the pile so that no food is exposed.
- **Turn the compost pile frequently** to keep it actively composting. (Turning each pile every 30 - 40 days is sufficient. Follow the temperature data and the fill frequency to determine the need for turns.)
- **Maintain the bins over time!** Holes or weaknesses can become an open invitation for some unwanted critter's dining experience.

- **Raise the bins off of the ground** to add a space below the bins allowing for good airflow and to prevent any leachate from pooling. Line the bottom of the bin with ½ inch hardware cloth.
- **Cover it:** Using a latched lid for at least the active bin is highly recommended.
- **Additionally, lining the outside of the bins** with rigid insulation will aid in pest deterrence by reducing odors. (it is not recommended to put insulation inside the bins as it will eventually break down into small pieces in your compost and create a mess).

How To Keep Costs Down

A wood and wire three-bin "Turning Unit" made from virgin lumber can cost approximately $300. However, a similar three-bin "Turning Unit" that also meets all the school's composting needs can be made from re-used pallets and hardware cloth or chicken wire for about $150.

Another way to keep costs down is to solicit donations for bin materials, money and/or labor from local organizations and/or businesses. Also consider the possibility of grant programs supplementing a school composting budget.

A Note on Cost Savings:

Staff/custodial team labor may slightly increase while systems are being developed. Once systems are in place, labor costs will simply shift from time hauling and collecting heavy, stinky trash to time spent cleaning buckets or managing bins.

Cost Savings

In many schools, the food waste is usually disposed of by adding it to the other solid waste generated. This adds to the disposal costs for the school either by volume, weight or frequency of pick up, depending on the waste services available to your school. Once a food waste composting program is underway, there will be the obvious benefit of saving money from avoided waste disposal costs. Another food waste disposal method commonly used in schools is to flush it down the garbage disposal, grinder or "pigger" with water. When a school switches from this disposal method to composting the food waste, there will be a savings incurred by not only extending the life of their leach field and septic tank but also requiring less maintenance and cleaning.

Additional cost savings will come from a reduction in imported compost, soil fertility amendments and mulch for school gardens and general grounds landscaping.

In What Will Food Waste Be Collected?

Food waste is relatively wet and heavy.
Consequently, collection containers need to be:

- **Water Proof -** To keep wet food from leaking and for easy cleaning.
- **Light Weight -** For ease of lifting, weighing and carrying by students and/or staff.
- **Covered -** To control odors and avoid attracting fruit flies.

To help determine the proper size of the container needed, consider the size and strength of the person lifting and transporting the food waste, as well as the amount of food waste produced at the school. A few options for food collection containers are:

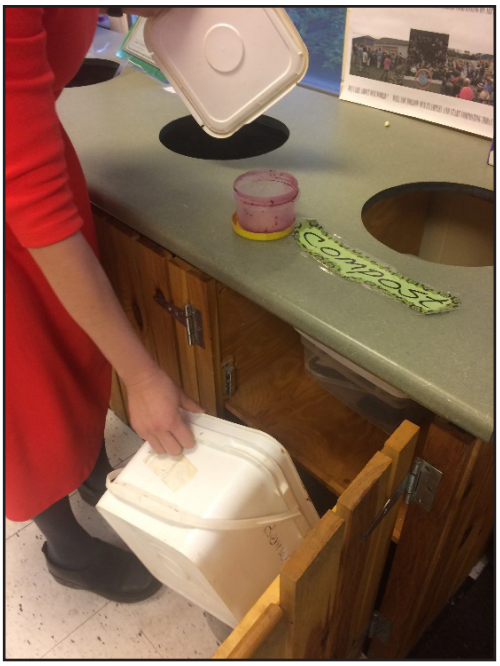
Five (5) gallon buckets: Often times it is easy to find 5-gallon plastic buckets which are discards of bakeries, grocery stores or drywall contractors (sometimes referred to as sheetrock" or "mud" buckets). These buckets can usually be obtained at a low cost and are easy to handle, wash and place in a convenient spot for kitchen staff. Don't forget the lids!


Photo by Ben Laroche, Thetford Elementary School, Vermont

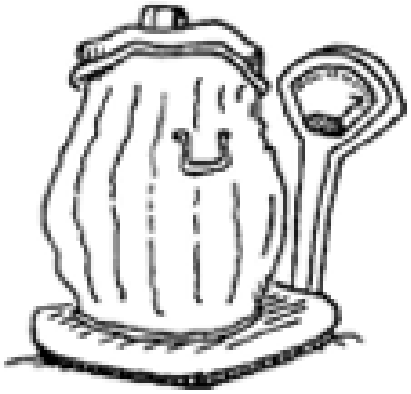
Thirty-three (33) or fifty-five (55) gallon garbage cans (with or without wheels) lined with a plastic bag: These can be obtained at most hardware or department stores or through a maintenance supply catalog. They can be handy for large quantities of food waste. For heavy duty wheels, a dolly can be attached to a garbage can with bungee cords. Keep in mind that these bins will become heavy and will need to empty into the compost bin.

Consider how food scraps will be transported from inside the school to the compost bins. If stairs are not an issue, a wagon with short walls is an excellent addition to your system to carry a few 5-gallon buckets.

Cafeteria food waste wagon (above) brings compost to bin at Thetford Elementary, VT (NRRA Photo)



Classroom collection station at Thetford Elementary, VT (NRRA Photo)



How Much Food Waste Is Composted?

Record the food waste's weight to document how much food is being diverted from the school's waste stream and to estimate how much bulking material is needed. A standard bathroom scale can be used by placing the bucket of food waste on the scale and then subtracting the weight of the bucket, or standing on the scale with the bucket of food waste and subtracting the weight of the person and the bucket. Although it may be a little more expensive, a hanging scale typically purchased at a local hardware or feed store can also be used.

What About Plate Scrapings?

Collecting plate scrapings or “post-consumer” food is very different from collecting prep scraps or “pre-consumer food.” Plate scraping collection involves educating the entire student body. It also requires a fair amount of monitoring at the garbage cans. Students need to understand the correct way to sort their plate waste in order to keep out contaminants such as plastic straws.

Cafeteria sort station with built in buckets at student height levels for easy tray clearing.

Thetford Elementary School, VT (NRRA Photo)

Many schools are interested in composting food collected from the students’ cafeteria plate scrapings. Research of a few schools that do separate plate scrapings has provided some of the following suggestions on getting started...

- **Watch the students’ routine** in the cafeteria in order to develop an efficient traffic flow and avoid a backup of students at the food separation point.
- **Provide a ‘share table’** as the first stop on the food separation area and keep it separate from the food scraps and trash area.
- **Educate the garbage can monitors** about the “do’s and don’ts” of separating plate scrapings for composting. They need to be present near the garbage cans at every lunch period to serve as a friendly reminder to the students.
- **Create signs** so the students can refer to the list of “do’s and don’ts” and prepare themselves for the correct procedure. A mounted example on poster board of what to put in each garbage can will help the students identify the correct places to put things.
- **Make the ‘trash’ bin the last stop** and keep the bin small in size.

Deciding to compost school cafeteria plate scrapings can be an excellent opportunity to educate everyone in the school about food waste composting and potentially save even more money on disposal costs. For more detailed information on incorporating plate scrapings into your school's composting program, please contact NRRA's School Recycling CLUB.

Students using the cafeteria sort station at the Somersworth Middle School, NH

Notice the colorful, descriptive signs on the wall helping guide students to sort properly.

(NRRA Photo)

Photo by Ben Laroche, Thetford Elementary School, Vermont

"Humankind has not woven the web of life.
We are but one thread within it.
Whatever we do to the web, we do to ourselves.
All things are bound together … all things connect."

—Chief Seattle

Photo by Ben Laroche, Thetford Elementary School, Vermont

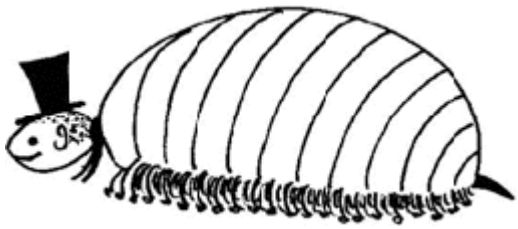
GETTING STARTED

Starting a school composting program can be fun and easy. However, an understanding of how school composting works and whether or not composting is an option for a specific school is needed before starting. Generate a team of 3 – 4 people (staff and community members) with a point person who will support the project for the long term and develop a system to keep that team going for years to come.

What Does it Take to Compost?

Schools produce food waste from a few sources.

- **Kitchen:** preparing meals (prep scraps)
- **Cafeteria:** students' leftovers (plate scrapings)
- **Classroom snacks**, especially younger students
- **Teacher's lounge**



The operation of a school composting program involves:

1. Collecting the food waste (we recommend starting with prep scraps")

2. Depositing it into a composting bin

3. Mixing it with a bulking agent (i.e., leaves or wood shavings)

4. Ensuring the proportion of food waste, bulking agent and moisture is correct

5. Developing a shared maintenance system for turning, washing buckets and gathering feed stocks

6. Deciding how to use the finished compost

Although the operational steps listed above are simple, there are many small details of setting up, coordinating, and operating a school composting program. It is essential to address these details for a successful program.

Can Your School Compost?

Every state has unique laws and regulations around composting. Check with your state environmental services/solid waste department to determine laws and regulations for on-site school composting.

The checklist below can help a school community decide if it should compost...

- ☐ Is there a school lunch program?
- ☐ Does the school administration support a composting project?
- ☐ Is there one person willing to be the point of contact for the program and keep the program going? (Recommend a team of 3 - 4 people.)
- ☐ Do teachers, maintenance, or other involved staff support composting?
- ☐ Is the kitchen staff willing to place the food waste in a separate container?
- ☐ Can an adequate site for the compost bin be found on the school grounds?
- ☐ Are there people (staff, local volunteers or students) willing to construct and/or maintain the composting bins?
- ☐ Can enough bulking material regularly be made available to the school to mix with the food waste?
- ☐ Is there a strong interest in using the compost system as an extension of the class room for project-based education? If not, composting on site may not be for you – instead focus on source separation and hire a hauler to take the scraps away to a composting facility. Arrange a field trip to the facility!

Photo by Cat Buxton, Thetford Elementary School, Vermont

Getting Everyone's Support!

Once the leader(s) in charge of implementing and maintaining the school composting project have been designated, it is then time to meet with the principal to gain his/her full support. Hopefully, the response will be "I love composting. What can I do to help?," or "Sure, great idea. Take the ball and run with it." However, if the response is "Composting, what's that?" refer to the tips listed below for a tactful and sensitive approach. The reply "No way, composting is not for this school," may mean regrouping or finding a new project.

If the principal supports the idea, arrange a meeting with all interested parties and anyone whose daily routine may be affected by a school composting project, i.e., maintenance or custodial personnel, kitchen staff, teachers' aides, school nurse or health aid, and school administration. Go over the "Can Your School Compost?" list as a group, listening to and carefully addressing each individual's needs, fears and concerns.


Photo by NRRA

Use the tips listed below when talking to the group:

1. Introduce the idea as something you are exploring, and the decision to compost will need to be a **joint decision**.

2. Sell the program on the positive aspects that relate to studying science and ecology, solving real world problems like addressing food waste, building healthy soil, and understanding how ecosystems function, working with the community, an example of a natural life cycle, and a possible financial savings to the school, rather than just emphasizing "being good for the environment". Contact NRRA to get assistance with looking at the overall cost of throwing food in the trash dumpster and potential savings to be made for the district.

3. Sell the product! Adding finished compost to soil will improve overall fertility of the school gardens, trees, grounds, sports field, and help to manage increasing storm water volumes by adding pore space, increasing water infiltration capacity, reducing flooding in heavy rains and reducing field damage during drought.

