Yes You CAN*! (*Compost & Naturescape)
Train-the-Trainers Course

A Council of the Carolinas Recycling Association
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WEB: www.carolinascompostingcouncil.org

Yes You CAN*! (*Compost & Naturescape)
Train-the-Trainers Course
Course Agenda

Friday

8 AM – 9 AM	Orientation/Goals & Objectives
9 AM – 10 AM	Icebreaker Activity
10 AM – 10:15 AM	Break
10:15 AM – 11:30 AM	Making High-Quality Compost -I The Composting Process Compostable Materials Conducting Solid Waste Audits
11:30 AM – 12:30 PM	Lunch
12:30 PM – 2:00 PM	Making High-Quality Compost -II Composting Methods & Equipment Needs Composting Operations Composting System Management Site & Environmental Considerations
2:15 – 5:00 PM	Field Exercise Building a Compost Pile Determining Bulk Density Determining Moisture Content

Saturday

8 AM - 9 AM	Compost Use Compost Quality Testing for Compost Parameters Benefits of Compost Use Use of Compost

9 AM – 10 AM	Naturescaping I Naturescaping Principles: Ecology for Gardeners Soil Stewardship
10 AM – 10:15 AM	Break
10:15 AM -11:30 AM	Naturescaping II Native & Invasive Plants Lawn Care Reducing Toxins and Managing Pests
11:30 AM - 12:30 PM	Lunch
12:30 PM -2:00 PM	Naturescaping III Pledge card Action plan Course Evaluations
2:15 PM – 5:00 PM	Field Exercise Monitoring Compost Pile Temperature Site Assessment & Soil Testing Native & Invasive Plant Identification

CAROLINA RECYCLING ASSOCIATION

Carolinas COMPOSTING COUNCIL

Making High Quality Compost

Yes You CAN!

(Compost and Naturescape!)

Training Program

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Composting Process

Yes You CAN!

(Compost and Naturescape!)

Training Program

What is Composting?

- The aerobic (oxygen-demanding) decomposition of organic materials by microorganisms under controlled conditions
- Inputs: organic matter, oxygen, moisture
- Outputs: carbon dioxide, heat, water vapor, humus
- Mother Nature's process tuned by man
- As much an art as it is a science

Benefits of Composting

- Saleable useful product
- Better environmental sustainability
- Improved waste handling
- Pathogen destruction
- Improved soil quality
- Improved crop yield, drought resistance and disease suppression

Drawbacks of Composting

- Time and money
- Land
- Odor
- Weather
- Marketing
- Slow release of nutrients

What happens during composting?

- Initial mixing of raw materials introduces oxygen to start process
- Microbial activity raises temperature
- Oxygen is replenished with aeration or turning
- As temperatures fall, active composting finishes
- Second stage – curing – lower temps
- Compost continues to break down over time – but much more slowly

Active Composting

- Biological process – 10 to 30+ days
- Objectives:
  - Degradation/stabilization of organic matter
  - Pathogen destruction
  - Weed seed destruction
  - Remove odor potential
- Process Control
  - Parameters - porosity, oxygen level, moisture
  - Microbial diversity ensured by temperature control

Degradation of Organic Matter

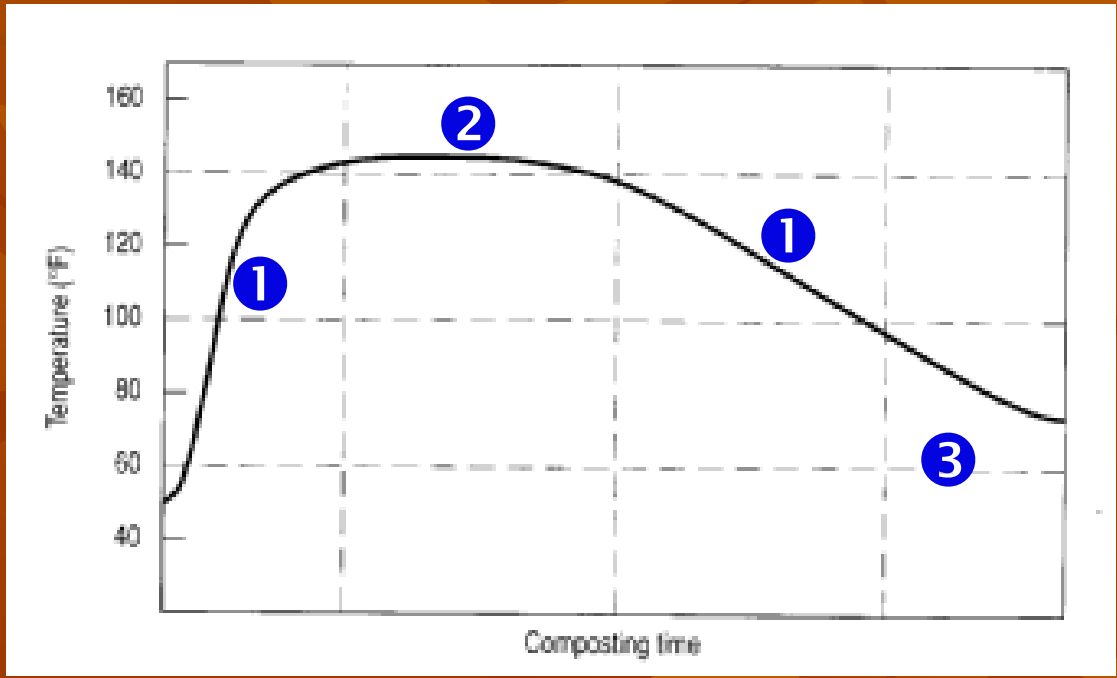
- Made up of carbohydrates, proteins, fats, lignin
  - Carbs: sugars, starches, cellulose
  - Lignin: very resistant to decay
- Microbes excrete enzymes to break down complex molecules, make them H_20-soluble
- Once soluble, taken up by microbes for metabolism and mineralized
- Metabolism consumes O_2 & produces heat
- Mineralization produces CO_2 & H_20

Composting Time & Temperature

- Temperature
  - As “food” is consumed, microbial activity diminishes and temperatures drop
- Time
  - Many variables control
    - Materials, temps, moisture, aeration & user requirements
  - As little as 30 days, as long as 2 years

Composting stages

1. Mesophilic
2. Thermophilic
3. Curing



Mesophilic stage

- Temperatures below 105ºF
- Microorganisms multiplying and breaking down easily available carbohydrates begin to heat up pile.
- pH begins to drop as acids are produced

Thermophilic stage

- Temperatures above 105°F
- Desirable to destroy pathogens, weed seeds and fly larvae
- Regulatory temperature for pathogen kill is 131° F.
- Critical temperature for destroying weed seeds is 145° F.
- Heat buildup should be controlled by aeration/turning


How to Design A Successful
Composting Process

Process Design

- Feedstocks Characterization
  - Quantities
  - Properties (physical & chemical)
  - Seasonal variations
- Preliminary Process Design
- Pilot Scale Evaluation
- Product Testing

Feedstocks Characterization

- Quantities
  - Tons per day? Cubic yards per month?
- Properties
  - Bulk density (weight per unit volume)
  - Moisture content
  - Nutrients (C & N, also P, micronutrients)
  - Contaminants
- Seasonal Variations
  - Grass (spring) vs. leaves (fall)

Preliminary Process Design

- Design Criteria
- Compost Recipe Development
- Feedstock Preparation & Mixing
- Composting Technology

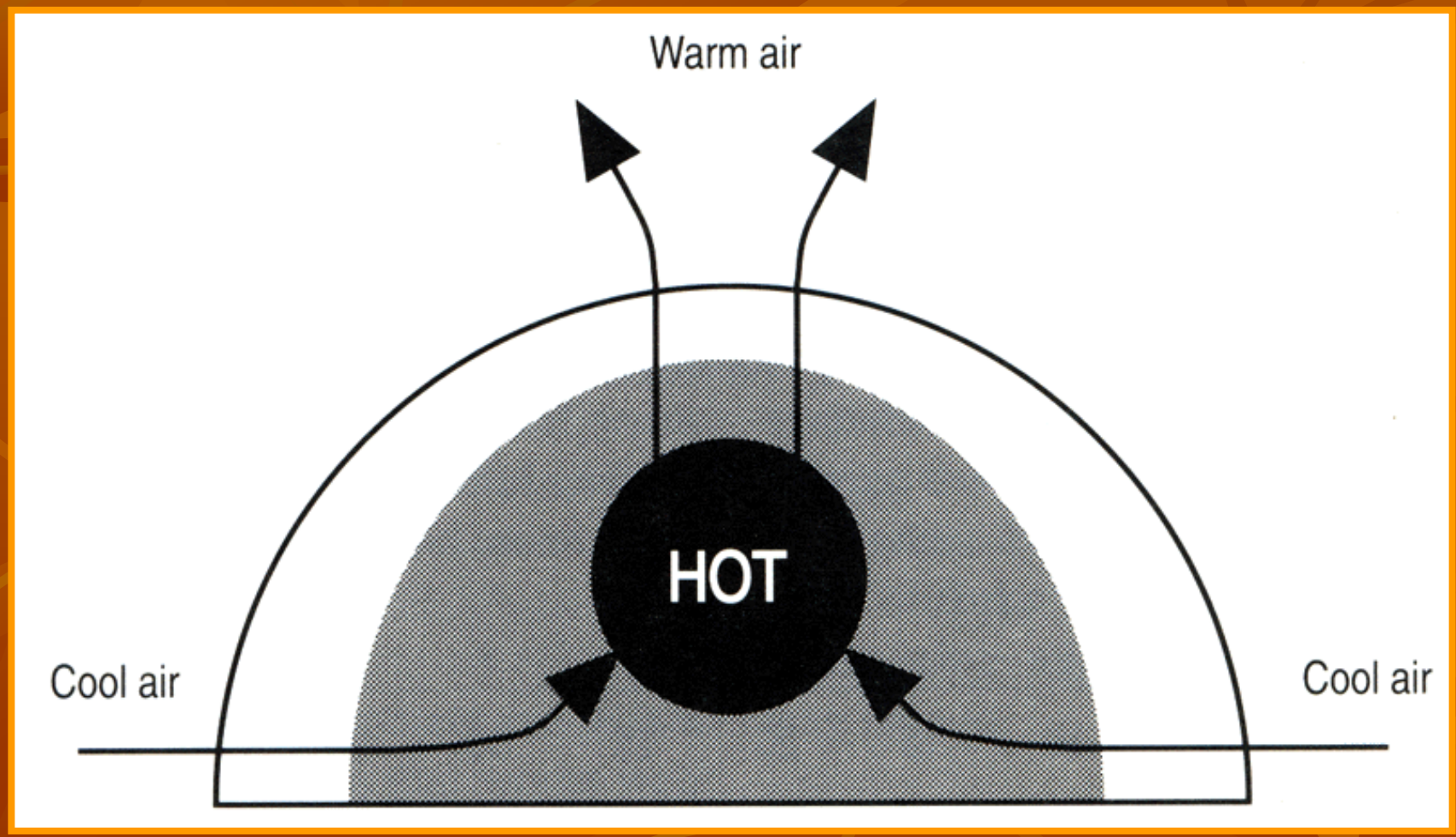
Design Criteria

- Air (oxygen, no less than 5%)
- Moisture (40-60%)
- Particle size (less than 2 inches)
- Porosity (free air space of >35%)
- C:N ratio (30:1 or less)
- pH between 6.5 and 8.0
- Temperature (131-150°F, >160 °F inactive)
- Time

Oxygen

- Normal oxygen level in air is 21%
- Minimum of 5% oxygen needed in compost pile to keep microorganisms alive
- Need free air space (i.e. porosity) above 20% to maintain 5% oxygen.
- Aeration provides oxygen, removes heat, removes water vapor and gases.

Air movement in a composting windrow or pile



Oxygen or Air

Forced aeration

Turning windrow to aerate

Moisture

- Moisture needed to support microbial life
- Composting needs a minimum of 40%
- Moisture evaporates during the composting process
- Less than 40% slows process
- More then 60% produces anaerobic conditions and lower temperatures
- Final product 30-40%.

Moisture Measuring

- Squeeze Test
  - If water drips out….too wet!
  - If clump breaks apart…..too dry!
- Weighing Test
  - Dry in oven until weight stops changing

$$MC = \frac{\text{Water Loss During Drying}}{\text{Initial Weight of Sample}}$$

$$MC = ((W_i - W_f) / (W_i - W_d)) \times 100$$

W_i = initial weight

W_f = final weight

W_d = dish weight

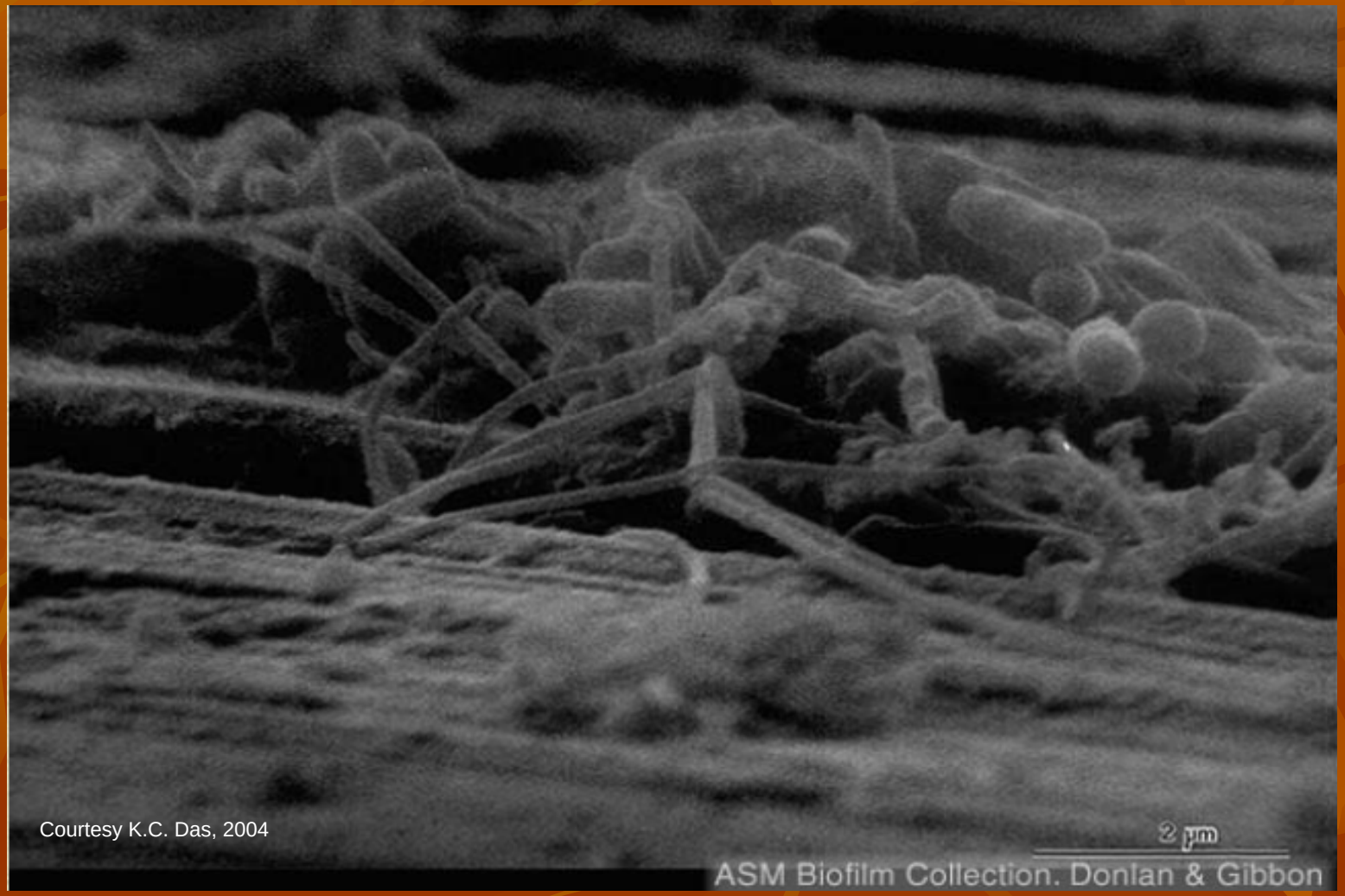
Particle size/Surface area

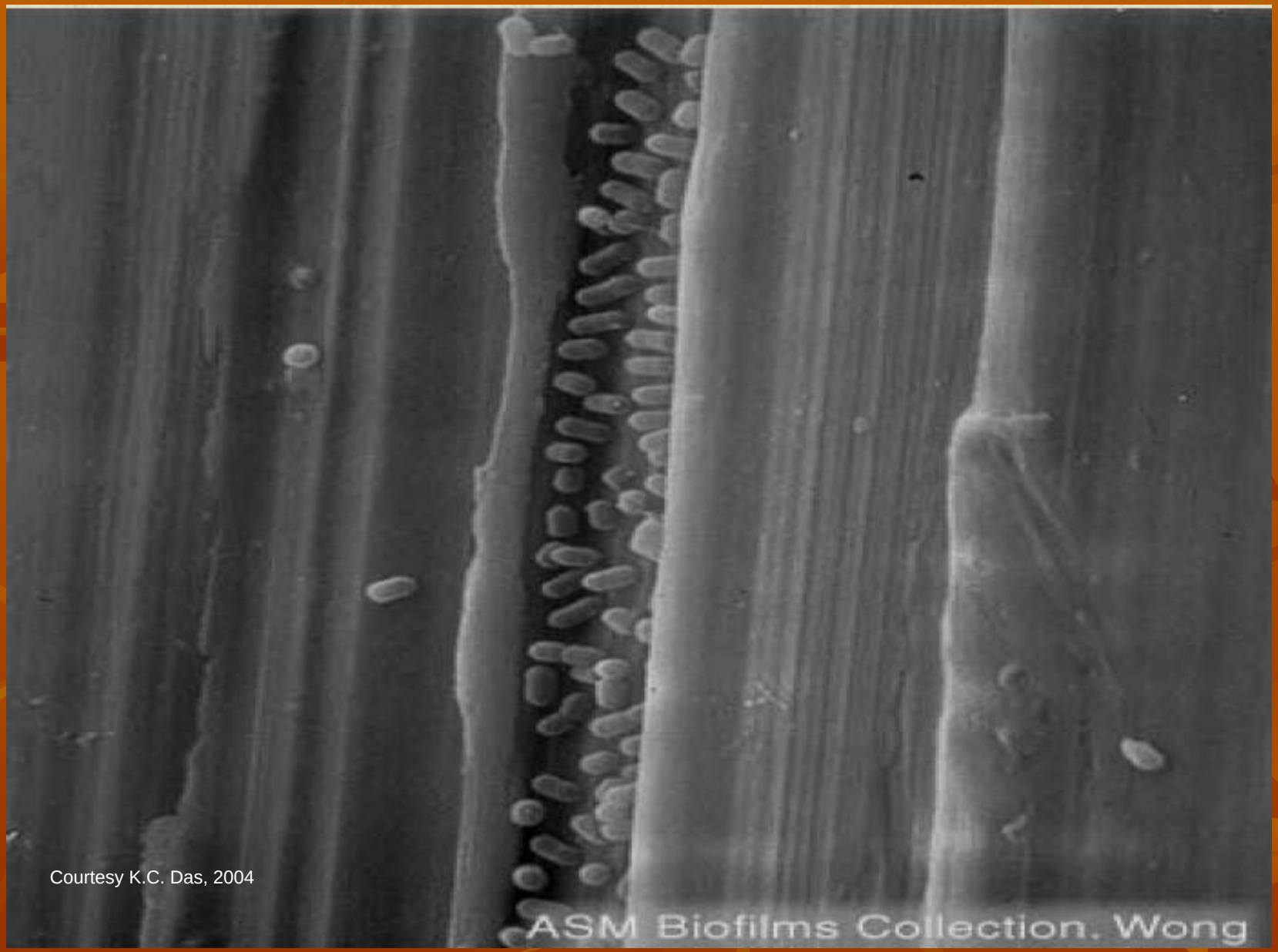
- Critical for most efficient composting
  - 1/2” – 2” optimum
- Too large-slows composting, decreases temperature and loses moisture.
- Too small-anaerobic, clogs air channels

Importance of Particle Size

- Microbes live/work on particle surface
- Composting starts at the outside of particle and proceeds inward
- Too large – slow composting, heat loss (excessive porosity)
- Too small – clogging of air channels leads to anaerobic conditions

Why Particle Size is Important –
Microbes live/work on particle surface



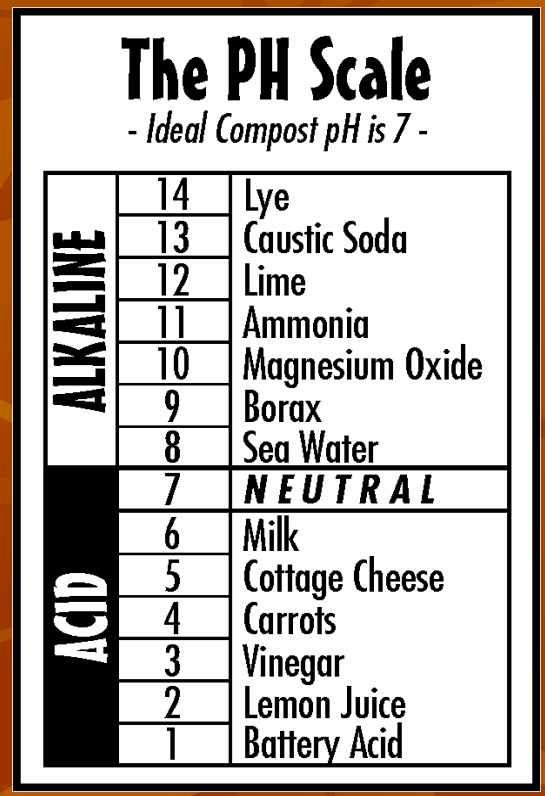

Courtesy K.C. Das, 2004
ASM Biofilms Collection. Wong

Nutrient Balance in Composting

- C/N ratio – target is 30:1
  - > 30:1 – not enough food for microbial population
  - < 30:1 – nitrogen lost as ammonia (odors)
- Sources of N & P - Organic wastes, manures, sludges
- Sources of C – wood wastes, woodchips, sawdust
- Example C/N Ratios:
  - Food waste 14 – 16 : 1
  - Refuse/trash 34 – 80 : 1
  - Sewage sludge 5 – 16 : 1
  - Corrugated cardboard 563 : 1
  - Telephone books 772 : 1
- Mixing components needed to optimize C/N ratio

pH

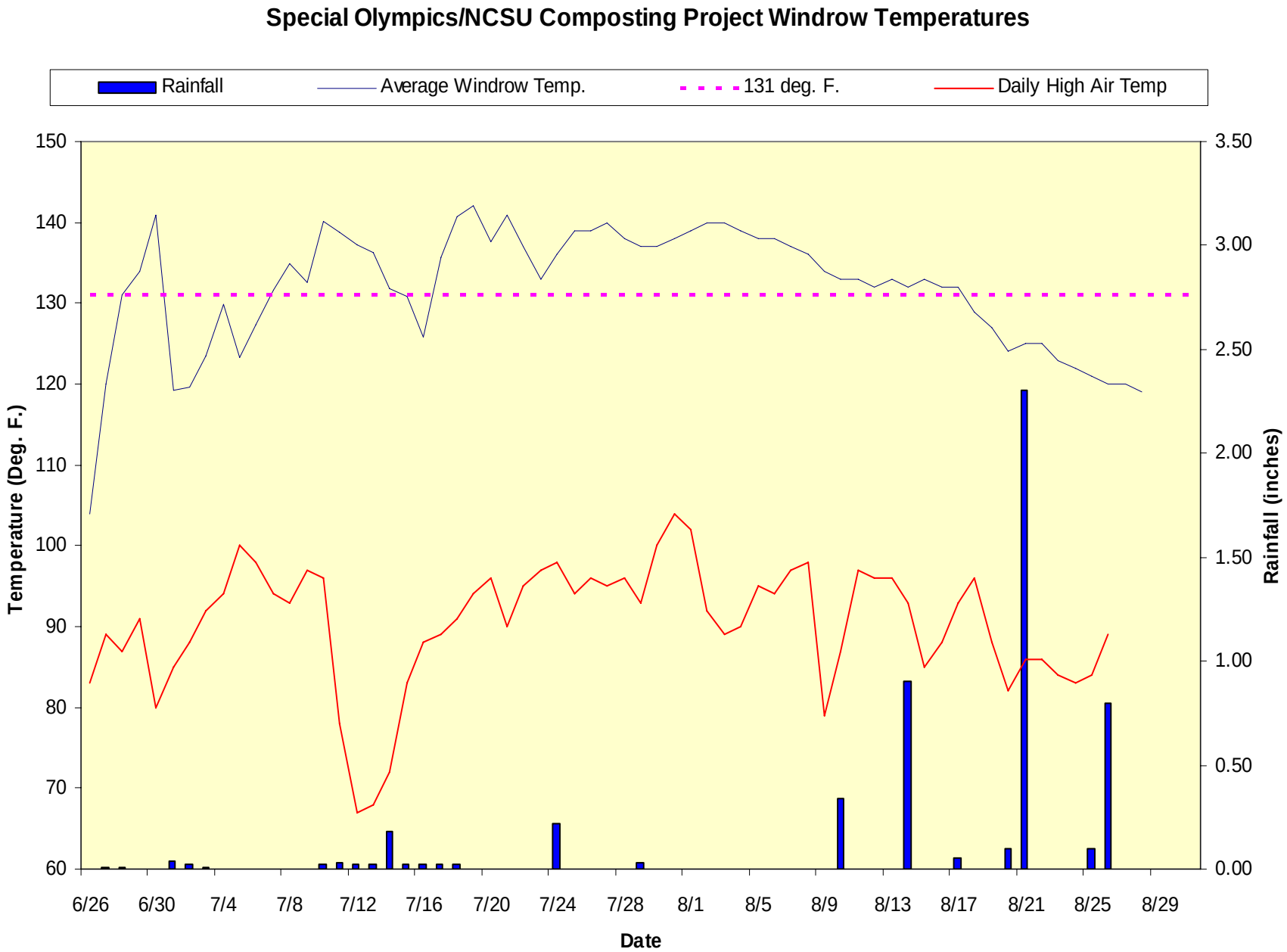
- Optimum range 6.5 – 8.0
  - Bacterial activity dominates
- Below pH = 6.5
  - Fungi dominate over bacteria
  - Composting can be inhibited
  - Avoid by keeping O_2 > 5%
- Above pH = 8.0
  - Ammonia gas can be generated
  - Microbial populations decline



Time and Temperature

- Temperature is key process control factor – monitor closely
- Optimum temperatures: 130^{o} F. – 150^{o} F.
- Temperatures above 131^{o} F. (55^{o} C.) will kill pathogens, fecal coliform & parasites
- Regulations (BYC, small yard waste and on-farm often exempt)
  - Temperatures > 131^{o} F. for 15 days in windrows
  - Temperatures > 131^{o} F. for 3 days in ASP or invessel
- Optimum temps achieved by regulating airflow (turning) and/or pile size

Time and Temperature, cont.



Compost Recipes

- Like a cake – ingredients should be in right proportions
- Lab testing of feedstocks – necessary for accurate recipe development
- Balance targets:
  - C:N ratio 25:1 – 30:1
  - Moisture 50 – 60%
  - Moisture is more critical

MIX RATIO CALCULATIONS							
INGREDIENTS	Yard Waste	Leaves	Wood Waste	Urea	Ingredient E	TOTAL MIX	TARGET
C (% AS IS)	53	60	75	0	0		
N (% AS IS)	1	0.9	0.8	46	0		
MOISTURE%	55	38	25	1	0		
UNITS IN MIX BY WGT (LB)	10,000	10,000	5,000	20	1	25,021	
UNITS IN MIX BY VOL (CY)	20	40	0.1	0	#DIV/0!	#DIV/0!	
DENSITY (LBS/CY)	500	250	600	800	0		
RELATIVE DENSITY	1.00	0.50	1.20	1.60	0.00		
	10000.00	10000.00	60.00	20.00	#DIV/0!		
POUNDS OF CARBON	5,300	6,000	3,750	0	0	15,050	
POUNDS OF NITROGEN	100	90	40	9	0	239	
C:N RATIO	53.00	66.67	93.75	0.00	#DIV/0!	**62.92**	20 TO 30
POUNDS OF MOISTURE	5,500	3,800	1,250	0	0	10,550	
NUMBER OF UNITS	10,000	10,000	5,000	20	1	25,021	
PERCENT MOISTURE						**42.17**	50 TO 65%
Notes:							
1. Input Carbon and Nitrogen Percentages on a wet-weight basis							
2. Input Moisture Content Percentage							
3. Input Weight in pounds							
4. Input Bulk Density in pounds per cubic yard							

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	25000.00	10000.00	60.00	500.00	#DIV/0!		
POUNDS OF CARBON	13,250	6,000	3,750	0	0	23,000	
POUNDS OF NITROGEN	250	90	40	230	0	610	
C:N RATIO	53.00	66.67	93.75	0.00	#DIV/0!	**37.70**	20 TO 30
POUNDS OF MOISTURE	13,750	3,800	1,250	5	0	18,805	
NUMBER OF UNITS	25,000	10,000	5,000	500	1	40,501	
PERCENT MOISTURE						**46.43**	50 TO 65%
Notes:							
1. Input Carbon and Nitrogen Percentages on a wet-weight basis							
2. Input Moisture Content Percentage							
3. Input Weight in pounds							
4. Input Bulk Density in pounds per cubic yard							

Pilot Testing

Invessel pilot testing

Windrow pilot testing

Courtesy K.C. Das, 2004

Curing

- An “aging” step necessary to make compost “mature”
- Immature compost can be toxic to plants
- Curing decomposes resistant compounds, organic acids, and larger particles
- Increases the amount of plant-available nitrogen (PAN) or nitrate-nitrogen
- Curing done when pile temperatures drop to ambient air temperatures

Curing – Issues to Consider

- Prevent pathogen reintroduction
  - Keep curing piles upstream of pad runoff
  - Handle with clean equipment
  - Use only fresh irrigation water (if needed)
- Temperature re-heat
  - Either not yet stabilized, or
  - Fungal growth enhanced by
    - Lack of competition, lower temps, available substrate

Curing – Issues to Consider

- Porosity – keep between 35% & 65%
  - Don’t screen out bulking agent yet
- Oxygen – keep > 16%
- Moisture – keep between 40% & 50%

Stability

- Stage of decomposition
  - Function of biological activity
  - Aim for full stability at end of active composting
- Measuring stability
  - Solvita™ Ammonia/CO_2 colorimetric test
  - Re-heat potential (Dewars Flask)
  - O_2/$C0_2$ respirometry

Maturity

- Biochemical state of the compost
  - Indicator of phyto-toxicity
    - VFAs produced anaerobically
  - To be achieved during curing
- Measuring maturity
  - Germination test – cress or radish seeds
  - Humification Indices
  - Acetic acid assay

Product Testing

- Physical and Chemical Analysis
  - Horticultural parameters
- Demonstration project
  - Small landscaping project

Questions?

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Compostable Materials

Yes You CAN!

(Compost and Naturescape!)

Training Program

Types of Compostable Solid Wastes


Yard Trimmings

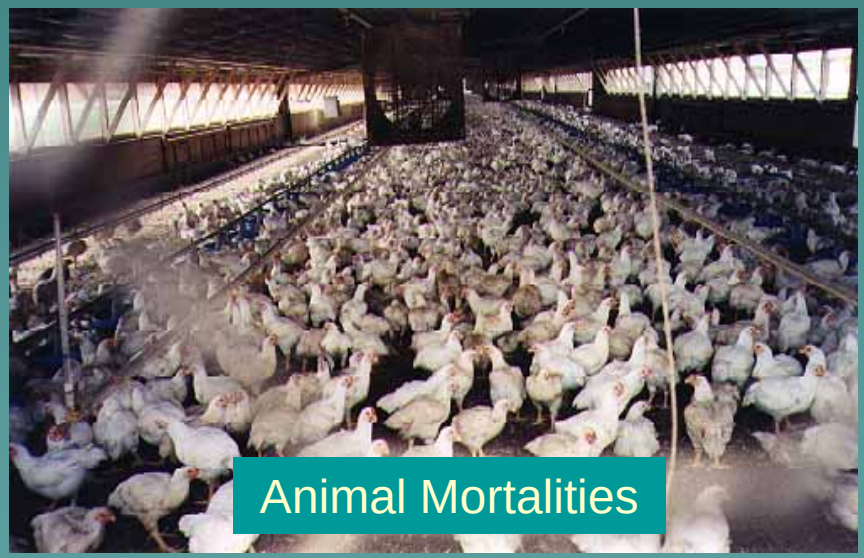

Land Clearing Debris


Food Scraps


Storm Debris

Biosolids & Sludges

Animal Manures



Animal Mortalities

Agricultural Wastes


Wood Wastes


Sheetrock


Water Plant Sludges


Grease Trap Wastes

Composting Feedstocks

- Many types of compostable feedstocks
  - Solids – clean or mixed feedstocks
  - Liquids – beverages, oil & grease, manures
  - Semi-solids – sludges (sanitary and non-sanitary)
- What do we need to know about feedstocks?

Solid Feedstocks

Moisture content	%, wet basis
Volatile solids	%, dry basis
Bulk density	lbs/CY
Particle size	$inch_{avg}$
C, N, P	%, dry basis
Micronutrients	% or ppm
pH	none
Salt content, EC	dS/m
Stability index	mg/g/hr
Metals & contaminants	% or ppm

Solid Feedstock Example

	Wood Fiber	Wood Ash
Moisture, %wb	7.3	0.8
Volatile solids, %db	99.5	1.8
Bulk density, lbs/CY	95.8	2160
pH	5.2	11.7
Soluble salts (EC), dS/m	1.57	11.8
C, %db	47.4	0.7
N, %db	4.3	0.1
C/N	11.1	7.2

Liquid Feedstocks

Solids content	%, wet basis
BOD	mg/L
Soluble C,N, P	ppm
Micronutrients	% or ppm
pH	none
Salt content, EC	dS/m
Metals & contaminants	% or ppm

Types of materials

- High Nitrogen – Chicken manure
- High Carbon – Wood, sawdust, paper
- High Moisture – Food wastes
- High Bulk Density - Biosolids

Feedstocks

- Animal manures (chicken, dairy, cattle, horse)
  - Can be slurries or semi-solid
  - Often mixed with animal bedding
- Biosolids (sewage sludge)
  - Highest pathogen potential
  - Highest odor potential
  - Usually dewatered to 15 – 35% T.S.

Feedstocks, cont.

- Food wastes
  - Pre-consumer – largely produce, meats
  - Post-consumer – soluble salts an issue
- Yard wastes
  - Very heterogeneous
  - High potential for contamination
  - Seasonal changes
    - Grass clippings in spring & summer
    - Leaves in fall

Feedstocks, cont.

- Industrial sludges
  - DAF float (~ 1.5% T.S.)
  - Waste-activated sludges (biological)
  - Clarifier settled solids (phys-chem)
- Water treatment plant residuals
  - Alum (aluminum sulfate)
  - Ferric chloride

Feedstocks, cont.

- Woody wastes
  - Wide variety of particle sizes
    - Sander dust, sawdust
    - Ground land-clearing debris
    - Pallets & clean construction wood waste
  - Grinding usually needed
- Agricultural wastes
  - Readily compostable
  - Usually cleanings from processing

Contaminants

- Inerts - Glass, metal, plastic
- Household Hazardous Wastes
  - Batteries, cleaning products, motor oil, paints, pesticides
- Pressure-treated wood
- Painted or stained wood
- Removal methods:
  - Manually - Classifiers
  - Trommel screen - Separators

Chemical Contaminants

	Source	Issues	EPA limits
Arsenic	Pesticides Defoliants Electronic parts CCA treated wood	Causes : Cancer Nerve damage	41
Cadmium	Batteries Electroplating Industrial waste..	Plant uptake Human toxin – kidney function	39
Chromium	Plating Paints – dyes	Plant uptake Phytotoxic – Animal consump.	1200

EPA limits in mg/kg

Chemical Contaminants

	Source	Issues	EPA limits
Copper	Plumbing/Electrical HHW Chemicals Industrial	Plant uptake Phytotoxic – Animal consump.	1500
Lead	Batteries - paints Industrial	Phytotoxic Animal toxic Human anemia …	300
Mercury	Some lamps, batteries, electrical switches		17

Chemical Contaminants

	Source	Issues	EPA limits
Molybde-num	Electronic tubes Furnaces Lubricants	Req. at low levels High level : Toxic to Animals/ Humans [kidney]	18
Nickel	Batteries Stainless Steel	Phytotoxic	420
Selenium	Photographic supplies Pigments Electronics	Animal toxicity – blind staggers	36
Zinc	Galvanized parts Batteries, wires, solder	Phytotoxic	2800

Courtesy, K.C. Das, 2004

Testing Feedstocks

- Use generators' data (metals, TCLP)
- Get representative sample
- Have tested for compost parameters
- Testing Labs
  - U.S. Composting Council's website: http://www.compostingcouncil.org/section.cfm?id=38
  - State Land Grant Universities
  - State Departments of Agriculture
    - North Carolina Division of Agronomy
- Test annually or if waste changes

Feedstock Handling

- Solid wastes
  - Keep under cover if potential for runoff contamination or dust problems
- Semi-solid wastes (sludges)
  - Incorporate into mix within 24 hrs
- Liquids
  - Steel or concrete tank storage
  - Need dry amendment to absorb

Dust & Runoff Control

- Exposed feedstocks can leach into rainfall runoff
- Dust problems will aggravate neigbors

Liquids Storage Alternatives

Concrete Storage Tank

Absorbent Materials

Glass-lined Steel Tank

Questions?