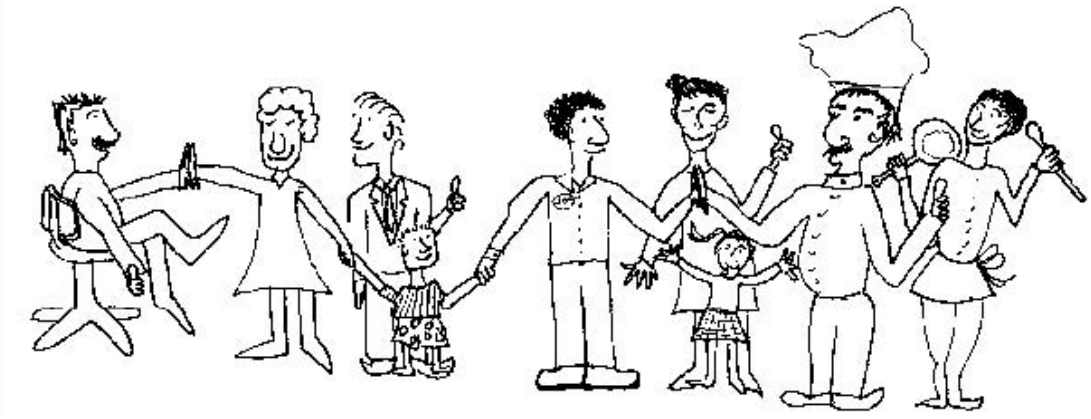
4. "Let staff people know it is not the intention to create more work for them in their daily routine, and that feedback is needed on how to avoid that.

5. Global food waste and soil degradation are real world problems that require behavior and culture change. This is an opportunity to model community problem solving and provide a solid project-based educational opportunity that also builds life skills.

6. Let staff know that there are excellent examples of schools already doing this with integrated project-based educational programming tied to STEM (Science, Technology, Engineering and Math) and NGSS (Next Generation Science Standards).

7. Be sure that everyone understands how composting works and what a school composting program involves.

8. Do not force the issue. If people are not receptive, it may not be the right project or the best time to start.



Time to Get Organized!

Once a decision is made to compost and the full support of all involved parties is obtained, it is time to organize a composting committee and solicit volunteers to participate in the program. The following are suggestions on ways to get the word out to the school and community for moral support, and financial and/or physical help.

- Notify other environmentally focused school organizations and clubs.
- Use school and community newsletters.
- Notify the Student Council.
- Use the school's public address system for announcements.
- Contact local Garden Clubs, Conservation Commissions, Recycling Committees, etc.
- Make announcements at school related meetings.
- Contact local Public Works, Recycling Contractors and Coordinators.
- Contact the NRRA School Recycling CLUB and keep them up-to-date on your progress!

Photo by Ben Laroche, Thetford Elementary School, Vermont

"You cannot get through a single day
without having an impact on the world around you.
What you do makes a difference,
and you have to decide what kind of difference
you want to make."

— Jane Goodall

Photo by Cat Buxton, Thetford Elementary School, Vermont

"...The further we separate ourselves from the dirt,
the further we separate ourselves from ourselves..."

— Tom Robbins,
Another Roadside Attraction

SCHOOL COMPOSTING OVERVIEW

What is going to happen?

The school's compostable food waste will be placed in a separate container from "non-compostable" waste and mixed with a bulking agent (leaves or wood shavings) in an outside bin for composting. This will help to get food waste out of the garbage can, where it is costly and useless, and into a compost bin, where it will break down into a very useful, valuable and fertile soil-like material.

Part 1: Collector

It is suggested that you start composting only "prep scraps" until you feel comfortable with the composting process.

Separating food scraps and composting them is most likely a new and different activity for schools. Consequently, it is important to begin as simply as possible (i.e., avoid contamination, fewer people requiring training and smaller quantities of food). Starting with just kitchen prep scraps will allow time to build the support, cultural awareness and behavior changes needed to eventually take it to the next level of a school-wide separation of food scraps. Whether you start big or small, to get an understanding of how much food waste this will be, consider collecting and weighing it for a week. This will help with planning a collection schedule, feed-stock ingredients and the number of compost bins needed.

The job of the food waste collector is to collect the buckets of food waste from the kitchen staff, record their weight and bring them to the composting bins. This task provides an opportunity to involve the students, consequently giving them responsibilities and ownership of the program. Selecting reliable volunteers for the collection of food waste is critical. Willing and eager partici-pants are key.

The collection process can be part of the regular classroom routine and responsibilities. Teachers can set up rotating schedules for students to follow, giving everyone a chance to participate. The environmental club, student council or other similar student organizations may also be a resource for volunteers. An individual may also enjoy the responsibility of food waste collection. Once a system is established and the whole school is on board, each grade can play a specific role in the whole system alleviating burn-out and modeling a true community-scale effort.

When collecting food waste, the following are a few things to remember.

1. Check with kitchen staff to see if containers need to be emptied. If amenable, involve the kitchen staff by asking them to place daily kitchen waste into the collection area at the scheduled time to flow with the daily maintenance system.

2. Weigh food waste and record weight on tracking form.

3. Take food waste out to composting bins and blend with carbon materials in the compost bin.

> ***Why Remove Food Waste Quickly?***
> Promptly removing the food waste from the kitchen is not only being considerate, but a necessity because the kitchen staff has Board of Health regulations about cleanliness they have to follow.

When kitchen "prep scraps" are being composted, it is important to have the support and cooperation of the kitchen staff. The job of the kitchen staff is to keep compostable food scraps separate from other waste materials. Education is the key to keeping this a relatively simple task.

A few ideas on how to gain the support of the kitchen staff are to...

- **be aware of the kitchen staff's needs** and minimize inconvenience for them
- **ask for kitchen staff feedback**, address concerns and determine a comfort level of participation together
- **pay attention to where most of the food gets prepared** for convenient placement of the collection containers
- **provide clear signage** to minimize confusion. Students may want to be involved in creating attractive signs for compost containers
- **outline the "do's and don'ts"** of the types of food accepted

In the kitchen, food waste for composting needs to be kept separate from other materials. Please use the designated containers for food waste collection. Using the lids on these will help control odor and any potential fruit fly problems. A food waste collector will check with kitchen staff routinely to monitor the amount of food waste generated.

Why Can't Everything Be Composted?

Meats, dairy products, oils and fats compost slowly and can create odors that, if not composted correctly, are likely to be offensive, as well as attract animals to the bins. This applies to smaller compost systems that do not reach high enough temperatures to break down more difficult food wastes.

There are some schools where compositing meat and dairy is allowed and has been shown to be successful. Check with your state to see what your school is allowed to compost on site. Inexperienced composters should start with the acceptable ingredients listed on the right to be safe.

When separating food waste for composting, here are a few things to remember:

ACCEPTABLE

- Fruit Scraps
- Vegetables
- Breads
- Egg Shells
- Tea Bags
- Coffee Grinds

DEPENDS

- Oils
- Fats
- Bones
- Meats
- Dairy Products

Photo by Ben Laroche, Thetford Elementary School, Vermont

The following tips are useful when preparing the collection routine for the volunteers.

- **Set a regular schedule** for collection volunteers.
- **Collect the food waste containers on a schedule** which fits both the kitchen staff and the custodial staff needs.
- **Create clear and precise instructions** for the food collectors.
- **Make sure all of the supplies are ready** for collectors: thermometer, scale, gloves for a squeeze test (or a moisture meter); Ipad or spreadsheet for data collection; clean wagon; replacement buckets in all areas of collection; feedstocks for bulking agents; and jugs of water or a hose within reach of the bins to add any needed moisture.
- **Spend time educating collectors** about their duties and responsibilities.
- **Keep everybody happy!** Do not create more work for the cafeteria or the custodial staff. Their support is critical in the success of the composting program.
- **If possible, ask every department to play a small and consistent role** in the community waste reduction plan. For example, **the kitchen staff** could be in charge of making sure their scraps are collected and that the collection area in the kitchen or cafeteria is supplied with fresh replacement buckets. **The custodial staff** could take on daily bucket and wagon washing, leaving it set up in the cleaned collection area for the next day. **Students and teaching staff** can manage the system and **parent volunteers or committees** can manage the feedstock supplies.
- **Consider giving food scraps to a local farmer** with chickens, pigs or goats one day a week throughout the school year. This will better meet the Food Recovery Hierarchy by feeding animals, will reduce the load of work of the school, and expand the length of time between pile turnings.

Part 2: Bin Operator

The job of the bin operator is to mix the food waste into the bin, and to be sure it is covered with bulking agent so that no food waste is left exposed. Use the recipe guide located in Appendix D. When operating the bin, there are a few things to remember.

1. Open the bin, insert the compost thermometer into the center of the food waste and bulking agent, and record the temperature. If time allows, do this in 2 – 3 places to gain more accurate data of the whole pile.

2. Assess and record the moisture (see 'assessing moisture' and 'squeeze test' in Appendix D).

3. Stir the food and top layer of bulking agent that is already in the bin (from the last food waste deposit) with the pitchfork.

4. Add the food waste from the container, mixing it in with the food waste and bulking agent you just stirred and spread the material in the bin evenly.

5. Cover the mixed food waste and bulking agent with a layer of new bulking agent, making sure no food waste is visible.

6. Be sure to securely replace the door on the bin.

7. Bring the buckets to the washing station. Do not leave messy buckets hanging around!

Why the Bulking Agent?

The bulking agent will need to be mixed with the food waste to achieve the appropriate carbon/nitrogen ratio and provide oxygen for the composting process, to avoid odor problems that might also attract pests and insects.

Photo by Ben Laroche, Thetford Elementary School, Vermont

Part 3: Compost Coordinator

The job of the compost coordinator is to make sure the composting process is working well. This is a very important part of the project and can help to eliminate any potential problems. The following list of tasks are pertinent to coordinating the compost project.

1. Check the moisture of the bin. It should be as moist as a wrung-out sponge. (See squeeze test in Appendix D.)

2. Check the temperature of the bin and record it on the tracking form. When inserting the thermometer into the compost, grasp the stem about 6" back from the point and push (DO NOT push the head of the thermometer). Once the stem goes in 6", grasp the stem 6" farther back, and push again. Repeat until the stem is completely inserted to at least a 1-foot depth. This method will avoid bending the stem. Once the thermometer is inserted in the pile, wait at least 45 seconds before reading the temperature. When finished using the thermometer, return it to its box.

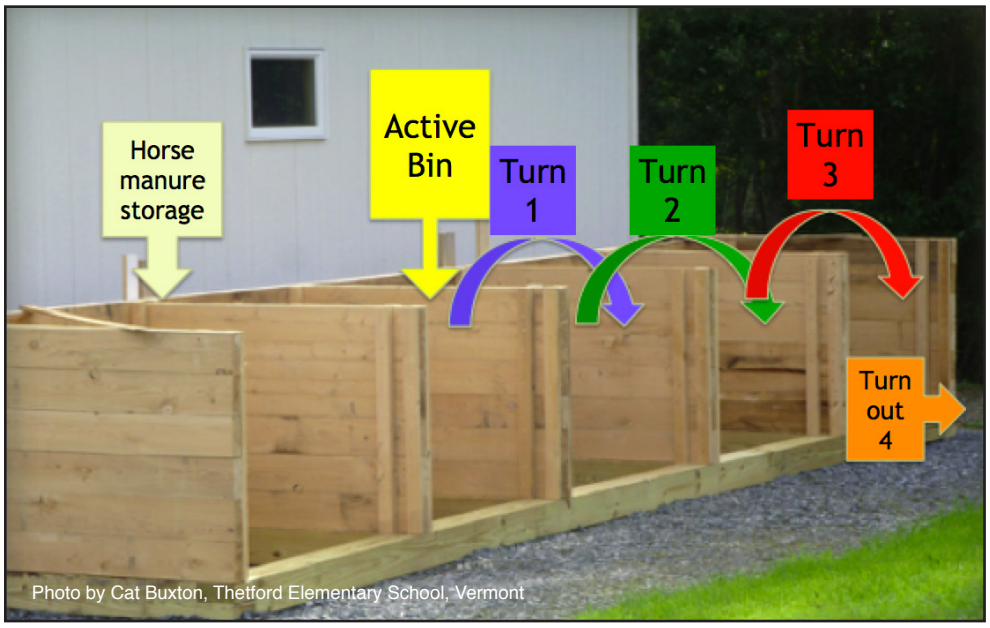
Why Check the Temp?

Moisture is needed for the microbes to work and too much moisture will keep oxygen out. The hotter the pile, the faster the composting (100°F+) but if too hot (150°F+) it will kill off compost bacteria.

3. If the temperature is under 100°F, or over 150°F, mix the whole bin (too hot kills off compost microbes, too cold means the compost process has slowed down).

How to Turn the Compost...

When Bin #1 is full, notify the "Compost Starter." Turning the compost can be a great way for community groups such as a gardening club to become involved with the school, especially once more than one bin needs turning at a time. A successful K-6 school in Vermont rallies 4th and 5th graders for a week during recess to turn up to three bins. Usually, the active bin is turned by adults as that is the only bin that might produce unpleasant odors when turning.



Having clear systems in place is critical for success when working with a large group such as a school. Choose a bin on one end of the system to always be the active bin where new food scraps are deposited. All other bins are for compost that has already been turned.

1. **Transfer all material** from Bin #1 into Bin #2 using the pitchfork.
2. **When turning the materials** be sure to be adding air along the way by 'fluffing' and not 'flopping' each forkful of compost into the new bin. As much as possible try to get what was the top toward the bottom, and the outside contents toward the inside, thoroughly mixing. Add moisture as you turn if the pile seems too dry.
3. **Be sure to securely replace** the top and front of the bin.

Part 4: Compost Starter

The job of the compost starter is to start a new composting bin by setting the appropriate materials in the bin and to turn the contents of a full bin into an empty bin. Make sure there is plenty of bulking agent available until the process will have to be repeated again. This is an ongoing responsibility. Follow the steps below to start Bin #1 again.

Photo by Ben Laroche, Thetford Elementary School, Vermont

1. Place 6"-10" of bulking agent in the bin as a base. This will absorb any excess moisture from the food waste.

2. Scatter the food waste over the entire bulking agent surface.

3. If you are using leaves for a bulking agent, you will not need to "seed" (add microorganisms to) your compost. If you are using wood shavings, you may want to "seed" your compost. To "seed," sprinkle and mix approximately one (1) five-gallon bucket full of animal manure (cow, sheep, horse, chicken or rabbit - do not use dog or cat manures) or existing compost or leaves into the food waste and bulking agent. A "compost activator" sold at feed and hardware stores can also be used.

4. Cover the food waste with a layer of bulking agent, making sure no food waste is visible.

5. Be sure to securely replace the top and front of the bin.

Why Mix and Cover?

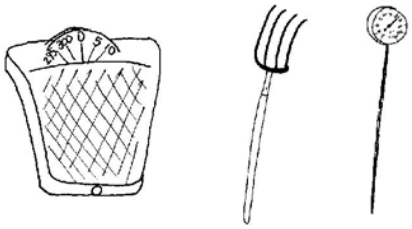
The well-mixed food waste and bulking agent will aid in the composting process and help keep odors and pests away.

COMPOST BIN OPERATION

The following information pertains to a school using the three- or four-bin turning unit for their school composting program.

What Equipment Is Needed?

A few basic pieces of equipment are needed for the composting operation. Refer to the check list below for suggestions on what is needed. Unless noted, these items can be found in hardware and garden supply stores.



- **Pitch Fork** for turning the compost. Get a wide one and ideally two forks.
- **Wheel Barrows** for moving finishing compost from bin to bin and out into windrows. A good sturdy sled will make this possible in wintertime.
- **Tarp** for covering the bins to keep out rain or snow. Note: It is preferable that each bin have a sturdy lid to prevent pests. The active compost bin should always have a roof or a well-secured pop-up tent to cover the area.
- **Compost Cloths** (optional). Specially made fabric designed to regulate air and water flow through curing compost piles or windrows to keep the microbes alive for fertility purposes when using the compost in gardens.
- **Bungee Cords** to fasten the tarp to the bins.
- **Compost Thermometer** to take the temperature of the compost.
- **Hanging or Bathroom Scale** for weighing the amount of food waste you place in compost bins. Feed store or department store.
- **Bib or Coveralls** to protect the clothing of the bin operator. Retail store.
- **Rubber Gloves** for conducting a squeeze test.
- **Data Recording Materials** such as record sheet, pen, clipboard, or an ipad with active compost data collection form. Office supply store.
- **Several Lightweight 35- to 50-Gallon Trash Cans** with lids to store feedstock bulking agents.
- **Space:** You'll need enough storage space nearby the compost bin for dry feedstock materials. Once you started producing volumes of compost you will need an area to store compost in a windrow until it's finished curing and ready for use.

Let's Compost!

Once the bins are constructed, the bulking agent selected and composting equipment obtained, you can begin composting.

STARTING A NEW COMPOST PILE

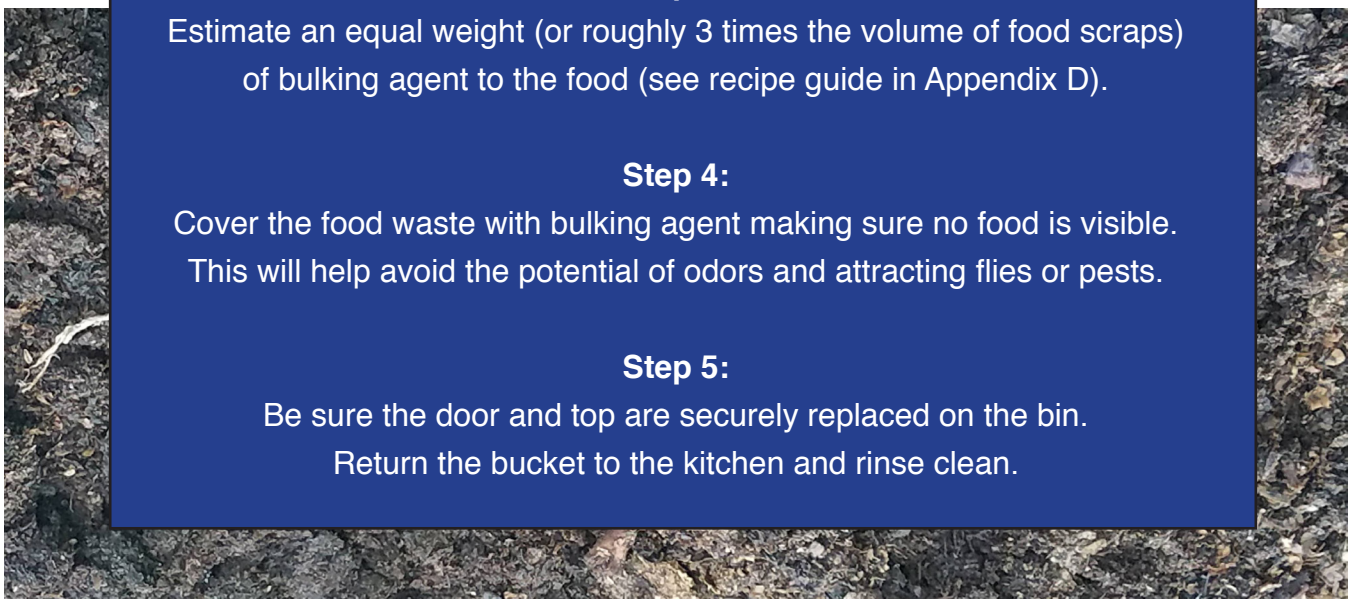
Step 1: Place six to ten inches of bulking agent in the bottom of the bin as a base. This will absorb any excess moisture from the food waste and help let air into the pile.

Step 2: After the weight of the food has been recorded, scatter the food over the entire bulking agent surface.

ADDING TO THE COMPOST PILE

Step 1: Insert compost thermometer into center of the compost and record the temperature. Thoroughly mix food and top layer of bulking agent from last food deposit with a pitch fork.

Step 2: After the weight of the food has been recorded, mix it in with the food and bulking agent you just stirred.



Step 3:
Estimate an equal weight (or roughly 3 times the volume of food scraps) of bulking agent to the food (see recipe guide in Appendix D).

Step 4:
Cover the food waste with bulking agent making sure no food is visible. This will help avoid the potential of odors and attracting flies or pests.

Step 5:
Be sure the door and top are securely replaced on the bin. Return the bucket to the kitchen and rinse clean.

What About Winter?

If your recipe is just right for the microbes your compost will stay hot and very active all winter long. Depending on your climate and how well your pile is structured, when the temperature drops below freezing, microbial activity may slow down and the compost may freeze.

Even though compost may freeze, food waste and bulking agent can continue to be added during the cold winter months. Here are some tips for getting through the winter:

- **Place bins** in an area where they can be plowed to keep access open all winter long.
- **Have access** to plenty of dry bulking agent.
- **Mix the food** with the bulking agent thoroughly when adding it to the bin.
- **Cover the bins** with a sturdy lid or a thick tarp to keep out the snow.
- **Start the winter** with at least one empty bin. (Plan ahead!)

A suggestion for extending your composting season is to insulate the bins before November. Stacking bales of hay or attaching rigid insulation board around the outside of the bins before the compost temperature drops below 100°F are two ways of insulating the bins.

Photo by Cat Buxton, Thetford Elementary School, Vermont

Photo by Ben Laroche, Thetford Elementary School, Vermont

"To-day I think
Only with scents, - scents dead leaves yield,
And bracken, and wild carrot's seed,
And the square mustard field;

Odours that rise
When the spade wounds the root of tree,
Rose, currant, raspberry, or goutweed,
Rhubarb or celery;

The smoke's smell, too,
Flowing from where a bonfire burns
The dead, the waste, the dangerous,
And all to sweetness turns.

It is enough
To smell, to crumble the dark earth,
While the robin sings over again
Sad songs of Autumn mirth."

— A poem called DIGGING."
Edward Thomas, Collected Poems

"FINISHED" COMPOST

In anywhere from six weeks to one or two years, you will be able to enjoy one of the greatest benefits of a school composting program: "finished compost!"

Is the Compost Finished?

Compost is finished when the materials placed in your bin have transformed into a crumbly brown "soil." The compost pile will be close to air temperature and the compost should feel like good garden soil with a sweet, clean aroma. If the compost is still "cooking," it will be too "hot" to use on young plants. If you're not sure if it's finished, turn the pile one more time and take the temperature. If the temperature rises, it's not quite finished. If the temperature stays the same as the ambient temperature, it's finished!

> ***Why Such a Time Gap?***
>
> The time it takes depends largely on your recipe and how often the piles are turned. Regular daily turning may yield a finished product in six weeks, rarely turned compost in two years.

Should the Compost Be Tested?

It is not necessary to have the finished compost analyzed. However, for those interested, a soil analysis of the end compost product can be done at a local university for a fee.

They will provide a comprehensive analysis covering the minerals and salts present and overall plant nutrient value of the finished product. A biological assay can be done to assess the diversity and populations of organisms in you compost. These tests are expensive (about $200) but can be useful for advanced biological science curriculum extensions.

How to Use the Compost?

How compost looks and how it will be used determines whether or not it needs to be screened. Most uses of compost, i.e., landscaping, mulching, and gardening projects, do not require screening. However, if screening is desired, half-inch hardware cloth can be used to pass the compost through.

Most compost does not contain a whole lot of available nutrients for plants. Good compost is an excellent inoculum to replenish soil biology into landscapes – it's the life in the soil that enables the natural biological cycling of nutrients.

Because the finished compost is valuable, it most likely will be in great demand. Compost can be used as a rich soil amendment or mulch for:

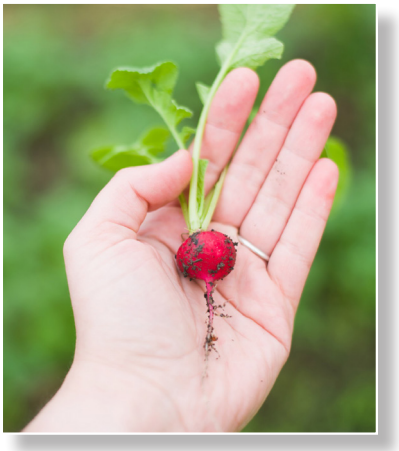
- **landscaping projects** or **class planting projects**
- **greenhouses** or **vocational programs**
- **school grounds landscaping** (work with the maintenance staff)
- **mulch and food for fruit trees** and **berry bushes**
- **home gardens** (for the school community)
- **a fundraiser for the school** (some teachers may want to incorporate this into their math, business, accounting or art curricula)

Using Compost to Enhance Soil Health

There is a big difference between dirt and soil. Dirt is a varying mixture of sand, silt and clay but has no life in it. Dirt is what is under your fingernails or on your shoes. You really cannot grow plants in dirt! Soil contains organic matter in the form of living organisms (remember the billions in a teaspoon of healthy soil) and in the form of decayed plant matter or humus – food for the microbes.