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Conducting Solid Waste Audits

Yes You CAN!

(Compost and Naturescape!)

Training Program

Why Audit?

- Composting is a materials-handling intensive activity
- Knowing quantities optimizes labor and costs
- Knowing composition optimizes composting recipes
- Audits help identify other recyclables
- Raise awareness of solid waste issues

Organizing an Audit

- Do audit at time that reflects average level of activity
- Consider seasonal factors
  - More yard waste in Spring than Fall
- Materials needed:
  - Sorting tables
  - Bins for all sorting categories
  - Scales for weighing wastes
  - Gloves/calculators/paper

Doing an Audit

- Select monitoring areas that represent distinct waste generation locations
- Do a preliminary audit with a small amount of solid waste to confirm waste categories
- Collect at least five (5) bags of solid waste from each generation area
- Before sorting, determine weight and volume of each bag/container
  - Vol.(cubic feet) = (2)(3.1415)(radius, in ft.)(height, in ft)

Sorting

- Sorting categories depend on recycling needs
- For compostables:
  - Pre-consumer food waste (i.e. prep waste)
  - Post-consumer (i.e. table scraps
  - Soiled paper (i.e. napkins, paper towels)
  - Wax-coated cardboard
  - Vegetative debris
  - Other?

Food Waste Audits

- An educational and promotional event
- Stimulates awareness about food wastes
- Concepts to be communicated:
  - Uneaten food is not inevitable
  - Taking modest portions prevents waste
  - Each individual's choice has a large impact on the collective waste generated
- Goal – determine average amount of waste created during a meal

Organizing the Audit

- Get everyone involved – staff, customers, vendors
- Select a date for the audit, particular meal(s), and waste collection method
- Find out what will be served on the day of the audit – tailor sorting as needed
- Organize audit area to maximize convenience for customers

Ensuring Audit Success

- Set up audit station near entrance to dishwashing
- Staff audit table with monitors to answer questions
- Use oversized signs and posters
- Use clearly-labelled collection containers

Gathering Audit Data

- Determine number of patrons during audit meal
- Determine number of meals served
- Total up weighed audit sorts (prep waste, scraps, soiled paper, etc.)
- Calculate per-person averages (amount weighed divided by number of patrons)

Audit Data

Date	Location	Meal	Number Served	Lbs. Food	Lbs. Per Person	Lbs. Trash	Lbs. Per Person	Lbs. Napkins	Lbs. Per Person	No. Napkins Per Person
4/20/95	Carson	Lunch	980	260.0	0.265	42.0	0.043	8.0	0.008	1.0
4/20/95	Hamilton	Dinner	690	250.0	0.360	14.0	0.020	11.0	0.016	2.0
4/20/95	Univ. Inn	Breakfast	267	57.0	0.210	17.0	0.060	3.0	0.011	1.4
1/16/96	Univ. Inn	Dinner	406	200.0	0.490	15.0	0.036	10.0	0.024	3.0

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Composting Methods & Equipment Needs

Yes You CAN!

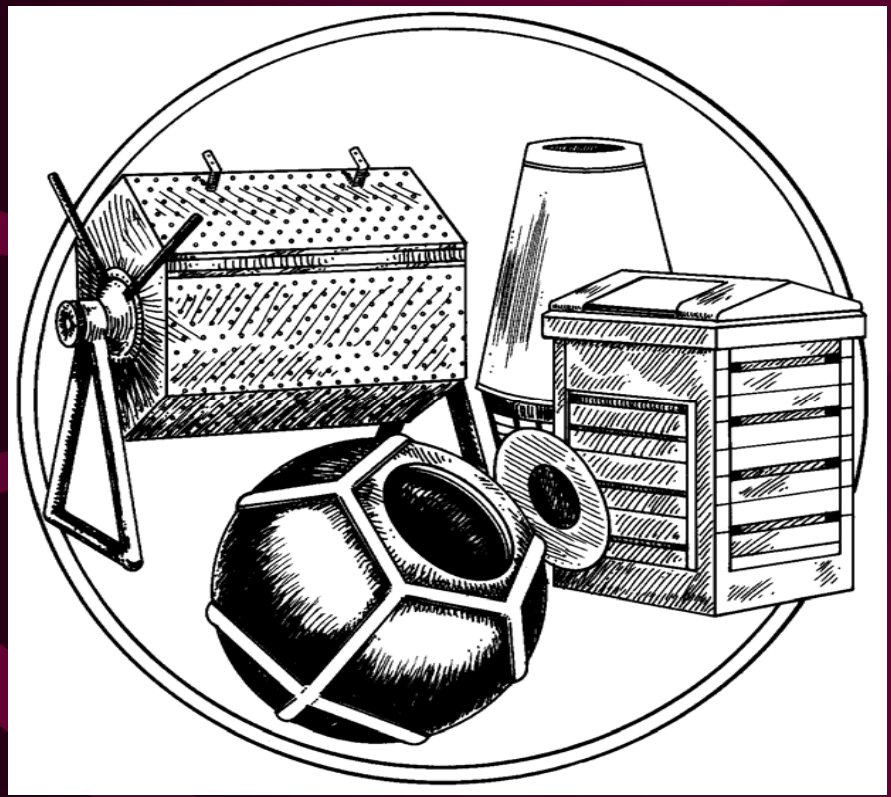
(Compost and Naturescape!)

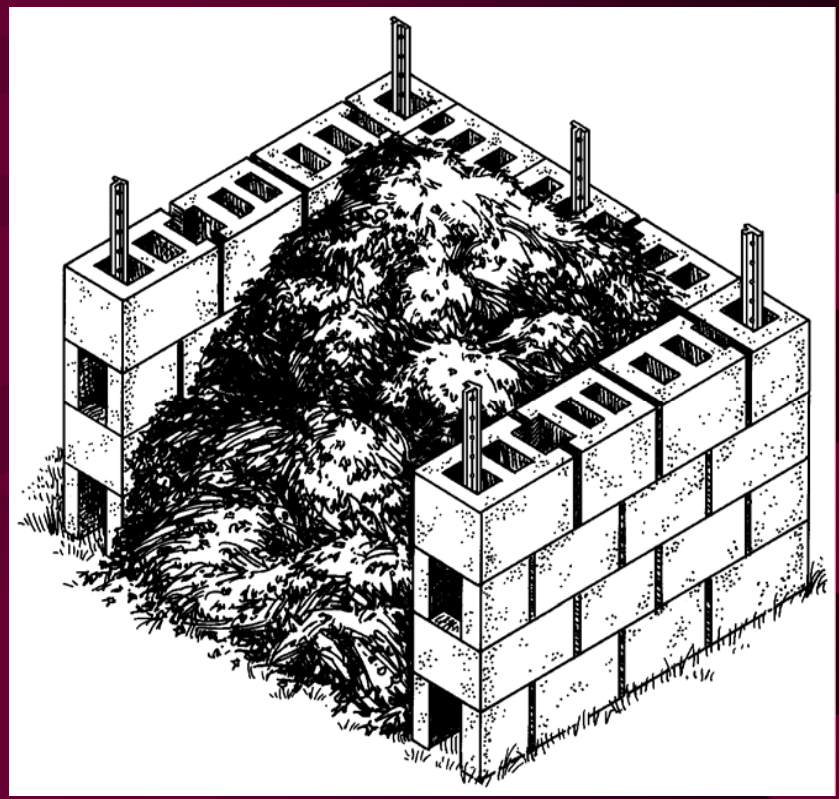
Training Program

Backyard Composting

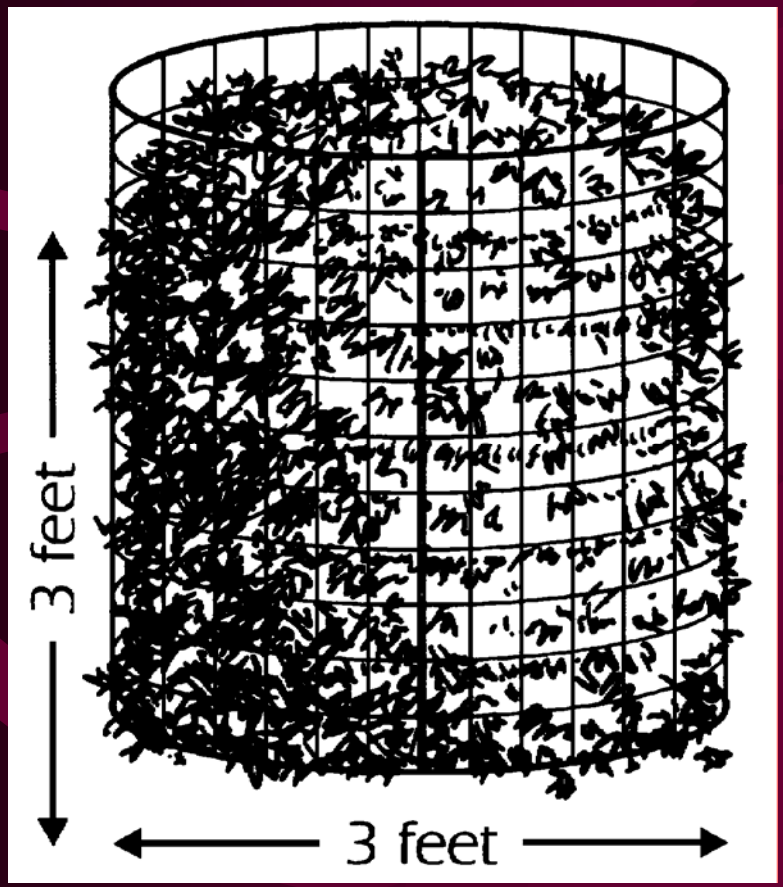
- Potential diversion – 400 – 800 lbs/year/household
- Suitable materials
  - Yard trimmings (leaves, grass, shrubs)
  - Food wastes (produce, coffee grounds, eggshells)
  - Newspaper
- Unsuitable materials
  - Pet wastes
  - Animal remains (meat, fish, bones, grease, whole eggs, dairy products)
  - Charcoal ashes
  - Invasive weeds and plants (kudzu, ivy, Bermudagrass)

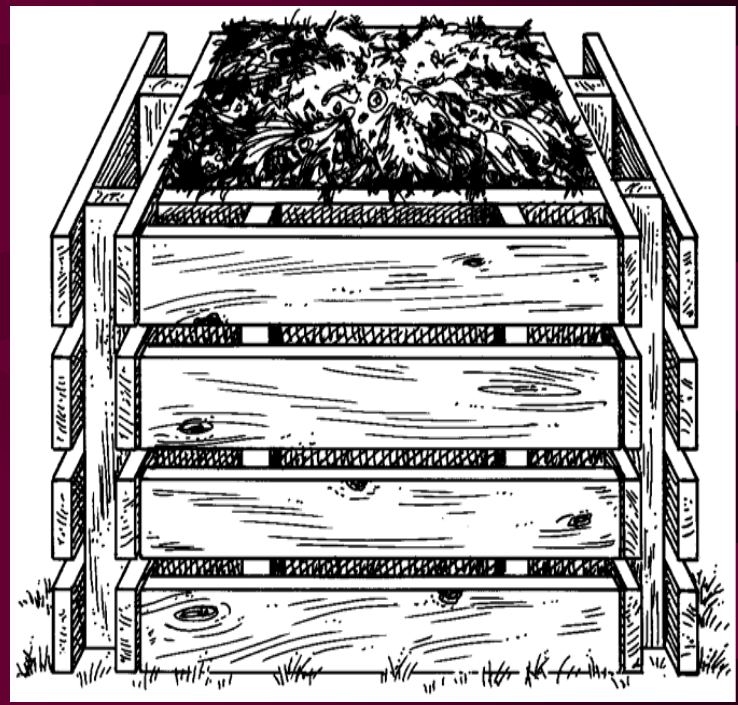
Types of BYC Systems





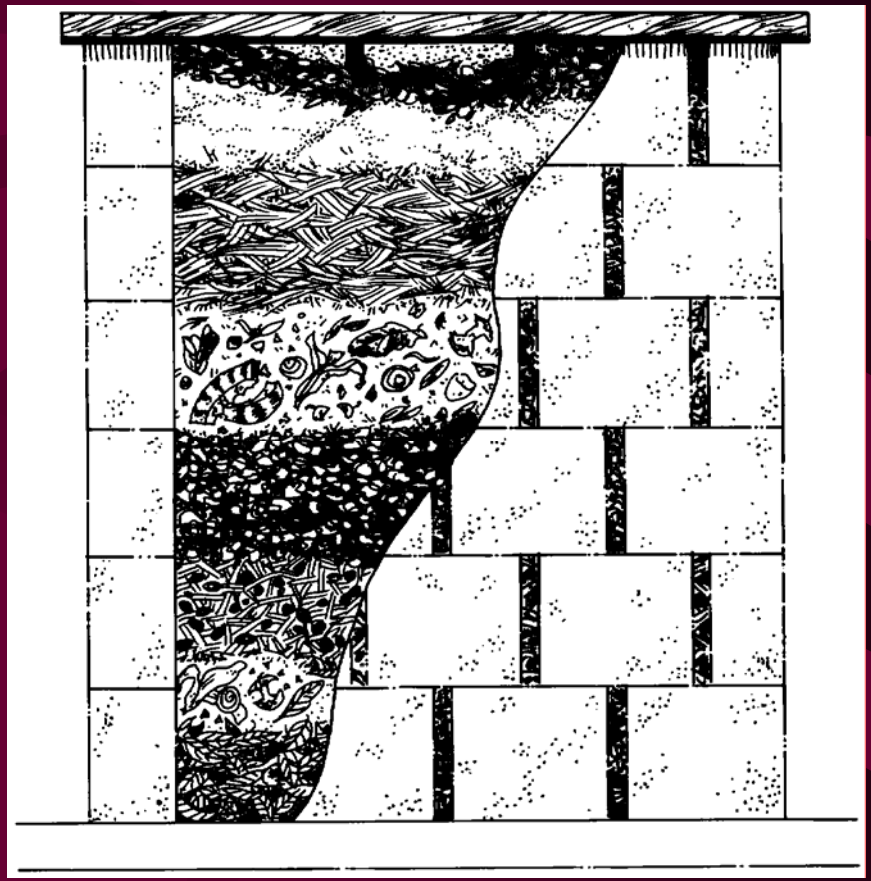
Types of BYC Systems





Backyard Composting – Easy To Do!

- Locate in flat area, shielded from sun & wind
- Add materials in layers (browns/greens)
- Turn pile after 1st week, then 2-3 times over next two months

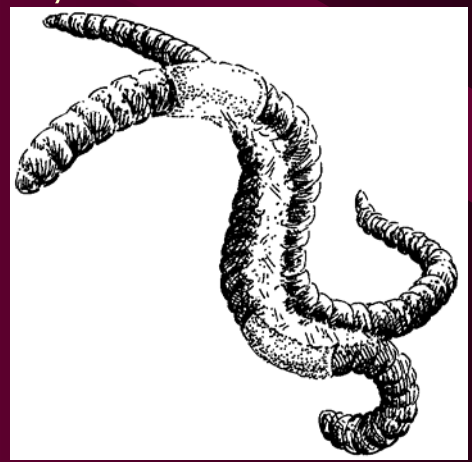


Backyard Composting, cont.

- Can add fresh wastes when turning, but better to start new pile
- Compost will be ready to use in
  - 4 – 6 months for piles started in Spring
  - 6 – 8 months for piles started in Fall

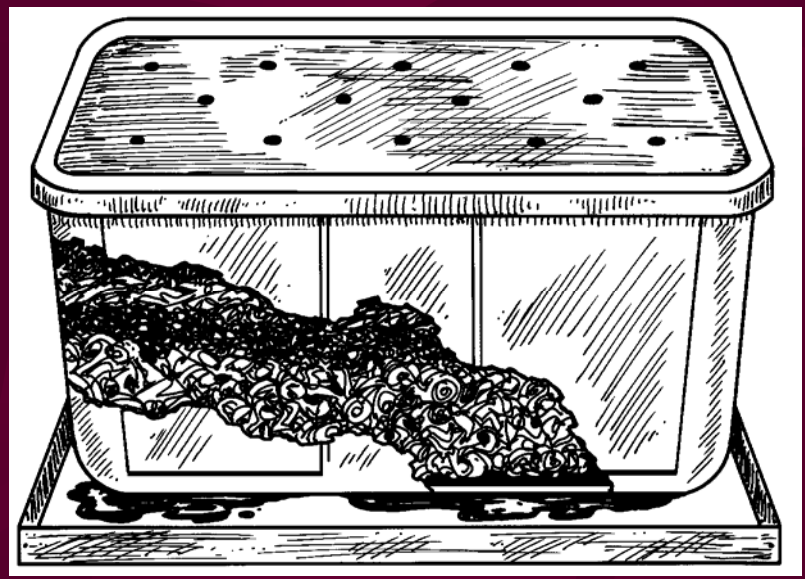
Vermicomposting Home Wastes

- Vermicompost = worm castings + bedding
- Nutrient Value - 6600 ppm organic nitrogen, 1300 ppm phosphorus & 1,000 ppm potassium
- What to feed worms –
  - Vegetable scraps, breads and grains
  - Fruit rinds and peels
  - Tea bags, coffee grounds, coffee filters, etc.
- What <u>not</u> to feed worms –
  - Meat, fish, cheese or butter
  - Greasy, oily foods
  - Animal wastes



Vermicomposting – How To Do It

- Bin – wooden, plastic or metal with tight-fitting lid
  - 2’ x 3’ x 1’ – good for 2-3 person household
  - Need drainage holes in bottom and air vents on top and sides



Vermicomposting – How to do it

- Add moist drained bedding to worm bin
  - 1” – 2” strips of newspaper/cardboard/leaves/peat moss/sawdust
  - Fill bin with bedding
- Start with 2 lbs of redworms/lb daily scraps
  - Eisenia foetida or Lumbricus rubellus
- Bury food scraps under 4 – 6” bedding
  - Rotate burial around bin to prevent overloading
- Harvest vermicompost in 3 – 6 months

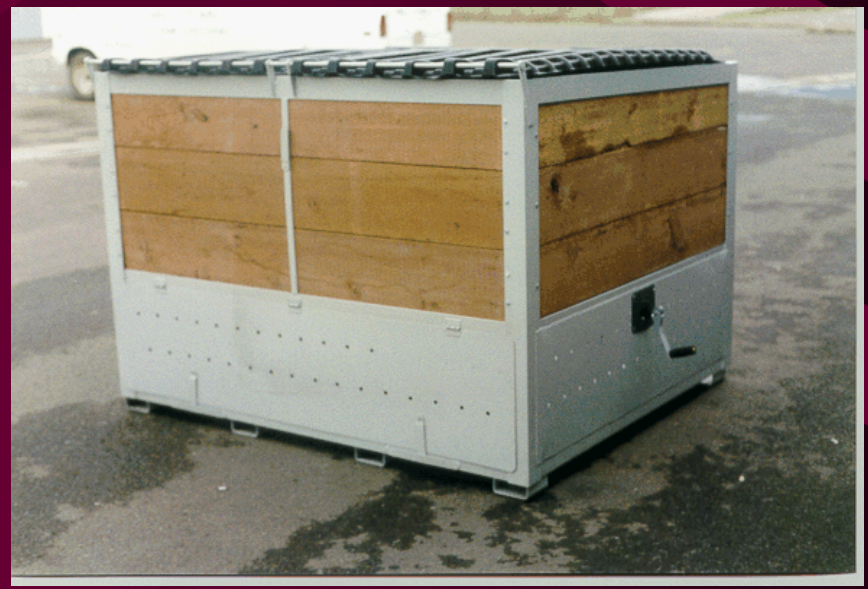
Institutional Composting

- University dining halls
- Industrial/government cafeterias
- Hotels
- Correctional Facilities
- Resort facilities
- Special Events (fairs, festivals, sporting events)

Institutional Composting

Worm Wigwam (small)

Worm Wigwam (large)



Institutional Composting

Rotary Drum

Earth Tub

Institutional Composting

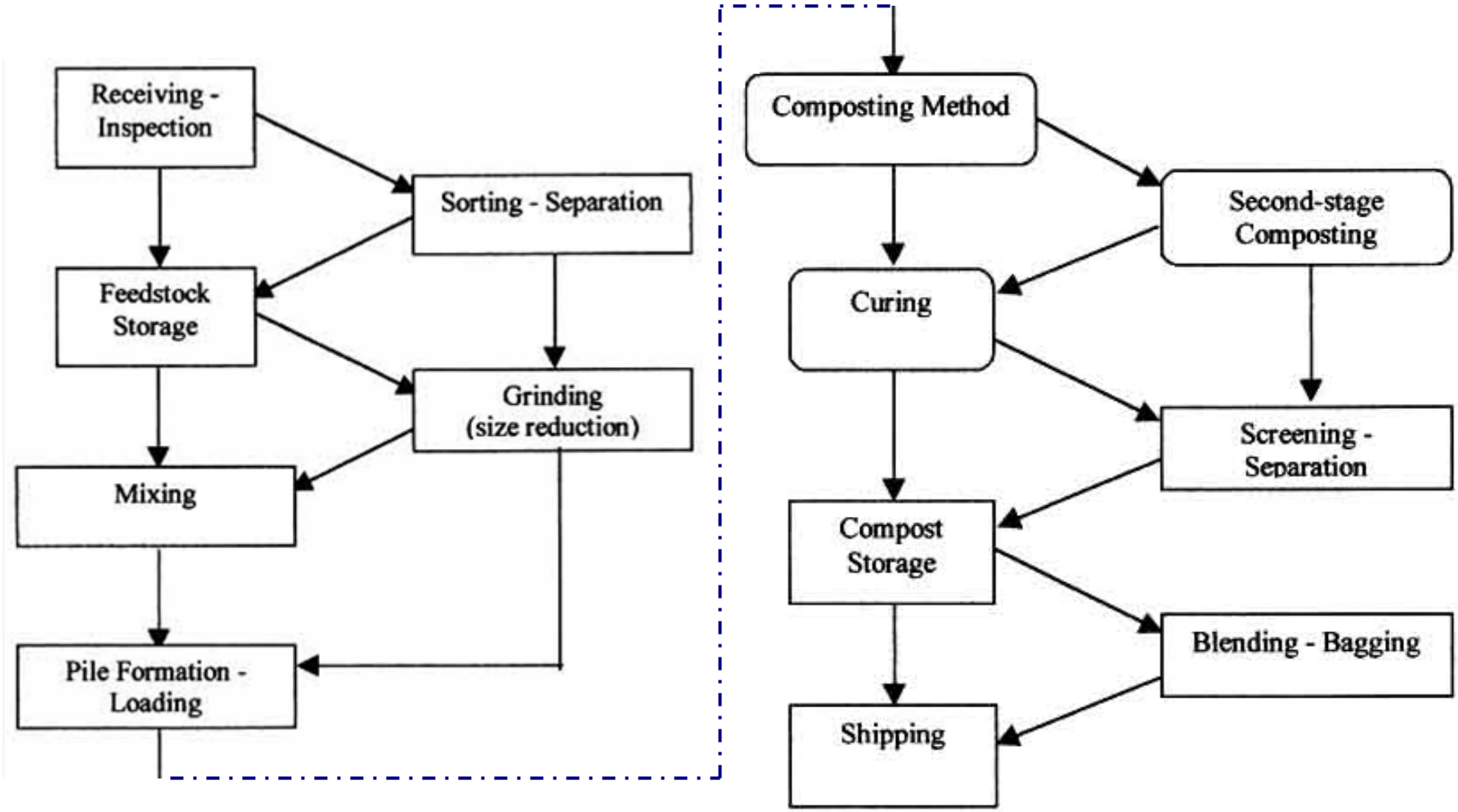
- Key is efficient source separation of organics
- Separate collection containers from regular trash
- Training needed to minimize contaminants (non-compostables like plastics, foils, metals)

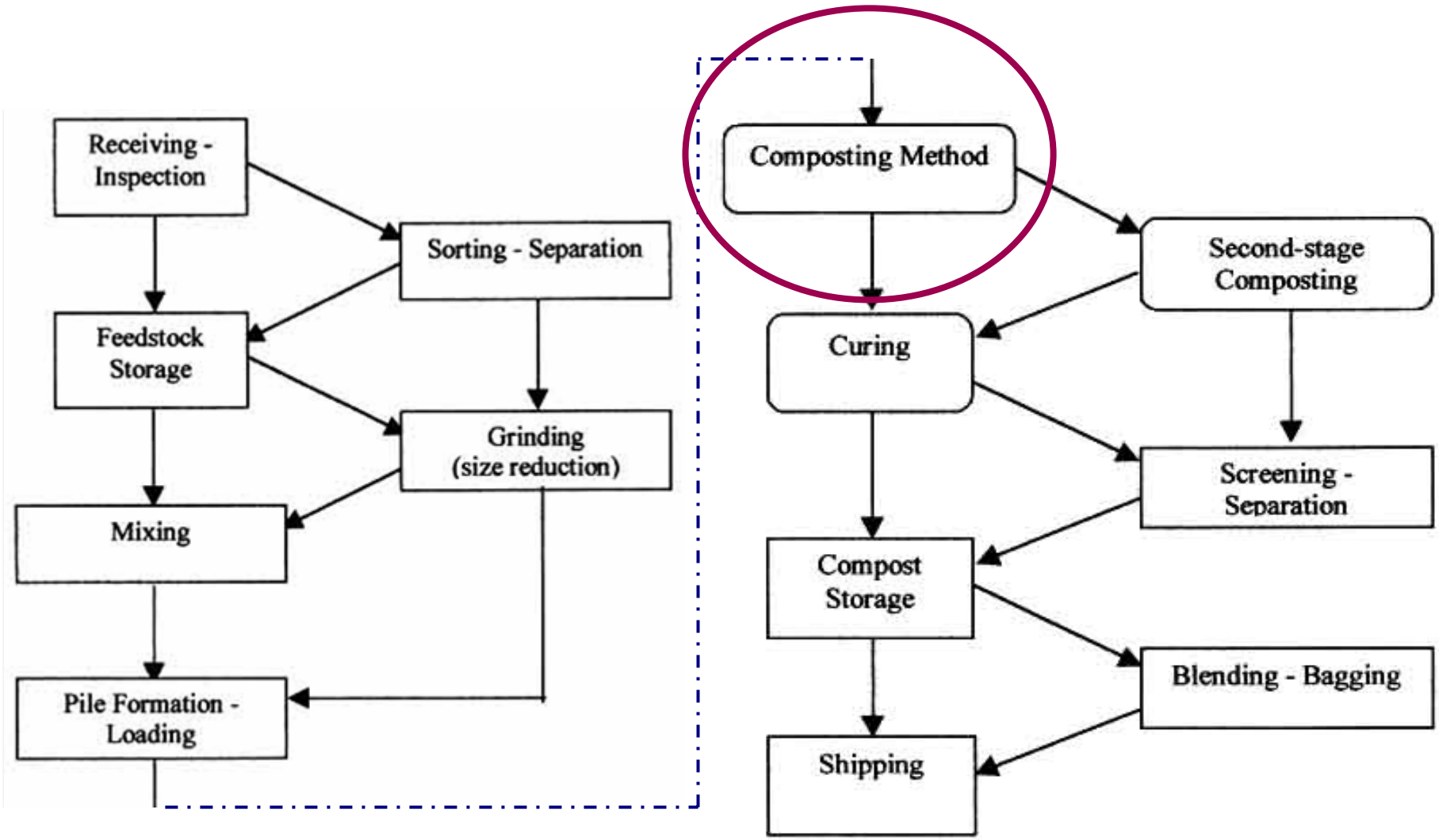
Commercial Composting

- Larger-scale commercial and municipal facilities
- Feedstocks: manures, agricultural wastes (I.e. cotton gin trash), industrial and municipal wastewater treatment sludges, food wastes
- Technologies used:
  - Windrows
  - Aerated Compost Bins
  - Aerated Static Pile
  - In-Vessel Systems
- Produced compost sold for $18 - $20/$yd^3$

Terminology

“Composting Systems” vs.
“Composting Methods”


Receiving - Inspection
Sorting - Separation
Feedstock Storage
Grinding (size reduction)
Mixing
Pile Formation - Loading
Composting Method
Second-stage Composting
Curing
Screening - Separation
Compost Storage
Blending - Bagging
Shipping


Receiving - Inspection
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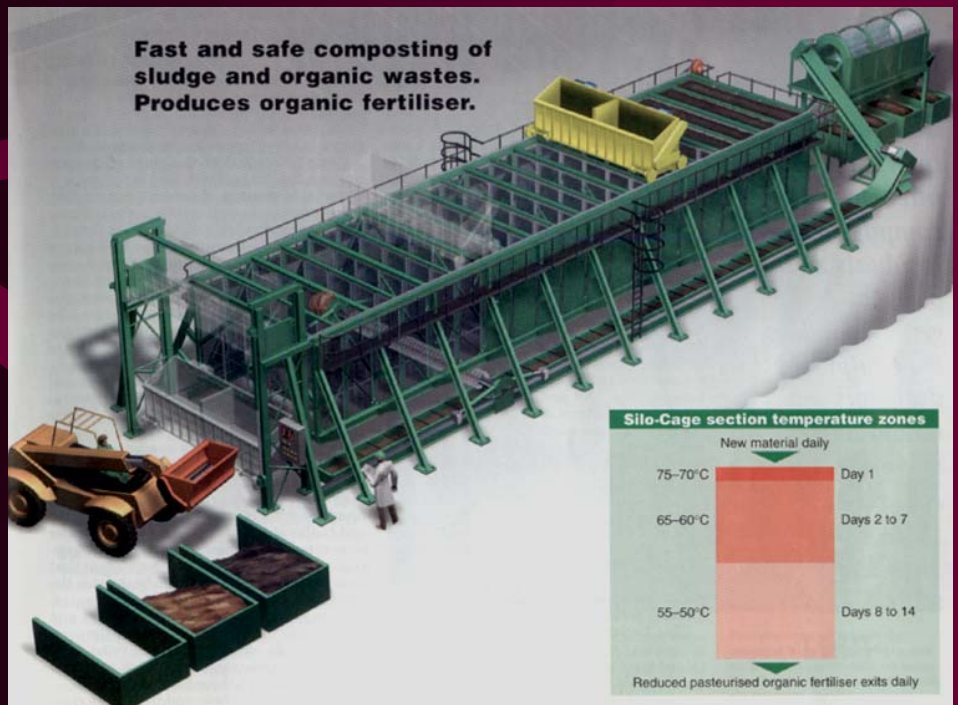
Composting Method
Second-stage Composting
Curing
Screening - Separation
Compost Storage
Blending - Bagging
Shipping

Characterizing Composting Systems

- Open vs. In-vessel (contained)
- Passive vs. Forced Aeration
- Static vs. Agitated (turned)
- On-site vs. centralized
- Scale (large, small, commercial, farm, etc)
- Single vs. Multiple Stage
- Modular

Open “Systems”

Contained or In-vessel “Systems”



Gray Areas:
open or
in-vessel?

System Selection

- Do they work?
  - Nearly all composting methods and systems can produce good compost
  - Nearly all composting methods and systems are based on sound composting principles
  - Beware of those that don’t
- Efficiency and cost?
  - Most systems have advantages, disadvantages, niches, inflated expectations
  - Beware of those that look too good

Systems & Equipment

- Composting systems are multiple pieces of equipment
- Not all “systems” come complete with all equipment
- Materials handling focus of compost production requires reliable equipment
  - Equipment downtime is very costly
- Plan on spending a lot of money!

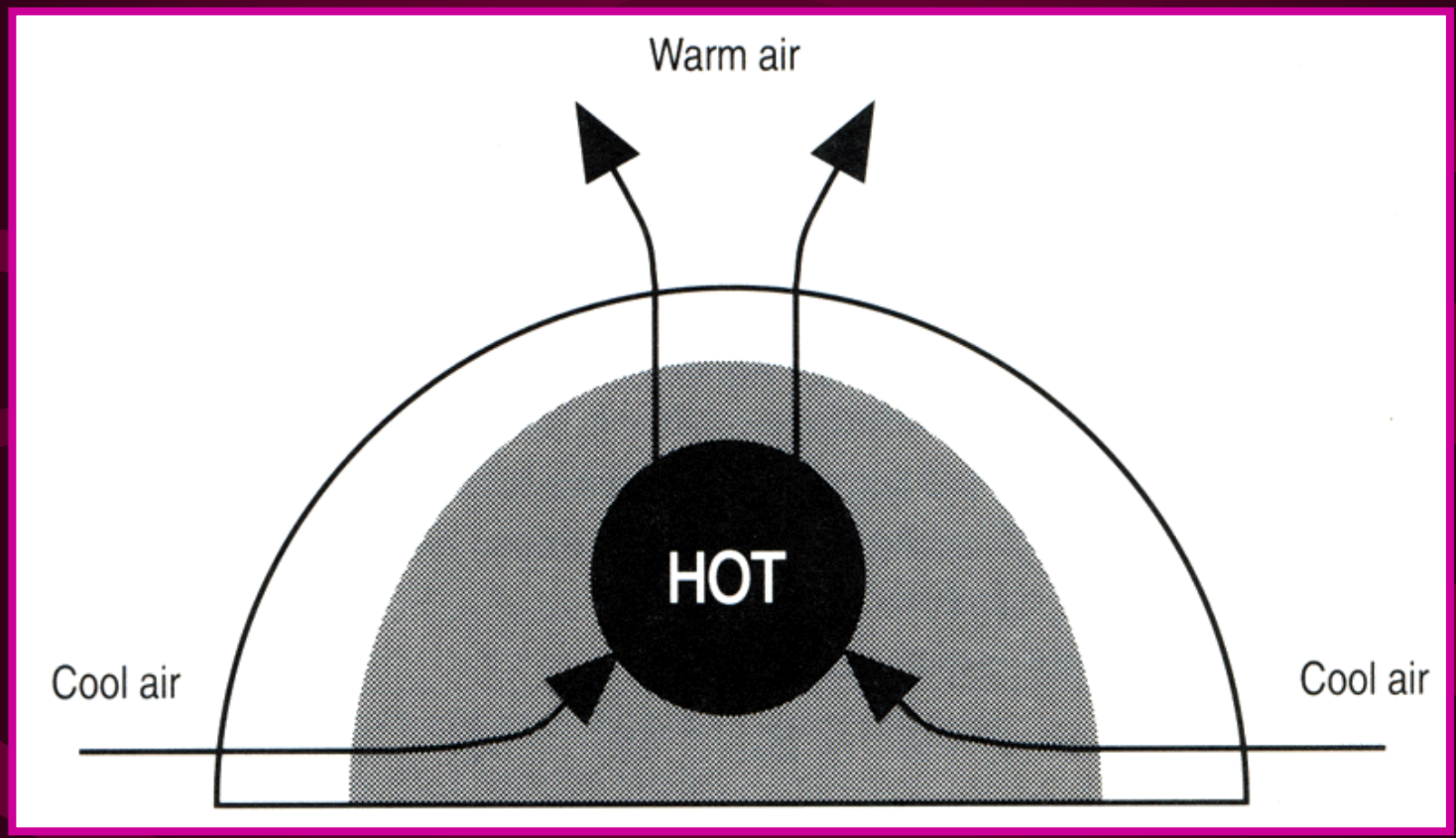
Composting Methods

- Turned Windrows
- Passive aerated windrows
- Aerated static pile
- In-vessel composting

Windrow Composting

- Consists of of placing the mixture of raw materials in a long narrow piles or windrows which are agitated or turned on a regular basis.
- Windrows aerate by passive air movement

Passive air movement in a composting windrow (chimney effect)



Turning the Windrows

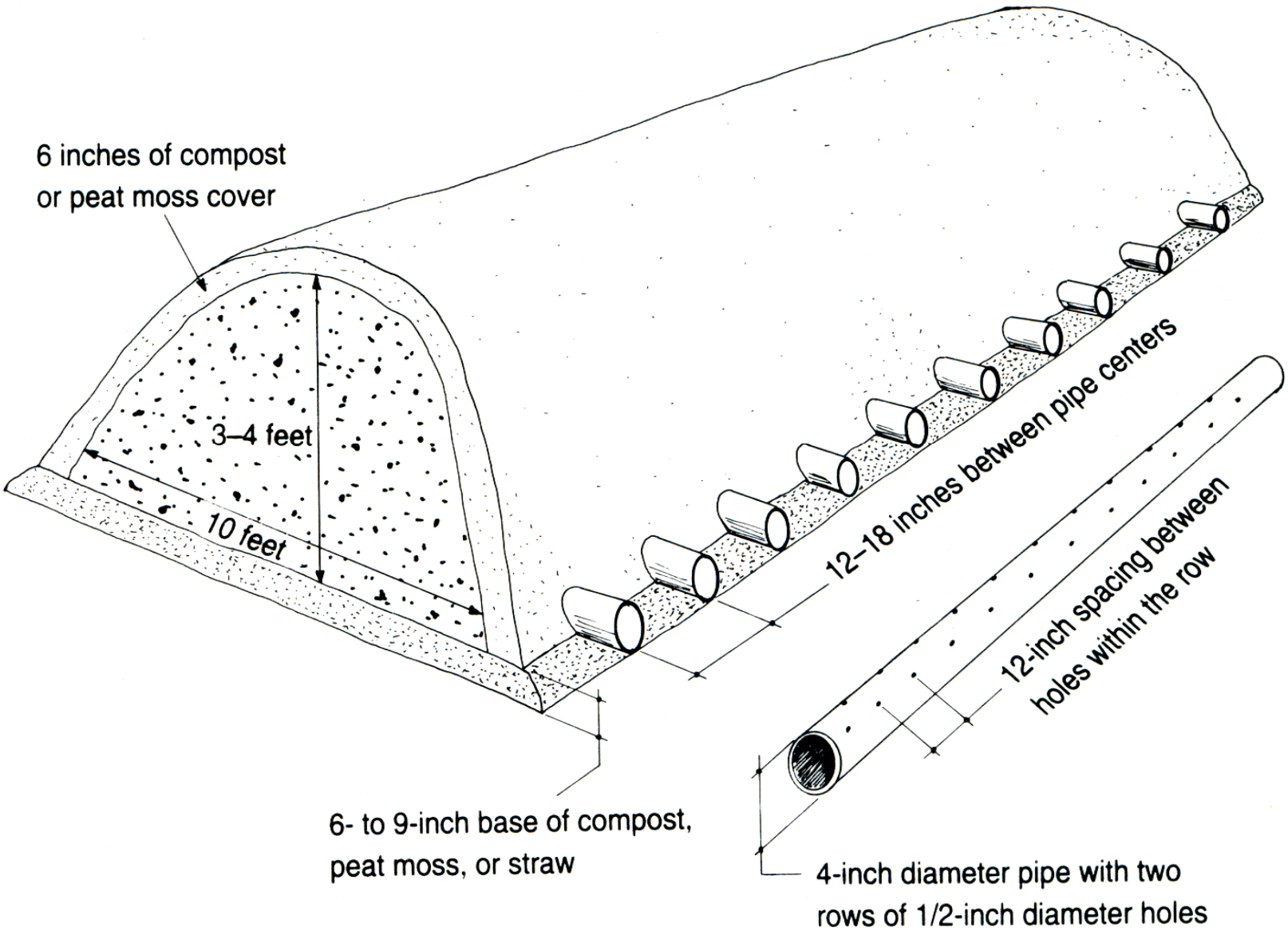
- Rebuilds the porosity by fluffing material
- Releases trapped heat, water, and gasses.
- Exchanges the material at the windrow's surface with material from the interior (more weeds seeds, pathogens, and fly larvae are destroyed by high interior temperature)
- Oxygen is depleted quickly (~ 45 min.)