Compost can be used in gardens as an amendment, mixed in or layered on top. The worms, beetles and other macroorganisms will work the compost down into the soil profile. Finished compost is an excellent amendment to add to lawns and pastures to improve overall soil health, water infiltration and water-holding capacity, leaving grasses greener and lush throughout the season. The best time to add compost to the lawn is in fall or spring after a lawn has been aerated. Apply an even but spare coating (like powdered sugar on a cake!) and ideally, rake it in after aeration to get the compost to sprinkle down into the aeration holes.

Compost of any kind makes great mulch around fruit trees, berry bushes and in garden beds. Apply as thickly as you need for full coverage to reduce weed pressure and retain moisture – there is no such thing as too much compost.



"There's something satisfying about getting your hands in the soil."

— E.A.Bucchigneri

PROGRAM EVALUATION

Changes will probably be made throughout the program making it more efficient each step of the way. However, once the project has been up and running, take some time to meet with those involved, evaluate the program, and see if there are ways it can be streamlined. Encourage the cafeteria staff, students, faculty, the school nurse and maintenance staff to spend time discussing what they like and dislike about the program.

This feedback will help the program to run smoothly. With school composting, getting the people involved and excited is really important. If the process goes smoothly, the group of composters will be happier. Make sure they know that their input is valued and important.

Education, Kick-Off and Promotion

Start the year off right with a school compost assembly; a grade appropriate presentation in the classrooms; and/or an annual trash assessment week to include how to sort food scraps in the cafeteria. A successful composting program needs to educate all of the active participants. Have an event or activity to mark the start of the program, and keep the motivation going throughout the program's life.

Education Is Key!

Education can begin when the idea of a school composting program is first conceived and continue as an ongoing process. ***Some school composting education ideas to think about are...***

- **teaching people** (faculty, staff and students) the basic concepts of composting, i.e., compost formula, what can be composted, etc.
- **relating composting to the basic solid waste management concepts** of "reduce, reuse, recycle". Composting is nature's way of recycling!
- **helping people** in the school and community learn the importance of the program and how it can impact the school through school or community wide events.
- **including education** in school assemblies and individual classroom presentations.
- **starting a competition** to see which class or grade can reduce their food waste the most.

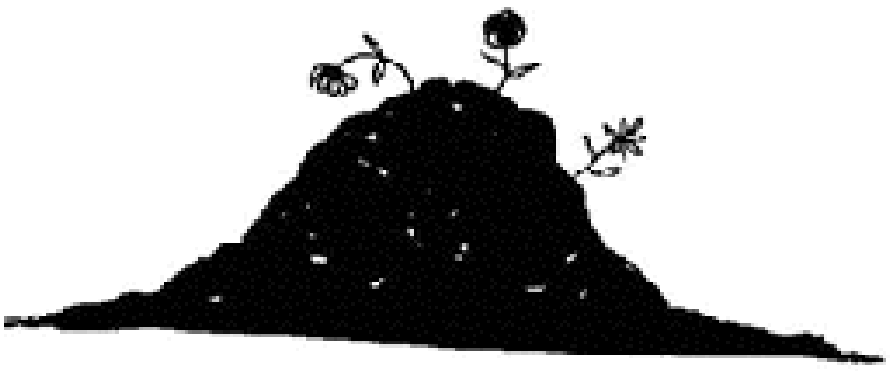
- **utilizing informational resources that are available**, including the cooperative extension services, community recycling coordinators and state recycling represen tatives. The School Recycling CLUB also has a number of educational materials that can help incorporate composting into the reading, writing, and math of every day classroom learning and curriculum (see Appendix F for examples).

Kicking It Off!

Having a specific time set aside to celebrate the start of the school composting program will help ensure enthusiasm and follow through with all active participants.

Some suggestions for a kick-off are...

- **inviting the press** to cover the kick-off event.
- **organizing a "compost bin building" event** on the day of the kick-off and invite the community to participate.
- **kicking off the project** in conjunction with other community events, like Earth Day or Arbor Day.
- **making posters** and other public information materials to publicize the event.
- **inviting keynote speakers**, i.e., local Conservation Commission members, Cooperative Extension educators, Garden Club members, landscapers, organic farmers, state or local environmental representatives, etc., to endorse the composting project and to help illustrate the importance and impact of the project.
- **inviting professional performers** to entertain and educate students and staff about composting and other environmentally related issues.



Don't Forget Promotion!

Once a school composting program is implemented, the new routines can become second nature to the participants. The program basically runs itself! However, to get the full benefit of the program, it is important to keep the motivation going.

The following lists some suggestions for ongoing promotion.

- **Keep the motivation for the project going** by providing recognition to participants, i.e., kitchen staff and collection and compostingcrew, for a job well done.
- **Use the public address system** to make announcements about the project's milestones.
- **Post graphs or charts** indicating how much food is being diverted from the waste stream.
- **Get more press coverage** highlighting results.
- **Plan a celebration** focusing on use of the end product (i.e., a tree planting on Arbor Day utilizing the compost to plant the tree).
- **Help other schools** who may be interested in learning the benefits of implementing a composting program.

Good Luck!

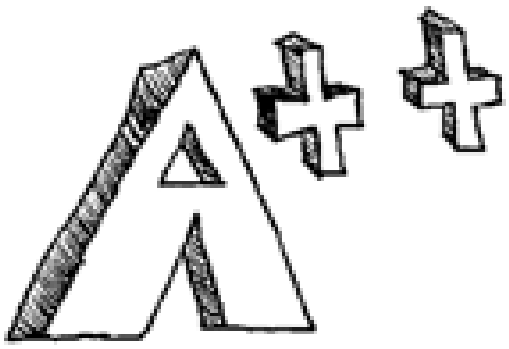
School composting is an excellent way to recycle important and plentiful organic waste. All who are interested in this concept are heartily encouraged to pursue it. There are many potential volunteers throughout the school and community to help make it a reality.

So, good luck with school composting. Remember, this is not the end of the "Closing the Food Loop at School" guidance. This is just the beginning of available school composting assistance and resources.

When you start your school composting program, please contact NRRA's School Recycling CLUB. We would like to keep track of the schools that are composting and are always happy to answer any questions.

NRRA School Recycling CLUB

www.nrra.net
www.schoolrecycling.net
(603) 736-4401



APPENDIX A: A Glossary of Terms

Actinomycetes Microorganisms that have the characteristics of both fungi and bacteria. Actinomycetes create cobweb-like growths throughout the compost and give compost an earthy aroma.

Active compost The compost bin where food scraps are being added on a regular basis.

Aeration The process by which the oxygen-deficient air in compost is replaced by air from the atmosphere. Aeration can be enhanced by turning compost.

Aerobic decomposition Decomposition of organic wastes occurring in the presence of oxygen, making possible conversion of material to compost.

Allelopathy or allelopathic A biological phenomenon by which an organism produces one or more biochemicals that influence the germination, growth, survival, and reproduction of other microorganisms.

Ammonia A colorless gas with a characteristic pungent smell, produced by microorganisms in low-oxygen environments.

Anaerobic decomposition Decomposition of organic wastes occurring in the absence of oxygen. Causes production and release of methane gas.

Bacteria In a compost pile, the microorganisms that do most of the work to decompose wastes. Hardworking bacteria cause the compost pile to heat up. There can be more than 75,000 species of bacteria and over a billion bacteria in a teaspoon of compost.

Biodegradable Capable of being broken down by microorganisms (bacteria and fungus) into simple compounds that act as fertilizers in the soil (plant and animal remains are biodegradable). Another word for biodegradable is compostable.

Bulking agent Material, such as leaves, wood chips or shavings, added to compost primarily to help create good pore structure for air flow. Often provides part of carbon source as well.

Carbon All plants have carbon as their most important element. Without carbon plants would not exist. That means every animal on Earth also needs carbon to survive. Carbon is a critical component of compost recipes. It is abundant in dead or dying plant material such as wood chips, sawdust, straw, and leaves. Carbon provides energy for living things.

Celsius (C) A temperature scale in which 0°C is freezing and 100°C is boiling.

Compost A rich humus-like mixture that is produced when organic materials break down into soil organic matter (SOM).

Composting The managed aerobic process of conversion of most organic materials into humus by the activity of microorganisms, and an effective solid waste management technique for reducing the organic portion of waste.

Decomposition The natural breakdown of organic waste materials by aerobic and anaerobic bacteria, protozoa, nematodes and fungi into simpler components (e.g., carbon dioxide, water and inorganic solids).

Disposal The discharge, deposit, injection, dumping, incineration, leaking or placing of any waste into or on any land, air or water medium.

Dump An open and unmanaged disposal site used prior to sanitary landfills where waste materials were burned, left to decompose, rust or simply remain.

Environment All the conditions, circumstances and influences surrounding and affecting the development or existence of people or of nature. One's surroundings, inside or out-of-doors.

Fahrenheit (F) A temperature scale in which 32°F is freezing and 212°F is boiling.

Finished compost Compost that has minimal recognizable food scraps and when turned remains at the ambient temperature indicating lower biological activity.

Fungi Microorganisms such as molds, yeast and mushrooms that feed on dead organic matter.

Humus That more-or-less stable organic fraction of the soil matter remaining after the major portion of added plant and animal residues have decomposed. Humus is usually dark in color.

Hyphae Each of the branching filaments that make up the mycelium of a fungus.

Invertebrate An animal without a backbone, such as an insect or worm.

Kitchen waste The unused portions of food when making a meal. Aka food scraps, such as potato peels, apple cores, moldy food and wilted lettuce.

Landfill A large outdoor area for waste disposal. Landfills where waste is exposed to the atmosphere are called open dumps; in sanitary landfills, waste is layered and covered with soil.

Leachate Water that has percolated through a solid and leached out some of the constituents.

Methane An element. An odorless, colorless gas produced by microorganisms in low-oxygen environments. Methane is a powerful greenhouse gas.

Microorganism Aka microbes. A tiny living thing that is so small you need a microscope or magnifying glass to see it. Microorganisms help break down organic wastes.

Millipede A tiny worm-shaped animal with many pairs of legs. They live in soil and compost.

Mite A tiny animal, or arachnid, no bigger than a pinhead, that lives in soil, plants, and compost.

Mulch A covering, such as leaves, straw, peat moss or compost, that is placed on top of the soil in gardens and around trees to suppress weeds, keep soil moist, and keep plant roots cool in summer and warm in winter.

Nitrogen A naturally-occurring element that is essential for growth and reproduction in both plants and animals. It is found in amino acids that make up proteins, in nucleic acids, that comprise the hereditary material and life's blueprint for all cells, and in many other organic and inorganic compounds. It is found in all living things such as food scraps, grass clippings, plants and manure.

Nutrient A food ingredient that supplies energy for living and growth.

Organic Made from living microorganisms, such as plants and animals. Organic substances include tree leaves, wool from sheep, and any other materials containing the nonmetallic element carbon (like diamonds and graphite, which are pure carbon in different forms).

Pill bug A small animal that lives in moist soil and rolls up in a little ball when it is threatened or scared.

Plate scrapings The food waste left on plates after a meal.

Potworm A small worm that lives in soil and compost. Their scientific name is enchytraeids. The common name comes from being found in pot plants. They flock to fermenting foods.

Prep scraps The food waste produced from preparing meals.

Protozoa Protozoa are one-celled microscopic animals. They are found in water droplets in compost but play a relatively minor role in decomposition. Protozoa obtain their food from organic matter in the same way as bacteria do but also act as secondary consumers ingesting bacteria and fungi.

Recycle To pass through a cycle again; to collect and reprocess manufactured materials for reuse either in the same form or as part of a different product.

Resources A supply of something that can be used or drawn upon. Something that can be used to make something else — wood into paper, iron ore into steel, old newspapers into cardboard.

Roundworms (nematodes) Nematodes are very small worms, usually only 1 millimeter or less in length. They are simple microorganisms, equipped only to eat and reproduce. Most members of this very diverse family are beneficial. Individual species prey on a variety of microscopic microorganisms, including bacteria, fungi and other nematodes. Nematodes are good for compost.

Solid waste Any unwanted non-liquid material that is discarded from households, industries or communities.

Sulfur A gas with a characteristic pungent smell, produced by microorganisms in low-oxygen environments.

Turning In a compost pile, mixing and moving the organic material.

Turning unit Multiple compost holding bins built next to each other.