Windrow Management

- Important to maintain schedule of turning
- Frequency decreases as windrow ages
- Low temps and/or odors signal need to turn
- Also turn if temps get too high (>140^{o} F.)
- Turn at least weekly to break fly reproductive cycle
- Volume loss over first 2 weeks – combine windrows

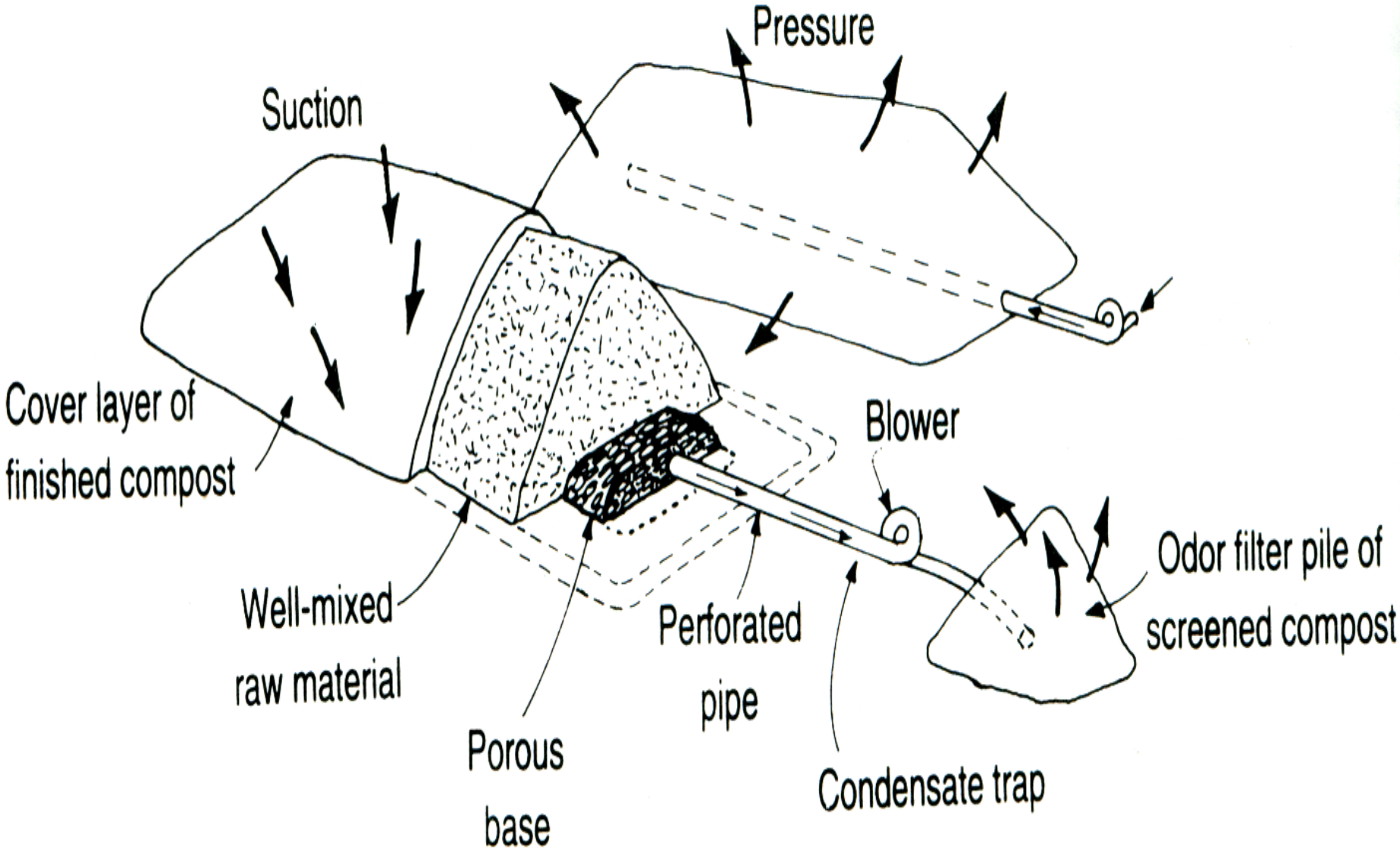
Passive aerated windrows

- Eliminates the need for turning by supplying air to the composting materials through perforated pipes embedded in each windrow (hot gases rise upward out of the windrow).
- No turning or agitation of the materials occurs once the pile is formed.
- Good for odorous feedstocks (i.e. fish waste)


6 inches of compost
or peat moss cover
3–4 feet
10 feet
12–18 inches between pipe centers
12-inch spacing between
holes within the row
6- to 9-inch base of compost,
peat moss, or straw
4-inch diameter pipe with two
rows of 1/2-inch diameter holes

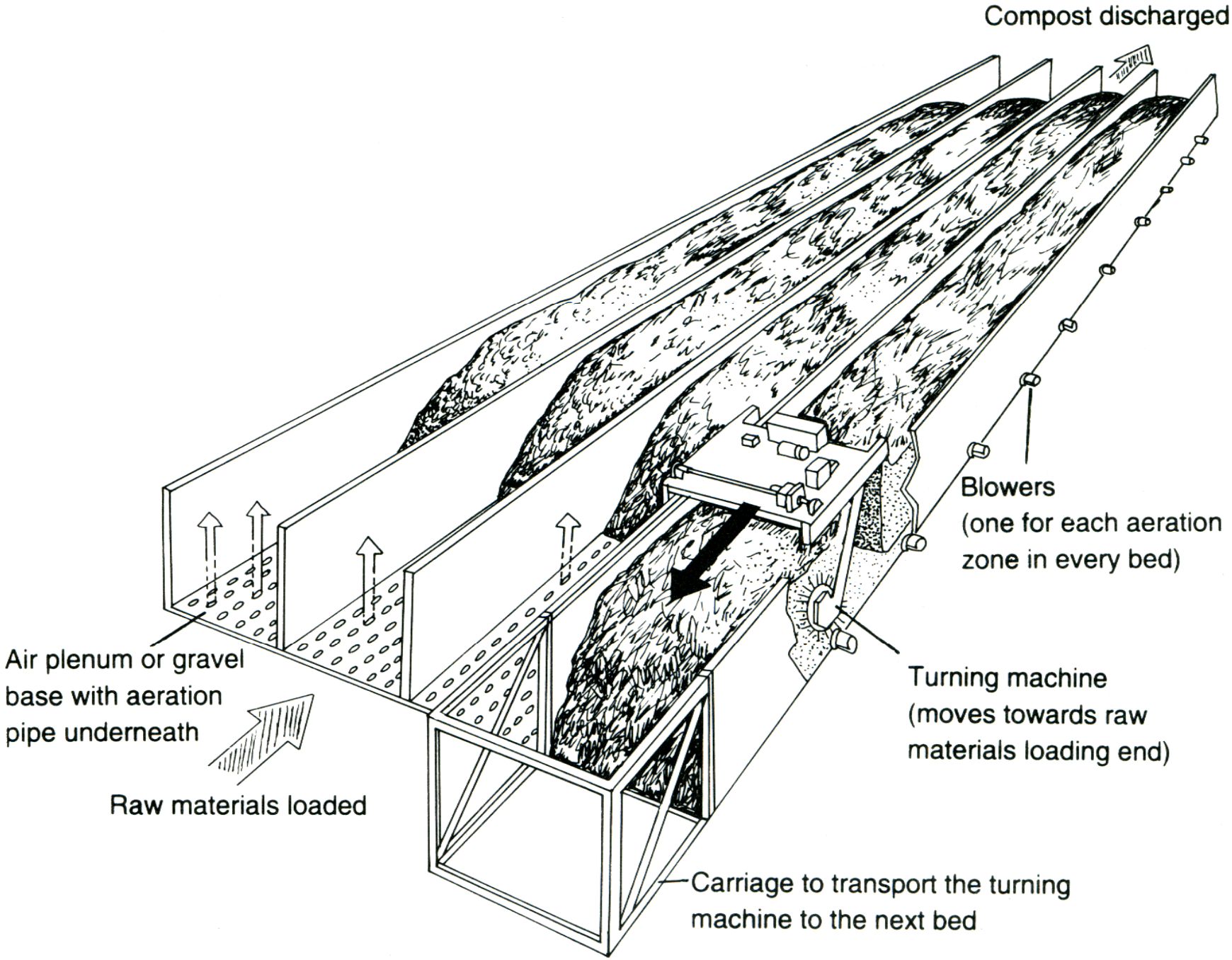
Aerated static pile

- Takes the piped aeration system a step further, using a blower to supply air to the composting materials.
- No turning or agitation of the materials occurs once the pile is formed.
- Good for biosolids


Pressure
Suction
Cover layer of
finished compost
Blower
Odor filter pile of
screened compost
Well-mixed
raw material
Perforated
pipe
Porous
base
Condensate trap

In-Vessel Composting

- Confine the composting materials within a building, container, or vessel.
- Rely on a variety of forced aeration and mechanical turning techniques to speed up the process.
- Bin composting, rectangular agitated beds, silos, rotating drums


Compost discharged
Blowers
(one for each aeration
zone in every bed)
Air plenum or gravel
base with aeration
pipe underneath
Turning machine
(moves towards raw
materials loading end)
Raw materials loaded
Carriage to transport the turning
machine to the next bed

Backhus Bridge Tunnel

Rotocom (Japan)

ECS Cont. Compost System

BW Organics Greendrum

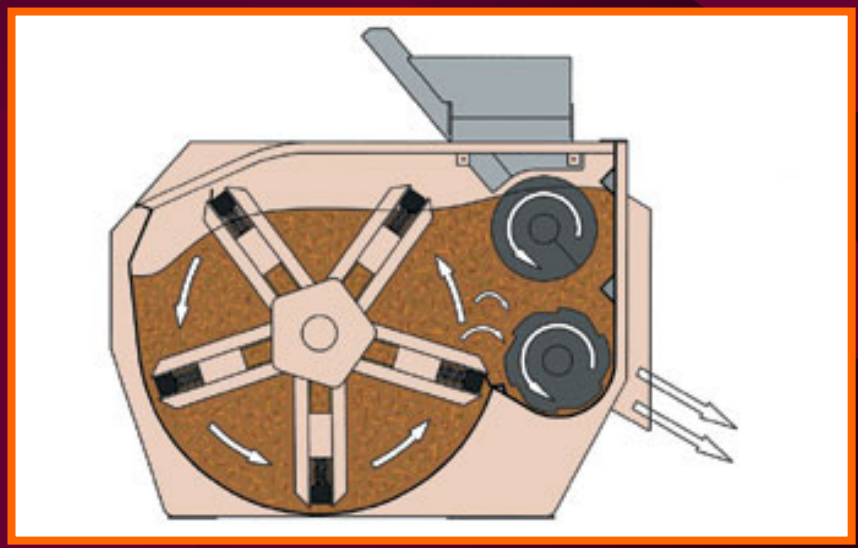
NatureTech CCS

Hot Rot System (New Zealand)

GMT Earth Tub

Composting Equipment

- Mixing Equipment
  - Provides consistent mix of feedstocks
  - Can include scales
  - Types
    - Vertical shaft
    - Horizontal shaft



Composting Equipment

- Loading Equipment
  - Forming windrows
  - Turning windrows
  - Mixing
  - Batching
  - Loading trucks
  - Loading Screen
  - Moving materials
  - Multiple attachments

Composting Equipment

- In-process Equipment
  - Compost Turners
    - Pull behind
    - Side face
    - Strato

Pull behind

Side face

Strato

Composting Equipment

- In-process Equipment
  - Compost Turners
    - Pull behind
      - PTO tractor driven or self propelled
      - Minimal moving parts
      - Good for small scale composting or start up
      - Access isle is required
      - Takes up pad space

Composting Equipment

- In-process Equipment
  - Compost Turners
    - Side face - Windrow
      - Pull behind & self propelled
      - Track or tire
      - ½ windrow with each pass
      - Access isle required
      - Takes up pad space
      - Lots of moving parts

Scat-self propelled

Wildcat-loader mounted

Composting Equipment

- In-process Equipment
  - Compost Turners
    - Side face-Trapezoid Heap
      - Self propelled
      - Track or tire
      - Takes a side face and transposes
      - Access isle not required
      - Less air-more bulking
      - More frequent tuning required

Composting Equipment

- In-process Equipment
  - Compost Turners
    - Strato (triangular heap)
    - Track or tired
    - Self propelled
    - Minimal isle space
    - More air from natural convection
    - Can transpose whole windrow
    - Moisture addition

Composting Equipment

Backhus Compost Turners

Composting Equipment

Scarab Manufacturing

Sandberger

Frontier

Komptech

Composting Equipment

- Monitoring Equipment
  - Temperature Probes
    - Analog
    - Digital
    - Data logging
    - Thermal Coupler

Composting Equipment

- Monitoring Equipment
  - Temperature Probes
    - Data logging
    - Record keeping

Windrow Manager
Probe-Temp & O_2

Green Mt. Technologies-Windrow Manager

Composting Equipment

- Monitoring Equipment
  - Oxygen/Carbon Dioxide Probes
    - Analog
    - Digital
    - Data logging

Fyrite CO_2 Meter

Windrow Manager-Probe-Temp & O_2

Demista-Temp & O_2 Meter

Composting Equipment

- Aeration Equipment

Composting Equipment

- Post process Equipment
  - Screens
    - Shaker deck
    - Trommel
    - Star deck

Shaker deck

Trommel

Star deck

Equipment

- Major cost item in composting capital costs
- Whenever possible, buy either new or low operating hours used equipment
- Talk with other owners of the same type/model of equipment before buying
- Make sure equipment maintenance is a daily priority at the composting facility

Questions?

CAROLINA RECYCLING ASSOCIATION

Carolinas COMPOSTING COUNCIL

Composting Operations

Yes You CAN!

(Compost and Naturescape!)

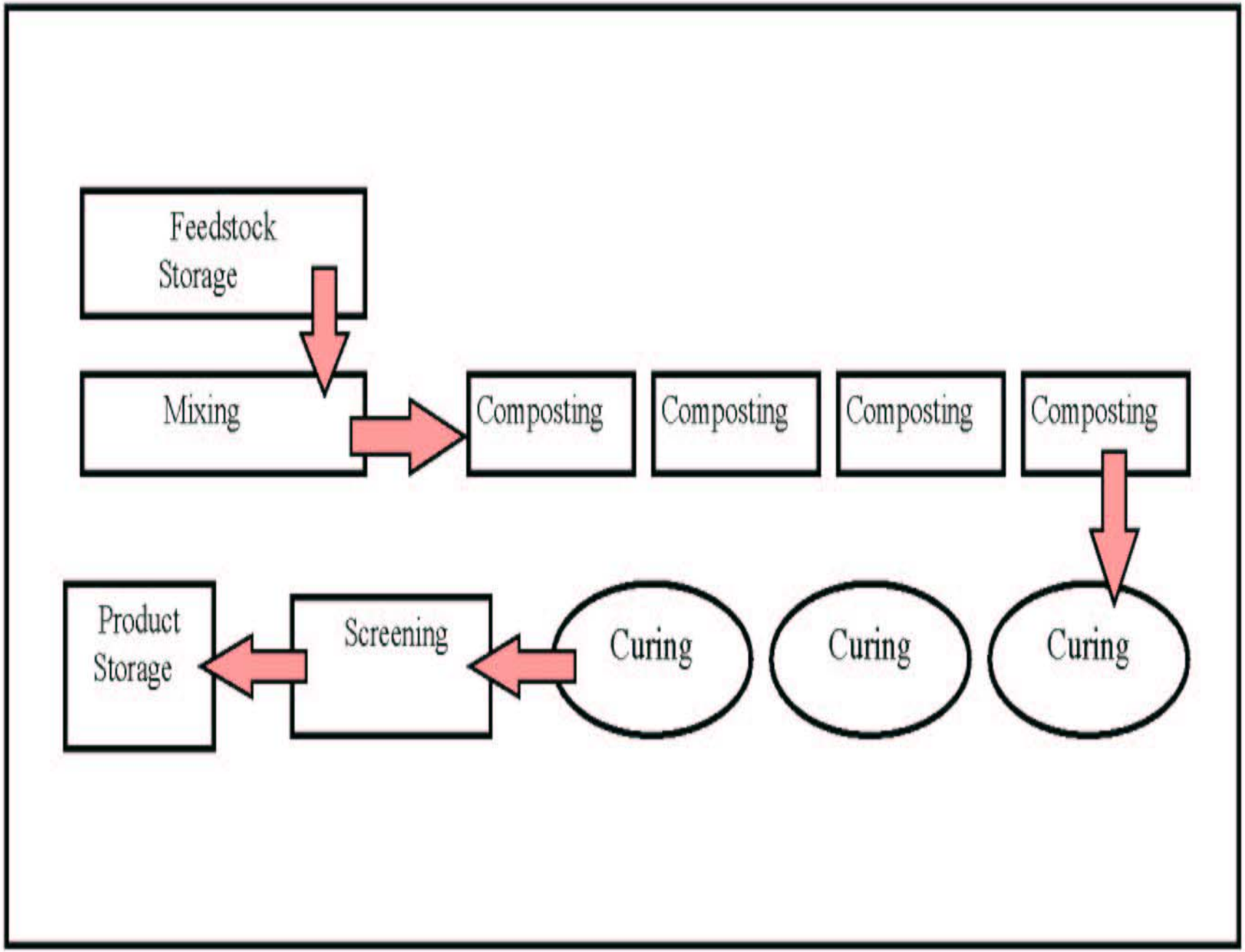
Training Program

Work Flow

- Compost manufacturing is materials-handling intensive
- Minimize materials handling inefficiencies
- Remember – materials handling does **not** increase the value of the compost product(s) – it is a cost

Work Flow

- Minimize the frequency, distance and manual effort associated with materials handling
  - Keep product flow as linear as possible (given siting constraints)
- ***No material should move twice in the same physical condition!***


Feedstock Storage
Mixing
Composting
Composting
Composting
Composting
Curing
Curing
Curing
Screening
Product Storage

Ancillary Requirements

- Allow for a covered work area to service equipment
  - Provide secure tools storage
- Allow for materials and supplies storage areas
  - Fireproof cabinets for chemicals
  - Keep organized spare parts inventories
- Allow for employee clean-up and changing areas
  - Most families won’t tolerate the smell coming home!

Ancillary Requirements

- Utilities
  - Ensure water hose bibs and power outlets are everywhere
  - Keeping facility clean reduces odors
- Windbreak Treelines (Upper canopy and understory)
  - Plant native treelines both upwind and downwind of compost pad to:
    - disrupt windflow
    - minimize odor transport
    - provide particulate capture

Feedstock Delivery & Preparation

- Materials Storage
- Bulking Agents
- Putrescible Wastes
- Mixing

Materials Storage

- Most materials can be stored outside
- Place tarp covers over light, windblown material
  - Sawdust, wood ash, cotton fibers, tobacco dust
- Provide adequate space nearby to mixing area for materials storage

Bulking Agents

- Used to balance C:N ratio, moisture content
- May need regrinding
  - 2” screen size recommended
- Monitor storage pile temperatures
  - If above 180^{o}F. – risk of spontaneous combustion

Suitable Bulking Agents

- Yard waste
- Leaves
- Wood chips
- Sawdust
- Wood shavings
- Horse bedding
- Straw/Hay

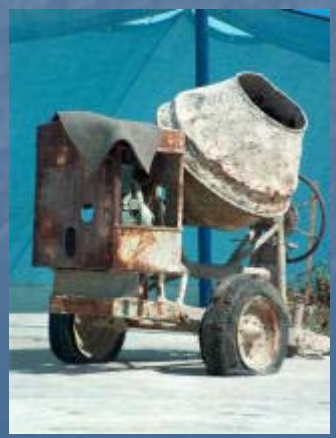
Putrescible Wastes

- Examples: biosolids, manures, food wastes
- These wastes don't store well
  - Odors, leachate
- Should be mixed with bulking agent shortly after delivery
- Unload trucks in morning if possible, give operator time to mix
- Be aware of weather conditions when unloading (temp inversions)

Mixing

- Mix quality is key to product quality
- If using loader, take time to mix thoroughly
- If using mixer, take time

  to premix feedstocks with loader or manually before loading mixer



Compost Processing Information

- Monitoring the manufacturing process is critical to making a good compost
- Data to collect:
  - Representative temperature data daily
  - Moisture content (squeeze test) of mixed feedstocks and compost piles weekly
  - Oxygen/Carbon Dioxide readings periodically
  - Temperature and moisture of curing piles weekly
- Use lab analysis to help staff understand proper recipe preparation

Reasons to Monitor Process

- To facilitate and verify:
  - Product safety standards
    - Example – pathogens
  - Product market specs/standards
    - Example – maturity index
  - Process control
    - Example – oxygen levels
  - Regulatory compliance
    - Example – PFRP and VAR

Process Evaluation

- Record:
  - Type
  - Source
  - Date
  - Amount and
  - Quality of:

- Feedstock processed
- Unacceptable wastes
- Recyclables recovered
- Compost Produced

Regulatory Compliance Recordkeeping

- If required to meet “Process To Further Reduce Pathogens” (PFRP) and/or “Vector Attraction Reduction” (VAR), daily temperature logs are the only proof.
- Requirements vary by state
- In many states, composters must record:
  - Temperature data to prove PFRP
  - Compost heavy metals concentrations
  - Compost inerts (percentage)
  - Tonnages processed

Controllable Process Variables
(in order of importance)

- Porosity
- Nutrient Balance
- Oxygen Levels
- Moisture Levels
- Temperature
- Retention Time

Note: Process to Further Reduce Pathogens (PFRP) is the basic requirement of Time/Temperature effect.

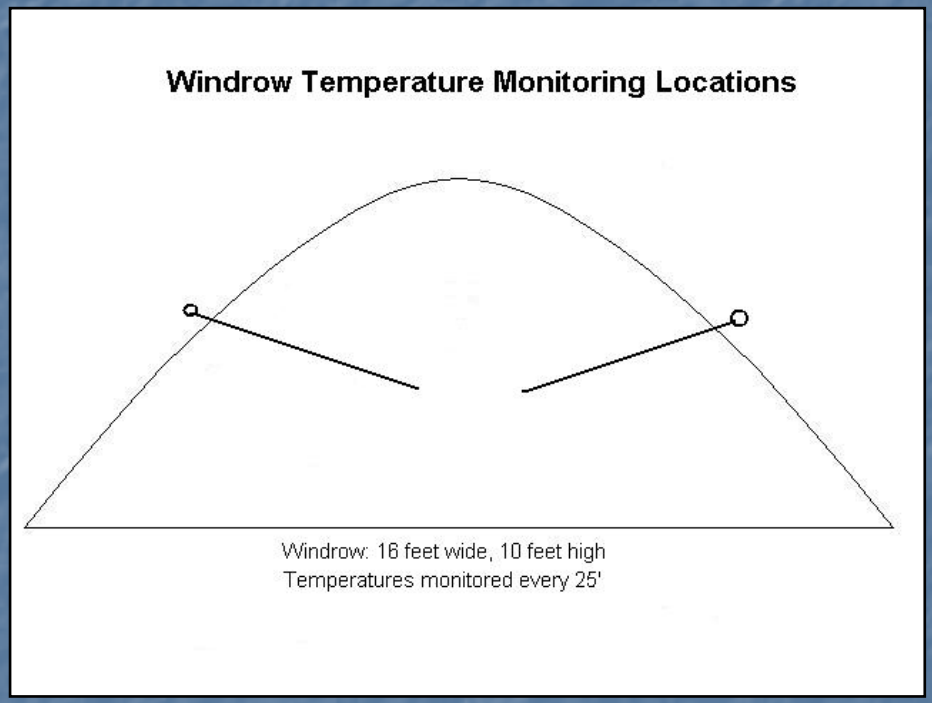
Monitoring Frequencies

	Composting	Curing	Storage
Porosity	Weekly	Initially	Initially
Oxygen	3-day	2-week	Monthly
pH	Weekly	Monthly	Monthly
Moisture	Weekly	2-week	Monthly
Temp.	1-3 day	2-week	Monthly

Monitoring in the Field

- Pile temperatures
- Oxygen concentrations
- Moisture “squeeze” tests

Temperature Monitoring



Windrow # _____		
Distance (ft)	Temp. ^{o} F. (left)	Temp. ^{o} F. (right)
0		
25		
50		
75		
100		
125		
150		

Monitoring Product Quality

- Market and Regulatory Standards
  - Stability
  - Maturity
  - Nutrients/Chemicals
  - pH
  - Soluble salts
  - Inerts/Sharps/Film
  - Horticultural parameters (i.e. CEC)

General Product Market Standards

Property	NC Regs	General Use	Refined Compost	Refined and Mature Compost
Moisture (%)	-	40-60	40-45	40-45
Inerts > ¼” (%, dwb)	< 6	5	1.5	1.5
Sharps (%, dwb)	-	None	None	None
Film plastic (cm2/m3)	-	-	200	200

Odor Management in Composting

Sources of Odors in Composting

Source Location of Odors	Typical conc. ranges, D/T
Ambient Air	
Feedstock Storage Areas	50 – 500
Pre-treatment Areas	50 – 500
Composting Areas	600 – 1,000
Ducted Air	
Invessel Drum exhaust	20,000 – 80,000
Aerated windrow exhaust	5,000 – 25,000

Homans and Fischer, 1992

D/T = Dilutions-to-Threshold – volumes of air needed to dilute odor to recognition threshold

Odor Compounds in Food Waste Composting

Compound	Total Emission (g/ton)
Alcohols (propanol, ethanol, etc.)	285
Ammonia	152
Aldehydes/Ketones (acetone, butanone, etc.)	158
Terpenes (limonene, pinene, etc.)	82
Esters (ethyl acetate, etc.)	53
Sulfur (DMS, DMDS, CS_2)	9.2
Ethers (ethyl furane, etc.)	2.7

Smet et.al, 1999

When are Odors Released?

- Most in first 14 days
  - Higher biological activity
  - Lack of oxygen availability
    - SOER = 10-20 m^3/min-m^2 in first 7 days with biosolids, reduced to 2 m^3/min-m^2 after 15 days
- After turning – odors 10x – 25x higher
  - SOER in biosolids composting = 550 m^3/min-m^2, reduced to 22 m^3/min-m^2 (baseline) after four hours

Odor Control through Process Management

- Maintain good process criteria
  - C/N, porosity, moisture
- Windrow turning
  - Turn to restore porosity only, not to reaerate
  - Minimal turning 1st 7 – 10 days (let temps rise)
- Good housekeeping
  - Prevent leachate ponding
  - Don’t stockpile unstable compost

Process Management, cont.

- Cover piles/windrows with 6” layer of finished compost or wood ash
  - Will absorb odors (mini-biofilter)
  - Wood ash will raise product pH
- Incorporate ash into mix at < 30% dwb
- Keep piles/windrows at optimum size for “chimney effect” aeration
- Have a contingency plan that spells out actions to be taken in event of odor problem.

Odor Treatment Techniques

- Biofiltration
- Windrow covers
- Chemical Scrubbers
  - Absorption
  - Chemical Neutralization
- Masking Agents
- “Neutralizers” / Counteractants
- Electric field / ozone generators

Questions?

CAROLINA RECYCLING ASSOCIATION

Carolinas COMPOSTING COUNCIL

Site & Environmental Factors

Yes You CAN!

(Compost and Naturescape!)

Training Program

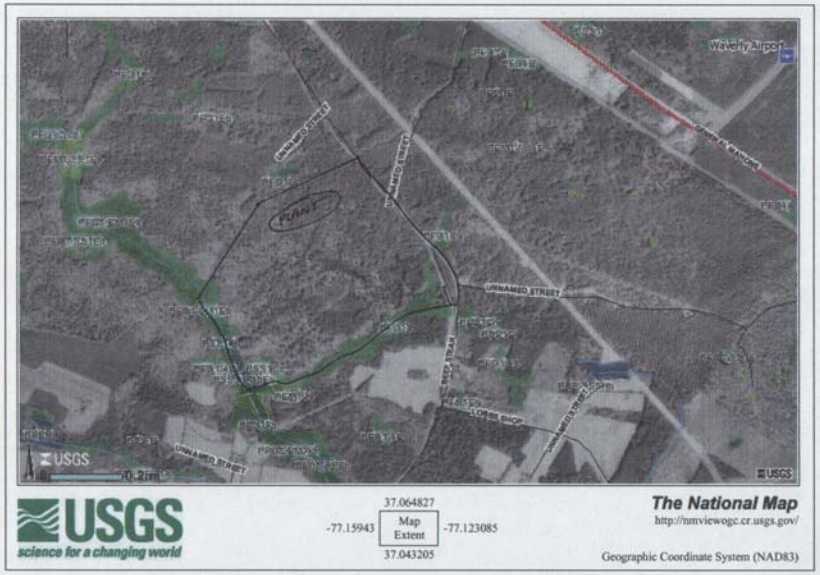
Site Selection

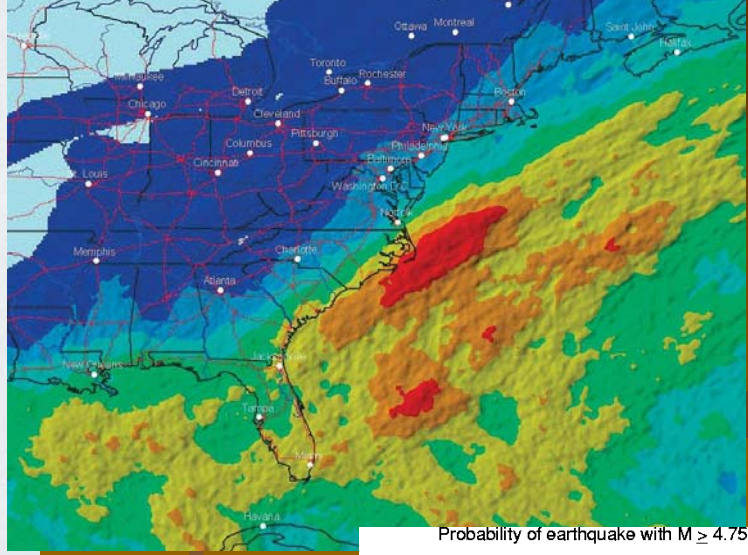
Picking the right location will minimize potential problems in the future.

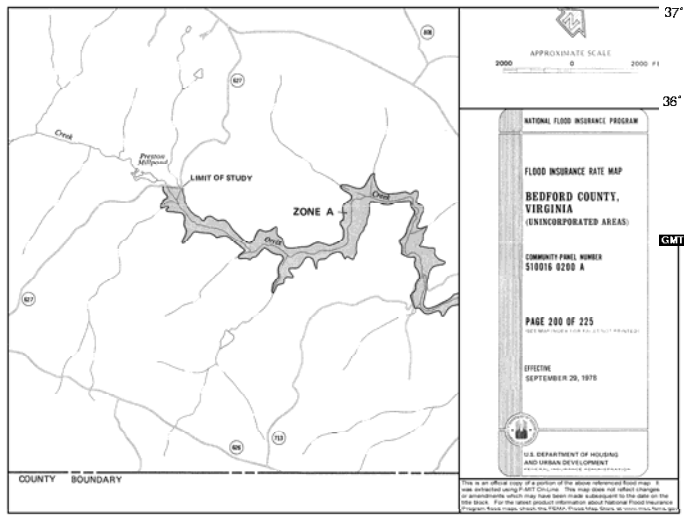
- Common Sense Design & Engineering
- Topography
- Buffers & Setbacks
- Residential Developments

Siting

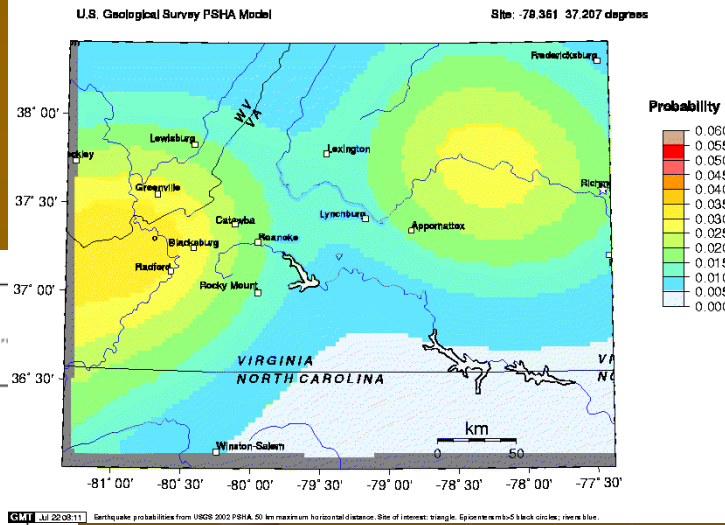
- The most critical aspect of development
- Thorough evaluations needed of:
  - Acreage (2x processing area)
  - Buffers (type & distance)
  - Road network
  - Environmental features
    - Soils, geology, drainage, wetlands, wildlife, historical resources, meteorology







Probability of earthquake with M ≥ 4.75 within 20 years & 50 km



Site Selection

- Site location should be in close to both feedstocks and end markets (50-75 miles)
- Ensure truck access – ideally, less than 2 mi. from 4-lane arterial
- Know the prevailing and seasonal wind directions
- Know the development patterns in your community...now...and 20 years from now

Site Selection

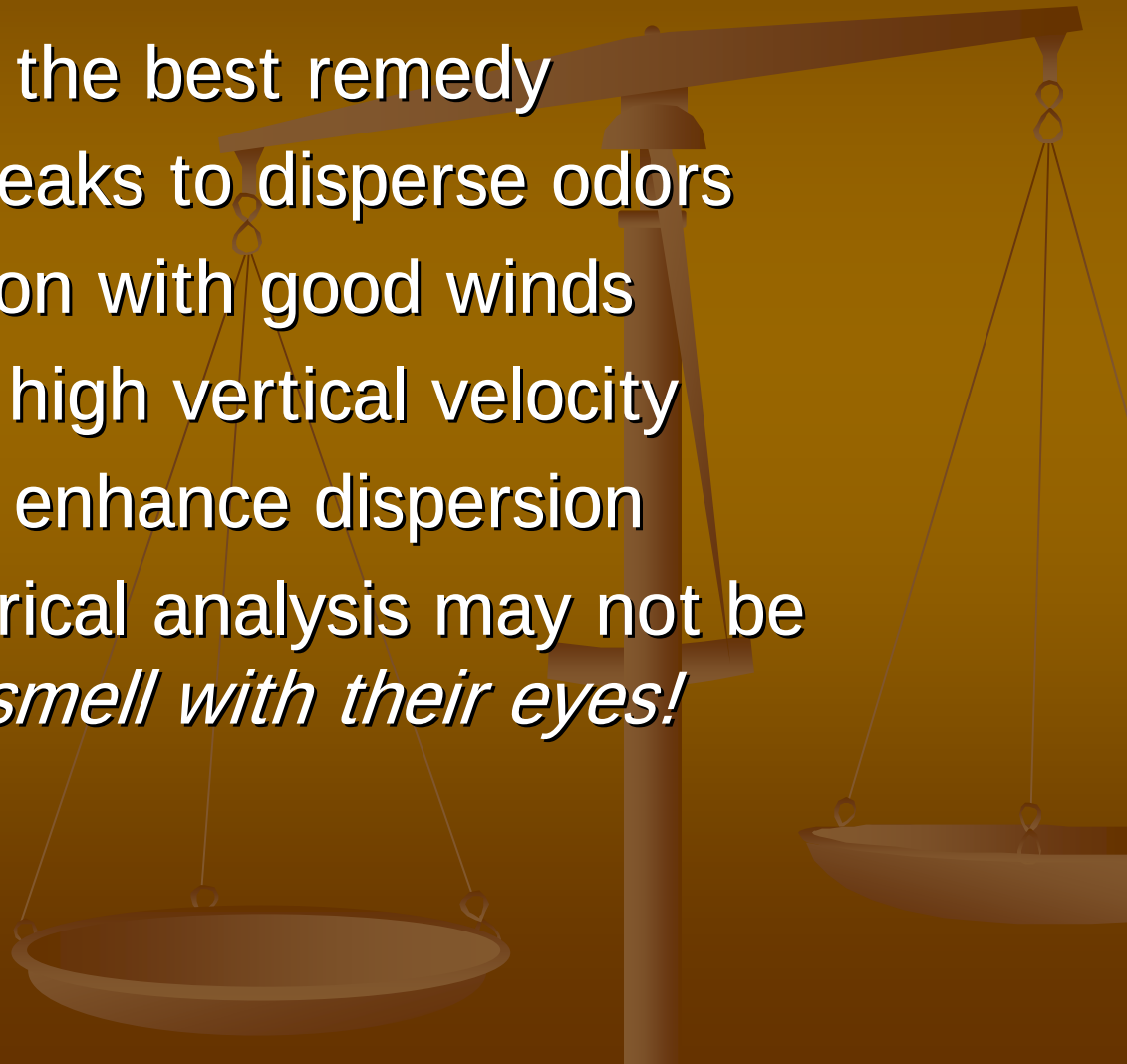
- Sensitive Receptors
  - Healthcare facilities, churches, schools, assisted living centers
  - Issues: odors, bioaerosols
  - If downwind in prevailing wind direction, stay at least ½ mi. away
- Truck Traffic
  - Keep trucks off residential streets if at all possible
  - Have spill cleanup plan in place
- Communicate, communicate, communicate!