Waste stream All materials and resources being thrown away.

Yard and garden wastes Grass clippings, dead leaves, small branches and weeds.

APPENDIX B: Composting Resources

There are plenty more. These are the primary state agencies and non-profit organizations that contributed to this guide.

NEW HAMPSHIRE

New Hampshire Department of Environmental Services
29 Hazen Drive
Concord, NH 03301
(603) 271-3503
www.des.nh.gov

NH Farm to School
Sustainability Institute at the University of New Hampshire
107 Nesmith Hall
131 Main Street
Durham, NH 03824
(603) 862-2542
www.nhfarmtoschool.org

Northeast Resource Recovery Association
2101 Dover Road
Epsom, NH 03234
(800) 223-0150
www.nrra.net

MAINE

Maine Department of Environmental Protection
17 State House Station
Augusta, ME 04333-0017
(207) 287-7688
www.maine.gove/dep/

10 Steps: Starting a Successful School Composting Operation
Maine DEP, Division of Sustainability
https://www.maine.gov/dep/sustainability/compost/index.html

MASSACHUSETTS

MA Department of Environmental Protection
One Winter Street
Boston MA 02108
(617) 292-5500
https://mass.gov/orgs/massachusetts-department-of-environmental-protection

MA Green Team
20 Newton Street
Brookline, MA 02445
https://thegreenteam.org/

RecyclingWorks Massachusetts
(888) 254-5525
info@recyclingworksma.com
https://recyclingworksma.com/

RecyclingWorks Massachusetts Food Waste Estimation Guide
https://recyclingworksma.com/food-waste-estimation-guide/#Jump3

VERMONT

Cat Buxton
Grow More, Waste Less | Food Systems Consulting, LLC
Sharon, VT 05065
cat@growmorewasteless.com

Vermont Agency of Natural Resources
Department of Environmental Conservation
Waste Management and Prevention
One National Life Drive
Montpelier, VT 05620-3520
(802) 828-1556
https://anr.vermont.gov/

VT DEC School Composting Resources
https://dec.vermont.gov.about-dec/a-z/waste-topics

APPENDIX C: Composting at Schools

The following school profiles are helpful to schools who are unsure of how to start a composting initiative. These stories provide insight into some of the steps required to pilot an effective program. They also illustrate various approaches used by educators to discover and implement solutions to unique scenarios. It's important to personalize your composting program to fit the specific needs of your school!

The PRIMARY Goal of Composting at School: To develop a school composting program that can be easily duplicated by other schools with a minimal investment of time and money.

The SECONDARY Goal of Composting at School: To educate students in science, math and solid waste issues by learning how to compost and demonstrating the possible environmental and economic advantages of composting.

From the Archives (1995 and 1996) of the Belmont High School (Belmont, NH) & New Boston Central School (New Boston, NH)

For both NH pilot programs that were the impetus for this guide in 1996, the three bin composting unit made from reused wooden pallets would have been sufficient for the volume of food waste they produced. At Belmont High School, "prep scraps" were approximately 1/2 pound per student per month, while at New Boston Central School, "prep scraps" were approximately one pound per student per month. However, just in case more space was needed, a fourth bin was built at both schools, and became very handy to store the bulking agent.

Both pilot programs were designed so that the only responsibility of the kitchen staff was to place the "prep scraps" into a separate container. The New Boston Central School kitchen staff found this new routine required less time and energy than the garbage disposal that they had been using previously. There was also the advantage of the septic tank requiring less maintenance.

The NH pilot schools started their composting programs in March of 1995 using mulch hay as a bulking agent. After three months of composting, much of the food was breaking down but the hay was not. Belmont continued to experiment using hay as the bulking agent, while in September, New Boston switched their bulking agent to leaves. New Boston used a ratio of one part food to one part leaves (by weight) and by three months, both the food and leaves had broken down to a finished compost product. Belmont's hay continued to show little breakdown, so they reused their partially decomposed hay by mixing it again as a bulking agent with the food waste.

Belmont High School Highlights

630 students
Grades 7-12

In Belmont, the kick-off event was in conjunction with the High School students building the composting bins. Before construction began, a brief “What is composting?” presentation was given to the participating classes by the NH Governor’s Recycling Program and the NH Department of Environmental Services. Two reporters from local newspapers attended the event to take photos and interview the students.

To experiment with extending the active composting season further into winter, the bins were insulated in November with 1-inch styrofoam insulation board with an R value of 5. However, the compost bins were not active at the time the insulation was applied (bin temp was about 45°F) and the temperature did not increase again until the spring thaw.

New Boston Central School Highlights

384 students
Grades K-6

The school’s food waste was initially picked up after lunch every day. However arrangements were later made for every other day on Monday, Wednesday and Friday. This new schedule was satisfactory with the kitchen staff as long as the students were consistent with their pickup routine and did not forget.

A finished compost sample was taken from the New Boston Central School bins in June in 1996 and analyzed at the UNH Analytical Services Lab. The soil scientist commented on the excellent C:N ratio of 12:5 and that the compost sample was a nutrient rich media that looked like and excellent growth medium for plants.

New Boston has a Christmas tree planting program, in which the students
students plant seedlings every year and then dig them up and sell them to the public a few years later. This was an ideal situation to use the finished compost as a mulch to enrich the soil around the trees and to protect their rots in the winter.

From a Survey of Schools Embarking on a New Program (2018 and 2019)
Hoosac Valley High School (Cheshire, MA)
622 students
approx. 63 staff
Grades 6-12

Through a process of training to prepare for intended school initiatives, Hoosac Valley High was chosen as one school to apply for funding from the Henry P. Kendall foundation. It was the only one of four schools to be approved for the grant in July 2019. The school applied to roll out three greenhouses, two supply sheds, thirty raised beds and an outdoor classroom in abandoned tennis courts on school property (approximately a space of 100′ X 120′). The Middle School is in the same building as the High School and the intention is to eventually incorporate those students, but the project will begin with the High School.

Vacant tennis court lot and the anticipated location of Cornerstone Grown - view from the back corner adjacent to the school woodlot/nature trail

The Superintendent, who facilitated the piloting of much of this composting initiative, asked the school's Green Team to get involved in the composting and recycling aspects of the Farm-to-School Grant. The mission of Hoosac Valley High School's "Cornerstone Grown" is to establish a Farm-to-School program that prepares its students to be thriving, contributing, responsible citizens of the northern Berkshire County community and beyond. Hoosac students will engage in meaningful community partnerships and opportunities that teach them perseverance, and accountability while creating and strengthening their connection to their peers and school community. An extensive school garden program will serve as the epicenter of GROWTH.

The intention of Cornerstone Grown is to have as much student community involvement as possible so that Hoosac Valley High School students have a sense of ownership and community. That being said, two elective classes - Wood Technology and Timber Framing - will be doing the building of Cornerstone Grown infrastructure. The Timber Framing class will focus on the timber

and the Wood Technology class will be focusing on the raised beds, walls and roofs of timber frames. The three greenhouses will have timber frames (12′X16′) with no walls as they will have plastic covering. The two timber frame supply sheds (10′X10′) will have walls and a roof, and additionally the outdoor classroom will be a timber frame with a roof but no walls.

Building the infrastructure started on Labor Day. Ten students are involved in collecting food scraps and piloting the education of getting the school community to separate food waste from trash. The plan is to have at lease one timber frame and all raised beds built by April 2020. Junior/Senior interns will also be involved to help maintain the garden over the summer, which includes going to farmers markets to sell produce in order to make the Farm-to-School initiative more sustainable.

Cornerstone Grown consists primarily of three teachers as the project team (Special Education, the Cornerstone Program and Environmental Science) who are in charge of getting the project up and running. The Cafeteria Manager will be assisting as produce is harvested and transitions into the school cafeteria lunch menu. The goal is to promote healthy eating through sustainably and locally grown fruits and vegetables. However, Cornerstone Grown will naturally extend beyond the classroom and cafeteria, into the local community.

The district purchased two backyard composting bins (Earth Machines) with the Farm-to-School Project to put in the garden. Currently there is a limited recycling program, only cardboard boxes in each classroom but Hoosac Valley received three recycling bins (with wheels) to collect recyclables from classrooms, fifty 14-gallon recycling bins and fifty 7-gallon recycling bins from the Massachusetts Department of Environmental Protection (MADEP).

Hoosac Valley High School. New recyling bins (above) and composting bins (right).

From a Long-Standing and Successful Program (2009 - present)
Thetford Elementary School (Thetford, VT)
206 students
approx. 50 staff
Grades K-6

The school Green Team and the sixth grade students manage all of the school's organic waste, about 200 lbs. of pre- and post-consumer food scraps including meat, dairy and bones in a 4-bin turning system. Ten years in, as of 2019, the program is carefully designed to connect to the curriculum and is interwoven throughout the school culture involving many hands and creating little work.

Sixth grade students manage the total daily compost and collect data to compliment their math and science studies. K – 5 students each play a role by collecting classroom paper towels and cafeteria scraps and bringing them to a central location daily. The oversight is managed by the Green Team including, key teachers, administration, parents, the cafeteria staff and custodial team.

In 2009 the school began by collecting snack scraps from just the K-2 classroom. During the early years, scraps were managed (not well) in a plastic bin system. Some scraps were thrown out, others were fed to farm animals. By 2011, all grades were separating food scraps in the classroom and the kitchen/cafeteria also began source separation. Students and teachers offered daily support for sorting waste in the cafeteria until it became a natural behavior change.

In 2012, the school hired a consultant who helped to design a system and a recipe and arranged for an all-school assembly to launch the program. The school got a grant to build a 4-bin turning system and began sourcing a regular supply of carbon feed stocks from the community. In 2013, a roof was installed over the compost bins to make winter easier – we love it! Also in 2013, students determined that according to the VT Association of Natural Resources (VTANR) Food Recovery Hierarchy it would be better to feed food scraps to farm animals before making compost from the waste. As a result, two days a week food scraps are collected and sourced out to local families with chickens. The remaining three days of food scraps are added to the compost system. This development created some room for flexibility in the program during busy times and has lightened the daily load and extended the life of the 4-bin turning system.

By 2014, the school realized they could replace leaves and shredded paper with their own abundance of classroom paper towels. The Green Team has secured a few sources for horse manure with bedding (straw or wood chips) and wood shavings or sawdust from area mills and furniture makers, storing about ten 50-gallon trash barrels worth of dry feed stocks in a covered, un-insulated garage near the compost station. The Green Team replenishes these as needed, every 2 – 3 weeks. Thetford Elementary School welcomes visitors to make an appointment to see the compost system in action.

Most of the photographs in this Guide are from the Thetford Elementary School program.

APPENDIX D: Helpful Documents

3-BIN COMPOSTING UNIT MADE FROM REUSED WOODEN PALLETS

In the 1996 pilot program, the design was a three-bin turning unit made from pallets and hardware cloth. (This continues to be a very popular design for schools.)

INSTRUCTIONS

Cover pallets with hardware cloth and connect to each other using "L" brackets. The tops and fronts of the bins are made from hardware cloth attached to wooden strapping for lightness, easy maneuverability, and maximum ventilation (see diagram of bins below). Usually, a compost bin will sit right on the ground to maximize contact with microorganisms. However, a floor is recommended to keep rodents and any other pests out of the compost. Therefore, the materials list is based on a three-bin unit with floors.

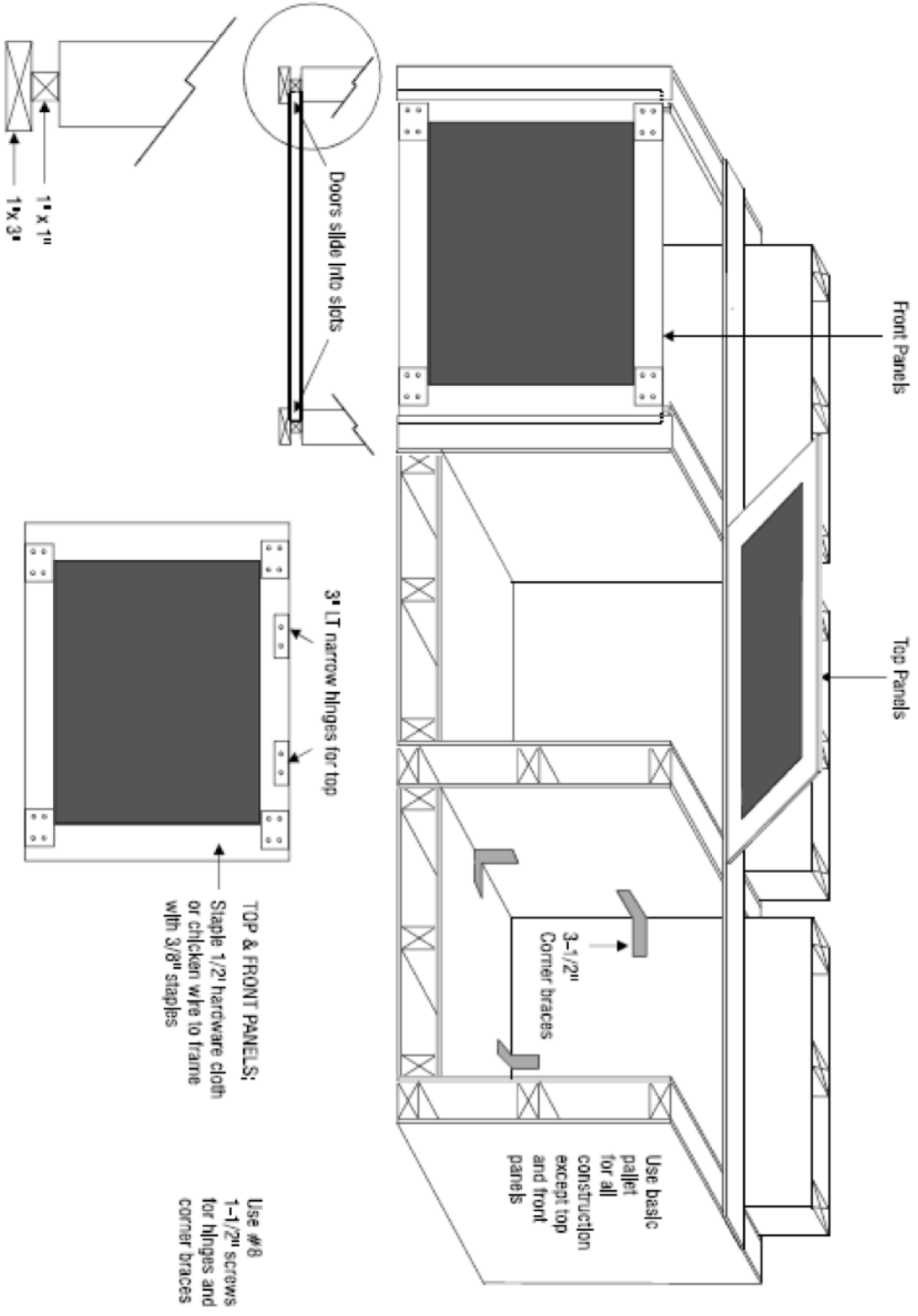
It is a good practice to maintain a space under the floor as rodent prevention and it aids in consistent air flow.

The tops are attached to the bins using hinges. A piece of strapping is screwed along the back of the top of the bins to provide a common site of attachment for the tops. The separately built front is fitted to slide into two tracks on the sides of the unit. The tracks are constructed by using a 1" x 1" and a 1" x 6" to form a slot into which the door can slide up and down (see diagram on next page). Safety gate hooks are used to fasten down the tops keeping in mind that raccoons have been known to unhook a regular hook and eye.

Helpful Hint:

Measure your pallets before you bring them to the school. Wooden pallets are not always made the same size. For ease in putting together the bins, it is important to have the pallets as close to the same size and as square as possible.

SCHEMATIC of 3-BIN COMPOST SYSTEM



MATERIALS LIST

To Borrow

- 1 Heavy Duty Staple Gun
- 2 Battery Powered Drills — One for drilling holes and one for screwing screws (Electric drills and extension cords are OK if electricity is near by.)
- 1 Pair — Heavy Duty Wire Cutters
- 1 Hand Saw (Powered saw and extension cords are OK if electricity is near by.)
- Measuring Tape

To Buy or Have Donated (local hardware or lumber supply store)

- 10 Wooden Pallets ***(All the same size)***
- 13 — 1″ x 3″ x 8′ Strapping or Furring Strip
- 4 – 1″ x 1″ x 3½′ Lumber (14 linear feet total)
- 2 — 1″ x 6″ x 12′ Lumber (24 linear feet total)
- 1 Box of 100 - 8″ x 1″ Flat Phillips Head Screws
- 1 Box of 50 - 8″ x 1½″ Flat Phillips Head Screws
- 20 — 10″ x 3″ Flat Head Screws
- 20 — 3½″ “L Bracket”
- 6 — 2½″ Safety Gate Hooks
- 6 — 3″ LT Narrow Hinge, Tight Pin
- 1 Box 1,000 — “D Staples”
- 1 — 100′ x 48″ roll of ½″ Gauge Hardware Cloth or Equivalent Chicken Wire

Helpful Hint:

For free pallets, shop at your local recycling center/transfer station, businesses, and department, grocery, or hardware stores.

BIN BUILDING STEPS

Step 1.
Measure, cut, and staple the hardware cloth or chicken wire onto one side of eight pallets for bottoms, backs and sides of bins. Two of the pallets will need hardware cloth or chicken wire on both sides to serve as inside walls. Use plenty of staples for strength, placing one every few inches.

Step 2.
Lay the hardware cloth or chicken wire covered pallets in place, as illustrated in the diagram (with the wire sides on the inside of the bins), making sure all corners meet. If necessary, do one bin at a time.

Step 3.
Use one drill to drill the holes in the pallets for the corner brace screws, and the other drill to screw in the 1″ screws, fasten one corner brace along each corner between pallets as illustrated in the diagram.

Step 4.
Cut four pieces each of 1″ x 1″ and 1″ x 6″ lumber the same height as the front of the bins.

Step 5.
Fasten a precut 1″ x 1″ centered vertically on the front of each vertical pallet of the bins with two 3″ screws as illustrated in diagram. (This is to create the runners for the doors.)

Step 6.
Fasten precut 1″ x 6″ centered on top of the 1″ x 1″ with two more 3″ screws as illustrated in diagram. Repeat for all 4 fronts on bins (you have just made the slots that the front doors will slide into).

Step 7.
Measure for front door dimensions and cut pieces of strapping as illustrated in the diagram. Keep in mind that you want the door to fit loosely so it is easy to slide it in and out.

Step 8.
Fasten strapping together with 1½″ screws to make the door as illustrated. Use spare strapping as a corner brace, or use corner braces, purchased at a hardware store.

Step 9.
Measure, cut and staple hardware cloth or chicken wire to the inside of the door and slide door in place in the front of the bins. Repeat for all three bins.

Step 10.
Lay strapping along the top of the back of the bins and fasten to the top of the pallets with 1½″ screws.

Step 11.
Measure for tops the same as the front doors, keeping in mind that the top should lay over the door so that the door cannot be opened unless the top is up. Another option is to make one long top to cover the first two bins and a single top for the third bin. This is so you can open and prop up the top of the middle bin from the left side rather than throwing it open from the front of the bins.

Step 12.
Fasten together strapping for tops and staple hardware cloth or chicken wire the same as the doors.

Step 13.
Place tops on top of the bins, then line up and attach two hinges to the back pieces of strapping and each top as illustrated.

Step 14.
Attach safety gate hooks from each side of the front edge of the tops to the pallets on which they rest.

Step 15.
You are ready to compost!

COMPOST RECIPE GUIDE

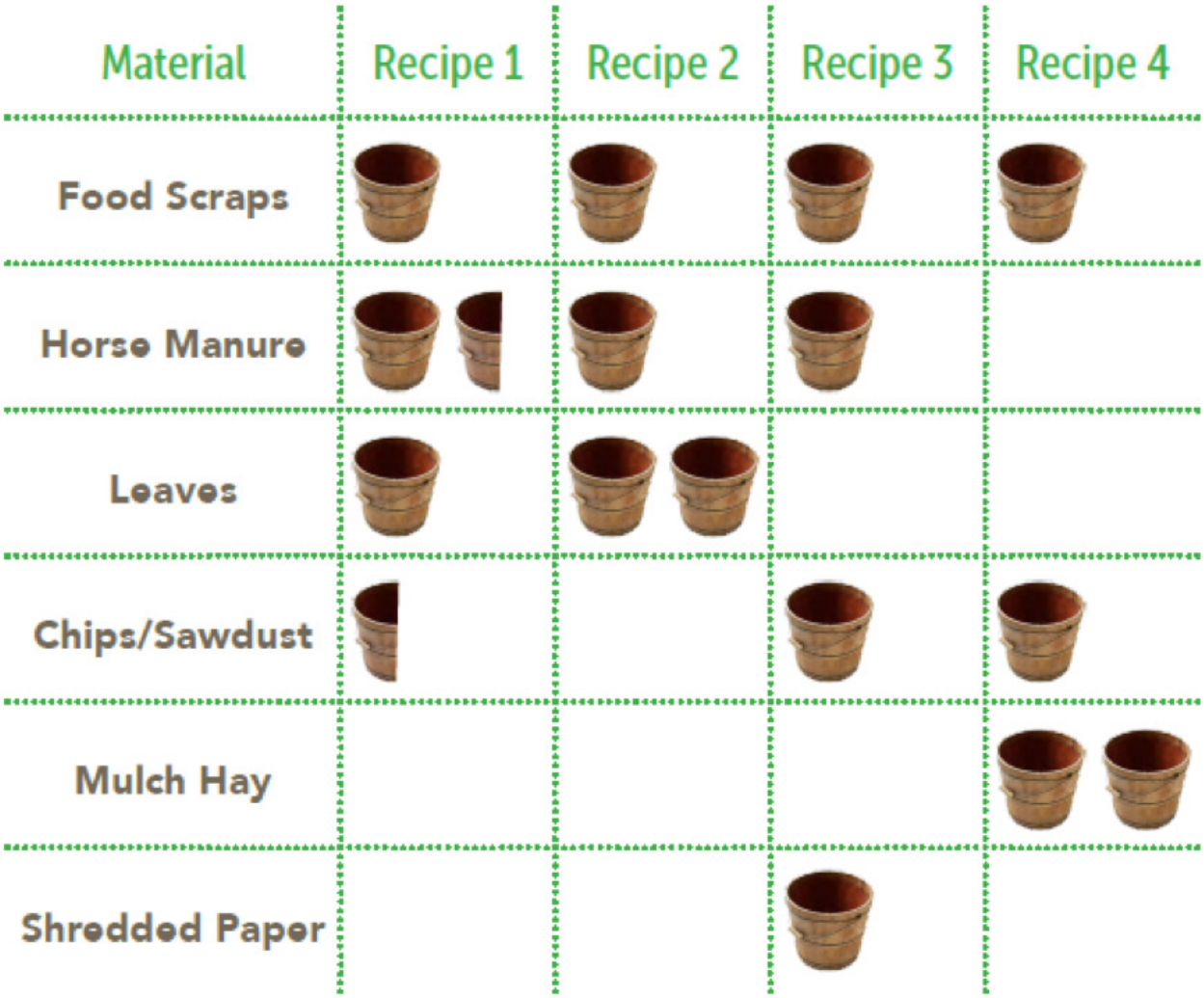


Table from VT ANR On-Site Composting School Implementation Guide (2015)

Listed are four of hundreds of possible recipes for composting.

Most notable are the consistent 3:1 C:N ratio and a variety of carbon materials for bulk density. So, for example, if you do not have access to horse manure there are still lots of options not listed here.