Siting Requirements

Based on State Rules and Regulations

	North Carolina	South Carolina
100-yr floodplain	Outside	Outside
Property Lines	100’	50’
Dwellings	500’	200’
Streams	50’	100’
Wells	100’	100’
Depth to Seasonal High Water Table	2’	2’
Local zoning approval	Yes	Yes
Wetlands	Outside	Outside

Siting Decisions based on Odors



- Distance – always the best remedy
- Vegetative windbreaks to disperse odors
- Site on high location with good winds
- Exhaust fans with high vertical velocity
- Wind machines to enhance dispersion
- Remember: numerical analysis may not be enough – *people smell with their eyes!*

Transportation Logistics

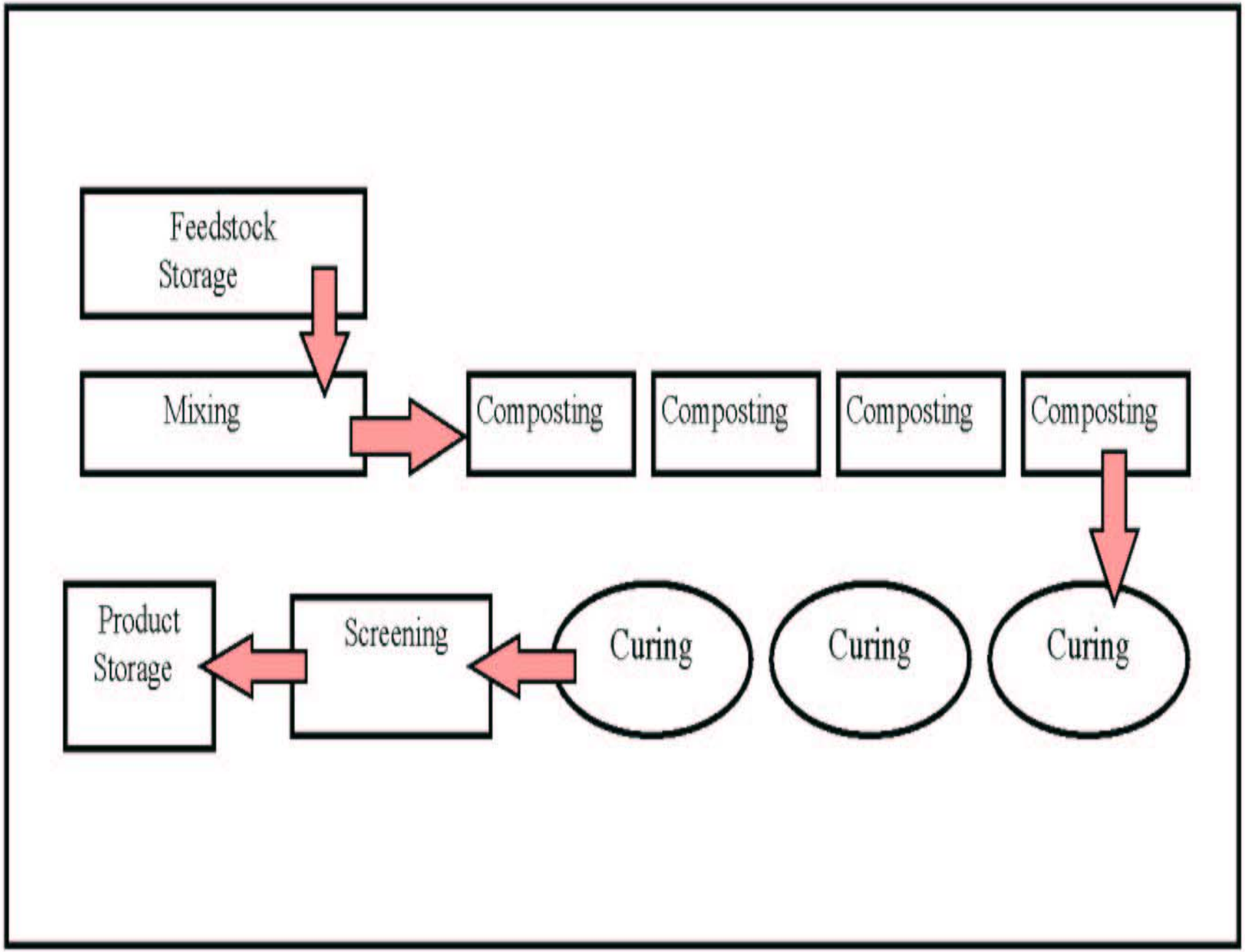
- 53-ft tractor trailers norm for hauling
- Proximity to major highways
- Avoid long distances on country roads
- Avoid residential neighborhoods

Community Involvement

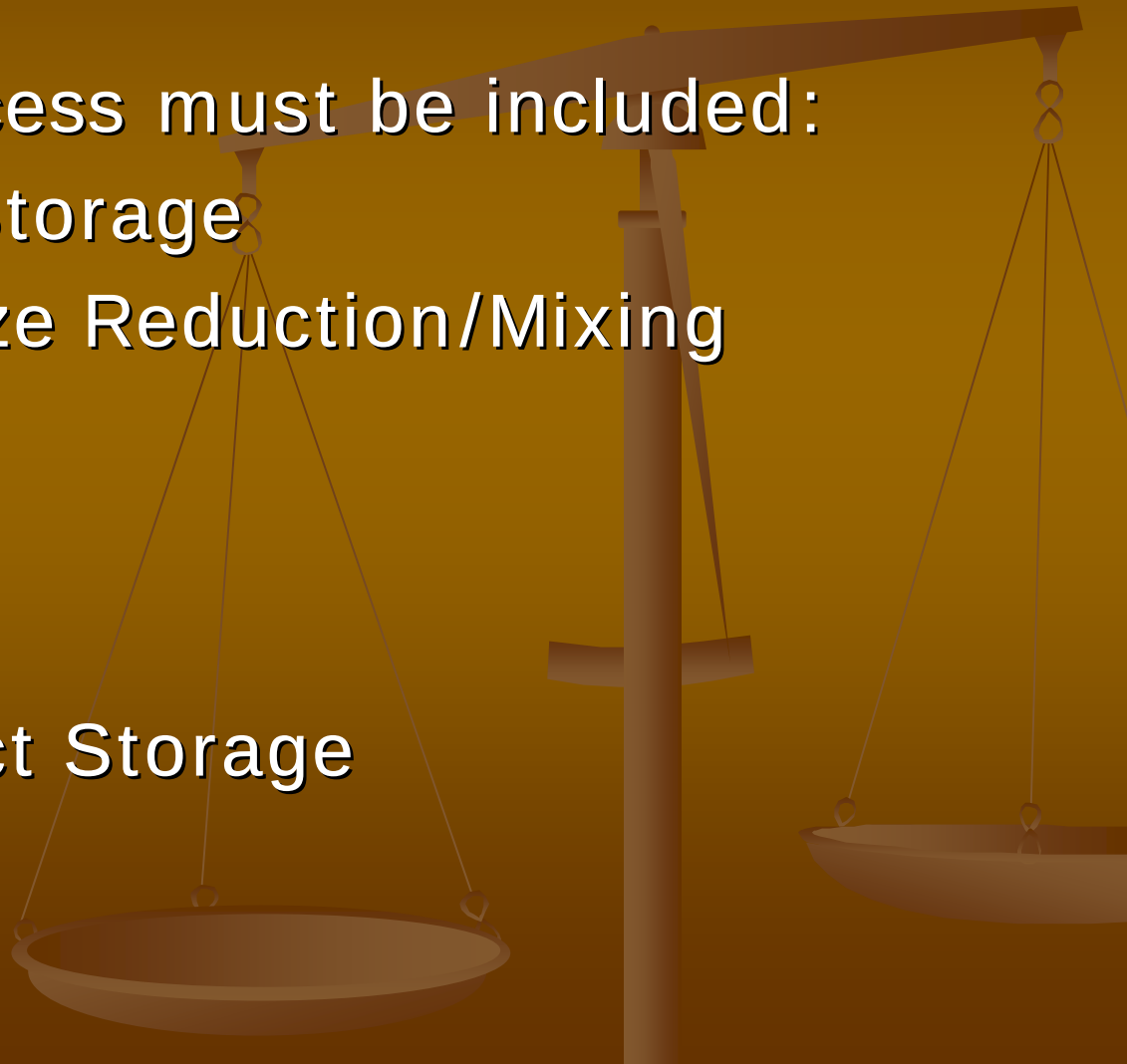
- Communication is key to acceptance and success
- Seek out neighbors and solicit questions
- Be prepared to answer *anything*!
- Keep communications open and ongoing during operations
  - Consider a periodic newsletter
  - Consider giving product to neighbors

System Layout and Design

- Minimize materials handling inefficiencies
- Remember – materials handling does **not** increase the value of the compost product(s) – it is a cost
- Minimize the frequency, distance and manual effort associated with materials handling
  - Keep product flow as linear as possible

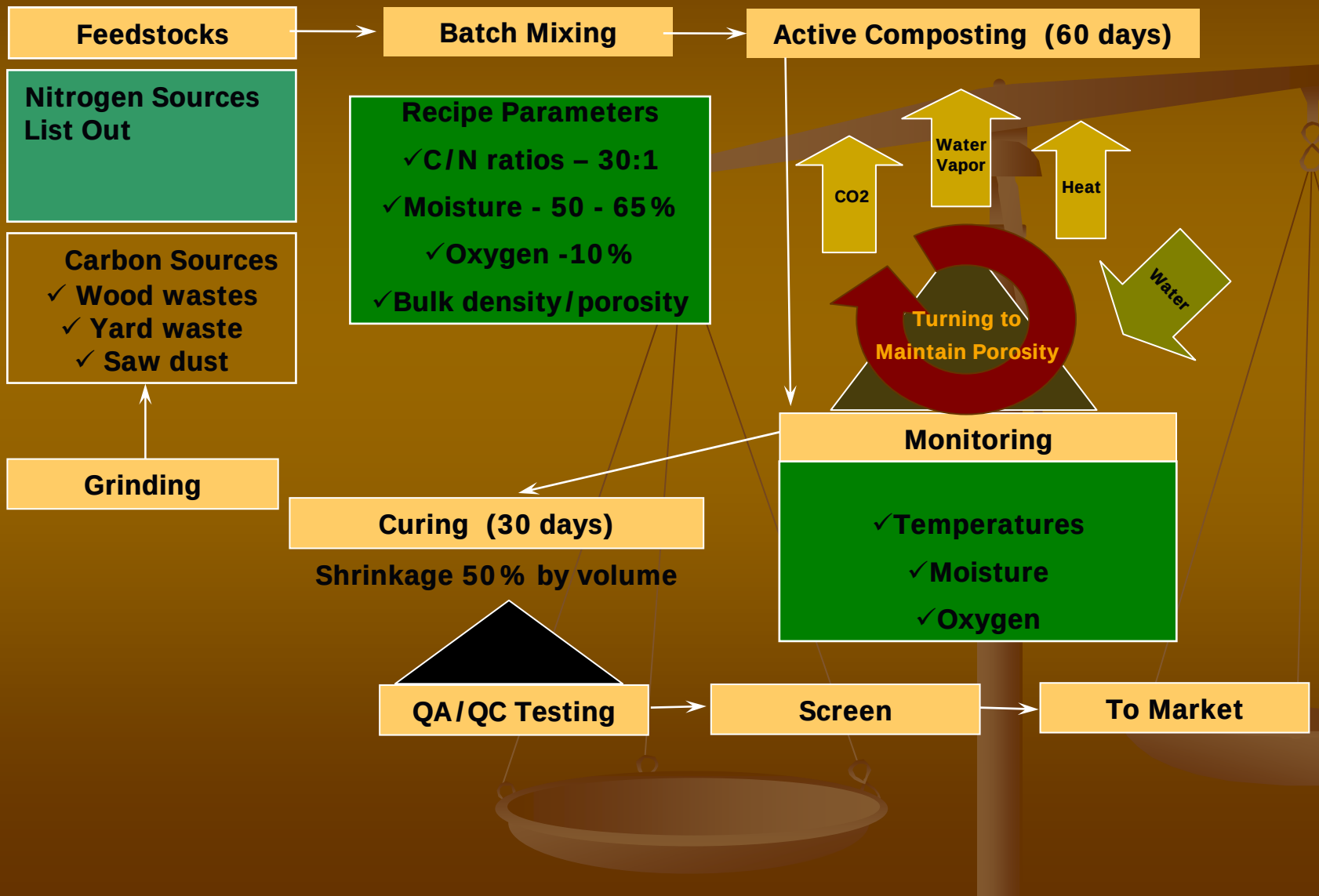

Feedstock Storage
Mixing
Composting
Composting
Composting
Composting
Curing
Curing
Curing
Screening
Product Storage

Facility Layout - Sizing



- Each unit process must be included:
  - Feedstock Storage
  - Grinding/Size Reduction/Mixing
  - Composting
  - Curing
  - Screening
  - Final Product Storage

Facility Layout – Process Flow



Facility Layout - Sizing

- Plan “wide spots” in the layout
  - Allow for inventory accumulation throughout process
- Size each element for 30-60 days capacity in composting, 30-60 days in curing
- If windrows, orient windrows parallel to slope

Facility Layout - Sizing

Compost Facility Design

- Infrastructure Needs
  - Power
    - Based on equipment selection- 3 phase
    - Site lighting
  - Water
    - Used for fire control and moisture addition
  - Fuel Storage & Delivery
    - Follow OSHA guidelines for storage & containment
  - Security
    - Fencing & Lighting
  - Sewer
    - For Domestic wastes or as an option for leachate management
  - Stormwater and Leachate Management

Compost Facility Design

- Stormwater & Leachate Management
  - Considerations
    - Design the site to minimize sources
      - Location of nitrogen & pathogen sources
      - Prevent stormwater run on
    - Zero discharge – Prepare to catch all runoff up to a 25 year 24hour storm event – based on average annual rain fall – calculate total surface area of compost site
    - Constructed wetlands Option
    - Separate Leachate from Stormwater

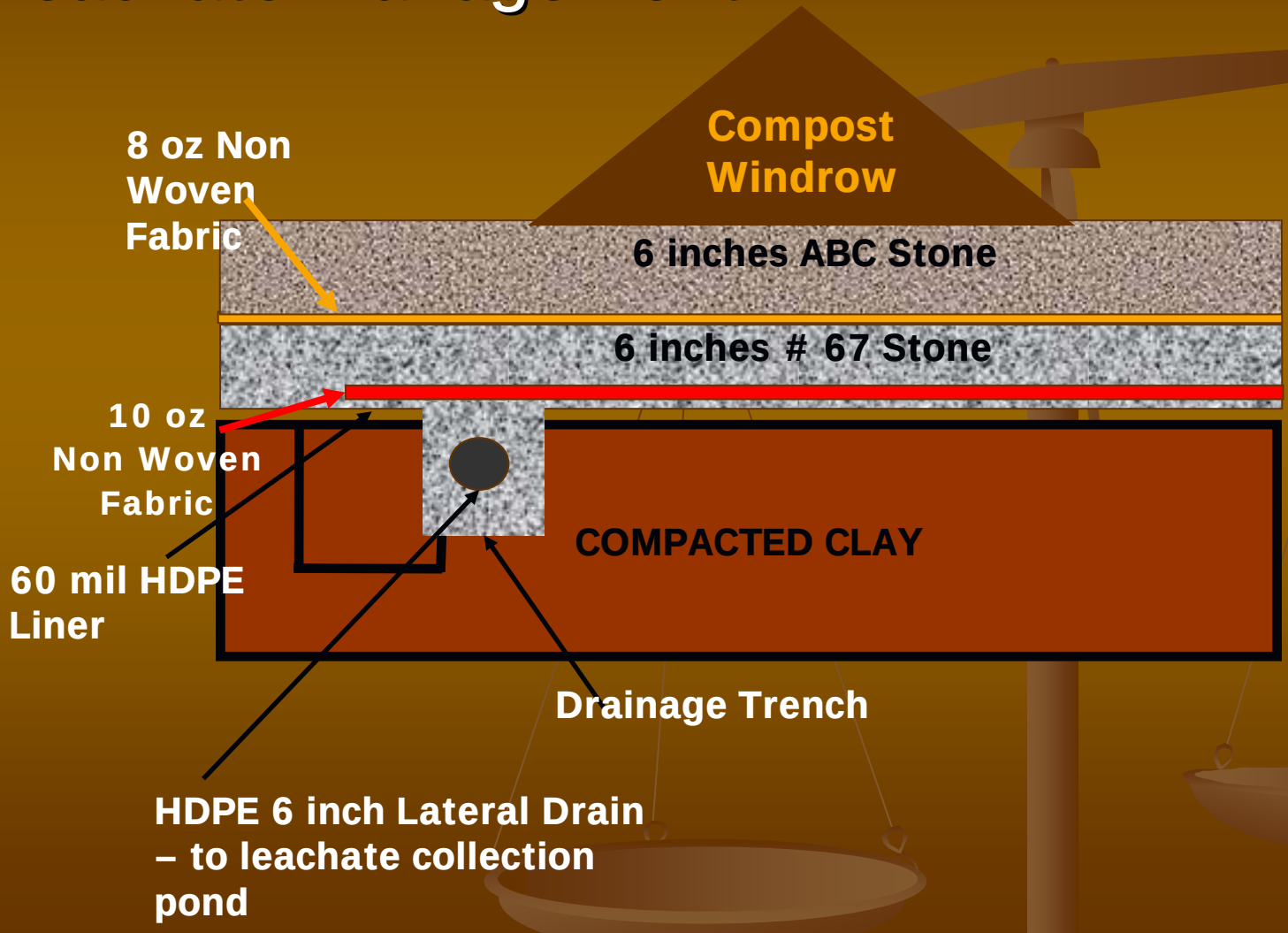
Compost Facility Design

- Stormwater Management

Grassed lined storm water ditches prevent run-on and capture run-off

Compost Facility Design

- Leachate Management



Compost Facility Design

- Stormwater Management

Storm water pond operating

Level spreader operating

Compost Facility Design

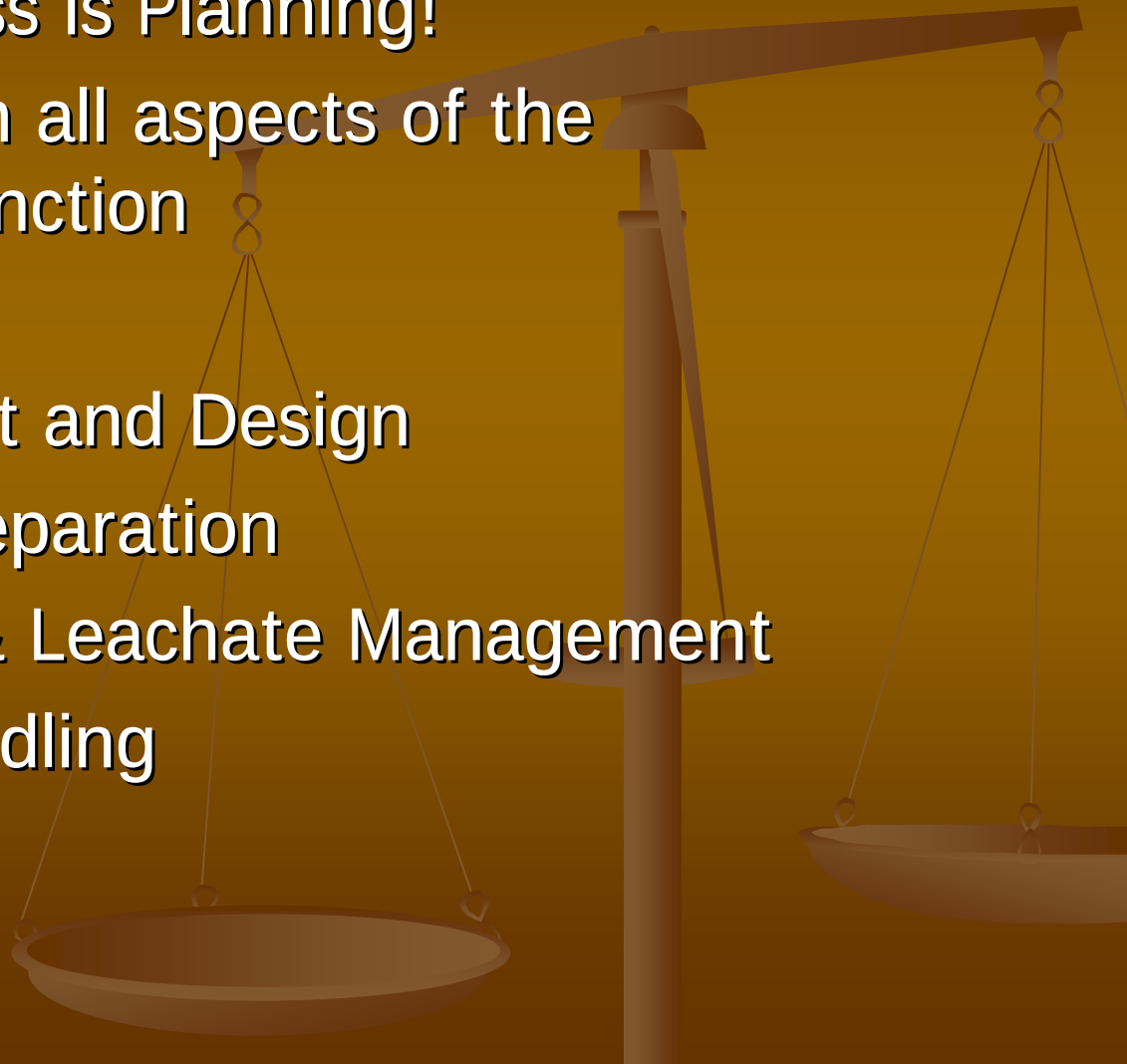
- Leachate Management

60 mil white liner installed for leachate pond

Leachate pond and storage tank

Summary

- Key to Success is Planning!
- Think through all aspects of the production function
- Siting
- Facility Layout and Design
- Feedstock Preparation
- Stormwater & Leachate Management
- Materials Handling



Yes You CAN*! (*Compost & Naturescape)
Train-the-Trainers Course

Field Exercises – Day One

1. **Building A Compost Pile**
2. **Determining Bulk Density**
3. **Determining Moisture Content**

A Council of the Carolinas Recycling Association
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WEB: www.carolinascompostingcouncil.org

Composting in the Piedmont

By Don Boekelheide, Developer of Mecklenburg County's Master Composter Program

Getting Started Composting

Types of Yard Waste

In Mecklenburg County we're famous for our majestic trees and green expanses of lawn, but our beautiful avenues and landscapes come at a price. In one year, enough yard trimmings are collected in Mecklenburg County to build 1 cubic yard compost piles from Charlotte to Wilmington, and then over 20 miles more out into the Atlantic Ocean!

Disposal of yard waste is not complicated when the homeowner is aware of how to properly manage the different types of yard waste produced. The average homeowner's yard waste consists of leaves, weeds, brush, tree limbs, and grass clippings. Each yard is different and may produce different quantities of each type of waste. There are different strategies for managing yard waste. During leave fall seasons some homeowners have massive amounts of leaves that accumulate while others may have very little or none.

A homeowner has several options for managing their yard waste including taking the waste to yard waste facilities, composting, pickup by city work crews, or by professionals. These are a few examples of when disposal at a facility may be necessary. A homeowner has more leaves than they can manage on their own property through composting, or has brush clippings that are too large to compost, removal of damaged trees or limbs (hurricane Hugo), thinning of trees, and removal of stumps.

Since 1993, it has been against the law to send yard trimmings to the landfills in North Carolina. Mecklenburg County now collects yard trimmings separately and composts them on a large scale: about 50,000 tons of materials are composted each year.

Why produce backyard compost in Mecklenburg County?

Home composting is an environmentally friendly and economically wise way to help solve the problem of what to do with some of the yard waste. With a little knowledge and planning, techniques like composting and mulching actually take less time, effort and money than dragging those bulging plastic bags to the curb. Not only that, but home composting can utilize kitchen scraps as well as leaves and trimmings. The end result is its own reward, compost, pure "garden gold" for your flowers, vegetables and landscape plants.

According to The Composting Council, organic compostable materials make up two-thirds of the "waste stream" in the US. By composting at home, you redirect some of these materials back to their natural purpose of restoring life to the soil in your garden and lawn.

Making compost also saves you money. The cost of making each batch of backyard compost amounts to less than $5 on the average, and some composters spend nothing. In return, you get 10 cubic feet of rich compost, which would cost at least 5 times as much ($25) at the garden center – if you could find such a high quality product.

What is compost?

Compost is dark, crumbly, sweet smelling material, similar to the top layer of soil in a forest. It is made of organic materials that have been broken down into a stable form by the action of microorganisms.

A compost pile isn't a garbage heap. Using proven techniques, you can make compost without unpleasant smells or pest problems.

In nature, autumn leaves and even entire fallen trees slowly decompose, and seem to disappear into the soil. Actually, they are being eaten by a vast number of microbes and other organisms, which leaves behind a dark colored material called humus. Humus and related organic substances, along with the living organisms that help create them, are key elements to rich, fertile soil.

A backyard compost project uses this natural process to create humus-rich compost for your use in the yard or garden.

Fundamentals:

Where do I put the compost pile?

Put the compost where it is most convenient. This often means near the kitchen, if you are including food scraps.

It can be located in sun or shade. Depending on your sense of aesthetics, you can put it somewhere inconspicuous or hide it behind a low trellis or other screen. Due to a risk of termites, it is not recommended to put the pile right next to wooden parts of houses, such as porches. It is not recommended to place the pile near creeks or streams that may be next to your property. Yard waste should never be dumped into streams, creeks or waterways.

Water

You will need to have water readily available, so the compost area should be where a hose can reach.

Space

Leave space enough around the bin so it is easy to work with hand tools. The minimum space is about 3 feet x 5 feet (15 square feet or 1.5 sq.m).

The "ideal" for many backyards is to leave space for two compost bins plus a "holding pen" the same size or slightly bigger. The holding pen is a catchall where you can conveniently gather and temporarily hold compost materials from the yard and garden over several weeks. The two bins are dedicated to making full batches or compost, where kitchen scraps can be added every few days. The area for the ideal is about 6 feet x 15 feet, or 90 square feet (roughly 90 sq. meters).

Tools

You need a few basic garden tools to make compost, all of which can be used for other purposes around the house and yard.

- Shovel for scooping
- Garden Hose
- Wheelbarrow (for moving manure or soil)
- Rake (for clean up)
- 4-tined Garden Fork or Pitchfork (long handled-optional but very useful)
- 3 or 4 foot length of 5/8" metal reinforcement rod ("rebar"). This is available for about $1 in any garden center. (A 4-foot Dowel, 1" thick or a stick will also work).

Compost Recipes

Slow & Cool

The "cool and slow" method costs nothing and provides compost in about two years, sometimes less. It requires no turning and little special attention. It is not recommended for use with kitchen scraps.

Simply set aside an area in a secluded corner of your yard for piling up fallen leaves and other organic materials. Place piles well away from creeks or streams to ensure they don't get accidentally dumped into them. Do not include kitchen scraps in this sort of pile.

Over two years or less, the materials on the bottom will compost. Pull back the top layers, and use the rotted material in your garden.

Hot and fast

The "hot and fast" method provides compost much more quickly, especially in the summer. At Compost Central, experimental hot and fast piles made in April and May were ready in August and September, and fall piles were ready the following spring.

In addition, the quality of the compost is more consistent. The heat produce in the pile destroys many weed seeds and diseases.

Kitchen scraps may be added to a hot pile. This benefits the finished compost by adding another excellent source of plant nutrients (and microbe food).

Making a hot and fast pile takes a bit more attention than a cool pile. In Mecklenburg County, the following techniques have been tested and have proven successful.

How to make a simple wire compost bin

Bins look neater than piles. Since loose materials are kept bundled together, a pile can heat faster, which speeds the composting process. If you add kitchen scraps, you can bury them in the middle of the filled bin. This helps prevent unwanted bugs or animals from being drawn to the bin.

Bins are a very good choice here in the piedmont area. They are easy to make with inexpensive materials.

- Materials: 12 ½ feet (3m) of 2" x 4" welded wire fencing, 36 inches (90cm) high {Many hardware stores sell this type of fencing in rolls of 50 ft. which when divided makes 4 bins.}
- Assembly:
  1. Cut the fencing to length (12 ½ ft) with a pair of pliers using the cutting edge. On one end, leave about 1-inch lengths of the horizontal wire sticking out, so they can be used to fasten the ends of the pen together.
  2. Form a cylinder 36" tall (the diameter will be a little over 3 ft). To hold the shape, push several ends of wire through the wire on the opposite end and hook the wire together.

     The bin is lightweight and easy to move (when empty). To "turn" or move the pile, unhook the wires and lift the fencing away from the pile of materials. Reset the bin next to the pile of materials. The materials usually will hold the shape of the bin after it is removed. Turn the materials back into the bin.

Making a batch of hot compost

When making a hot and fast pile, it is best to make compost in "batches", where you fill your bin to the top with the right mix of materials. This is aerobic composting; powered by microbes which require oxygen. There is a long list of materials you can compost, but when you make a batch, you need some basic ingredients.

Ingredients:

- *Water and air*

The compost-making organisms require water and air. Water should be added as you make your batch of compost so that it is moistened thoroughly throughout.

Air is provided by turning the pile, and by including "chunky" materials such as "gum balls" (from Sweet Gum trees) and small branches or twigs.

- *"Food" for the microbes*

Here in the piedmont, that usually means fallen leaves. You can use leaves any time of the year, which explains the benefits of gathering up leaves in the autumn and putting them in a holding pen or pile. About 15-20 big plastic "yard trash" bags of leaves normally packed, are needed for a wire bin like the one we make in class.

If you don't have enough leaves, I suggest you check with the neighbors (I've seen bags of leaves on the curb throughout the year). Another source is wooded areas. Half-rotted leaves work fine.

Other cheap basic sources of "microbe food" (meaning the carbon they need for energy and building cells) are spoiled hay and straw, and barnyard or stable litter. Look for free stuff!

- *Nitrogen*

Nitrogen is an essential nutrient for plants and microbes. Without a sufficient amount of nitrogen-rich material, your pile will not heat up

Many home composters, especially those just starting out, may prefer to buy a nitrogen rich material. To produce an organic compost pile, it is recommended to use rabbit food pellets (rabbit food is made up of alfalfa, which is mostly nitrogen). It comes in either 25 or 50 lb. bags. 25 lbs. is enough to add to the bin to produce temperatures about 110-120 degrees. 50 lb. is enough to reach temperatures of 140 to 150 degrees. The higher the temperatures, the more sterile it becomes.

Other sources of nitrogen include: bagged chicken manure, and organic sources of nitrogen including alfalfa meal, cottonseed meal, blood meal and organic commercial fertilizers such as those made by the Hoffman and Espoma companies. Local sources of nitrogen include manure from local farms. Some kitchen scraps contain a fair amount of nitrogen, but they are not always easy to work with.

An effective and inexpensive source of nitrogen is a 40 pound bag of commercial cow manure (about $1) supplemented by 6 cups of cottonseed meal, or 2 cups of an 30-10-10 organic lawn fertilizer. Add this to every 3 or 4 bags of leaves and mix well (the manure seems to help the fertilizers coat and stick to the leaves).

Though your compost will not meet "certified organic" requirements, you can also use a commercial fertilizer high in nitrogen such as urea, lawn fertilizer or 34-0-0. In this case, cut the amount to one cup.

Layering and mixing

One time-honored way to start a compost pile is by layering. This makes it easy to get the proportion of materials right, moisten the pile evenly, and set everything up for a good mixing when you turn the pile. It is also a useful way of thinking about compost, since you can easily visualize ingredients and amounts.

However, much evidence points to the advantages of thoroughly mixed piles. A good compromise is to fill the bin up about a foot or so with leaves, then mix in the rabbit food or other nitrogen source very well.

Seeding the pile

There are products available called "compost starters". These are not recommended. It is not desirable to add lime to your compost. However, a few scoops of finished compost or rich topsoil will have no harmful effects and may add beneficial organisms.

What goes in?

Compost microorganisms need a food source with nutrients. Ingredients with carbon (leaves, kitchen scraps) supply the food; ingredients with nitrogen (rabbit food, manure, kitchen scraps) supply many of the needed nutrients. Use a variety of materials and remember, the smaller the pieces, the faster the pile will decompose.

Leaves: Fallen leaves are an ideal source of carbon and will probably make up the bulk of your compost. Magnolia leaves and pine needles tend to take longer to compost, so if you have lots of them, consider composting them in a batch by themselves. Other options include spoiled straw or hay or even well-shredded newspaper or cardboard.

Unusual Ingredients: Pet hair, people hair, vacuum clean sweepings, and sawdust from untreated lumber.

Water: Keep the compost moist, but not soggy. The right moisture content is essential for rapid decomposition. Compost should be watered to the consistency of a wrung out sponge.

Grass clippings are rich in nitrogen but they tend to form matted layers that keep out the necessary oxygen causing bad smelling gases. It's better to leave grass clippings on your lawn using "grasscycling" techniques (discussed later).

Manure from horses, cows, chickens.

Food Scraps

fruit/vegetable peels, stems, and trimmings
citrus rinds (best if chopped fine)
spoiled or rotten fruits and vegetables
corn cobs (broken up or shredded)
egg shells
coffee grounds and filters
tea leaves and bags
hard-shelled nuts (best if ground or crushed)
peanut shells
clam/oyster shells (must be ground)
canning/preserving wastes (pomace, etc.)

Recycled Compost: Parts of a regular compost pile that have not broken down completely by the end of the composting period should be placed on the bottom of a new pile. This is especially true for twigs and small branches that can use the extra protection of the pile's height to speed their decomposition.

Things to keep out:

- **Cat litter and droppings** can contain disease organisms that cause brain and eye diseases in newborns. The safest thing is to absolutely avoid all cat and dog droppings.

- **Charcoal ashes** contain toxic compounds like those in coal ash, also a no-no. Enjoy your barbecues, but don't dump the charcoal ash in the compost. Wood ash is ok in modest amounts.

- **Herbicide or pesticide treated plant material** may contain an unpredictable mix of chemicals that can destroy the microbial life in your pile, persist to kill your garden plants, and even pose a threat to you and your family's health.

- **Invasive weeds and plants,** like kudzu, ivy, bindweed (wild morning glory), quackgrass, bermuda grass stolons, etc., can be spread in home compost.

- **Meat, bones, grease, oils, dairy** attract vermin and often cause fly and odor problems. Use common sense: a stable piece of peanut butter or

cheese sandwich is fine; a whole jar of spoiled peanut butter probably isn't.

- **Sick garden and house plants** can turn your compost heap into a source of disease.

- **Glossy slick paper,** from magazines and catalogs with color photos, contain toxic inks. Newsprint, including the funnies, should be ok.

- **Poisonous or thorny plant materials,** from poison ivy to thorny rose branches, can make working with compost a miserably unforgettable ordeal. Also, oleander, castor bean, hemlock and eucalyptus should be avoided since they produce substances that can harm soil life or other plants.

- **Stuff that takes forever to break down,** like pine needles and magnolia leaves, will not contribute to the compost. Use them for mulch on top of the soil or compost separately.