School Food Waste Weight Record Sheet

Lunch Period ______

Bin	Monday	Tuesday	Wednesday	Thursday	Friday	Weekly Total
1						
2						
3						
4						
5						
Daily Weight						

Lunch Period ______

Bin	Monday	Tuesday	Wednesday	Thursday	Friday	Weekly Total
1						
2						
3						
4						
5						
Daily Weight						

Lunch Period ______

Bin	Monday	Tuesday	Wednesday	Thursday	Friday	Weekly Total
1						
2						
3						
4						
5						
Daily Weight						

COMPOST PILE TROUBLE SHOOTING GUIDE

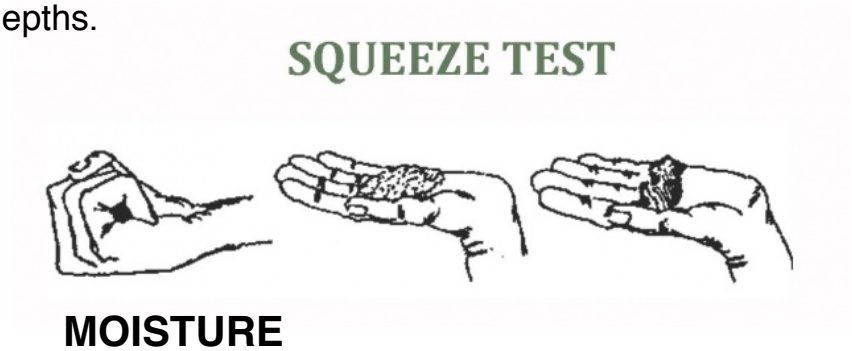
	Possible Issue	Solution
Pile is wet and smells rancid like vinegar or rotten eggs	Not enough oxygen in compost pile	Turn compost pile
	Too much Nitrogen (food waste or manure) in compost pile	Add Carbon-rich materials (granted you are still actively adding materials to the compost pile) such as hay, straw, sawdust, wood shavings, or dry leaves
	Compost pile is too wet	Turn pile and possibly add a bulking material (wood chips or straw) or dry materials (hay, sawdust, etc.)
Compost pile is not heating up	Compost pile is to small	If appropriate, stockpile materials in order to add more mass to the compost pile all at once
		Insulate compost bin or compost pile
	Compost pile is too dry	Slowly add water to compost pile, preferably while turning the compost pile
	The correct balance of Carbon and Nitrogen materials in the compost pile has not been achieved	Assess compost pile for whether it might need more Carbon or Nitrogen-rich materials
Compost pile is damp, sweet smelling, and will not heat up	Likely not enough Nitrogen-rich materials in the compost pile	Add fresh grass clippings, food scraps, fresh manures, or other Nitrogen-rich materials to the compost pile
Compost pile is attracting animals	Meat or other animal products are attracting animals	Enclose the compost pile/bin with ¼" hardware cloth. If problem persists, avoid adding animal products to the pile
	Food scraps are exposed	Cover all food scraps with 4" or more of fluffy, Carbon-rich materials
	Compost pile is not hot enough to deter vectors	See above

Table from VT ANR On-Site Composting School Implementation Guide (2015)

TEMPERATURE

Get a reading in **three places** inside the active compost bin BEFORE you make a new deposit: to the **left**, the **center** and the **right** of the bin.

**Always take readings 1 foot away from the bin walls or floor, and at 1 foot depths.



MOISTURE

1

1) **Grab a handful of unfinished compost.**
2) **Squeeze tight.**
3) **Assess Moisture.**

If it's dripping, that's too wet.

If beads of moisture have formed, that's perfect!

If no beads of moisture have formed, that's too dry.

STRUCTURE

2

1) **Open Your Fist.**
2) **Assess structure.**

If it's crumbly, like the image on the left, it's dry.

If it's a wet clump, like the image on the right, it's wet.

If it's in-between, it's perfect!

Source: Cat Buxton, GMWL. Download your own copy from the GOOGLE DRIVE at https://drive.google.com/file/d/1C6ku6a9uhixMKdWkK6XZIA41-Q74meZt/view?usp=sharing

APPENDIX E: Works Cited & Resources

From Cat Buxton (Grow More, Waste Less), listed as they appear in this Guide...

California Department of Resources, Recycling and Recovery
Generator-Based Characterization of Commercial Sector Disposal and Diversion in California, 2014
California Department of Resources, Recycling and Recovery.

Vermont Agency of Natural Resources: Department of Environmental Conservation, Solid Waste Program
School Composting Implementation Guide, 2015
Montpelier, VT ANR.

Vermont Agency of Natural Resources: Department of Environmental Conservation, Solid Waste Program
On Site Composting Designing a Bin System for Hot Composting, 2015.
Montpelier, VT ANR.

The following images are available for use in your school projects. We have done our best to send you to accessible online sources...

Image 1: Soil Food Web image, page 15
https://www.nrcs.usda.gov/wps/portal/nrcs/photogallery/soils/health/biology/gallery/?cid=1788&position=Promo
Note: Please contact the Soil and Water Conservation Society at pubs@swcs.org for permission to use copyrighted (credited) images used throughout the Soil Biology Primer.

Image 2: The Soil Connection image, page 16
From a 2014 article: https://www.centerforfoodsafety.org/blog/3635/the-soil-carbon-opportunity
Image source: http://www.centerforfoodsafety.org/files/soil-climate-connection_07954.png
Mon. July 29 2019
Email the Center for Food Safety for permission: office@centerforfoodsafety.org

Image 3: Simpler soil food web, page 17
Go to Wikimedia and search for: “Air, water and organic matter within soil support soil organisms.”
Image credit: Wikimedia Commons

Image 4: bin size chart image, page 23
Designing A Bin For Hot Composting, Vermont Agency of Natural Resources
https://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/ANR%20On-Site%20Composting%20Designing%20a%20Bin%20System%20for%20Hot%20Composting.pdf

Image 5: TES bin turning diagram, page 43
Source: Thetford Elementary School (photo and slide by Cat Buxton, GMWL)

Labs for testing compost biology, referenced on page 49
Part Fort Lab, Oregon https://www.earthfort.com/lab-services/
Woods End lab, Maine https://woodsend.com/compost/composts/

ADDITIONAL MATERIALS and ACTIVITIES

Composting in the Classroom: Scientific Inquiry for High School Students,
Nancy M. Trautman and Marianne E. Krasney, 1997

Compost Critters Descriptions & Worksheet
Source: Central Vermont SWMD "Do the Rot Thing" guide, pages 15 - 17 at the following link
http://www.cvswmd.org/uploads/6/1/2/6/6126179/do_the_rot_thing_cvswmd1.pdf

Compost Theater
A skit by Cat Buxton, GMWL (Modified from Project Seasons Book, Shelburne Farm)
PDF in GOOGLE DRIVE:
https://drive.google.com/open?id=1Yizq9fjAz_RlsdHNzvS-iTXLlzi9gjhN

ADDITIONAL RESEARCH

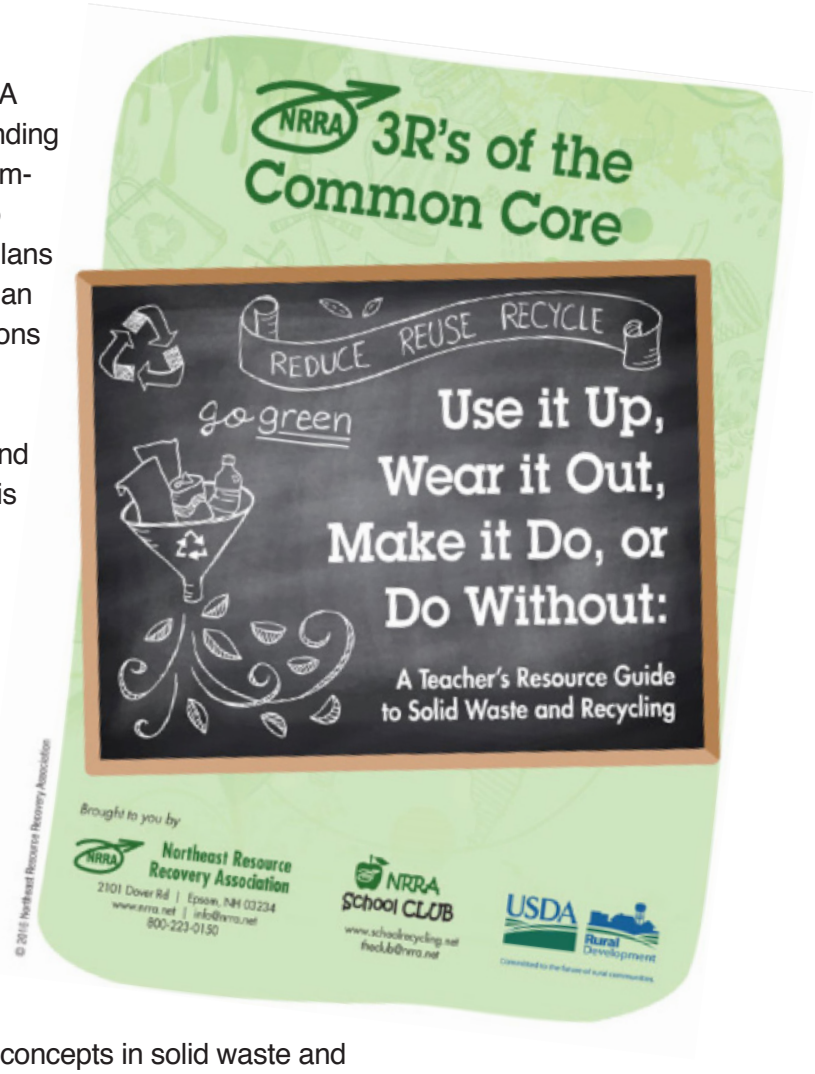
Food Waste Generation by Students per Week, 2014
http://anrmaps.vermont.gov/websites/Organics/documents/Methodology_OrganicsMapDatabase.pdf

Data on the numbers of students at each school was compiled from the VT Agency of Education website
(http://edw.vermont.gov/REPORTSERVER/Pages/ReportViewer.aspx?/Public/School+Report), National Center for Education Statistics (NCES) website, and individual school websites. Each school was categorized as elementary (1.13 lbs. per student per week), middle (0.73 lbs. per student per week), elementary/middle (0.93 lbs. per student per week),

APPENDIX F: NRRA Lesson Plans

In 2012, the Northeast Resource Recovery Association (NRRA) assumed ownership of the school resources and materials produced by the former Association of Vermont Recyclers (AVR), a leader in Vermont recycling education programs for twenty-five years. One of these resources was AVR's popular curriculum, A Teacher's Resource Guide (TRG), which was originally created to renew the Vermont spirit of frugality and environmental stewardship:

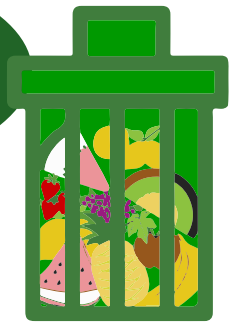
As stewards of AVR's resources, NRRA received funding to update this outstanding curriculum to align with the national common core standards. The intent was to correlate the standards to the lesson plans as originally written. This proved to be an incorrect assumption. Most of the lessons were revised and the Information and Resources sections upgraded, but the authors upheld the original concepts and objectives. *3R's of the Common Core* is the 21st century edition of a Teacher's Resource Guide to Solid Waste and Recycling Education.



The following are samples from the full curricula set which is housed and can be purchased at the NRRA offices or in digital form. These samples were pulled from grade groups 4-6 and 9-12 and as you will see are compost related activities to accompany school composting projects.

The full curricula set explores broader concepts in solid waste and resource conservation. For full descriptions and information about purchasing visit: www.schoolrecycling.net or contact theclub@nrra.net.

How Can We Recycle Organic Matter?



Concept
Organic waste can be recycled to enrich soil for growing more organic matter.

Objective
Students will learn about recycling organic matter.

Method
Students will build a model compost pile in a classroom terrarium.

Materials
Aquarium, organic wastes, soil (not potting soil), thermometer, trowel or large spoon, 1-2 dozen red earthworms

Subject
Science, Language Arts, Mathematics

Skills
Graphing data, investigating, observing, predicting

Vocabulary
Decomposition, humus, microorganisms, aerate

Time
One class period to a full year

Resources
"The Wild World of Compost," *National Geographic;* Mary Appelhof, *Worms Eat My Garbage*; Pat Hughey, *Scavengers and Decomposers*

3R's of the Common Core
Parallel Activities
K-3, Take Me Out to the Compost
7-8, Making Good Compost
9-12, Microorganisms
9-12, Effective Fertilizers
Information:
Composting
Resources:
Environmental Education and Educational Resources, Green Consumption, Consumerism and Sustainable Development

Background

When we mention 'recycling,' we often think of recycling glass bottles, aluminum cans and newspapers. But another 30% of the household garbage we throw out can also be recycled. These recyclables are food scraps, leaves, grass clippings and other biodegradable organic wastes. Organic wastes can be recycled by composting. Simply stated, composting creates optimal conditions for decomposition to occur. Decomposition is the biochemical process by which bacteria, fungi and other microscopic organisms break organic "wastes" into nutrients that can be used by plants and animals. Decomposition occurs in nature whenever a leaf falls to the ground or an animal dies. It is essential for the continuation of life on earth. The result of decomposition in a compost pile is a nutrient-rich humus that is excellent for improving soil quality and plant growth.