- **Too much soil...** Don't overload your compost pile with soil. If you take up sod, compost it in a separate pile, carefully placing the grass sides down (it takes about a year to break down, and gives a very nice result). Once your are experienced, you may want to try making a special "acid" compost from pine needles and other acidic materials for your acid-loving plants.

Carolinas Composting Council
Carolina Recycling Association

Compost Training Course
Field Exercise #1

Bulk Density Determination and
Conversion of Compost Mix Recipe from Weight basis to Volume Basis

The bulk density (BD), determined by bucket drop method, is the ratio of the mass of the materials (wet or dry) to its volume. BD is used to convert compost recipes from a weight (mass) basis to a volume basis for field mixing. The bulk density figures will be used to convert the recipe from weight to volume.

Equipment:

Tape measure or 12-inch ruler & Black marking pen;
Water
5-gallon plastic pail (two pails may be needed in the field, one for the sample and one for water). Five gallons should measure to the brim of the pail with no additional holding capacity.
Scale: 0-50 pounds, fish scale type preferred or platform type

Procedure

1. Make a series of dash-markets around the inside circumference of the bucket 1/3 and 2/3 from the rim of the pail (the 5-gal. fill-level). This marks the 1/3 and 2/3 fill levels.
2. Obtain a weight of the clean, dry empty bucket and record the weight.
3. Gather a sample of the material to be analyzed.
4. Fill the bucket 1/3 full with the material.
5. Pick-up the pail by the handle and drop the bucket containing the sample onto a firm flat surface from a height of 6-inches ten times, being careful to guide it with the handle so it stays upright and doesn't tip.
6. Now add additional feedstock and fill to the two-thirds full level.
7. Repeat the procedure (#5) a **second time**, dropping the pail ten times from 6-inches.
8. Add material to the pail to fill it to the top,
9. Repeat the dropping procedure (#5) a **third time**. After the third time, fill the bucket to the rim, but do **not** repeat the dropping procedure (#5).
10. Weigh the pail and its contents on as accurate a scale as is available.
11. Record the weight of the 5-gallon bucket filled to the top with sample material.
12. Subtract the weight of the empty bucket (2.2 lbs) to obtain the weight of the sample. **Example**: The total weight of a 5-gallon pail filled to the top with sample material may be about 28.5 pounds; subtract the weight of the empty pail (2.2 lbs) to obtain the weight of the sample contained in the pail and record, i.e. 28.5 – 2.2 = 26.3 pounds
13. Divide the weight of the material by 0.025 (the volume of the bucket in cubic yards). Record result on space for Bulk Density (BD).

Feedstock _____

1. Weight of 5-gallon pail filled with feedstock _____ lbs.
2. Subtract the weight of the empty 5-gal. pail (-)_____ lbs.
   (=)_____ lbs.

3. Divide by .025 (volume of bucket) _____ = Bulk density (D1) (lbs/cy)

Feedstock _____

1. Weight of 5-gallon pail filled with feedstock _____ lbs.
2. Subtract the weight of the empty 5-gal. pail (-)_____ lbs.
   (=)_____ lbs.
3. Divide by 0.025 (volume of bucket) _____ = Bulk density (D2) (lbs/cy)

Convert Recipe from Weight to Volume

To be practical in a typical composting situation, the quantities of feedstocks (calculated in Step 1) need to be converted to volume, i.e. for a front end loader bucket load, how much of each material should I use in the mix?

Use the formula V = Q/D (Volume = quantity divided by density).

The amount of Q1 & Q2 was calculated with the spreadsheet in class. Q1 and Q2 should be measured in pounds.

V1 = Q1/D1 = _____ cu. yds.; V2 = Q2/D2 = _____ cu. yds.

This will result in tiny volumes for both materials. To make this amount useable in terms of buckets, divide the larger number by the smaller number, or for example: **V2/V1** = _____. This result is V2 (expressed in bucket loads) that needs to be mixed with each **full** bucket of V1. If the answer (V2) is a percent that is not easily expressed as a fraction i.e., ¼, ½, etc. round to the nearest useful measure for a bucket such as “a little over a half, a little under a half, etc.”

Carolinas COMPOSTING COUNCIL
CAROLINA RECYCLING ASSOCIATION

Compost Training Course
Field Exercise #2

Moisture Content Testing

Moisture content of a compost mix is important because the micro-organisms responsible for biodegradation of the waste need water to survive and grow. The desired moisture content of a compost mix is between 50% and 60%. There are two methods of determining moisture content: the "squeeze" test, and weighing both a moist and a dried sample. This laboratory will go over both procedures.

Squeeze test: Field Measurement of Pile Moisture Percent

Mix moisture percent can be approximated by squeezing a handful of material as follows:

1. Reach into the pile and take a handful of material
2. Squeeze the handful of material firmly
3. Release your grip and inspect the material you squeezed in your hand.

Interpretation of results:

1. If the material you squeezed is crumbly and doesn't stick together, and your hand is dry, the material is about 40% moisture or less.
2. If the material you squeezed sticks together, and your hand is moist, the material is around 50% moisture
3. If the material you squeezed sticks together and drips, and your hand is wet and dripping, the material is around 60% moisture or more.

With practice you can distinguish 55% moisture, from 50% and 60% moisture.

Weight Test

Equipment Needed: Weigh scale (triple-beam or laboratory scale)
Microwave oven
Paper disposable plates

1. Weigh paper plate and adjust scale to tare out at zero.
2. Weigh out 100 grams (g) of sample.
3. Place sample on a paper disposable plate.
4. Put sample on plate in microwave oven. Turn power level down to 50%. Cook sample in microwave for four (4) minutes.
5. Take sample and weigh sample (and plate). Record weight.
6. Place dish back in microwave for 2 more minutes of heating.
7. Reweigh the sample.
8. Repeat Steps 6 and 7 until the weight of the sample and the plate stops changing.
9. Subtract final weight from 100 (the weight of the original sample). This is the weight of the water evaporated off in the microwave.

10. Multiply by 100 to get moisture content percentage.

Example: After following the procedures above, the final weight is 43.0 grams (g).

Weight of original sample	=	100.0 g
Weight after drying	(-)	43.0 g
Weight of water evaporated	=	57.0 g

Moisture percentage:

$$\frac{57.0\ g}{100.0\ g} = 0.57 \times 100 = 57.0\%$$

CAROLINA RECYCLING ASSOCIATION

Carolinas COMPOSTING COUNCIL

Compost Use

Yes You CAN!

(Compost and Naturescape!)

Training Program

CAROLINA RECYCLING ASSOCIATION

Carolinas COMPOSTING COUNCIL

Improving Your Soil with Compost

Yes You CAN!

(Compost and Naturescape!)

Training Program

Improving Your Soils with Compost

Commercial Scale Composting

- **U.S. composting industry has grown significantly, and it will continue to do so**
- **Manufacturers can consistently produce high quality composts**
- **Composting is an understood science**
- **Compost usage is an understood science**

Improving Your Soils with Compost

- Testing
  - **Soil**
    - **NCDA Soil Lab – free for NC residences**
    - **www.agronomy.agr.state.nc.us**
    - **Clemson Extension Agricultural Services Lab – $5.00 www.clemson.edu/agsrvlb**
  - **Compost**
    - **NCDA Waste Analysis- $6.00-10.00**
    - **Clemson Extension Agricultural Services Lab - $25.00**
    - **A&L Labs-Richmond, VA**
    - **USCC STA Program - www.compostingcouncil.org**
      - **List of participating labs**

US COMPOSTING COUNCIL
Seal of Testing Assurance

Improving Your Soils with Compost

Soil Testing

- Teach the end-user on how to test their soils
- Usually free service from State Cooperative Extension Service
- Helps to understand existing levels of nutrients, pH, Cation Exchange Capacity
- Helps the end-user to understand how much compost to use

Improving Your Soils with Compost

- The characteristics of a compost product help to determine what application(s) it can best be used in

Improving Your Soils with Compost

Typical Characteristics of Municipal Feedstock-Based* Composts

Parameter	Typical Range	Preferred Range [1]
Moisture Content	30-60%	40-50%
Organic Matter Content	30-70%	50-60%
Particle Size	_	Pass ½ inch
Trace Elements Heavy Metals	_	Meet EPA & State Requirements
Growth Screen	_	Must pass seed germination or plant growth assay
Stability	_	Stable to highly stable

1-Preferred range for various applications under average filed conditions

*- Municipal feedstock-based composts are primarily derived from yard trimmings, biosolids, municipal solid waste, or food by-products, or a combination of the above.

Improving Your Soils with Compost

Typical Characteristics of Municipal Feedstock-Based* Composts

Parameter	Typical Range	Preferred Range [1]
pH	5.0-8.5	6.0-7.5
Soluble Salts	1-15 dS (mmhos/cm)	5 dS (mmhos/cm) or less
Nutrient Content (dry weight basis)	N - 0.5-2.5% P - 0.2-2.0% K – 0.3-1.5%	N – 1% or above P - .5% or above
Water holding capacity (dry weight basis)	75-200%	100% or above
Bulk density	700-1,200lbs/CY	800-1,000 lbs/CY

1-Preferred range for various applications under average filed conditions

*- Municipal feedstock-based composts are primarily derived from yard trimmings, biosolids, municipal solid waste, or food by-products, or a combination of the above.

Improving Your Soils with Compost

Three Categories of Soil Qualities

Physical (structural):
tilth, infiltration, porosity, bulk density, aggregation, texture (mix of sand, silt and clay)

Chemical:
nutrient content, salinity, pH, organic matter, mineral content (parent material)

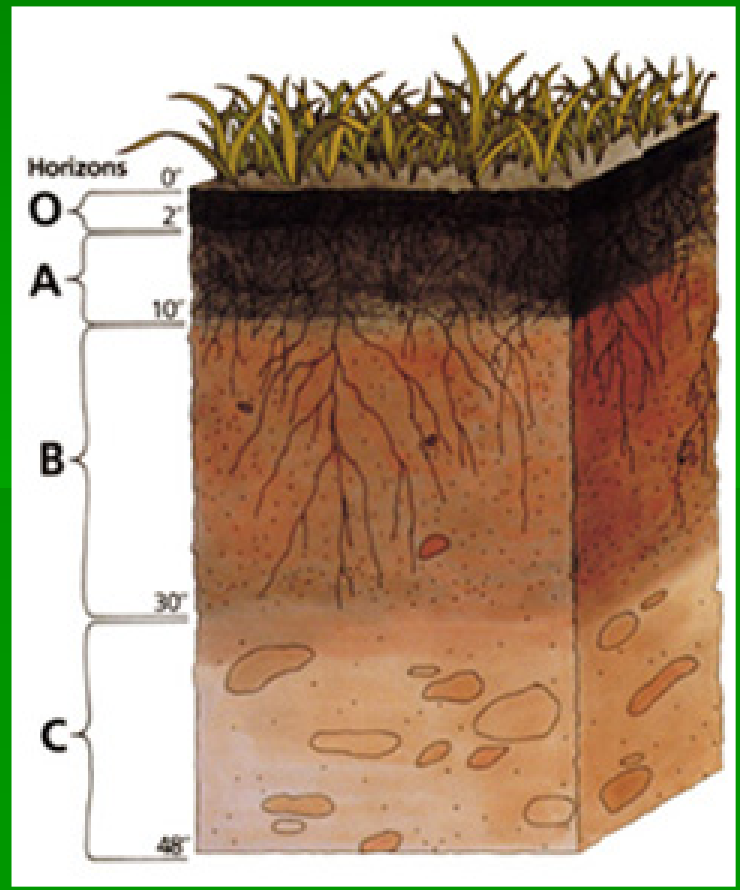
Biological:
biomass, biodiversity, biological activity, disease suppressiveness

Improving Your Soils with Compost

Why amend soils with compost?

TO IMPROVE SOIL QUALITY!

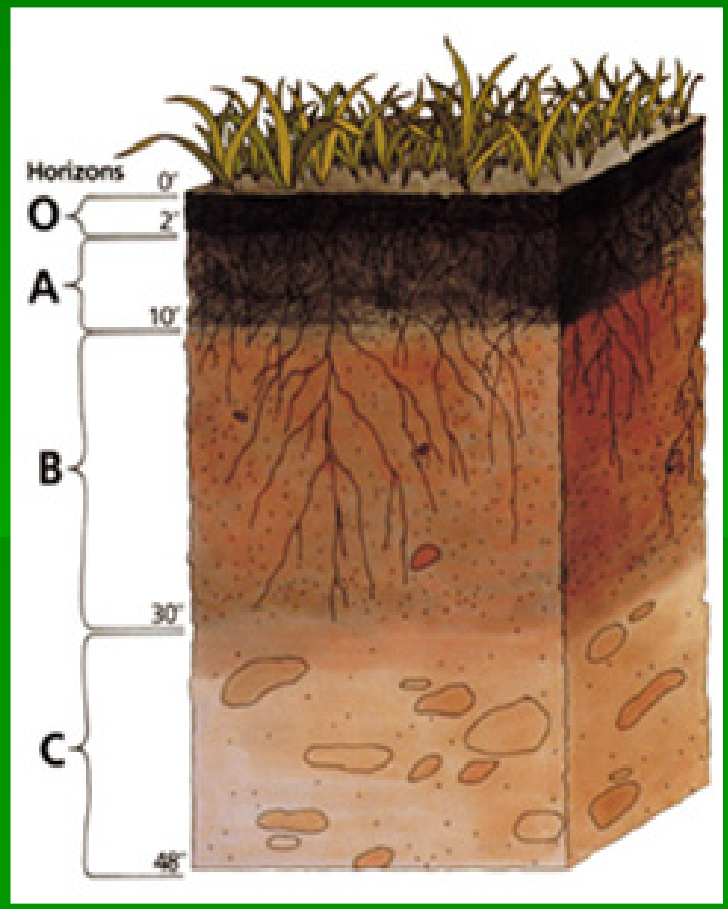
- "O" Horizon – organic layer
- "A" Horizon – surface horizon (topsoil)
- "B" Horizon – subsoil
- "C" Horizon - substratum



Improving Your Soils with Compost

Topsoil and Subsoil

- Topsoil ("O" and "A" Horizons)
  - Major zone of root development for plants
- Subsoil ("B" Horizon)
  - Harder for plant roots to penetrate
  - Less reservoir of nutrients and moisture
  - Often less drainage (wetness)
- Plant growth defined by "Law of the Minimum"
  - Constrained by most limiting nutrient (water, N, P, K, microelements, organic matter)



Improving Your Soils with Compost

Benefits of Compost Use

Physical:	Improved structure Moisture management
Chemical:	Modifies and stabilizes pH Increases CEC Provides nutrients
Biological:	Provides soil microorganisms Suppresses plant diseases
Other:	Binds/degrades contaminants Binds nutrients Sequesters air-borne carbon

Improving Your Soils with Compost

Physical Benefits to Soils

Improving Your Soils with Compost

Improves Soil Tilth

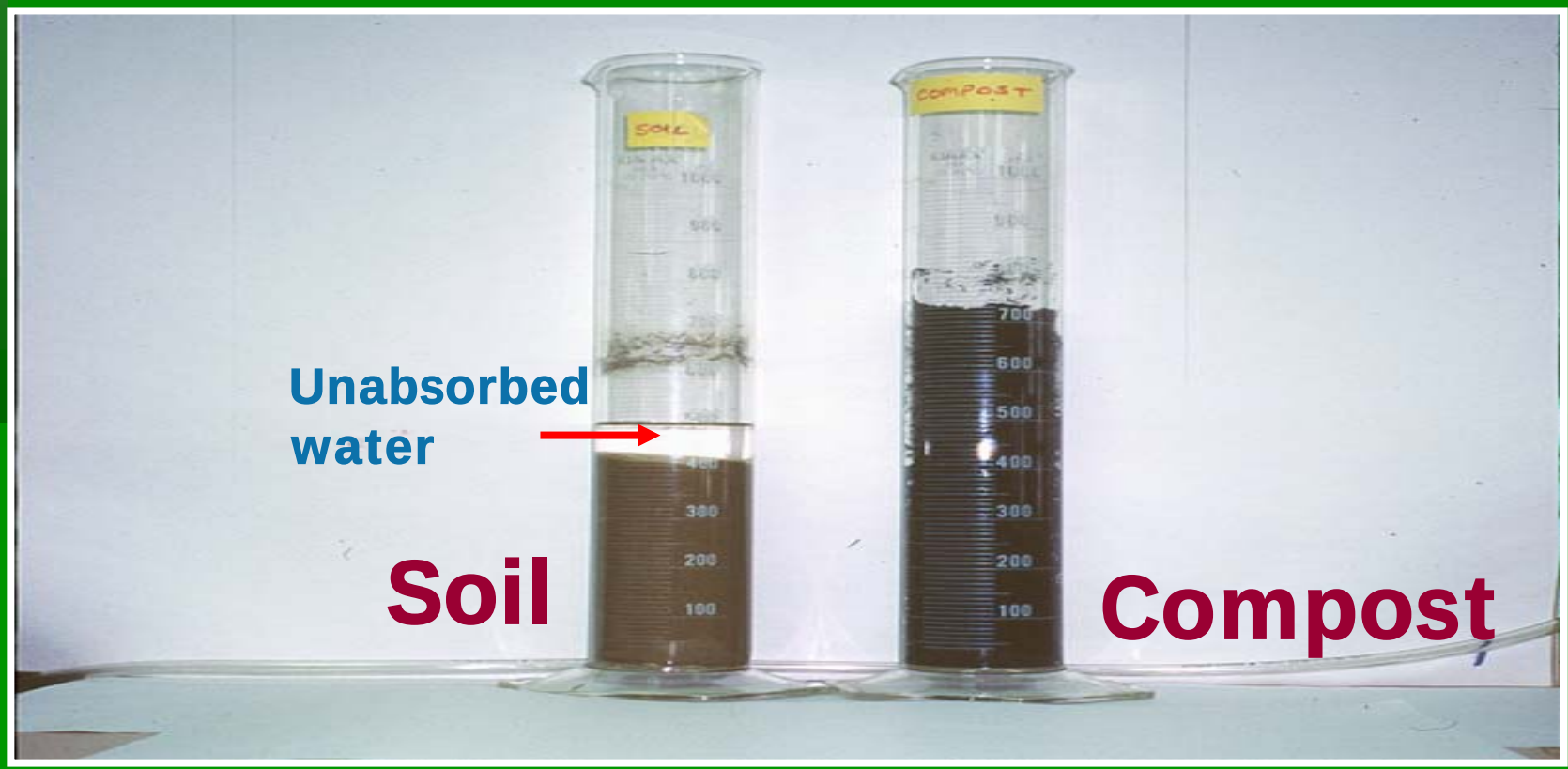
- Compost improves:
  - Soil Structure (not texture)
  - Aeration
  - Water permeability
  - Plant roots penetration
  - Seedling emergence
- Compost reduces:
  - Crusting
  - Clod formation

Improving Your Soils with Compost

Reduction in Soil Bulk Density

Improving Your Soils with Compost

Equal amounts of soil & compost absorb different amounts of water



Improving Your Soils with Compost

Increased Soil Water Holding Capacity Produces More Vigorous Plant Growth

Chemical Benefits to Soils

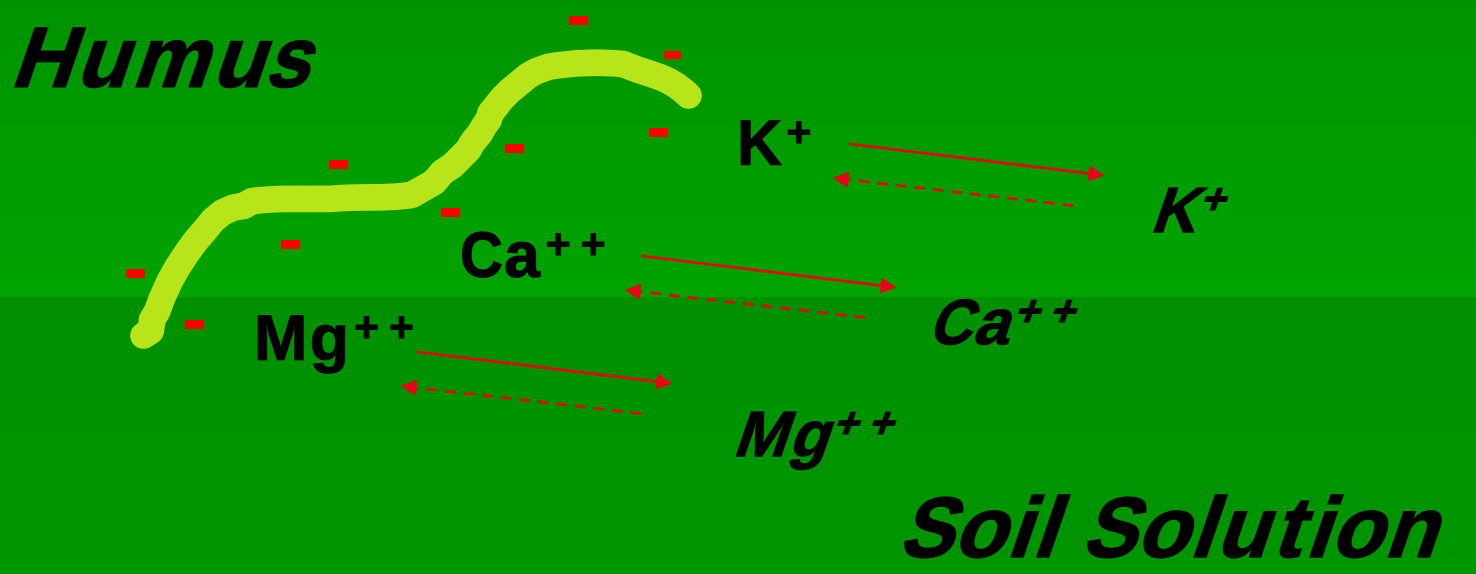
Improving Your Soils with Compost

Compost Effect on Soil pH

- Improved CEC improves soil buffering capacity
  - More resistant to pH change
- In most acidic soils, compost will raise pH
- Minimal effect on alkaline soils
- Increased organic matter in soil offsets pH as control over nutrient uptake rate

Improving Your Soils with Compost

Nutrient reservoir – created by increased cation exchange capacity (CEC)



Improving Your Soils with Compost

Effect of Organic Matter on CEC

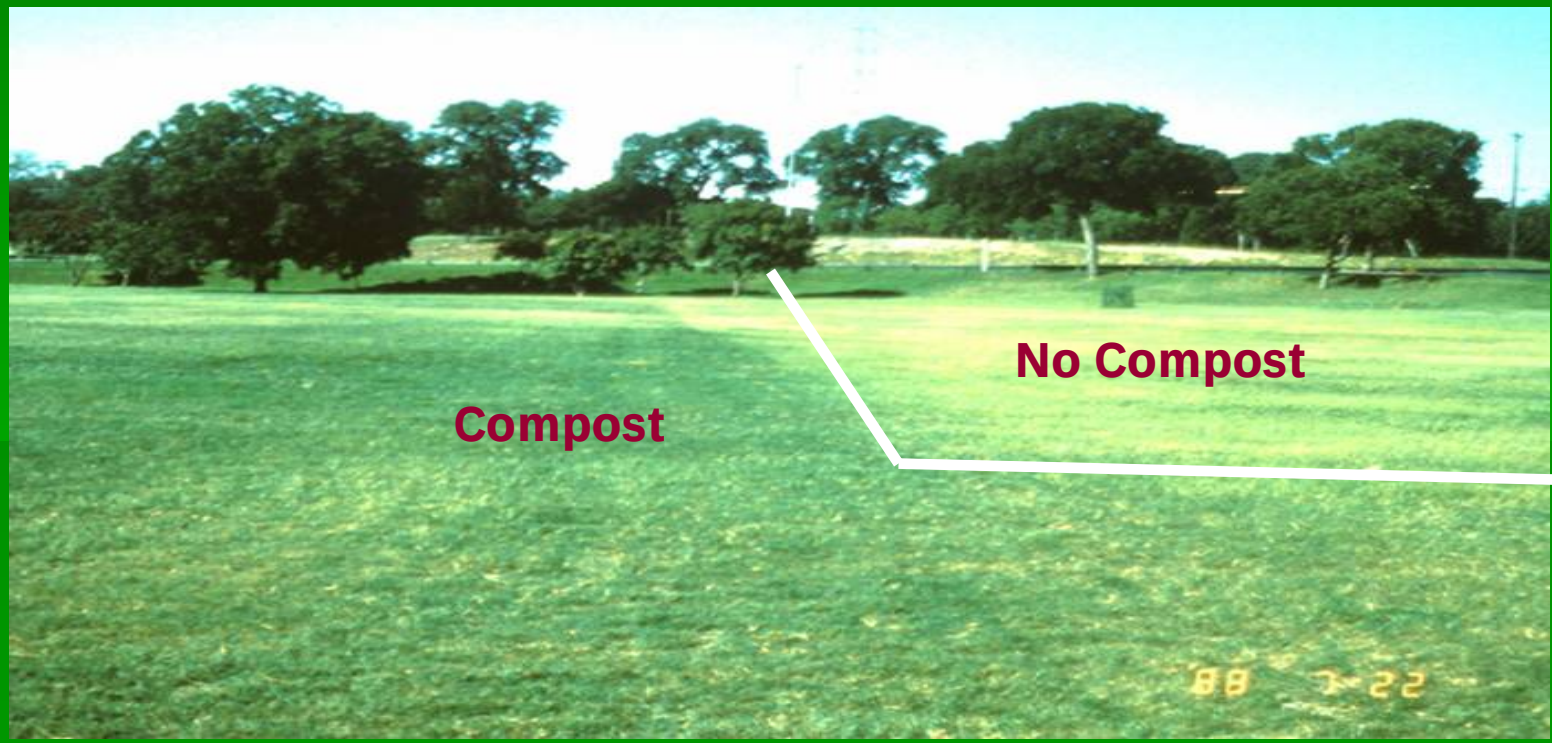
PERCENT ORGANIC MATTER

	1	2	3	4	5	6
ph	CEC (meg/100 grams of soil)					
5	0.8	1.6	2.5	3.4	4.2	5.0
6	1.8	3.6	5.4	7.2	9.0	10.7
7	2.8	5.5	8.3	11.0	13.8	16.5

Source: Mardoff, 1993, calculated by equation

Improving Your Soils with Compost

Supplies Macro & Micro Nutrients



Improving Your Soils with Compost

Biological Benefits to Soils

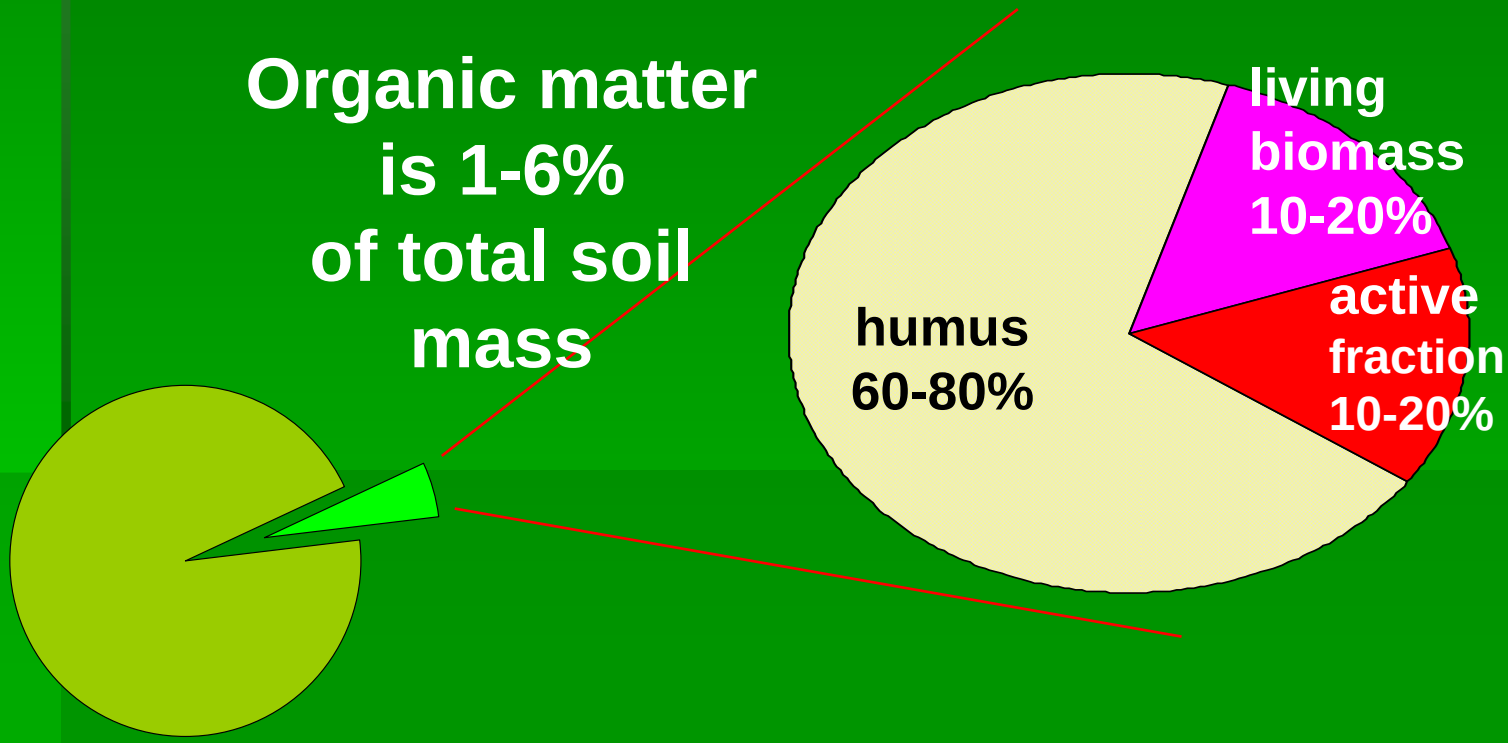
Improving Your Soils with Compost

Role of Soil Organisms

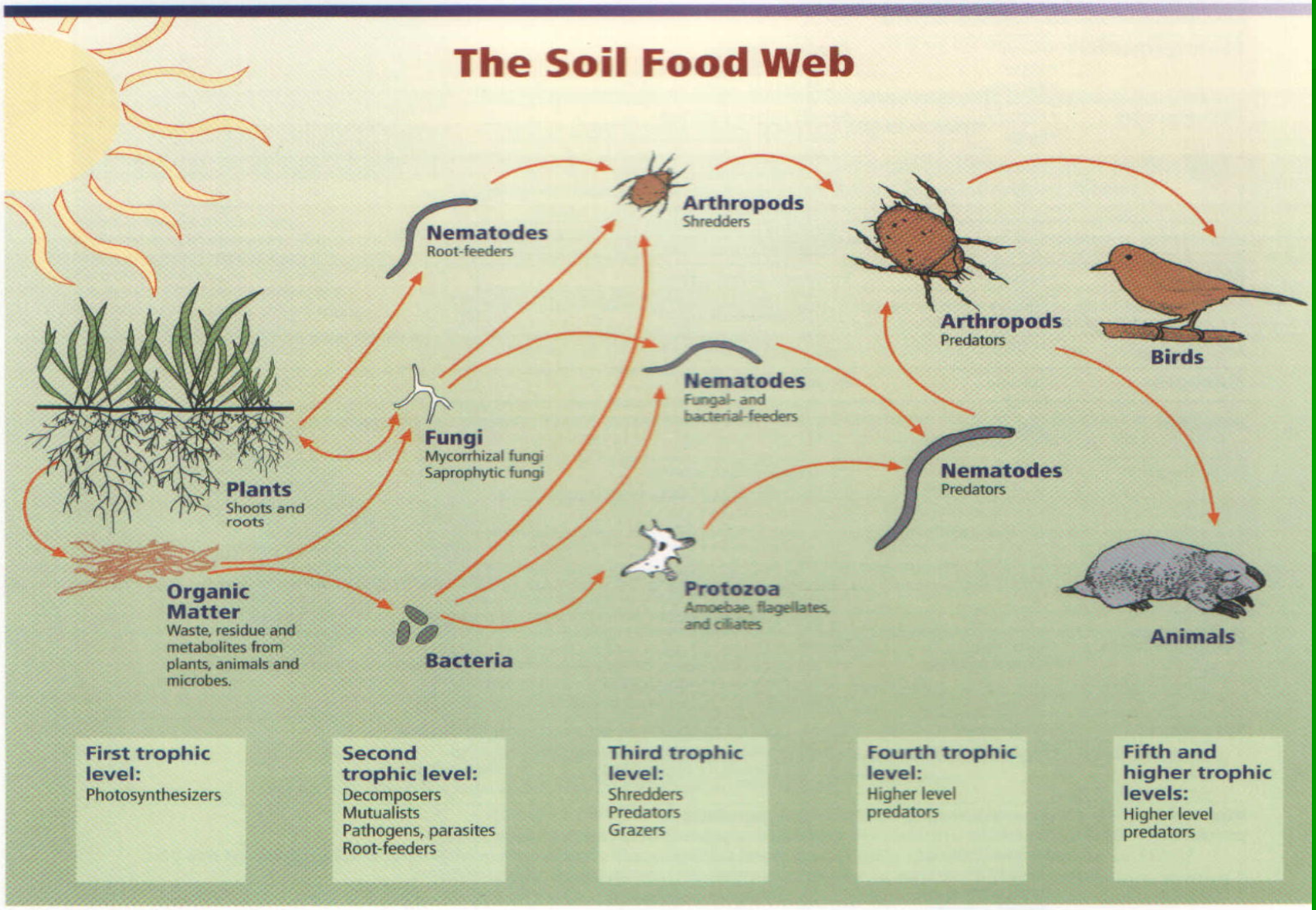
- Decompose organic matter
- Cycle nutrients and increase plant availability
- Bind soil aggregates with fungal hyphae and excretions
- Enhance soil structure
- Control pest populations

Improving Your Soils with Compost

Soil Organic Matter

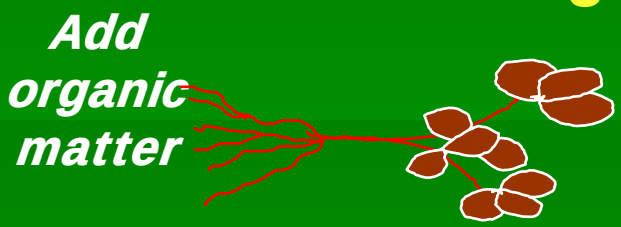


Improving Your Soils with Compost



Improving Your Soils with Compost

Effects of Organic Matter Addition



Improving Your Soils with Compost

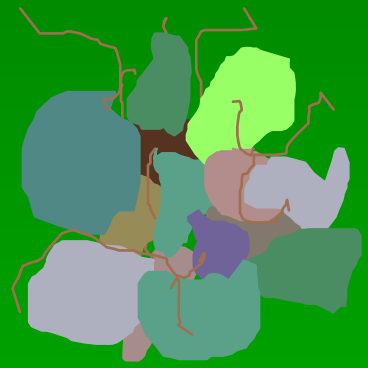
Role of Soil Organic Matter

- Binds mineral particles into granules (tilth)
- Improves water holding capacity
- Major soil source of phosphorus and sulfur
- Primary source of nitrogen
- Main source of energy for soil organisms
- Primary source of humus in soils
  - Humus: stable organic fraction left after decomposition of residues is complete

Improving Your Soils with Compost

Soil structure:
Biological mechanisms of aggregation

- Fungal hyphae - help form macroaggregates



- Gels produced by microbes and plant roots "water-stable aggregates"

Improving Your Soils with Compost

Improving Your Soils with Compost

Disease Suppression Mechanisms

- Successful competition for nutrients by beneficial micro-organisms
- Antibiotic production by beneficial micro-organisms
- Successful parasitism against pathogens by beneficial micro-organisms
- Activation of induced systemic resistance
- Production of toxic or stimulatory compounds from compost
- Changes to physical properties of growing medium
- Changes to soil conductivity and pH

Source: Hoitink, H.A.J. and Boehm. M.J., “Biocontrol within the context of soil microbial communities: a substrate-dependent phenomenon”, *Annual Review of Phytopathology*, Vol. 37, 1999, p. 427

Improving Your Soils with Compost

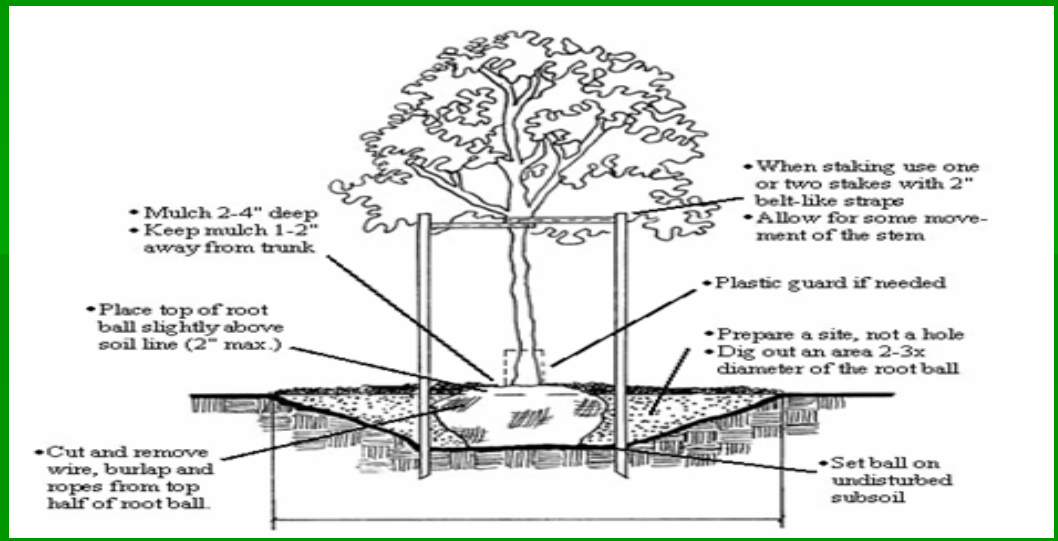
Improving Your Soils with Compost

Applications for Compost:

- Trees & Shrubs
- Flower & Vegetable Gardens
- Turf Grass
- Container & Raised Bed Gardens
- Foundation Plantings
- Potting Soils and Container Media
- Whole Field Applications
- Mulching

Improving Your Soils with Compost

- Trees & Shrubs – Backfill Planting
  - Mix compost with existing native soil at a 50:50 rate. Mulch 2-4 inch top layer.



Improving Your Soils with Compost

- Flowers & Vegetable Gardens
- Turf Grass Establishment
  - Work 2-3 inches into top 6 inches before planting

Improving Your Soils with Compost

- Turf Grass Topdressing
  - Core Aerate with hollow tine aerator
  - Apply 1/4 - 1/2 inches on top of existing turf
  - Over-seed or sprig with desired grass type

Improving Your Soils with Compost

Soil Organic Matter (OM)

- Primary source of nutrients to plants
- Made of decomposed plant and animal residues
- Continually broken down and resynthesized by soil microorganisms
- Needs to be replenished by adding plant and animal residues --- OR COMPOST!

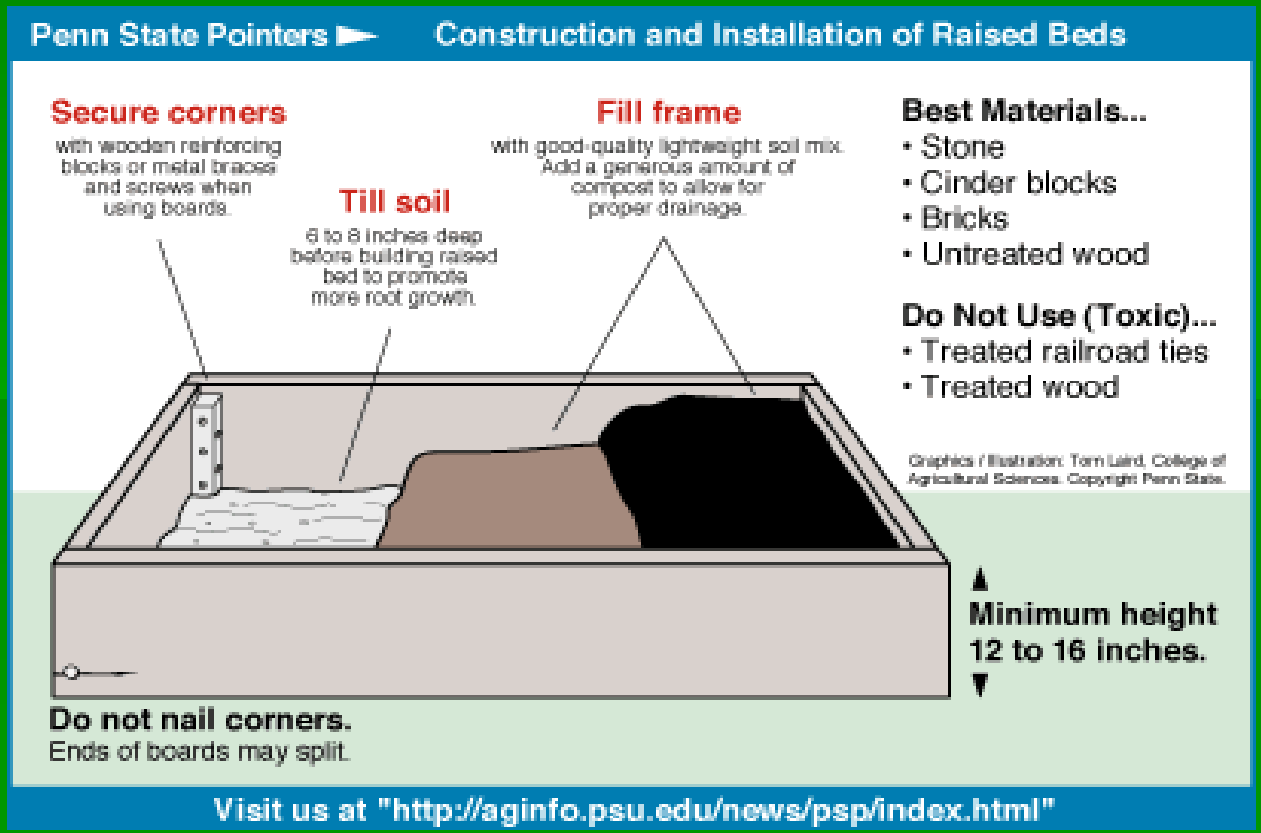
Improving Your Soils with Compost

- Turf Grass Topdressing

  Blower Truck Application

Improving Your Soils with Compost

- Container & Raised Bed Gardens
  - Till existing soil. Add transplants to containers or raised beds fill with mixture of 30% compost 70% topsoil



Improving Your Soils with Compost

- Foundation Plantings
  - **Replace compacted or poor quality soil with a blend of compost, coarse sand and top soil**

Improving Your Soils with Compost

Characteristics of Potting Soils

Potting Soils

- Either soil-containing or soil-less
- Soil-less – peat moss, ground pine bark, vermiculite/perlite, lime, nutrients
- Important features of potting soils:
  - Porosity - Particle Size
  - Volume Stability - pH/Buffer Capacity
  - Nutrients - Soluble Salts
  - Water Holding Capacity
  - Bulk density/weight
  - Freedom from contaminants

Improving Your Soils with Compost

Effect of Compost on Potting Soils

- Porosity/Particle Size/Volume Stability
  - Fast decomposition – clogs air channels
- Water Holding Capacity
  - If > 25-30%, plants get wet feet
- pH/Buffer Capacity
  - Compost helps keep pH constant
- Nutrients
  - More N, P, and K than commercial soils
- Bulk Density
  - Generally heavier

Improving Your Soils with Compost

Purpose of Container Mix

- Serve as reservoir of plant nutrients
- Hold water to be plant-available
- Provide adequate porosity for the exchange of gases
- Provide anchorage and support for the plant

Improving Your Soils with Compost

Root Substrate Component Costs

Component	$/CF	$/CY	Component	$/CF	$/CY
Field soil	$0.80	$21.60	Sphagnum Peat	$0.85	$22.95
Bark (0” – 3/8”)	$0.65	$17.55	Sawdust (rotted)	$0.65	$17.55
Manure	$0.65	$17.55	Vermiculite	$1.45	$39.15
Calcined Clay	$2.45	$66.15	Bark (3/8” – ¾”)	$0.65	$17.55
Sand (conc. grade)	$0.77	$20.79	Perlite	$1.45	$39.15
Polystyrene	$0.50	$13.50	Compost	$0.66	$18.00

(Nelson, 1998)

Improving Your Soils with Compost

Whole Field Applications

Improving Your Soils with Compost

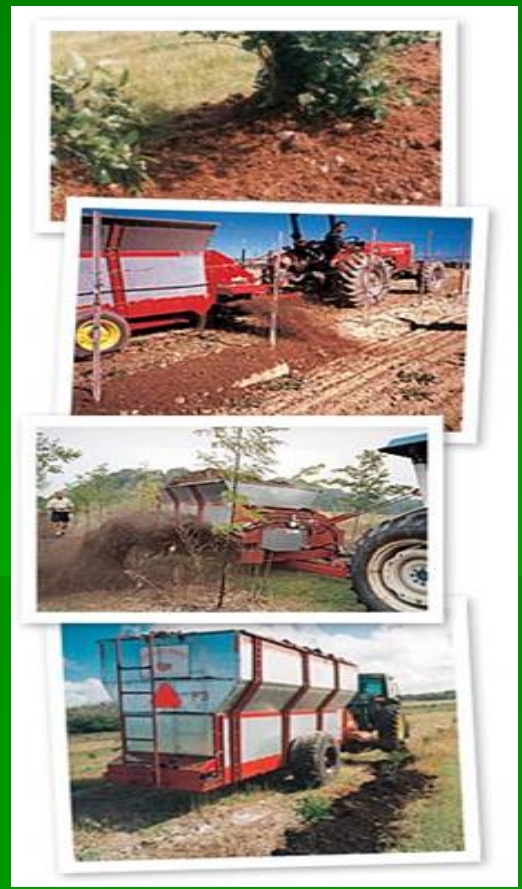
Liner Beds

- High-intensity production areas with high-dollar return
- Compost competes with peat moss
- Use as soil amendment and as mulch
  - Mulch helps prevent frost heave

Improving Your Soils with Compost

Band Application

- Spread compost only on root zone of trees
- Can significantly cut costs compared to whole field applications
- Benefits to shade trees:
  - Increased caliper size (more $$)
  - Reduced time to market
  - Savings in fertilizer and water



Improving Your Soils with Compost

- **Compost as a mulch**
  - Spread a 2-4 inch layer around plants to prevent erosion, acts as a weed barrier and conserves water

Improving Your Soils with Compost

Mulch vs. Soil Amendment

Property	Mulch	Amendment
Moisture conservation	Moderate to high	Low to moderate
Moisture retention	Low (mulch) High (soil)	High
Soil temperature	Immediate changes	Slight or unchanged
Soil structure	Changes with time	Changes immediately

Improving Your Soils with Compost

Mulch vs. Soil Amendment

Property	Mulch	Amendment
Phytotoxicity potential	Low to medium	Low to high
Root contact	Low initially	High
Fertility	None to low	Low to moderate
Pathogens	Low to none	None to high
Nitrogen tie up	Low to none	None to high
Weed control	Moderate to high	Low to none

Downen, J. and B. Faber, “Creating A Healthy Root Zone”, courtesy R. Alexander Associates, Inc.

Questions?

CAROLINA RECYCLING ASSOCIATION

Carolinas COMPOSTING COUNCIL

Naturescaping 1

Yes You CAN!

(Compost and Naturescape!)

Training Program

NATURESCAPING:
Fostering environmentally sound practices and biodiversity

By Mary Stauble, Master Gardener, Master Composter and Mecklenburg County (NC) Soild Waste Management PLANT Instructor

NATURESCAPING, LANDSCAPES THAT LOOK AND ACT LIKE NATURE

Before you buy, or plant anything, take a good look at your yard and what it has to offer. Observation and a little planning can save you lots of trouble later on. Experienced gardeners do a site assessment, noticing drainage patterns, any erosion, areas of sun and shade. It's helpful to sketch out a rough plan of the environmental conditions your yard offers. Then choose plants that fit the site conditions. If you work with nature your maintenance will be reduced dramatically.

Traditional home yards tend to be huge green lawns with a few shrubs around the house and possibly a tree or two. Achieving the "perfect lawn is a full time occupation requiring a heavy input of chemicals, water and regular mowing during the growing season, which is often the hottest time of the year.

Naturescaping involves giving up this traditional goal of a perfect grass monoculture in favor of greater diversity. Under shady trees, where grass doesn't grow well, reduce the lawn size to create natural areas. Select well-adapted native plants and add organic mulch to retain moisture and reduce time spent weeding. Whether you wish to naturalize your yard to reduce maintenance (tired of mowing!), or because you want a more interesting landscape, or you want to support wildlife, start small and experiment. See what works best for you. Many of these ideas help reduce water use in the yard and are components of the seven principles put together by the National Xeriscape Council. Above all take time to see the beauty of the natural world. Nature is our best teacher.

SOIL STEWARDSHIP:
Success in your yard starts here

By Mary Stauble, Master Gardner, Master Composter and Mecklenburg County (NC) Solid Waste PLANT Instructor

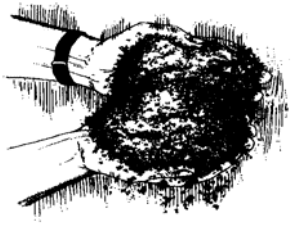
SOIL, A PRECIOUS NATURAL RESOURCE

People spend lots of time thinking of the plants they'd like to have, but often overlook the soil conditions. Soil is a precious natural resource that is too often treated with little respect. Many new home sites have literally had the topsoil scraped off the land. Other sites have water drainage problems and the topsoil has been carried away by water erosion. It takes time to build a fertile soil, but your investment will reap many rewards in healthier plants, with deep roots, which are more resistant to environmental stresses.

It is a good idea to have a soil test done to help you know what your soil needs. Many soils in the Piedmont are Cecil soils, which are especially high in clay. These soils often have poor drainage, are deficient in oxygen and tend to be slightly acidic. There are no shortcuts to proper soil preparation. Different kinds of plants have different soil requirements. A soil test will take the guesswork out of how to amend your soil for the specific plants you want to grow.

Good soil needs structure that allows for proper air circulation, moisture retention and drainage. Its structure should be crumbly. Adding organic matter like compost is an excellent way to improve soils naturally high in clay. Prepare your planting beds 2-3 months before you plant to allow time for soil to settle. To control weeds, put down organic mulch 2-4 inches deep. Plan to add new mulch each year. It will break down and improve the soil. Start small, taking on small areas to improve at one time. Each year your work in the yard will get easier as you build a more fertile soil.

Think About It



Soil is more than just dirt. Pick up a handful of soil and imagine it is the earth's surface. Right away, remove three-fourths of the handful and drop it back on the ground – that's how much of the earth is covered by oceans and rivers, and lakes. What's left represents the land. Now, drop one-half of the soil in your hand to account for desert regions, glacial poles, and mountain peaks where many things won't grow. Then drop one tenth to account for the places where people live – where the land is used for big cities, towns, houses, schools, roads, and parking lots.

Now, look. What's left in your hand represents all the soil we have to support life on earth. This soil is trickling through our fingers at an alarming rate due to unchecked erosion. In fact, recent statistics indicate the U.S. is losing 6.4 billion tons of soil each year due to erosion. This amount of soil would fill 320 million dump trucks, which if parked end-to-end would extend to the moon and three quarters of the way back. The eroding soil is washed into lakes and rivers and blown into our air where it pollutes our environment. If we all knew a little bit more about soil, we could each do our part to help conserve this precious resource. Read on for some fascinating facts about conservation tips about soil.

U.S. Dept. of Agriculture Soil Conservation Service National Wildlife Federation, Feb. 1992

Soil Facts

- Soil makes up the outermost layer of our planet.
- Topsoil is the most productive soil layer. It has varying amount of organic matter (living and dead organisms), minerals, and nutrients.
- Five tons of topsoil spread over an acre is as thick as a dime.
- Natural processes can take 500 years to form one inch of topsoil.
- Soil scientists have identified over 70,000 kinds of soil in the United States.
- Soil is formed from rocks and decaying plants and animals.
- An average soil sample is 45% minerals, 25% water, 25% air, and 5% organic matter.
- Different sized mineral particles, such as sand, silt, and clay give soil texture.
- Lichens help to break apart rocks to form soil.
- Fungi and bacteria help break down organic matter in the soil.
- Plant roots break up rocks, which become part of new soil.
- Roots loosen the soil and allow oxygen to penetrate. This is beneficial to the animals living in the soil.
- Roots hold soil together and help prevent erosion.
- Five to ten tons of animal life can live in an acre of soil.
- Earthworms digest organic matter, recycle nutrients, and make the surface soil richer.
- One earthworm can digest 36 tons of soil in one year.
- Mice take seeds and other plant materials into their underground burrows, where this material eventually decays and becomes part of the soil.
- Mice, moles, and shrews dig burrows, which help, aerate the soil.

U.S. Dept. of Agriculture, Soil Conservation Service National Wildlife Federation, Feb. 1992

Tips on Protecting Your Soil

In Your Backyard

It is not hard to help conserve soil in your own backyard. The first step is recognizing areas that are prone to erosion. You should look for:

- areas where no plants are growing along property lines, walkways, and drives.
- sloped areas where gullies are forming from water runoff.
- exposed soil around houses and downspouts.

Other signs of soil erosion are dust in the air on windy days, and mud in the gutters and on sidewalks. These factors indicate that soil is eroding from surrounding areas.

Once you have identified the problem areas, consider these ways in which you can help curb erosion:

- Seed exposed areas with grass, or plant some other groundcover. After seeding, spread mulch (such as straw or compost) over the area to help keep the seeds moist and in place until they germinate. On steeper slopes you should cover the mulch with burlap netting for extra protection.
- Build steps, made of logs or old railroad ties, on areas with steep slopes to help prevent increased erosion. Between the steps, spread a thick layer of wood chips to protect the soil.
- Put splashguards on downspouts to help reduce erosion around the foundation of your home.
- Plant windbreaks of trees or shrubs to reduce soil loss from blowing wind and also to provide habitat and shelter for wildlife.
- Contact your local resource agencies, such as the forest service, parks and recreation, extension service, or soil conservation service, for technical assistance and advice in devising an appropriate erosion control plan for your backyard.

In Your Garden

Here are some soil-wise ideas that will help keep your garden healthy and productive:

- If your garden is on a slope, plant the vegetable rows along the contour, rather than up and down the slope. This will help slow down water runoff and decrease the rate of erosion.
- Plant different crops in different places in your garden each year. For example, a plot used for growing tomatoes one year is used for planting beans the following year. Rotating crops balances the uptake of valuable nutrients from the soil and keeps your plants strong and healthy.
- Spread mulch around your garden plants using compost and grass clippings to help reduce erosion, keep moisture in the soil, suppress weed growth, and add nutrients.
- A good way to create mulch and enrich your soil is by making a compost pile. Construct a small bin beside your garden plot to hold the composting material. Fill it with alternating layers of organic material i.e., grass clippings, dead leaves, and plant stalks and hulls, and garden soil. Keep moist and turn the compost pile regularly to aerate it. This helps speed up the natural decaying process. A good compost will create rich fertile soil for your garden.
- Minimize the spraying of poisonous insecticide in your garden, by letting certain types of plants and insect-eating animals control pests. Some plants, such as marigolds and onions, contain chemicals that repeal pesky bugs. Toads, ladybugs, praying mantises, and other insect-eating animals can also help control pest populations in your garden.

U.S. Dept. of Agriculture, Soil Conservation Service National Wildlife Federation, Feb. 1992

HOW TO TAKE SOIL SAMPLES FOR YOUR LAWN, GARDEN OR ORNAMENTAL SOILS

Step 1: Obtain soil sample boxes and information sheet from the Cooperative Extension Service office. Choose a day when the soil is not frozen or too wet since under these conditions, soil will not mix thoroughly. The soil should be in a loose condition and break apart easily.

Step 2: Clean up the area to be sampled. Remove roots, rocks, and pieces of wood, glass, wire, excess organic matter, and other foreign material. Avoid taking soil from wet spots, washed out areas, ditches, tree stump holes, fertilizer bands, or other abnormal spots within the sampling area.

Step 3: Obtain clean, plastic bucket and a clean spade, shovel, or probe for collecting the individual soil cores that will make up the sample. **DO NOT** expose the soil sample to galvanized containers, dirty tools, fertilizer or chemicals that may contaminate it.

Step 4: Use the spade or sampling tool to get a soil core or slice (about a handful) from each of eight to ten different places scattered over the sampling area. (For lawns or gardens approximately an acre in size, 15 to 20 cores would be better). Sample established lawns to a depth of about four inches; otherwise, sample to about six inches or plow depth. Be sure that each soil core uniformly represents (top, middle, and bottom to the specified depth) the spot where it is taken.

Step 5: Put each soil core into the clean, plastic bucket. After sampling, stir up the cores and mix them thoroughly to obtain a good soil sample, representative of the sampling area. Fill soil sample box with the mixed soil and discard extra soil.

Step 6: Write your name, address, and sample number on the box. An information sheet that comes with the boxes must also be filled out and mailed to the Soil Testing Lab in your state.

Any questions about taking a soil sample or reading your soil test report, contact your County Cooperative Extension Service.

Understanding the Soil Test Report

LAWNS, GARDENS AND ORNAMENTALS (Crop Codes 020 – 031)

The amounts of lime and fertilizer shown under the heading Recommendations are the most important parts of the soil test report. Rates are given in units of lbs/M, which is the same as lbs/1000 ft^2. If you have a 3750-ft^2 lawn and are advised to apply 40 lbs/M, then the amount of lime or fertilizer to add is 150 lbs. or (3750 ft^2 / 1000 ft^2) x 40 lbs.

The type or grade of fertilizer recommended depends on the soil test level of phosphorus and potassium. A fertilizer recommendation might be, for example, 20 lbs. of 10-10-10 per 1000 ft^2 or an equivalent fertilizer, such as 10 lbs of 20-20-20. *NOTE 4*, enclosed with your report, shows how to calculate fertilizer rates from different sources. When phosphorus (P-I) and potassium (K-I) indices are higher than 50, nitrogen will be the only fertilizer recommended. A typical nitrogen recommendation would be 1.0 lb N/1000 ft^2. Ammonium nitrate (33.5% N) applied at 3.0 lbs would provide 1.0 lb of nitrogen. For centipede grass, the annual nitrogen rate is 0.5 lb/1000 ft^2.

The optimum pH for most turf grasses, vegetables, shrubs, and annual and perennial flowers ranges from 6.0 to 6.5. Acid-loving plants, such as azaleas and rhododendrons, do better at a pH between 5.0 and 5.5. The optimum pH for centipede grass is 5.5. Maintaining the property pH is just as important as applying fertilizer. For additional information on lime and fertilizer application, see *NOTE 4: Lawns, Gardens and Ornamentals* enclosed with your report.

Abbreviations

MIN	mineral soil
M-O	mineral-organic soil
O	organic soil
HM%	percent humic matter
W/V	weight/volume of soil
CEC	cation exchange capacity
BS%	percent of CEC occupied by bases
Ac	acidity (decreases as pH increases)
P-I	phosphorus index
K-I	potassium index
Ca	calcium
Mg	magnesium
Mn-I	manganese index
MnAI	manganese availability index
Zn-I	zinc index
Zn-AI	zinc availability index
Cu-I	copper index
S-I	sulfur index
SS-I	soluble salt index
NO_3-N	nitrate nitrogen (ppm)
NH_4-N	ammonium nitrogen (ppm)
Na	sodium
K_1O	potash
P_1o_5	phosphate
B	boron

Soil Test Index		Crop Response to Nutrient Application				
Range	Rating	Phosphorus	Potassium	Manganese	Zinc	Copper
0-10	Very Low	Very High	Very High	Very High	Very High	Very High
11-25	Low	High	High	High	High	High
26-50	Medium	Medium *	Medium *	None	None	None
51-100	High	None	Low-None	None	None	None
100+	Very High	None	None	None	None	None

* Response decreases as soil test index increases

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CAROLINA RECYCLING ASSOCIATION

Carolinas COMPOSTING COUNCIL

Naturescaping 2

Yes You CAN!

(Compost and Naturescape!)

Training Program

NATIVE PLANT INFORMATION

By Mary Stauble, ***Master Gardener, Master Composter and Mecklenburg County (NC) Soil Waste Management PLANT Instructor***

Basics About Using Native Plants

Maximize your success by matching the right plants with the right site conditions. Do your homework before planting:

- Assess the available light, moisture, and soil pH at your planting site.
- Have your soil tested to learn the pH and if the soil needs to be improved.
- Choose native plants that match your site conditions.

Buy nursery-propagated plant material.

The practice of growing native plants from seeds and cuttings protects wild populations.

Don't dig plants from the wild.

Taking wild plants devastates native plant populations and often the plants removed do not survive in backyards.

Native Plant Lists.

The following lists have been created to help you with selecting horticulturally appropriate plants. Most of these plants are available through native plant nurseries and sometimes other plant outlets. It is our hope that native plants will become more available in nurseries as public demand grows. This is not a complete listing of the native plants for the Southeast, only those that are not protected, endangered or threatened.

The lists are divided into sections including: Grasses, Wildflowers, Ferns, Vines, Bulbs, Shrubs and Trees

The list headings give selected criteria about the plants including the urban stream buffer or riparian zone; the common name; the botanical name; whether the plant grows in the mountains, piedmont or coastal areas; the stress tolerance if known; the distance to plant apart from each other-rate or spacing or the % of a seed mixture; sun or shade tolerance; soil moisture conditions; height & trunk or branch width; reproduction commonly available; any known benefits or problems.

Landscaping With Native Plants

Complied and Edited by D. Ann Gill

Across North America, more and more people are discovering the satisfaction of landscaping their homes, schools, businesses and places or worship with native plants.

What Are Native Plants?

Native species are those that occur in a region in which they have adapted over long periods of time. More specifically, native plants in a particular area are those that were growing naturally in the area before humans introduced plants from distant places. Plants change over geologic time in response to physical and biotic processes characteristic of a region: the climate, soils, timing of rainfall, drought, and frost; and interactions with the other species inhabiting the local community. Thus native plants possess certain traits that make them uniquely adapted to local conditions, providing a practical and ecologically valuable alternative for landscaping, conservation and restoration projects, and as livestock forage. In addition, native plants can match the finest cultivated plants in beauty, while often surpassing on-natives in ruggedness and resistance to drought, insects and disease. In eastern and central North America, native plants typically grow in communities with species adapted to similar soil, moisture, and weather conditions. Some of the widespread communities included oak-hickory-chestnut and beech-maple forests, tallgrass and shortgrass prairies, and freshwater marshes. Additional communities occupied specialized niches, including savannahs, fens, bogs, flood plains and alpine areas.

The included native plant species list identifies native trees, shrubs, wildflowers, grasses, ferns, vines and aquatic species. These native species are currently recommended by the North Carolina Division of Parks and Recreation, North Carolina Wildlife Resources Commission, North Carolina Division of Forest Resources, Southeast Exotic Pest Plant Council, The University of North Carolina at Chapel Hill – North Carolina Botanical Garden, National Wildlife Federation and other program cooperators for use in horticulture, land management, conservation, and restoration projects in North Carolina. The lists provide a selection of plant choices adapted to growing conditions in North Carolina, focusing on those native species currently or potentially available in the nursery trade. For the most part, relatively common species have been included on the list, although a few less common species were also included due to their establishment in the trade and the general stability of their habitat in North Carolina. Rare species were left off the list in order to protect the genetic integrity of naturally occurring populations of rare species and avoid the collection of rare plants.

Examples of SE native plants include:

TREES	SHRUBS	FLOWERS
Red Maple	Flame Azalea	Violent
Dogwood	Rhododendron	Black-Eyed Susan
Hickory	Elderberry	Coreopsis
Willow Oak	Silky Dogwood	Purple Coneflower
Tulip Poplar	Viburnum	Yellow Jessamine

Why Landscape with Native Plants?

Mecklenburg County Solid Waste Management endorses and recommends using native plants especially in landscaping situations that may affect natural areas. The use of native species on public lands demonstrate responsible stewardship practices. This practice was mandated on April 26, 2994 as Present Clinton signed an executive directive for federal agencies and all non-federal agencies (who use federal dollars) to landscape with native plants. As a proactive approach, Mecklenburg County has developed alternative native plant listings. It is our hope that native plants will become more available in nurseries as public demand grows. Mecklenburg County also promotes the use of native plants to raise awareness about the exotic pest plant issue.

Benefits of native plants

Landscaping with native plants has several appealing factors. The benefit of growing plants within the region they evolved is they are more likely to thrive under the local conditions while less likely to invade new habitats. Each native plant species is a member of a community that includes other plants, animals and microorganisms. The natural balance keeps each species in check, allowing it to thrive in conditions where it is suited, but the preventing it from invading. Thus, native species rarely become invasive, as plants introduced from other areas can be.

Native plants are well adapted to local environmental conditions. Many help to maintain or improve soil fertility, reduce erosion, and often require less fertilizer and pesticides than many alien plants. Their root systems help rainfall percolate into the soil, reducing erosion and runoff. Native vegetation is particularly effective as buffers along streams, lakes and wetlands and helps in flood zones and erosion prone sites. These characteristics save time and money and reduce the amount of harmful run-off threatening the aquatic resources of our streams, rivers and estuaries.

In addition, functionally healthy and established natural communities are better able to resist invasions by alien plant species. So the use of native plants can help prevent the spread of alien species already present in a region and help avert future introductions. With the large variety of grasses, ferns, wildflowers, shrubs and trees from which to choose, native plants can fulfill any landscaping

need, from simple container gardens to showy perennial borders to expansive public lawns and gardens.

Native plants provide familiar sources of food and shelter for birds, butterflies and other desirable wildlife. As natural habitats are replaced by urban and suburban development, the use of native plants in landscaping can provide essential shelter for displaced wildlife. Land managers can use native plants to maintain and restore wildlife habitat. Native wildlife species comprise a majority of the game and non-game animals we manage habitat for, and they evolved with native plant species. Although alien species are often promoted for their value as wildlife food plants, there is no evidence that alien plant materials are superior to native plants. For instance, on land managed for upland games animals, native warm season grasses (big and little bluesterm, switch grass, Indian grass, coastal panic grass, gama grass), and other native forbs (butterfly, weed, ironweed, Joe Pye weed) offer good sources of nutrition without the ecological threats associated with nonnative forage plants. Dramatic increases in nesting success of both game birds and songbirds have been observed in fields planted with native grasses, which also offer superior winter cover. In addition, warm season grasses provide productive and palatable livestock forage. (For more information on native warm season grasses contact the Virginia Department of Game and Inland Fisheries for the publication "Native Warm Season Grasses for Virginia and North Carolina: Benefits for Livestock and Wildlife.")

On a broader ecological scale, planting native species contributes to the overall health of natural communities. Disturbances of intact ecosystems that open and fragment habitat, such as land clearing activities, increase the potential of invasion by alien species. Native plants provide important alternatives to alien species for conservation and restoration projects in these disturbed areas. They can fill many land management needs currently occupied by nonnative species, and often with lower costs and maintenance requirements. Vigorous and hardy, they can survive winder cold and summer heat. Once established in an appropriate area, most native plant species are hardy and do not require watering or fertilizers. They are resistant to most pests and diseases, which decreases the need for pesticides and herbicides. Thus, native plants suite today's interest in "low-maintenance" gardening and landscaping.

In addition to ecological and land management benefits, the native flora of North Carolina offers a surprising variety of interesting flowers and foliage, color, form, and texture to gardeners and landscape designers. In fact, many familiar and popular landscaping plants such as black-eyed Susan, purple cornflower, yellow jasmine and dogwoods are native to North Carolina. Designing with natives allows the creation of distinctive natural landscapes including woodlands, meadows, and wetlands with unique regional character. In addition, native plants attract a greater variety of butterflies, hummingbirds, songbirds and other wildlife than traditional lawns. In fact, the greater the variety of native species

included in a landscape, the more likely uncommon or rare species will be attracted to an area. Native shrubs and trees provide a variety of heights, shapes and textures in the landscape. Many provide winter interest through their bark or seedpods. Another dimension of native plants is their historical and cultural interest. Some plants played a significant role in Native American cultural and in the European exploration and settlement. Many species have value as food or medicine and other have been used for cordage, textiles, dyestuffs, or similar domestic purposes. Native plants can provide children and adults with a tangible link t the past and to the future.

What you can do

Promote responsible landscaping practices by learning about native plants. Native are generally defined as plants that occurred in North America before European settlement. Large-scale changes in flora have resulted since European settlement and the introduction of exotic plants. Native plants help sustain native wildlife like butterflies, birds, mammals, reptiles, beneficial insects, and other fauna. Migrating birds depend on the food and cover, while resident species find high quality nesting sites among native trees and shrubs.

Know the habits of the species you plant. In addition to potential threats to biodiversity (See Ecology for Gardeners section) in natural areas, some exotics become pests plants in carefully planned landscapes and gardens. They may be very time-consuming and costly to remove or control.

Basics About Buying and Growing Natives

The use of native plants is on the rise across the country as more people discover their many benefits. An ever-widening selection of vigorous, nursery-propagated native plants is available from specialty growers and many larger nurseries as a result of this increased demand. This offers a much-needed alternative to wild collection or the purchase of wild-collected plants. Wild-collection threatens the existence of native species by causing net losses in population size and genetic diversity, and leaves the collector or purchaser with highly stressed plants that have a decreased likelihood of survival. These problems are multiplied when the plants are collected from a distance source population, then planted in a new location with different environmental conditions.

We encourage land managers, conservation professionals, restoration specialists, landscape designers, and private individuals to utilize local growers and nurseries that offer nursery-propagated native species, especially plants propagated from local populations. Buy only certified nursery-propagated plant material. Native plats are protected in North Carolina (see North Carolina Department of Agriculture and Consumer Services, Plant Industry Division – Plant Protection Section). Never dig plants from the wild. All of our native wildflowers are best

left to be enjoyed in their natural state. Many of the native wildflowers will only grow in very specific environmental conditions necessitating preservation of these conditions. A native plant nursery is the best place to obtain plants to obtain plants for installing in your yard. Native plants are available locally and through mail order.

Include a site assessment when planning for your landscape. Once a good source of native plants has been located, the next step is choosing appropriate plants for a project. One of the greatest benefits of designing with native plants is their adaptation to local conditions. But it is important to select plants with growth requirements that best match the conditions in the area to be planted. Consider using plants that occur together in their natural habitats. Do your homework before purchasing and planting; study the plants and the site condition information. Visit a natural area and observe how plants occur and design your landscape accordingly. Remember, landscaping with natives is art imitating nature.

When planning projects utilizing native plant species, you can start with this list for information on which plants grow in each of the three major regions of North Carolina. These three regions include: The Costal Plain in the east, the Piedmont (upper and lower) and the Blue Ridge Mountains in the west. Next study the minimum light and moisture requirements for each species, noting that some plants will grow under a variety of conditions. Recommended uses include wildlife benefits, horticulture and landscaping, conservation and restoration, or domestic livestock forage. Of course, many of these species are well suited to more than one of these categories.

For more information, refer to field guides and publications on local natural history for color, shape, height, bloom times, and specific wildlife value of the plants that grow in your region. For help in designing native plantings with combination of species that would occur together naturally, visit a local natural area and observe common plant associations, spatial groupings, and habitat conditions. Look up the resource listing at the back of this book.

Natives *versus* Aliens

In North America, plant species are generally described as native if they occurred here prior to European settlement. This distinction is made because of the large-scale changes that have occurred since the arrival of the European settlers. The Europeans imported a variety of plants to this country, many are still the major component of traditional lawns and gardens. They also include many beneficial plants important in farming, such as vegetables and grains. Today, appropriately 25% of flowering plants in North America are non-natives or alien species, most of Eurasian origin.

All plants are native to some region, and offer a variety of ecological, economic and aesthetic benefits. In fact, many alien species are beneficial, providing food and other valuable resources to society. It is only when a species is "out of place" that we become concerned. In these instances, exotic pest plant can pose a serious threat to biodiversity. Due to a lack of natural controls such as insect pests and competitors, some alien plants can easily become established in new areas. Once established, exotic pest plant species can out compete and displace the native plant species, disrupting ecological processes and significantly degrading entire plant communities. Many exotic pest plants spread quickly and grow so densely that other species cannot get established in areas that have been infested. Common native plants can be crowded out, or their populations threatened due to hybridization with escaped ornamentals. Endangered species may be driven from their last habitats by exotic pest plant species. Aquatic exotic pest plant species can clog waterways, disrupt groundwater flows, degrade water quality, and lead to dramatic changes in native plant and animal communities.

Although a majority of exotic pest plant species comes from other countries, they may also be introduced from a different region of the same country. For example, salt marsh cord grass is a dominant and important member of coastal salt marsh communities along the Atlantic and Gulf Coasts. But when used for restoration projects in west coast marshes, it become invasive, out competing and replacing western species.

In contrast to exotic pest plant species, other non-native plants are unable to thrive without extra effort by land managers. For instance, they may originate in regions with abundant rainfall and soils rich in nutrients. If then introduced into a drier region with less fertile soils, they may require additional watering and fertilizer. The natural defenses plants adapt to in their original habitats may not protect them in a new environment, requiring the application of pesticides to aid their growth.

What you can do

- Consider not planting the species that are exotic pest plants, especially if you live near natural areas such as Federal, State or private parks and forests. Those species pose a threat to the health, balance, and vitality of our native plants and animals.

- Practice invasive plant control on your own property by eradicating those species or preventing their fruit production by continued pruning and/or cutting.

- Promote responsible gardening practices by learning and using plants that are not invasive. Consider using some of the American counterparts to

the common invading species. For instance, the American species of the honeysuckle, wisteria, and bittersweet vines are great garden plants.

- Scrutinize the growth habits of the species you plant. If you choose a rapidly growing plant and/or plant that produce many seeds, watch out of sprouts or seedlings appearing from the “mother” plant. Be prepared to maintain control or your plantings.

- Buy nursery-propagated plant material from reliable growers. If the identity of the plants you buy is in question, seek the advice of other authorities.

- Consider incorporating regionally native plants in your garden. Natives will help sustain the natural balance that has developed between regional wildlife and plants over the years. Maximize your success by matching the right plant to the right soil conditions, and combine plants that occur in natural habitats.

Appendix 1.
Localizing the program

Sample: Mecklenburg County, NC

History & Sponsors of the PLANT Program

About the PLANT Piedmont Landscaping And Naturescaping Training

Mecklenburg County North Carolina, Land Use and Environmental Services Agency, Solid Waste is the public agency responsible for the proper management and disposal of the county's municipal solid waste. The agency implements the Ten Year Solid Waste Management Plan approved in 2000 by the Mecklenburg County Board of Commissioners and the City of Charlotte. The Plan sets a per capita waste reduction goal of 20% over ten years and establishes waste reduction programs, both residential waste and commercial waste, to meet that goal.