Leading Question

What do you do with your food scraps?

Procedure

1. Assemble a variety of organic wastes including with following: manure and green grass clippings, sawdust, hair, wood ash, leaves, kitchen food scraps, etc. Avoid meat scraps, dairy products, fats and oils which inhibit decomposition, cause odors and can attract pests. Chop the organic wastes into small pieces. You can leave some large pieces of the same materials to compare rates of decomposition between large and small items. Why might there be a difference?
2. Read Necessary Components of a Compost Pile. Turn and Talk: Ask students to provide a summary of the text to a classmate. Students should highlight or underline key information in the text that show evidence of one or two main ideas. Create a compost by alternating layers of the materials as follows (amounts are approximate): one inch of soil, two inches of organic waste, sprinkle of manure or green grass clippings, sprinkle of water. Repeat.
3. Cover with an inch of soil. Water the pile enough to make it moist but not soggy. It should feel like a damp sponge (It feels moist, but you can't squeeze water out of it).
4. Add the earthworms and observe their behavior. In notebooks ask students:

   a. to make predictions about what each believes will happen in one day, one week, one month, etc.

   b. to date and post their observations, inferences and conclusions.

Common Core Alignments

GRADE 4

CC.RI.4.1
Reading Informational Text:
Key Ideas & Details

CC.W.4.4
Writing:
Production & Distribution of Writing

CC.4.NBT.3
Mathematics:
Number & Operations in Base Ten

GRADE 5

CC.RI.5.2
Reading Informational Text:
Key Ideas & Details

CC.W.5.4
Writing:
Production & Distribution of Writing

CC.5.OA.1
Mathematics:
Operations & Algebraic Thinking

GRADE 6

CC.RI.6.2
Reading Informational Text:
Key Ideas & Details

CC.W.6.4
Writing:
Production & Distribution of Writing

CC.6.SP.2
Mathematics:
Statistics & Probability

Classroom Activities

5. Place the compost pile where it will be at room temperature (not in direct sun). Gently mix the compost once a week to aerate It. Use a thermometer to test the temperature of the pile. (For consistency do it at the same location and depth at the same time each day.) Students will date and post their conclusions in their notebooks. Students should have two columns: the first column is the actual temperature measurement to the nearest degree and the second column is the temperature rounded to the nearest five or ten degrees.
6. After the first week of measurements, calculate the following: a. sum, b. average (center), c. range (spread)
7. Make a graph of results, analyze the data and draw conclusions. Determine the overall shape of the graph. Is it symmetrical or is it skewed left or right?
8. Convert fahrenheit temperatures to celsius, using the following formula:

   Tc=celsius

   Tf=fahrenheit

   Tc=(Tf-32)x5/9
9. Discuss composting. How does it reduce the amount of waste you would have thrown out? What do you think happens to organic wastes that end up in the landfill? Is the landfill a gigantic natural compost pile, or are there problems with placing large amounts of organic material in landfills?

Evaluation

Students will identify the ingredients of a compost pile.

Classroom Activities

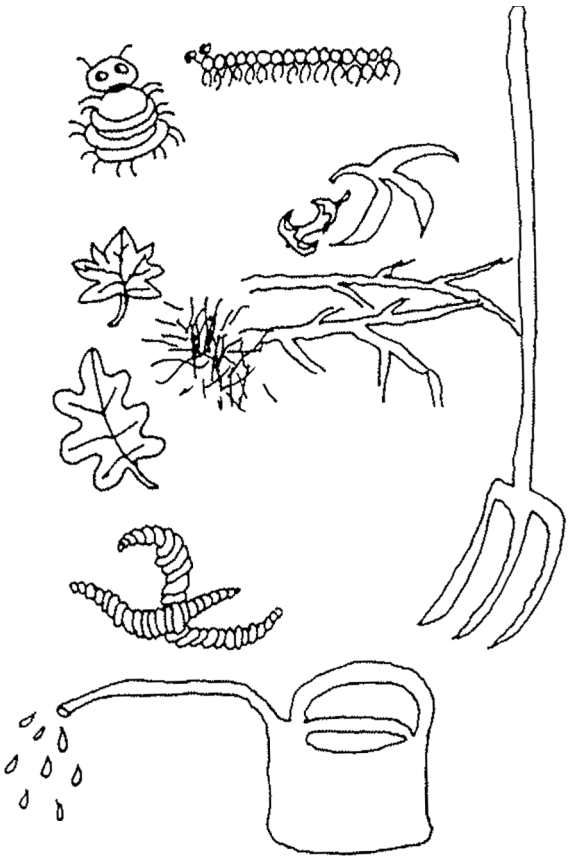
A. Construct a compost pile at home to use for the family garden or a vermi-compost bin in the classroom for disposing of daily snacks.

B. Begin a school garden. Use the soil you've made to plant some flowers or vegetables.

Necessary Components of a Compost Pile

SOIL: Contains microorganisms that help decomposition.

ORGANIC WASTES: such as leaves, food scraps and grass clippings. Wastes should be varied, including materials with both carbon and nitrogen. By alternating layers of high-carbon and high-nitrogen materials, you can create good environmental conditions for decomposition to occur.

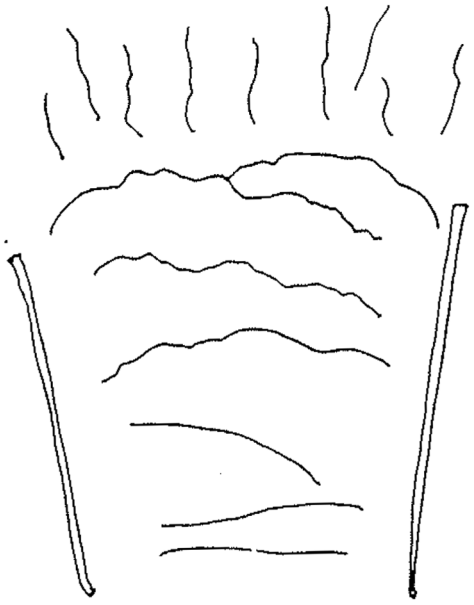


NITROGEN: many of the organisms responsible for decomposition need nitrogen, thus nitrogen is necessary for rapid and thorough decomposition. Nitrogen is found naturally in many organic wastes, such as manure and green grass clippings, as well as in many commercial fertilizers.

WORMS: they eat the waste, helping to break it down; make droppings, which enrich the soil; tunnel through and aerate the waste, facilitating decomposition and eventually die and become part of the compost.

WATER: necessary for normal functioning of life. Too much water in a compost pile may make it soggy and slow decomposition by reducing needed oxygen.

AIR: the biological activity of fungi, bacteria, small insects and other organisms results in decomposition. Most biological processes require adequate amounts of oxygen.



TIME: decomposition takes time. To speed up decomposition, aerate your pile every few days; otherwise, just leave it and wait.

HEAT: heat is produced by chemical reactions resulting from increased biological activity that occurs during decomposition. Heat helps sanitize compost by killing certain organisms, such as weed seeds, pathogens and harmful insect larvae.

MASS: In order to generate enough heat for optimal decomposition the pile must contain at least one cubic meter of organic material. Thus, the temperatures generated in an aquarium compost pile may be different from those generated in one that is larger.

How Can We Recycle Organic Wastes?

Concept
Organic and mineral wastes can be recycled into effective fertilizer.

Objective
Students will rate the effectiveness of various organic and inorganic fertilizers.

Method
Students will test growth rates of different plants.

Materials
Six bean seedlings ready for transplanting and six pots per student or group of students, stock amounts and solutions of some or all of the following: manure, fish fertilizer, algae, rabbit tea -a bag of rabbit manure and water mixed, potting soil, any balanced organic fertilizer.

Subjects
Biology, Science, Horticulture, Language Arts

Skills
Carrying out investigations, hypothesizing, interpreting data, observing

Time
Three weeks for seeds to germinate, four weeks experiment.

Vocabulary
Composting, fertilizer, blood meal, phosphate, organic, solubility, residuality

Resources
Robert Rodale. Ed., *The Basic Book of Organic Gardening;* Catharine Foster, *The Organic Gardener;* National Gardening Association.

3R's of the Common Core
Parallel Activities
K-3, Take Me Out To The Compost
4-6, Mini Compost
7-8, Making Good Compost
9-12, Effective Fertilizers
Information
Compost
Resources
Green Consumption, Consumerism and Sustainable Development
Solid Waste and Recycling

Background
Some common fertilizers: BONE MEAL is a powdered, crushed bone. It can be sprinkled around growing plants. BLOOD MEAL is dried, powdered blood. It has a high nitrogen content and should be used sparingly. FISH EMULSION is liquid fertilizer made from fish. It is a good source of both nitrogen and phosphorus and should be diluted in water before pouring around plants. GRANITE DUST is powdered granite and a good source of potash. It can be mixed with soil or added on the side. ROCK PHOSPHATE is a powdered rock rich in phosphorous, calcium, iron, sodium, magnesium, boron and iodine which can be mixed with soil or added on the side.

Leading Question
What are fertilizers made of'?

Procedure
1. Introduce the lesson. As a class create a lab report worksheet onto which experiment information can be recorded. Include space for hypotheses, dates, fertilizer added, amount of water added and measurement of growth. Have students keep a journal with their hypotheses, observations and conclusions about the best fertilizers to use.
2. Germinate bean seeds by soaking overnight and planting in soil 2-3 cm deep. Keep warm and moist. After three weeks pick plants of equal health for fertilizing and transfer to individual pots.
3. Have students state hypotheses about the effect of different fertilizers on plant growth. Discuss the nutrients in each fertilizer. Emphasize the recycled origin of most of these fertilizers. Discuss solubility and residuality of fertilizers. Discuss measurement of growth (e.g.: height, number and color of leaves, roots).

OPTION: Number fertilizers: don't tell students which plant corresponds with which fertilizer. This will make the experiment exciting and more valid.

4. Add recommended doses of fertilizer and maintain one control group of six. Have students water all plants at the same time, with the same amount. Record results once each week for four weeks. Have class compile results after one month. Discuss accuracy of class results vs. individual results. Determine rating scheme and reveal the winner. Discuss what other recycled materials could be used for fertilizer.

Common Core Alignments

GRADES 9-10

CC.L.9-10.6
Language:
Vocabulary Acquisition & Use

CC.SL.9-10.1
Speaking & Listening:
Comprehension & Collaboration

CC.WHST.9-10.4
Writing in History/Social Studies,
Science & Technical Subjects:
Production & Distribution of Writing

GRADES 11-12

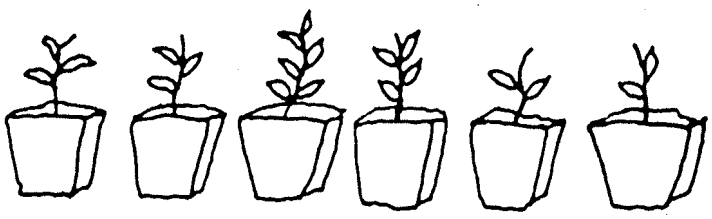
CC.L.11-12.6
Language:
Vocabulary Acquisition & Use

CC.SL.11-12.1
Speaking & Listening:
Comprehension & Collaboration

CC.WHST.11-12.4
Writing in History/Social Studies,
Science & Technical Subjects:
Production & Distribution of Writing

Evaluation

Name three kinds of fertilizers suitable for growing beans from seed. Which would you choose? Why? What are fertilizers made of? How is fertilizing a form of recycling? What does organic mean?



CLOSING THE FOOD LOOP AT SCHOOL:
An On-Site School Composting Guide

Photo by NRRA. At the Maine Compost School.

NRRA

Thank you For Recycling

Northeast Resource Recovery Association
2101 Dover Rd., Epsom, NH 03234
603.736.4401 | 800.223.0150 | www.nrra.net

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NRRA School Recycling CLUB

To order copies of this manual or any of our other teacher resource manuals, please contact NRRA at 800-223-0150