The County has been recycling since 1977. Its residential recycling program is extensive and effective. The City of Charlotte and other Mecklenburg municipalities operate curbside recycling and yard waste pickup. The County operates recycling drop centers, household hazardous waste collection sites and Swap Shops. SW staff works year-round to educate the public about recycling, waste reduction and organic yard care. SW's home composting program, started in 1993, has now reached over 4,000 households. In 1998 the program name was changed to PLANT (Piedmont Landscape And Naturescape Training). PLANT currently offers a 4 hour hands-on workshops, reduced price compost bin distributions, compost demonstration sites, school compost programs and supporting presentation materials and literature. Evaluation of the PLANT workshops submitted by the participants gives excellent ratings to both the instructors and the material. Most respondents say they would definitely recommend attending a workshop. The PLANT program will help enable us to meet the TenYear Solid Waste Management Plan of per capita waste reduction goal of 20%.

SW's large composting facility, featured in *Biocycle*, sells high quality compost and a variety of mulches made from city and county yard waste. PLANT helps create demand for SWM mulch and compost, and increases positive public awareness of the county's yardwaste composting operations.

PLANT partners with other government departments to:

- develop and promote training of staff, speakers and presenters;
- provide resource research materials, literature, books, etc.;
- advertise workshops through water bill inserts, news releases, newsletters, flyers, paid advertising, neighborhood associations, etc.;

- develop pilot projects emphasizing native plants, composting, water conservation, etc.

PLANT Partnership is leading an effort to make government more effective and responsive to the environmental needs of urban communities. The Partnership provides education, technical assistance and/or funding for environmental projects initiated by urban community groups.

Sponsors:

Mecklenburg County
- ♦ Solid Waste Reduction
- ♦ Land, Water and Air Quality
- ♦ Parks and Recreation, Department of Natural Resources
- ♦ Storm Water Services
- ♦ Land Development Services

City of Charlotte:
- ♦ Storm Water Services
- ♦ Charlotte Mecklenburg Utilities
- ♦ Neighborhood Development
- ♦ Solid Waste Services

Partners:
Government agencies and private organizations that partner with sponsors to promote training, resource/research materials and participate in Grant applications.
- ♦ NC Division of Pollution Prevention & Environmental Assistance, North Carolina Department Environment and Natural Resources (NC DENR)
- ♦ NC Division of Forest Resources
- ♦ NC Division of Water Resources, NC DENR
- ♦ NC Division of Parks and Recreation, NC DENR
- ♦ NC Soil and Water Conservation
- ♦ University of North Carolina at Charlotte
- ♦ Discovery Place, the Charlotte Nature Museum
- ♦ Central Piedmont Community College
- ♦ Private organizations like: CFR Recycling, Habitat for Humanity, Winghaven, HopeHaven, etc.

Programs:

- **Plant Organic Yardcare Program-** The PLANT program currently offers year round 4 hour hands-on workshops at several locations. These workshops achieve environmental goals associated with various county services including reducing yardwaste, preventing soil erosion, conserving water and energy, preventing and reducing pollution of soil, air and water, enhancing riparian buffer areas, creating habitats for beneficial wildlife and enhancing the equality of life for residents. Evaluation of the PLANT workshops submitted by participants gives excellent ratings to both the instructor and the material. Most participants say they would definitely recommend attending a workshop.
- **Native Plants-** An extensive native plant list for the Carolinas was developed to facilitate education in-house and the public. The list includes trees, shrubs, perennials, annuals, vines, ferns, grasses, and aquatics. An exotic pest plant list was also developed, including invasive plants found locally. The PLANT program has successfully partnered with other county services for use of native plants to create and maintain low maintenance, cost effective landscapes that promote wildlife diversity and prevent exotic plants from becoming invasive. Projects using native plants are installed at sites including Mecklenburg County Nature Preserves, Compost Central Garden, University North Carolina at Charlotte and the Discovery Place Charlotte Nature Museum. This allows education of visitors of these sites to see how to plan and install native plan projects of their own. Future plans are to install more native plant sites that allow public access.
- **Water Quality-** The new Mecklenburg County Surface Water Improvement Management (SWIM) buffer rules includes landscaping using native plants to improve water quality in neighborhoods with stream frontage. The PLANT program has successfully partnered with Mecklenburg county Stormwater Services for education of in-house staff. This has resulted in a stormwater riparian streamscape project that uses native plants and is proving valuable as a testing site and for reducing toxicity in stormwater. Several future stormwater projects will include using native plants for riparian streamscape improvements. The PLANT program endorses and supports the Charlotte Mecklenburg Utilities for education on water quality and conservation.
- **Soil Quality-Land Development-** The PLANT program has successfully partnered with Mecklenburg County Land Development Services for education of in-house staff, urban residential developers and contractors on preventing erosion and vegetative control issues.
- **Community Projects-** Environmental Justice is a component of the PLANT Program. A holistic neighborhood approach is taken to educate economically challenged residents. The PLANT program works with local neighborhood and creek groups to promote community

landscaping/naturescaping and establishes demonstration sites. PLANT also offers some financial assistance to residential and public projects.

- **Charlotte Mecklenburg Schools-** Composting is a required topic in the North Carolina science curriculum beginning with the 1999/2000 school year. PLANT has sponsored training sessions for elementary school teachers. A school curriculum and teacher training workshops were developed and implemented. Several hundred teachers were trained and materials were provided including wire bins, a nitrogen source (rabbit food-alfalfa), printed materials, coloring books and compost posters. A school curriculum and teacher training workshops for middle schools and high schools are under development. Twelve (12) Community Gardens are developed and operating as an outreach for inner city children to learn about composting and soil sciences as well as for grassroots educational efforts.
- **Voices and Choices-Outreach-** A 14 county regional environmental summit was held to reach consensus on environmental issues. As a result, Voices and Choices (five action committees) were formed to develop plans to reach a desirable future. Two of the action committees, the resource recovery (solid waste issues) action group and the water quality action group included PLANT as a model to be implemented in surrounding counties. This plan is being presented to the participating 14 county region for Board of Commissioners approval. Outreach to neighboring counties includes making presentations and workshops available to support developing programs.
- **Charlotte Nature Museum PLANT Courses-** A 2 hour topic class, once a month in the evenings, is ongoing at the Charlotte Nature Museum. Topics include: vermiculture, organic gardening, landscaping with native plants, xeriscaping with native plants, tool ergonomics, alternatives to grasses, proper mulching techniques, preventing invasive exotics, and others.
- **Compost Central Garden-** (CCG) was built in 1993 at Mecklenburg County Compost Central facility. CCG was designed to be a demonstration site for composting and for a variety of native plants, well adapted traditional plants and herbs growing in compost amended soil. The garden is also a demonstration for the uses of compost and mulch products. The garden is designed for self-guidance tours and frequently is used for conference tours.
- **Wildlife Habitat-** PLANT promotes conservation of wildlife habitat by promoting the Wildlife Federation Backyard Habitat program and through hosting workshops at these facilities that have wildlife habitats on display:
    - ❖ Parks and Recreation Department, Department of Natural Resources Nature Preserves and education museums/centers.
    - ❖ Discovery Place- The Charlotte Nature Museum
    - ❖ University of North Carolina- Charlotte Botanical Garden
    - ❖ Daniel Stowe Botanical Garden

- ❖ Private Organizations like: McGill Rose Garden, Winghaven, garden clubs, etc.

- **Continuing Education Program-** The MCPLANT program sponsors teacher workshops with Environmental Education certification, component II CEU's. The PLANT program sponsors local certification, CEU's with the science curriculum development coordinators for Charlotte Mecklenburg Schools.

- **Master Composters-** (MCPLANT)-A grant was obtained from the North Carolina Department of Natural Resources, Division of Pollution Prevention and Assistance to pilot a new program called MCPLANT (Master Composters). The goal is to educate 25 participants per year to expand the PLANT program to reach the public through developing projects. All volunteers complete a twelve week training course. The Master Composters then volunteer 40 hours each to various projects that are under development that enhance the quality of life in the region through home, neighborhood and school workshops. The MCPLANT project is a valuable contribution to accomplish the county's goals of reducing yardwaste; preventing pollution of air, soil, surface water and groundwater, encouraging naturescaping with native plants for low maintenance, water conservation, plant diversity and wildlife enhancement; prevention of exotic pest plants establishment and improving riparian buffer areas.

Presentations:

- Public events like Earth Day, Arbor Day and County Government Day are supported as an outreach to provide literature and information to the public.
- Annually, the Southern Spring Show, a native plant demonstration display was developed and installed to educate on water conservation by using native plants, compost displays, and Invasive plant displays.
- Several presentations and posters have been presented at conferences and are planned for future conferences like Composting in the Southeast, an Environmental Educators Conference, Carolinas Recycling Conference, Biocycle Conference, Native Plant Conference and National Recycling Conference.
- PLANT has hosted an annual commercial compost bin sales to target composting residential food waste. The bins are now offered for sale year round through home deliveries or at Compost Central Yardwaste Facility.

Publications and related materials:

- Books, slide and power point presentations and brochures have been developed and are available to facilitate public and school education including a compost book, poster and brochure, a native plant listing and brochure, a grass care brochure, and a brochure on toxicity reduction with alternatives to chemicals. Other brochures and presentation materials are under development including organic mulching materials and exotic pest plants prevention and control.

Resources:

- NC Division of Pollution Prevention & Environmental Assistance, North Carolina Department Environment and Natural Resources (NC DENR, DPPEA), http://www.p2pays.org/
- North Carolina Division of Forest Resources, http://www.dfr.state.nc.us/
- NC Division of Water Resources, NC DENR, http://www.dwr.ehnr.state.nc.us/home.htm
- NC Division of Parks and Recreation, Resource Management Program, NC DENR (Cherri L. Smith)
- NC Soil and Water Conservation, http://www.enr.state.nc.us/DSWC/
- North Carolina Wildlife Resources Commission, http://www.wildlife.state.nc.us/
- Southeast Exotic Pest Plant Council
  The University of North Carolina at Chapel Hill- North Carolina Botanical Garden, www.unc.edu/depts/ncbg
- University of North Carolina at Charlotte, http://gardens.uncc.edu
- Discovery Place, the Charlotte Nature Museum , http://www.discoveryplace.org/natframe.htm
- Central Piedmont Community College, http://www.cpcc.cc.nc.us/
- National Wildlife Federation, Backyard Wildlife Habitat Program, www.nwf.org
- North Carolina Wildlife Federation, www.ncwf.org
- Private organizations like: FCR,Inc., Charlotte Habitat for Humanity, McGill Rose Garden, Winghaven, etc.
- NC Wildlife Resources Commission, Non-game and Endangered Wildlife Program, Partners in Flight and Breeding Bird Survey, Mark Johns, http://www.wildlife.state.nc.us
- The North Carolina Natural Heritage Program is a part of the Division of Parks and Recreation within the Department of Environment and Natural Resources.
- The Wild Ones, www.for-wild.org
- Catawba Lands Conservancy , www.catawbalands.org
- The Ecological Services Division of the US Fish & Wildlife Service, http://www.fws.gov/
- North Carolina Department of Agriculture and Consumer Services, Plant Industry Division - Plant Protection Section http://www.agr.state.nc.us/plantind/plant/conserv/cons.htm
- Brooklyn Botanical Gardens, Ecology for Gardens, http://www.bbg.org/index.html,
- NC Department of Agriculture and Consumer Services, Plant Industry Division, Plant Protection Section, http://www.ncagr.com/plantind/plant.htm
- South East Exotic Pest Plant Council, http://www.se-eppc.org/
- Prairie Source Company

Supplier	Location	Address	City	State	Zip	Phone #	Seedlings	Container	Balled & Burlapped	Live Stakes	Shrubs	Perennials Annuals	Seed	Wetlands Plants	Ferns	Bulbs	Grasses
Allegany Co. SWCD		5425 County Rt 48	Belmont	NY	14813-9758	716-268-7831				X							
American Meadows		4750 Shelbourne Road	Shelbourne	VT	5482	802-985-9455											
Appalachian Nurseries		PO Box 87	Waynesboro	PA	17268	717-762-4733				X							
Applewood Seed Co.		5310 Vivian St.	Arvada	CO	80002	303-431-6283							X				
Aquatic & Wetland Company		9999 Weld County Road 25	Fort Lupton	CO	80621	303-442-4766											
Aspen Grove Nursery		5732 Bauter Rd.	Avoca	NY	14809-9775	607-566-2287				X							
Beersheba Wildflower Gardens		PO Box 551	Beersheba Springs	TN	37305	615-692-3575							X				
Benedict Nurseries		1054 S. Salisbury Blvd.	Salisbury	MD	21801	410-742-2266		X			X		X	X			
Bestmann Green Systems		7 Mall Street	Salem	MA	1970	508-741-1166											
Birdland Conservation Nursery		PO Box 1481	Sheldon	VT	5483	802-868-4345				X							
Bitterroot Native Growers			Corvallis	MO	59828=9406	406-961-4991		X			X			X			
Bobtown Nursery		16212 Country Club Road	Melfa	VA	23410	757-787-8484	X	X			X			X			
Boone's Native Seed Company		P.O. Box 10363	Raleigh	NC	27605-0363	no #											
Boyd Coffey & Sons Nurseries, Inc.		5016 Valley View Circle	Lenoir	NC	28645	704-758-9063			X								
Brickett Bailey		PO Box 83	Hyde Park	VT	5655	802-888-7956				X							
Byrum Seed Company	Sunsidiary of Southern States	227 Southside Drive	Charlotte	NC	28217	704-527-0481							X				X
California Carnivores		7020 Trenton-Healdsburg Rd.	Forestville	CA	95436	707-838-1630											
Carino Nurseries		PO Box 538	Indiana	PA	15701	412-463-3350				X							
Carolina Greenery	West End, NC	375 Carthage Rd.	West End	NC	27376-8731	910-947-3150	X	X		X	X	X		X			X
Carolina Native Nursery	http://www.carolinanativenursery	1126 Prices Creek Rd.	Burnsville	NC	28714	828-682-1471		X			X			X			
Carolina Nurseries		739 Gaillard Road	Moncks Corner	SC	29461	843-761-8181	X	X			X	X		X	X	X	X
Carolina Seeds		3580 Main ST. #10	Hartford	CT	6120	800-825-5477	X					X	X	X			X
Carrboro Farmers' Market		301 West Main St	Carrboro	NC	27510	no #											
Cill Ide Native Plant Nursery	http://wetlandplantnursery.com c	621 Starburst Lane	Raleigh	NC	27603	919-302-6900	X	X		X	X		X	X			
Clyde Robin Seed Company		PO Box 2366	Castro Valley	CA	94546-0366	510-785-0425											
Coastal Plain Conservation Nurs.		3067 Conners Dr.	Edenton	NC	27932	252-482-5707											
Croshaw Nursery		PO Box 339, Mill Lane	Columbus	NJ	8022	609-298-0477				X							
Crownsville Nursery		PO Box 797	Crownsville	MD	21032	410-849-3143											
Cure Nursery		880 Buteo Road	Pittsboro	NC	27312	919-542-6186	X	X	X		X			X			
Ecoscience Nursery		RR 4, Box 4294	Moscow	PA	18444	717-842-7631				X							
Emerald Coast Growers		7400 Klondike Rd	Penscola	FL		904-944-0808											
Elk Mountain Nursery	http://www.elk-mountain.com/	PO Box 599	Asheville	NC	28802	828-683-9330		X	X		X	X					
Environmental Concern Inc		201 Boundary Lane	St. Michaels	MD	21663	410-745-9620		X			X		X	X			
Environmental Seed Producers		PO Box 2709	Lompoc	CA	93438-2709	805-735-8888							X				
Ernst Conservation Seeds		9006 Mercer Pike	Meadville	PA	16335	814-425-7276							X				X
Fairweather Gardens		PO Box 330	Greenwiche	NJ	8323	856-451-6261											
Fancy Fronds		PO Box 1090	Gold Bar	WV	98251	360-793-1472											
Farm House Gardeners	Shiloh Church Rd. & Hwy 70	2142 Saulsbury Hwy.	Statesville	NC	28677	704-873-2057		X			X	X		X	X		
Fern Valley Farms		1624 Fern Valley Rd.	Yadkinville	NC	27055	336-463-2412											
Flowerwood Liners		PO Box 369	Loxly	AL	36551	334-964-5122											
Foliage Gardens		2003 128th Ave SE	Bellevue	WV	98005	425-747-2998											
Forestfarm		990 Tetherow Rd.	Williams	OR	97544-9599	541-846-7269											
Frank Hanchar		RD 1, Box 118	Mahaffey	PA	15757	814-277-6674				X							
Garrett Wildflower Seed Farm		1117 New Castle Court	Raleigh	NC	27603	919-662-9751							X				
Granite Seed		PO Box 177	Lehi	UT	84043	801-768-4422							X				
Greensboro Shrub Nursery		4514 Burlington Road	Greensboro	NC	27405	800-849-4514		X			X						
Growild, Inc	Mike Berkley, Terri Barnes	7190 Hill Hughes Rd.	Fairview	TN	37062	615-799-1910	X	X	X		X						
Hanging Dog Valley Nursery		2600 Boiling Springs Rd	Murphy	NC	28906	828-837-7921											
Henry's Plant Farm, Inc.		4522 132nd St SE	Snohomish	WA	98296	425-337-8120											
Hillis Nursery			McMinnville	TN		931-668-4364			X								
Hoffman Nursery		5520 Bahama Road	Rougemont	NC	27572	800-203-8590		X			X			X			
Hoffman Nurssery		5520 Bahama Rd.	Rougemont	NC	27572	800-203-8590											
Holland Wildflower Farm		290 O'Neal Lane	Elkins	AR	72727	800-752-5079							X				
Howard Nursery		RD 2, Box 139	Howaard	PA	16841	814-355-4434				X							
Humphries Nursery		4712 Whitfield Rd	Durham	NC	27707	919-489-5502											
HYDRA Wetland & Riparian Plant Nursery		15 Little Dipper Road	Tijeras	NM	87059	505-281-4480											
South Carolina SuperTree		5594 Hwy 38 South	Blenheim	SC	29516	1-800-222-129	X	X			X	X		X			
Issacs Family Farm		US Rt 113	Georgetown	DE	19947	302-856-7245				X							
King's Greenhouses, Inc.		524 Stallings Rd.	Matthews	NC		704-289-5822		X			X	X		X	X	X	X
Kuperus Farmside Gardens		Loomis Ave.	Sussex	NJ	77461	201-875-3160				X							
Kurt Bluemel, Inc.		2740 Greene Lane	Baldwin	MD	21013-9523	301-557-7229											
Lake Country Nursery		Box 122	Perry	OH	44081	216-259-5571				X							
Lamtree Farm		2323 Copeland Rd.	Warrensville	NC	28693		X	X			X	X	X				X
Lamoille Co NRCD		RR 4, Box 932, Professional Dr.	Morrisville	VT	5661	802-888-4965				X							
Latham's Nursery		Wholesale only	Monroe	NC		704-283-7668		X	X		X	X					X
Laurel Springs Nursery		401 Regal Street/intersection Bradle	Hendersonville	NC	28792	828-692-4012	X	X	X		X						
Lawyer Nursery		950 Hwy 200 West	Plains	MT	59859	406-826-3881				X							
Lofts Seed	191 Budd Blvd.	PO Box 25087	Winston-Salem	NC	27114	800-543-7333							X				X
Mail-Order Natives		PO Box 9366	Lee	FL	32059	850-973-4688											
Maryland Aquatic Nurseries		3427 N. Furnace Rd.	Jarrettsville	MD	21084	301-557-7615											
Meadowview Nursery		PO Box 241, 5994 Byron Holly Rd	Byron	NY	14422	716-548-2207				X							
Mecklenburg County Engineering & Bldg. Stnds.	county-wide harvest sites	700 N. Tryon Street	Charlotte	NC	28202	704-336-4328				X							
McAllister Greenhouse	Yorkmont Rd. by Colliseum	4830 Price Ln.	Charlotte	NC	28217	704-357-0780		X				X			X	X	X
McAllister Greenhouse	Bedding plants	603 Brief Rd.	Indian Trail	NC	28079	704-753-2042		X				X			X	X	X
Mellow Marsh Farm	Sharon Day	205 Anolis Rd	Piitsboro	NC	27312	919-542-3532	X	X		X	X		X	X			X
Mich Gardens at Jordan Lake		86 Beaver Creek Rd	Apex	NC	27502	919-387-0402											
Missouri Wildflowers Nursery		9814 Pleasant Hill Rd	Jefferson City	MO	65109	573-496-3492											
Mountain Gardens		3020 White Oak Creek Rd	Burnsville	NC	28714	828-675-5664											
Munro Ecological Services		990 Old Sumneytown Pike	Harleysville	PA	19438-1215	610-287-0671				X							
Musser Farms		PO Box 340	Indiana	PA	15701	412-465-5686				X							
N.C. Division of Forest Resources	Edwards Nursery/Trees	701 Sanford Drive	Morganton	NC	28655	828-438-6270	X						X	X			
N.C. Division of Forest Resources	Linville Nursery/Trees	6321 Linville Falls Hwy.	Newland	NC	28657	828-733-5236	X	X									
N.C. Division of Forest Resources	Claridge Nursery/Trees	762 Claridge Nursery Rd.	Goldsboro	NC	27530	919-731-7988	X	X									
Native American Seed		2088 West Jeter Rd.	Argyle	TX	76226	214-539-0534							X				
Native Gardens		5737 Fisher Ln.	Greenback	TN	37742	865-856-0220						X	X				X
New England Wetland Plants		800 Main St.	Amherst	MA	1002	413-256-1752				X							
New Jersey Forest Tree Nursery		370 E. Veterans Hwy. Rt 527-528	Jackson	NJ	8527	732-928-0029				X							
Niche Gardens		1111 Dawson Rd	Chapel Hill	NC	27516	919-967-0078						X					
Northcreek Nurseries,Inc		388 North Creek Rd	Landenberg	PA	19350	610-255-0100											
Northplan Seed Producers		PO Box 9107	Moscow	ID	83843	208-882-8040											
Octoraro Native Plant Nursery		6126 Street Road	Kirkwood	PA	17536-9647	717-529-3160		X			X			X			
Okefenokee Growers		PO Box 4488	Jacksonville	FL	32201	904-356-5577											
P&P Farms		1400 Cleveland School Rd.	Smithfield	NC	27577												
Penn Nursery		RD 1, Box 118	Spring Mills	PA	16875					X							
Pickseed West, Inc.		PO Box 88	Tangent	OR	97389	503-926-8886							X				
Pine Knot Farms		681 Rock Church Rd	Clarksville	VA	23927	804-252-1990											
Pinelands Nursery		323 Island Road	Columbus	NJ	8022	609-291-9486		X			X			X			
Pine Ridge Gardens		832 Sycamore Rd PO Box 200	London	AR	72847	501-293-4359											
Piping Tree Gardens & Nursery		13171 Scothdown Rd	Beaverdam	VA	23015	804-755-5481											
Plants For Tomorrow		16361 Norris Rd.	Loxahatchee	FL	33470-9430	407-790-1916											
Plant Delights Nursery		9241 Sauls Rd.	Raleigh	NC	27603	919-772-4794		X			X	X		X		X	X
Plunketts Creek Nursery		Box 353, Proctor Star Route	Williamsport	PA	17701	717-478-7035				X							
Prairie Moon Nursery		Rt. 3, Box 163	Winona	MN	55987-9515	507-452-1362											
Prairie Ridge Nursery		9738 Overland Rd	Mt. Horeb	WI	53572-2832	608-437-5245											
Prairie Nursery		PO Box 306	Westfield	WI	53964	800-476-9453											
Primrose Path		921Dawson Rd	Scottsdale	PA	15683	724-887-6756											
Renfrow Hardware		188 North Trade Street	Matthews	NC	28106	704-847-4088	X	X				X	X				X
Riverbend Nursery		1295 Mt. Elbert NW	Riner	VA	24149	540-763-3362	X	X			X	X		X	X	X	X
S & S Seeds		P.O. Box 1275	Carpinteria	CA	93013-1275	805-684-0436							X				
S & S Seeds, LLC		P.O. Box 947	Albany	OR	97321-0354	541-928-5868											
Sandy Wilson Hort. Services		834 Church Rd.	Harleysville	PA	19438	610-584-6302				X							
Saratoga Tree Nursery		Rt 5, Box 724	Saratoga Springs	NY	12866	518-885-5308				X							
Sharp Bros. Seed Co.		P.O. Box 665	Clinton	MO	64735	806-352-2781							X				X
GardenSouth	See Byrum	9223 Old Statesville Road	Charlotte	NC	28269	704-599-9192		X			X	X	X	X	X	X	X
Shiloh Nursery	shilohnursry@yadtel.net	164 Allen Rd.	Harmony	NC	28634	704-546-7582			X		X						
Shooting Star Nursery		444 Bates Rd	Frankfort	KY	40601	502-223-1679											
Singing Springs Nursery		8802 Wilkerson Rd	Cedar Grove	NC	27231-9324	919-732-9403											
c		PO Box 550	Portville	NY	14770	716-933-6169				X							
Stokes Seeds, Inc.		PO Box 548	Buffalo	NY	14240-0548	800-396-9238						X	X				
Stock Seed Farms, Inc		28008 Mill Rd.	Murdoc	NE	68407-2350	800-759-1520							X				
Sunlight Gardens	www.sunlightgardens.com	174 Golden Ln.	Andersonville	TN	37705	800-272-7396		X			X	X	X		X		X
Sylva Native Nursery & Seed Co.		1683 Sieling Farm Rd	New Freedom	PA	17349	717-227-0486				X							
TakeRoot	rboyles@intrex.net	220 Blakes Dr.	Pittsboro	NC	27312	919-967-9515		X							X		
Tarheel Native Trees		4339 Peele Rd.	Clayton	NC	27520	919-553-5927	X	X			X	X		X			X
The Plant Place		2010 Timberland Drive	Cumming	GA	30040	800-896-5770											
The Terra Ceia Farms		3810 Terra Ceia Rd.	Pantego	NC	27860	800-858-2852						X		X		X	X
Tree Dimensions		RR1 Box 216A	N. Haverhill	NH	3774	603-787-6825				X							
Treehaven Nursery		981 Jamison Rd.	Elam	NY	14059	716-652-4206				X							
Twisted Willow Nursery LLC		430 Reforest Way	Cross	SC	29436	843-753-3341	X	X	X	X	X	X	X	X	X		X
Van Pines Nursery, Inc.		7550 - 144th Ave.	West Olive	MI	49460-9707	800-888-7337				X							
Virginia Natives	Catalog $1.25/ Hume, VA, Vana	PO box D	Hume	VA	22639-0903	540-364-1665	X	X	X		X	X		X	X	X	X
Wavering Place Garden & Nursery		Rt.2, Box 269 Adams Hayne Rd	Eastover	SC	29044	803-783-1682											
Wa Ya Nursery & Tree Farm		11199 Canada Rd.	Tuckasegee	NC	28783	828-293-5720	X	X			X						
We-Du Nurseries		2055 Polly Spout Rd	Marion	NC	28752	828-738-8300		X			X	X		X	X	X	X
Wild Earth Native Plant Nursery		PO Box 7258	Freehold	NJ	7728	732-308-9777											
Wildflowers International		918-D Enterprise Way	Napa	CA	94558	707-253-0570							X				
Wildseed Farms, Inc.		PO Box 3000	Fredericksburg	TX	78624-3000	800-848-0078							X				
Woodlanders, Inc.	Appt. Only/Catalog $2.	1128 Colleton Ave	Aiken	SC	29801	803-648-7522	X	X	X		X	X		X	X	X	X
Yucca Do Nursery		PO Box 907	Hempstead	TX	77445	979-826-4580											
OTHER SOURCES OF INFORMATION																	
NC Wildflower Preservation Society	http://www.ncwfps.org/sources.htm																

Native Plants

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	**RIPARIAN ZONE**	**Common Tree Name**			**Mountain,**	**Stress**	**Rate or**	**Full Sun, (FS)**	**Soil Moisture:**	**Root-Tap**	**Flooding Tolerance**	**Height**	**Form**	**Seed production**	**Benefits- Growth Habits- Special Notes**
2	**A - UPLAND BUFFER ZONE**		**Botanical Name**	**Evergreen**	**Piedmont,**	**Tolerant**	**Spacing**	**Partial (P)**	**Wet, Moist,**	**Surface**	**Low**	**Trunk Diameter**			**All species provide specific food and habitat for wildlife.**
3	**B - UPPER**			**Deciduous**	**Coastal**	**Unknown**	**Min.**	**Shade**	**Dry**	**Depth**	**Some**				
4	**C - LOWER**										**High**				
5	**D - WATER'S**														
6	A	Southern Sugar Maple, Florida Maple, Hammock Maple	Acer barbatum	Deciduous	P,C	Tolerant	15'	FS,P	Moist, Dry	S, 6'	Low	60' - 2'	Rounded crown	Seeds, seedlings, containers 3 to 15 gal.	Prefers moist soils, can live on dryer uplands, understory species, shade tolerant. Seeds eaten by many species of songbird.
7	A	Boxelder	Acer negundo L.	Deciduous	M,P,C	Tolerant	12'	FS,P	Wet, Moist	S-1-2'	Some	30' to 60'-24" to 48 "	Rounded crown	Seeds, seedlings, containers 3 to 15 gal. (Cuttings are successful)	Understory species, shade tolerant, used in erosion control-fiberous root system, drought resistant also. Seeds eaten by many species of songbird.
8	A	Red Maple, Scarlet or Swamp Maple	Acer rubrum	Deciduous	M, P, C	Tolerant	30'	FS	Wet, Moist	T, S-1-2'	High	60' to 90' - 2 1/2'	Rounded, compact crown	Seeds, seedlings, containers 3 to 15 gal.	Shade tolerent, cuttings in June from lower branches treated. Ornamental due to spectular fall leaf color. Seeds eaten by many species of songbird.
9	A	Silver Maple	Acer saccharinum	Deciduous	P	No-Ozone	12'	FS,P	Wet, Moist, Dry	S, 1-2'	Some	50' to 80' - 3'	Rounded crown	Seeds, seedlings, containers 3 to 15 gal. Softwood cuttings in July & Oct., hardwood cuttings in winter	Floodplain & bottomland species, younger trees cuttings root easily-horizontial branches used. Seeds eaten by many species of songbird. Not recommended as a stand alone specimen, easily windthrown. Seeds reproduce rapidly, can be invasive in horticulture uses.
10	B	Yellow Buckeye	Aesculus flava (A. octandra)	Deciduous	M,P	Tolerant	12'	Shade	Wet, Moist	S, 1-4'-Strong laterals	Some	25'-8"	Rounded shrub, small tree	Seeds, seedlings, containers 3 to 15 gal.	Strong root system, understory species, prefers lowlands, stream borders, floodplains. Hummingbird food.
11	B	Red Buckeye	Aesculus pavia	Deciduous	M,P	Tolerant	12'	Shade	Wet, Moist	S, 1-4'-Strong laterals	Some	25'-8"	Rounded shrub, small tree	Seeds, seedlings, containers 3 to 15 gal.	Strong root system, understory species, prefers lowlands, stream borders, floodplains. Hummingbird food.
12	B	Painted Buckeye, Dwarf Buckeye	Aesculus sylvatica	Deciduous	M,P	Tolerant	12'	Shade	Wet, Moist	S, 1-4'-Strong laterals	Some	25'-8"	Rounded shrub, small tree	Seeds, seedlings, containers 3 to 15 gal.	Strong root system, understory species, prefers lowlands, stream borders, floodplains. Hummingbird food.
13	D	Black Alder	Alnus glutinosa	Deciduous	M,P,C	Tolerant	5'	FS	Wet, Moist	T, S 1-3' Laterial roots	High	20' -4"	Several trunks, spreading	Seeds, seedlings, containers 3 to 15 gal. (Cuttings are successful).	Forms thickets, prefers wet soil, borders streams, bottomlands, floodplains, swamps.
14	D	Common Alder, Hazel or Tag Alder	Alnus serrulata	Deciduous	M,P,C	Tolerant	5'	FS	Wet, Moist	T, S 1-3' Laterial roots	High	20' -4"	Several trunks, spreading	Seeds, seedlings, containers 3 to 15 gal. (Cuttings are successful).	Forms thickets, prefers wet soil, borders streams, bottomlands, floodplains, swamps.
15	B	Downy Serviceberry, Shadbush, Juneberry, Shadblow, Sarvis	Amelanchier arborea	Deciduous	M,P	Tolerant	20'	FS, P	Moist	T, S 1-3	Low Some	40' -1'	Narrow, rounded crown or irregularly shaped shrub.	Seeds, Seedlings, containers 3 to 15 gal.	Understory species, prefers moist soils in hardwood forests, streambanks, etc. Star shaped white flowers, many species of songbirds eat the fruit.

Mecklenburg County
Solid Waste Mgt.
700 N. Tryon St.
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Native Plants

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
16	B	Serviceberry	Amelanchier canadensis	Deciduous	M,P	Tolerant	20'	FS, P	Moist	T, S 1-3	Some	40' -1'	Narrow, rounded crown or irregularly shaped shrub.	Seeds, Seedlings, containers 3 to 15 gal.	Understory species, prefers moist soils in hardwood forests, streambanks, etc. Star shaped white flowers, many species of songbirds eat the fruit.
17	B	Pawpaw, Pawpaw Apple, False Banana	Asimina triloba	Deciduous	M,P,C	Tolerant	20'	FS, P, Shade	Moist	T, S 1-6'	Some	30' -8"	Shrub or small tree that forms colonies from root sprouts, pyramidal to rounded crown	Seeds, seedlings, containers 3 to 15 gal.	Moist soils, especially floodplains, in understory of hardwood forests, can grow in full sun as ornamental. Purple flowers, mid spring, fruit ripe in fall. Fruit edible, desired by humans, several mammals and many species of birds.
18	B	Sweet Birch	Betula lenta	Deciduous	M	Tolerant	10'	FS	Dry, Moist	T, S 1-6'	Low	30' -1'	Irregular spreading crown	Seeds, seedlings, containers 3 to 15 gal. (Cuttings appear favorable)	Mountain coves and rich slopes, near streams. Aromatic oils and flavorings (wintergreen) are obtained from tree.
19	B	River Birch	Betula nigra var. Heritage	Deciduous	M,P,C	Tolerant	10'	FS	Wet, Moist	T, S 1-6'	High	40' to 80'-1' to 2'	Irregular spreading crown	Seeds, seedlings, containers 3 to 15 gal. (Cuttings appear favorable)	Floodplain & bottomland species, can grow in dry areas, used for erosion control, vcan tolerate flooding, very attractive bark.
20	B	American Hornbeam, Ironwood	Carpinus caroliniana	Deciduous	M,P,C	Tolerant	15'	P, Shade	Wet, Moist	S, 1-6' Strong laterial	Some	30' -1'	Broad, rounded crown	Seeds, seedlings, containers 3 to 15 gal. (Cuttings appear favorable)	Strong root system, understory species, prefers lowlands, stream borders, floodplains.
21	A	Mockernut Hickory, White, Whiteheart, Hognut, Bullnut	Carya alba (C. tomentosa)	Deciduous	M,P,C	Tolerant	30'	FS	Moist, Dry	Pronounced Tap Root, S 1-6'	Low	50' to 80' - 1 to 2'	Rounded Crown	Seeds, seedlings, containers 3 to 15 gal.	Dry rocky or sandy uplands, ridges. Many mammals and birds eat the nuts.
22	D	Water Hickory, Bitter Pecan	Carya aquatica	Deciduous	P,C	Tolerant	30'	FS	Wet, Moist	Pronounced Tap Root, S 1-6'	High	70' to 100'-1 1/2 to 2 1/2'	Slender, upright branches, narrow crown	Seeds, seedlings, containers 3 to 15 gal. (Cuttings appear favorable)	Prefers bottomlands, lowlands, swamps, and floodplains, especially clay soils, transplants easily, seeds are waterborne. Many mammals and birds eat the nuts.
23	B	Bitternut Hickory	Carya cordiformis	Deciduous	M,P,C	Tolerant	30'	FS	Wet, Moist	Pronounced Tap Root, S 1-6'	High	60' to 80' - 1 to 2'	Broad, rounded crown	Seeds, seedlings, containers 3 to 15 gal. (Cuttings appear favorable)	Prefers bottomlands, lowlands, swamps, and floodplains, especially clay soils, transplants easily, seeds are waterborne. Many mammals and birds eat the nuts.
24	A	Pignut Hickory	Carya glabra	Deciduous	M,P,C	Tolerant	30'	FS	Moist, Dry	Pronounced Tap Root, S 1-6'	Low		Irregular , spreading crown	Seeds, seedlings, containers 3 to 15 gal.	Dry and moist uplands with hardwoods, bright yellow/gold fall color. Many mammals and birds eat the nuts.
25	A	Red Hickory	Carya ovalis	Deciduous	M,P,C	Tolerant	30'	FS	Dry	Pronounced Tap Root, S 1-6'	Low	70' to 100' - 2 1/2'	Narrow rounded crown	Seeds, seedlings, containers 3 to 15 gal. (Cuttings appear favorable)	Dry uplands with hardwoods, bright yellow/gold fall color. Many mammals and birds eat the nuts.
26	A	Shagbark Hickory, Shellbark, Scaleybark, Kingnut, & Upland Hickory	Carya ovata	Deciduous	M,P	Tolerant	30'	FS	Wet, Moist	Pronounced Tap Root, S 1-6'	High	70' to 100' - 2 1/2'	Narrow rounded crown	Seeds, seedlings, containers 3 to 15 gal. (Cuttings appear favorable)	Prefers bottomlands, lowlands, floodplains, especially clay soils, transplants easily, can grow well in hardwood stands on ridges too. Many mammals and birds eat the nuts.

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TREES

Native Plants

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
27	A	Sand Hickory, Pale, Pignut	Carya pallida	Deciduous	M,P	Tolerant	30'	FS	Moist, Dry	Pronounced Tap Root, S 1-6'	Low	30' to 80' - 1 to 2'	Rounded Crown	Seeds, seedlings, containers 3 to 15 gal.	Dry rocky or sandy uplands, ridges. Many mammals and birds eat the nuts.
28	A	Chinkapin	Castanea pumila	Deciduous	M,P,C	Tolerant	20'	P, Shade	Dry, Moist,	Dominant tap root, S-2-4'	Some	15' to 30' - 1 to 1 1/2'	Irregular , spreading crown	Seeds, seedlings, containers 3 to 15 gal.	Strong root system, Can be found from sand ridges to swamp edges, streambanks, valleys, understory of hardwood forest. Resistant to American Chestnut tree blight. Nuts are a valuable food source.
29		Catalpa, Indian Cigar Tree	Catalpa speciosa	Deciduous	P,C	Tolerant	20'	FS, P	Moist, Wet	Dominant tap root, S-2-4'	High	15' to 30' - 1 to 1 1/2'	Irregular , spreading crown	Seeds, seedlings, containers 3 to 15 gal.	Prefers bottomlands, lowlands, floodplains, especially clay soils, transplants easily, can grow well in hardwood stands on ridges too. Specific (Catalpa) worm lives on tree, food for fish.
30	A	Sugarberry, Hackberry, Southern Hackberry, Sugar Hackberry, Lowland Hackberry	Celtis laevigata	Deciduous	P,C	Tolerant	20'	FS,P	Wet, Moist	S-2 to 6'	High	80' to 100' - 1 1/2'	Broad, rounded, open crown	Seeds, seedlings, containers 3 to 15 gal. (Cuttings appear favorable)	Prefers streambanks or bottomlands, transplants easily, can grow in upland sites also. Many mammals and birds eat the fruit.
31	B	Hackberry, Sugarberry, Nettletree, Beaverwood, Northern Hackberry, American Hackberry		Deciduous	M,P	Tolerant	20'	FS,P	Moist, Dry	Deep tap root, T 10 to 20'	Some	50' to 90' - 1 to 3'	Broad, rounded, open crown	Seeds, seedlings, containers 3 to 15 gal. (Cuttings appear favorable)	Prefers streambanks or bottomlands, transplants easily, can grow in upland sites also. Many mammals and birds eat the fruit.
32	B	Eastern Redbud, Judas Tree	Cercis canadensis	Deciduous	M,P,C	Tolerant	12'	P, Shade	Moist	Dominant tap root, S-2-4'	Low	40' -8"	Short trunk, irregular rounded crown	Seeds, seedlings, containers 3 to 15 gal.	Legume; Ornamental; Prefers well drained soil, strong root system in uncompacted soil, understory species, as maturing becomes less shade tolerant. Beautiful spring flowers.
33	A	Atlantic White Cedar, Southern White Cedar, White Cedar, Swamp Cedar	Chamaecyparis thyoides	Evergreen	P,C	Tolerant	40'	FS,P	Wet, Moist	S 1-3'	Some	50' to 90' - 1 1/2' to 2'	Narrow pointed spire like crown	Seeds, seedlings, containers 3 to 15 gal.	Wet, peaty acid soils, fresh water swamps and bogs, poor root system, wind thrown easily, avoid clay soils, roots stop at hardpan
34	A	Fringetree, Old Man's Beard, White Fringetree	Chionanthus virginicus	Deciduous	M,P,C	Tolerant	20'	FS, P,Shade	Moist	T,S 1-6	Low	30' -6"	Short truck, narrow oblong crown, shrub	Seeds, seedlings, container 3 to 15 gal.	Strong root system, prefers moist soils, streambanks, valleys, understory of hardwood forest. Ornamental.
35	A	Yellowwood	Cladrastis kentuckea	Deciduous	M,P	Unknown	30'	FS,P	Moist	Deep tap root, S 1-6'	Low	50' - 1 1/2'	Short trunk, broad rounded head	Seeds, seedlings, containers 3 to 15 gal.	Prefers moist soils: streambanks, valleys, in hardwood forests. Beautiful flowering ornamental.
36	A	Alternate Leafed Dogwood, Pagoda Dogwood, Blue Dogwood	Cornus alternifolia	Deciduous	M,P	Tolerant	20'	FS, P, Shade	Moist, Dry	S- 1-3'	Some	30' -8"	Shrub or small tree, short trunk, broad, flattened spreading crown	Seeds, seedlings, containers 3 to 15 gal. (Softwood cuttings in June, hardwood cuttings in winter).	Shallow root system, survival higher when planted in marginal light conditions, rootball transplants more successful, berries blue colored.

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37	A	Flowering Dogwood, Boxwood, Cornel	Cornus florida	Deciduous	M,P,C	Tolerant	20'	FS, P, Shade	Moist, Dry	S- 1-3'	Low	30' -8"	Short trunk, spreading crown	Seeds, seedlings, containers 3 to 15 gal. (Softwood cuttings in June, hardwood cuttings in winter, layering or grafting).	Shallow root system, survival higher when planted in marginal light conditions, rootball transplants more successful, red berries have high calcium and fat content and consumed by migrating birds.
38	B	May Hawthorn, Apple Hawthorn	Crateagus aestivalis	Deciduous	P,C	Tolerant	20'	FS	Wet, Moist	T,S -1-3'	Some	30' -6"	Small, spiny, thicket forming with short stout trunk & broad dense crown	Seeds, seedlings, containers 3 to 15 gal.	Strong root system, prefers wet or moist soil: streambanks, riverbanks, borders of swamps. Fruit eaten by many species of birds.
39	A	Cockspur Hawthorn, Hog-Apple, Newcastle Thorn	Crateagus crus-galli	Deciduous	M,P,C	Tolerant	20'	FS	Moist	T,S -1-3'	Some	30' -1'	Small, spiny, thicket forming with short stout trunk & broad dense crown	Seeds, seedlings, containers 3 to 15 gal.	Strong root system, prefers moist soil: streambanks, pastures, woodlines, thickets, etc. Fruit eaten by many species of birds.
40	A	Yellow Hawthorn, October Haw, Summer Haw	Crateagus flava	Deciduous	P,C	Tolerant	20'	FS	Moist, Dry	T,S, 1-3'	Low	20' -8"	Small, short stout trunk & broad dense crown.	Seeds, seedlings, containers 3 to 15 gal.	Strong root system, prefers dry soil: sandy or rocky woodlands and thickets. Spiny, thicket forming.
41	A	Pear Hawthorn	Crateagus calpodendron	Deciduous	M,P	Tolerant	20'	FS	Moist	T,S -1-3'	Some	20' -6"	Small, spiny, thicket forming with short stout trunk & broad dense crown	Seeds, seedlings, containers 3 to 15 gal.	Strong root system, prefers moist soil of valleys, especially rocky streambanks and uplands. Fruit eaten by many species of birds.
42	A	Fanleaf Hawthorn	Crateagus flabellata	Deciduous	M,P	Tolerant	20'	FS	Moist, Dry	T,S, 1-3'	Low	20' -6"	Small, spiny, thicket forming with short stout trunk & broad dense crown	Seeds, seedlings, containers 3 to 15 gal.	Strong root system, prefers moist soil: streambanks, borders of forests, pastures, fields, and thickets. Fruit eaten by many species of birds.
43	A	Biltmore Hawthorn	Crateagus intricata	Deciduous	M,P	Tolerant	20'	FS	Moist, Dry	T,S, 1-3'	Low	20' -6"	Small, spiny, thicket forming with short stout trunk & broad dense crown	Seeds, seedlings, containers 3 to 15 gal.	Strong root system, prefers moist soil: streambanks, borders of forests, pastures, fields, and thickets. Fruit eaten by many species of birds.
44	A	Washington Hawthorn	Crateagus phaenopyrum	Deciduous	M,P	Tolerant	20'	FS	Moist	T,S, 1-3'	Low	30' -8"	Small, spiny, thicket forming with short stout trunk & broad dense crown	Seeds, seedlings, containers 3 to 15 gal.	Strong root system, prefers moist soil: streambanks, borders of forests, pastures, fields, and thickets. Fruit eaten by many species of birds.
45	A	Persimmon, Simmon, Possumwood	Diospyros virginiana L.	Deciduous	M,P,C	Tolerant	30'	FS, P, Shade	Moist, Dry	Deep tap root	Some	20' to 70' - 1 to 2'	Cylindrical or rounded head	Seeds, seedlings, containers 3 to 15 gal. (Cuttings appear favorable)	Understory species, used for erosion control because of deep roots, found in floodplains, old fields, roadsides, almost anywhere, male & female plants, fruit drops in late fall, fruit edible by humans and highly desired by wildlife.
46	A	American Beech	Fagus grandifolia	Deciduous	M,P,C	Tolerant	30'	FS, P, Shade	Moist, Dry	T, S 1 to 6'	Low	70' -2 1/2'	Stout trunk, dense rounded crown	Seeds, seedlings, containers 3 to 15 gal. (Cuttings appear favorable)	Understory species, shade tolerant, favorite food for many wildlife species.

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47	A	White Ash, Biltmore Ash,	Fraxinus americana	Deciduous	M,P,C	No-Ozone	30'	FS, P, Shade	Moist, Dry	Dominant tap root	Low	80' -2'	Straight trunk, conical or rounded crown	Seeds, seedlings, containers 3 to 15 gal. (Cuttings appear favorable)	Understory and overstory species, shade tolerant when younger, sensitive to ozone pollution, ornamental due to leaf color in fall, wildlife food for many species.
48	A	Carolina Ash, Water Ash, Pop Ash	Fraxinus caroliniana	Deciduous	P,C	Tolerant	30'	FS, P, Shade	Wet, Moist	T, S 1-6'	High	30' to 50' - 1'	1 or more trunks, rounded or narrow crown	Seeds, seedlings, containers 3 to 15 gal. (Cuttings appear favorable)	Understory species, shade tolerant when younger, floodplain, lowland, swamp.
49	B	Green Ash, Swamp Ash, Water Ash, Red Ash	Fraxinus pennsylvanica	Deciduous	M,P,C	Tolerant	30'	FS, P	Wet, Moist	T, S 1-6'	High	60' -1 1/2'	Straight trunk, rounded or irregular crown	Seeds, seedlings, containers 3 to 15 gal. (Cuttings appear favorable)	Prefers streambanks or bottomlands, transplants easily.
50	B	Pumpkin Ash, Red Ash	Fraxinus tomentosa	Deciduous	M,P,C	Tolerant	30'	FS, P	Wet, Moist	T, S 1-6'	High	80' -2'	Buttressed base, irregular crown	Seeds, seedlings, containers 3 to 15 gal. (Cuttings appear favorable)	Prefers streambanks, floodplains, bottomlands, transplants easily.
51	C	Water Locust	Gleditsia aquatica	Deciduous	M,P,C	Tolerant	12'	FS, P	Wet, Moist	Strong Taproot, S1-15'	High	50' -2'	Spiny trunk, open, flattened crown	Seeds, seedlings, containers 3 to 15 gal. (Cuttings appear favorable)	Prefers wet areas: streambanks, floodplains, bottomlands, transplants easily.
52	B	Honey Locust, Sweet locust	Gleditsia triacanthos L.	Deciduous	M,P,C	Tolerant	12'	FS	Wet, Moist	Strong Taproot, S1-15'	Low Some	80' -2 1/2'	Spiny trunk, open, flattened crown	Seeds, seedlings, containers 3 to 15 gal. (Cuttings appear favorable)	Legume; Prefers moist, well drained soils:streambanks, can grow well almost anwhere, used for erosion control, transplants easily. Pods/Seeds eaten by wildlife.
53	D	Loblolly Bay, Holly Bay, Gordonia, Bay	Gordonia lasianthus	Evergreen	P,C	Tolerant	15'	FS,P, Shade	Wet, Moist	S 1-6, Strong laterials	High	60' -1 1/2'	Compact crown, upright branches	Seeds, seedlings, containers 3 to 15 gal. (Softwood cuttings, stake is successful)	Prefers acidic, swampy soils, lowlands, stream borders, floodplains, can grow in water, strong root system, understory or topstory species. 3 to 4" white flowers.
54	A	Carolina Silverbell, Common Silverbell, Boxelder, Tisswood, Bellwood	Halesia tetraptera (H. carolina)	Deciduous	M,P	Tolerant	15'	P,Shade	Moist	Dominant tap root, S-2-4'	Low Some	80' -1 to 2'	Shrub or small tree with pyramidal crown	Seeds, seedlings, containers 3 to 15 gal. Softwood cuttings & layering.	Prefers moist soil, along streambanks, riverbottoms, understory species in hardwood forests. Spring flowers-white to pinkish, fruit in fall. Beautiful ornamental.
55	A	American Holly	Ilex opaca	Evergreen	M,P,C	Tolerant	15’	FS/Pt. Shade	Moist, Dry	Strong taproot, S1-10'	Low Some	40' to 70' - 1 to 2'	Narrow rounded dense crown, upright branches	Seeds, seedlings, containers 3 to 15 gal.	Moist or wet, well drained soils, floodplains, mixed hardwood forests. Bright red berries, high calorie, eaten by many species of birds.
56	A	Butternut, White Walnut, Oilnut	Juglans cinerea L.	Deciduous	M,P	Tolerant	20'	FS	Moist	Strong Taproot, S1-15'	Low	40' to 70' - 1 to 2'	Short straight trunk, broad open crown	Seeds, seedlings, containers 3 to 15 gal.	Prefers moist, well drained soils: streambanks, can grow well almost anwhere. Nuts are a valuable source of food for wildlife.

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57	B	Black Walnut, American Walnut, Eastern Black Walnut	Juglans nigra L.	Deciduous	M,P,C	Tolerant	30'	FS	Moist	Deep Tap Root-10 to 20', Strong laterials	Low	70' to 90' - 2' to 4'	Open, rounded crown	Seeds, seedlings, containers 3 to 15 gal.	Prefers moist, well drained soils, streambanks, bottomland if drained, up to sides of ridges, open fields, etc.; use 3 yr old for transplanting due to weed competition, other plants will not grow under.
58	A	Eastern Red Cedar, Red Juniper	Juniperus virginiana	Evergreen	M,P,C	Tolerant	30'	FS	Wet, Moist, Dry	Strong deep laterials	Low	40' to 60' - 1' to 2'	Narrow, compact, columnar crown	Seeds, seedlings, containers 3 to 15 gal.	Perfers moist, well drained soils, will grow almost anywhere. Songbirds eat fruit.
59	B	Sweetgum, Redgum, Sapgum, Starleaf Gum, Bilsted	Liquidambar styraciflua	Deciduous	M,P,C	Tolerant	30'	FS	Moist	Deep Tap Root-10 to 20', Strong laterials	Low Some	60' to 100' - 1 1/2 to 3'	Straight trunk, Conical Crown	Seeds, seedlings, containers 3 to 15 gal.	Prefers moist soils:streambanks, floodplains, bottomlands, dry sites, can grow almost anywhere, transplants easily. No fruit in var. "roundiloba".
60	B	Yellow Poplar, Tulip Poplar, White Poplar, Whitewood	Liriodendron tulipifera L.	Deciduous	M,P,C	Tolerant	30'	FS	Moist	Deep Tap Root-10 to 20', Strong laterials	High Some	80' to 120'- 2 to 3'	Straight trunk, narrow crown	Seeds, seedlings, containers 3 to 15 gal.	Prefers moist soils: streambanks, well drained bottomlands, transplants easily, used for soil toxicity remediation. Spring flowers important source of necter for bees.
61	A	Osage Orange, Bodark, Hedge Apple, Bois d' arc	Maclura pomifera	Deciduous	M,P, C	Tolerant	30'	FS	Moist or Dry	Very Deep Tap Root, Strong laterials	Low Some	30' to 70' - 2'	Spiney tree, broad rounded or irregular crown	Seeds, seedlings, containers 3 to 15 gal. & root cuttings.	Prefers moist soils: streambanks, well drained bottomlands, transplants easily, used for windbreaks, soil reclamation, resistant to drought & cold. Pick locations wisely due to fruit falling.
62	A	Cucumbertree, Cucumber Magnolia, Yellow Cucumber Tree, Mountain Magnolia	Magnolia acuminata	Deciduous	M,P	Tolerant	20'	FS,P	Moist	Deep rooted-10 to 20'	Low Some	60' to 80' - 2'	Straight trunk, narrow crown	Seeds, seedlings, containers 3 to 15 gal.	Prefers moist soils: streambanks, well drained bottomlands, slopes, transplants easily.
63	A	Southern Magnolia, Evergreen Magnolia, Bull-Bay, Big Laurel	Magnolia grandiflora	Deciduous	M,P,C	Tolerant	30'	FS	Moist	Dominant deep tap, strong laterials	Some	60' to 80' - 2 to 3'	Straight trunk, conical crown	Seeds, seedlings, containers 3 to 15 gal. (Cuttings appear favorable).	Prefers moist soils: streambanks, well drained bottomlands, slopes, can grow well in dry areas also, transplants easily.
64	A	Fraser Magnolia, Mountain Magnolia, Earleaf Cucumber Tree, Umbrella Tree, Mountain-Oread	Magnolia fraseri	Deciduous	M.P	Tolerant	20'	FS,Pt. Shade	Moist	Dominant tap, strong laterials	Low	30' to 70' - 1' to 2'	Open crown	Seeds, seedlings, containers 3 to 15 gal.	Strong root system, some shade tolerance, large showy white flowers.
65	A	Umbrella Magnolia, Umbrella Tree	Magnolia tripetala	Deciduous	M.P	Tolerant	20'	FS,Pt. Shade	Moist	Dominant tap, strong laterials	Low	30' to 40' - 1'	Open crown	Seeds, seedlings, containers 3 to 15 gal.	Strong root system, some shade tolerance, very large showy white flowers.
66	D	Sweetbay, Swamp Bay, Swamp Magnolia, White Bay, Laurel, Swamp Laurel	Magnolia virginiana	Evergreen	P,C	Tolerant	15'	FS,Pt. Shade	Wet, moist	T, S 1-3' Laterial roots	High	20' to 60' - 1 1/2'	Narrow, rounded crown	Seeds, seedlings, containers 3 to 15 gal. (Cuttings have been successful)	Prefers acidic, swampy soils, lowlands, stream borders, floodplains, can survive poor to very poor drainage, strong root system.
67	A	Southern Crab Apple	Malus angustifolia	Deciduous	M,P,C	Tolerant	25'	FS	Dry, Moist	T, S1-2' Laterial roots	Low	30' -10"	Wide, rounded crowns	Seeds, seedlings, containers 3 to 15 gal., grafting, budding.	Prefers low woodland borders, fencerows, old fields. Ornamental due to fragrant spring flowers-white to pink. Many hybrids- for wildlife & birds choose small fruited varieties.

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68	A	Sweet Crab Apple	Malus coronaria	Deciduous	M,P	Tolerant	25'	FS	Dry, Moist	T, S 1-2' Laterial roots/roots sprout easily	Low	30' -10"	Wide, rounded crowns	Seeds, seedlings, containers 3 to 15 gal., grafting, budding.	Prefers low woodland borders, fencerows, old fields. Ornamental due to fragrant spring flowers-white to pink. Many hybrids- for wildlife & birds choose small fruited varieties.
69	A	Red Mulberry, Moral	Morus rubra	Deciduous	M,P,C	Tolerant	20"	FS,P	Moist	T, S 1-6'	Low Some	60' -2'	Short trunk, broad rounded head	Seeds, seedlings, container 3 to 15 gal.	Prefers streambank, understory & topstory species. Can be found in dry areas. Fruit eaten by many species of birds.
70	D	Water Tupelo, Swamp tupelo, Sourgum, Cottongum	Nyssa aquatica	Deciduous	P,C	Tolerant	30'	FS,P	Wet	S 1-6, Strong laterials	High	100' -3'	Straight trunk, buttressed base, narrow open crown	Seeds, seedlings, stump suckering	Prefers wet, saturated soil, swamps, floodplains, close to water where can be submerged a few months per yr.
71	D	Black Tupelo, Blackgum, Pepperidge, Tupelogum	Nyssa sylvatica Marsh. Var. sylvatica	Deciduous	M,P,C	Tolerant	30'	FS	Wet, moist	Dominant tap,S 1-6, Strong laterials	Low	50' to 100' - 2 to 3'	Straight trunk, conical or flat topped crown	Seeds, seedlings, layering or stump suckering	Prefers light textured soils of uplands and stream bottoms.
72	D	Swamp Black Gum, Swamp Tupelo	Nyssa sylvatica var. biflora	Deciduous	P,C	Tolerant	30'	FS	Wet, moist	Dominant tap, S 1-6, Strong laterials	High	50' to 100' - 2 to 3'	Straight trunk, conical or flat topped crown	Seeds, seedlings, layering or stump suckering	Prefers heavy organic or clay soils of wet bottom lands.
73	A	Sourwood, Sorrel Tree, Lily of the Valley Tree	Oxydendrum arboreum	Deciduous	M,P,C	Tolerant	20'	P, Shade	Moist	Dominant tap, S 1-6, Strong laterials	Low Some	50' -1'	Conical or rounded crown	Seeds, seedlings, containers 3 to 15 gal.	Ornamental; Prefers moist soils in valleys and uplands, streambanks, understory species. Important source of necter for bees.
74	A	Wild Olive, Devilwood	Osmanthus americana	Evergreen	P,C	Tolerant	20'	SF,P,Shade	Moist	Dominant tap, S 1-6'	Some	30' -1'	Narrow oblong crown	Seeds, seedlings, containers 3 to 15 gal.	Prefers miost soils in valleys & streambanks to sandy uplands, understory species.
75	A	Eastern Hophornbeam, Hornbeam, Leverwood, Ironwood	Ostrya virginiana	Deciduous	M,P	Unknown	15'	FS,P, Shade	Moist	T, S 1-6'	Some	20' to 50' - 1'	Rounded crown	Seeds, seedlings, containers 3 to 15 gal.	Prefers moist soil, streambanks, understory of upland hardwood forest. Nutlet beneficial to wildlife.
76	D	Red Bay, Shorebay	Persea borbonia	Evergreen	P,C	Tolerant	15'	FS,P, Shade	Wet, Moist	T, S 1-6'	High	60' -2'	Dense crown	Seeds, seedlings, containers 3 to 15 gal.	Prefers wet soil, standing water, borders streams, bottomlands, floodplains, swamps.
77	B	Shortleaf Pine, Yellow Slash Pine, Swamp Pine	Pinus echinata	Evergreen	M,P,C	Tolerant	40'	FS	Dry	Dominant tap	Low	60' to 100' - 2' to 2 1/2'	Narrow, pyramidal crown	Seeds, seedlings, containers 3 to 15 gal.	Prefers uplands, old fields; acidic ph preferred; dominent tap root.
78	A	Longleaf Pine, Yellow Pine, Longstraw, Swamp Pine, Georgia Pine, Heart Pine, Pitch Pine	Pinus palustris	Evergreen	P,C	Tolerant	40'	FS	Moist, Dry	Dominant tap, extensive lateral roots	Low	80' to 100' - 2' to 2 1/2'	Open irregular crown	Seeds, seedlings, containers 3 to 15 gal.	Prefers well drained sandy soils of flatlands and sandhills.
79	B	Pond Pine	Pinus serotina	Evergreen	P,C	Tolerant	40'	FS	Wet, Moist	Dominant tap & laterials	High	25' to 75' - 2' to 2 1/2'	Open round topped crown	Seeds, seedlings, containers 3 to 15 gal.	Prefers wet soil, wet, flat woods and bogs, standing water, borders streams, bottomlands, floodplains, swamps.
80	A	White Pine, Eastern White Pine, Northern White Pine	Pinus strobus	Evergreen	M,P	Tolerant	40'	FS	Dry, Moist	Dominant laterials	Low	100' to 150' -3' to 4'	Crown of horizontal branches	Seeds, seedlings, containers 3 to 15 gal.	Prefers well drained soils of any kind. Susceptable to drought stress. Grows better in mountains, can grow in upper peidmont.

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81	A	Loblolly Pine, Old Field Pine, North Carolina Pine	Pinus taeda	Evergreen	P,C	Tolerant	40'	FS,P	Dry, Moist	Tap, dominant laterals	Low	80' to 100' - 2' to 3'	Rounded crown or spreading branches	Seeds, seedlings, containers 3 to 15 gal.	Will grow from deep, poorly drained floodplains to well drained slopes of rolling uplands. 80 yr. Lifespan.
82	A	Virginia Pine, Jersey Pine, Spruce Pine	Pinus virginiana	Evergreen	M,P	Tolerant	25'	FS	Dry, Moist	Dominant laterals	Low	30' to 60' - 1' to 1 1/2'	Open broad irregular crown	Seeds, seedlings, containers 3 to 15 gal.	Prefers clay, loam and sandy loam on well drained sites. Prone to wind throw.
83	B	Sycamore, American Sycamore, American Planetree	Platanus occidentalis	Deciduous	M,P,C	Tolerant	30'	FS	Moist, Dry	Strong Taproot, S1-15'	High	60' to 100' - 2' to 4'	Enlarged base, straight trunk, broad open crown	Seeds, seedlings, containers 3 to 15 gal. (Cuttings are successful)	Prefers streambanks, floodplains, bottomlands, can grow in dryer areas, transplants easily, can grow 6-8' per year, quick shade tree. Pick location wisely due to fruit dropping. Streambank reforestation recommended.
84	A	American Plum, Red Plum, River Plum	Prunus americana	Deciduous	M,P	Tolerant	10'	FS	Moist	S 1-6'	Low	30' -1'	Thicket forming shrub or small tree, spreading branches	Seed, seedlings, containers, 1 to 10 gal.	Grown for erosion control, moist soils of valleys, low upland slopes, fast grower. Fruit eaten by mammals and birds.
85	A	Chickasaw Plum, Sand Plum	Prunus angustifolia	Deciduous	M,P,C	Tolerant	5'	FS	Moist, Dry	S 1-6'	Low	5' to 15' - 4"	Thicket forming shrub or small tree, spreading branches	Seed, seedlings, containers, 1 to 10 gal.	Grown for erosion control, moist soils of abondoned places, fast grower. Fruit eaten by mammals and birds.
86	B	Carolina Laurelcherry, Cherry Laurel, Carolina Cherry	Prunus caroliniana	Deciduous	P,C	Tolerant	20'	FS	Moist	S 1-6'	Low	40' -10"	Thicket forming shrub or small tree, spreading branches	Seed, seedlings, containers, 1 to 10 gal.	Grown for erosion control, moist soils of valleys & lowlands, forests and borders, fast grower, often forms dense thickets. Fruit eaten by many species of birds.
87	A	Pin Cherry, Bird Cherry, Fire Cherry	Prunus pensylvanica	Deciduous	M	Tolerant	15'	FS	Moist, Dry	S 1-6, Good laterials	Low Some	30' -1'	Narrow, open rounded crown	Seeds, seedlings, container 1 to 15 gal. (Cuttings are successful)	Moist soil, opened areas, after fires, used as nurse tree providing shade for second generation hardwoods, fast grower. Fruit eaten by many species of birds.
88	A	Black Cherry, Rum Cherry, Mountain Black Cherry	Prunus serotina	Deciduous	M,P,C	Tolerant	20'	FS	Moist, Dry	S 1-6, Good laterials	Low	50' -1 1/2'	Narrow, open rounded crown	Seeds, seedlings, container 3 to 15 gal.	Moist soil, opened areas, fast grower; susceptable to black knot disease. Fruit eaten by many species of birds.
89	B	Eastern Cottonwood, Carolina Poplar, Southern Cottonwood	Populus deltoides	Deciduous	P,C	Tolerant	30'	FS	Wet, moist	T, S 1-6'	Some	100' -3 to 4'	Massive trunk, open spreading crown	Seeds, seedlings, containers 3 to 15 gal. (Cuttings are successful)	Prefers streambanks, floodplains, bottomlands, transplants easily, good shade tree, grows very fast.
90	C	Swamp Cottonwood, Black Cottonwood	Populus heterophylla	Deciduous	P,C	Tolerant	30'	FS	Wet, moist	T, S 1-6'	High	80' -2'	Straight trunk, narrow rounded crown	Seeds, seedlings, containers 3 to 15 gal. (Cuttings are successful)	Prefers streambanks, floodplains, bottomlands, transplants easily, grows very fast, grows where too wet for Eastern Cottonwood.
91	A	White Oak	Quercus alba	Deciduous	M,P,C	Tolerant	50'	FS,P	Moist, Dry	S 2-5'	Low	80' to100' -3 to 4'	Broad head, thick trunk	Seedlings, container (3-15 gal) or Dipple acorns over area	Slow growing, may have crown spread of 150', transplants easily. Acorns eaten by many species of wildlife.
92	B	Swamp White Oak	Quercus bicolor	Deciduous	P	Tolerant	30'	FS,P	Wet or Moist	T,S 2-5'	High	60'-70'	Vase, narrow open rounded crown	Seedlings, container (3-15 gal) or Dipple acorns over area	Prefers lowlands, floodplains, swamps, mixed forests subject to periodic inundated. Acorns eaten by many species of wildlife.

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93	A	Scarlet Oak, Black Oak, Red Oak, Spanish Oak	Quercus coccinea	Deciduous	M, P	Tolerant	30'	FS	Moist, Dry	Dominant Tap Root	Low	60' to 80' - 1 to 2 1/2'	Rounded open crown	Seedlings, container (3-15 gal) or Dipple acorns over area	Slow growing, transplants easily, brilliant red color in fall. Acorns eaten by many species of wildlife.
94	A	Southern Red Oak, Spanish Oak, Water Oak, Red Oak	Quercus falcata var. falcata	Deciduous	M,P,C	Tolerant	40'	FS	Moist, Dry	T,S 2-5'	Low	50' to 80' - 1 to 2 1/2'	Rounded open crown	Seedlings, container (3-15 gal) or Dipple acorns over area	Slow growing, transplants easily, dry, sandy & clay soils of uplands, in mixed forests. Acorns eaten by many species of wildlife.
95	A	Cherrybark Oak, Swamp Red Oak, Bottomland Red Oak, Elliott Oak, Red Oak, Swamp Spanish Oak	Quercus falcata var. pagodaefolia	Deciduous	P,C	Tolerant	40'	FS	Moist	T, S 1-6'	Low	100' to 130' -36 to 60"	Rounded open crown	Seedlings, container (3-15 gal) or Dipple acorns over area	Slow growing, transplants easily, moist soil, next to streambanks, well drained terraces, ph acid to med. acid. Acorns eaten by many species of wildlife.
96	A	Turkey Oak, Catesby Oak, Scrub Oak	Quercus laevis	Deciduous	P,C	Tolerant	30'	FS	Moist, Dry	Dominant Tap Root	Low	20' to 40' - 1'	Irregular open crown of crooked branches	Seedlings, container (3-15 gal) or Dipple acorns over area	Slow growing, transplants easily, dry, sandy ridges. Acorns eaten by many species of wildlife.
97	A	Laurel Oak, Darlington Oak, Diamond Leaf Oak, Swamp Laurel Oak, Obtusa Oak	Quercus laurifolia	Evergreen	P,C	Tolerant	40'	FS	Wet, Moist	Dominant Tap Root	Low Some	60' to 80' - 1 to 2 1/1'	Dense, broad, rounded crown	Seedlings, container (3-15 gal) or Dipple acorns over area	Fast growing, transplants easily, moist to wet well drained soil, along streambanks, rivers and swamps. Acorns eaten by many species of wildlife.
98	A	Overcup Oak, Swamp Post Oak, Swamp White Oak, Water White Oak	Quercus lyrata	Deciduous	P,C	Tolerant	40'	FS	Wet, Moist	T, S 1-6'	High	60' to 80' - 2 to 3'	Rounded crown	Seedlings, container (3-15 gal) or Dipple acorns over area	Fast growing , transplants easily, moist to wet clay, silty clay soil, along streambanks, rivers and swamps. Acorns eaten by many species of wildlife.
99	A	Black Jack Oak, Blackjack, Jack Oak	Quercus marilandica	Deciduous	M,P,C	Tolerant	40'	FS	Dry	Dominant Tap Root	Low	20' to 50' - 1'	open, irregular crown	Seedlings, container (3-15 gal) or Dipple acorns over area	Slow growing, transplants easily, dry, sandy & clay soils of uplands, in mixed forests. Acorns eaten by many species of wildlife.
100	B	Swamp Chestnut Oak, Basket Oak, Cow Oak	Quercus michauxii	Deciduous	P,C	Tolerant	40'	FS	Moist	T, S 1-6'	Some	60' to 80' - 2 to 3'	Compact, rounded crown	Seedlings, container (3-15 gal) or Dipple acorns over area	Slow growing, transplants easily, moist soil, next to streambanks, ph acid to med. acid. Acorns eaten by many species of wildlife.
101	A	Chinkapin Oak, Yellow Chestnut Oak, Rock Oak, Yellow Oak	Quercus muehlenbergii	Deciduous	M,P	Tolerant	40'	FS	Moist, Dry	T,S 2-5'	Low	50' to 80' - 2 to 3'	Narrow rounded crown	Seedlings, container (3-15 gal) or Dipple acorns over area	Slow growing, transplants easily, dry, sandy & clay soils of uplands and rocky riverbanks, in mixed forests. Acorns eaten by many species of wildlife.
102	B	Pin Oak, Swamp Oak, Water Oak, Swamp Spanish Oak	Quercus palustris	Deciduous	P	Tolerant	40'	FS	Wet, Moist	T, S 1-6'	Some	50' to 90' - 1 to 2 1/2'	Broadly conical crown	Seedlings, container (3-15 gal) or Dipple acorns over area	Fast growing, transplants easily, moist soil, next to streambanks, poorly drained clay soils, ph acid to med. acid. Acorns eaten by many species of wildlife.

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Native Plants

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103	B	Willow Oak, Swamp Chestnut Oak, Peach Oak, Pin Oak	Quercus phellos	Deciduous	P,C	Tolerant	40'	FS	Wet, Moist	T, S 1-6'	High	50' to 90' - 1 to 2 1/2'	Conical or rounded crown	Seedlings, container (3-15 gal) or Dipple acorns over area	Fast growing, transplants easily, moist soil, next to streambanks, floodplains or bottomlands of streams, poorly drained clay soils, ph acid to med. acid. Commonly occur in upland now, due to lack of fire. Acorns eaten by many species of wildlife.
104	B	Water Oak, Spotted Oak, Possum Oak	Quercus nigra	Deciduous	P, C	Tolerant	40'	FS	Wet, Moist	S 1-6'	Some	50' to 100' - 1 to 2 1/2'	Conical or rounded crown	Seedlings, container (3-15 gal) or Dipple acorns over area	Slow growing, transplants easily, moist soil, next to streambanks, floodplains, bottomlands of streams and borders of swamp, ph acid to med. acid. Commonly occur in upland now, due to lack of fire. Acorns eaten by many species of wildlife.
105	A	Chestnut Oak, Rock Oak, Tanbark Oak, Rock Chestnut Oak	Quercus prinus (Q. montana)	Deciduous	M,P	Tolerant	40'	FS	Moist, Dry	T, S 1-6'	Low	60' to 80' - 2 to 3'	Broad, open irregular crown	Seedlings, container (3-15 gal) or Dipple acorns over area	Slow growing, transplants easily, moist soil on well drained bottomlands to dry uplands soils. Acorns eaten by many species of wildlife.
106	A	Northern Red Oak, Common Red Oak, Eastern Red Oak, Gray Oak, Mountain Red Oak	Quercus rubra	Deciduous	M,P	Tolerant	40'	FS	Moist	T, S 1-6'	Low	60' to 90' - 1 to 2 1/2'	Rounded crown	Seedlings, container (3-15 gal) or Dipple acorns over area	Fast growing, shade & street tree, transplants easily, moist clay or rocky soils. Acorns eaten by many species of wildlife.
107	A	Shumard Oak, Spotted Oak, Schneck Oak, Swamp Red Oak, Southern Red Oak	Quercus shumardii	Deciduous	P,C	Tolerant	40'	FS	Wet, Moist	T, S 1-6'	Some	60' to 90' - 1 to 2 1/2'	Broad, rounded, open crown	Seedlings, container (3-15 gal) or Dipple acorns over area	Fast growing, transplants easily, moist well drained soils including floodplains along streams. Acorns eaten by many species of wildlife.
108	B	Post Oak, Iron Oak, Sand Post Oak	Quercus stellata	Deciduous	M,P,C	Tolerant	30'	FS	Moist, Dry	Dominant Tap Root, S-1-6'	Low	30' to 70' - 1' to 2'	Dense Rounded crown	Seedlings, container (3-15 gal) or Dipple acorns over area	Fast growing , transplants easily, moist well drained soil, along streambanks, rivers and swamps and on ridges in dry conditions. Acorns eaten by many species of wildlife.
109	A	Black Oak, Yellow Oak, Quercitron, Smoothbark Oak, Yellowbark Oak	Quercus velutina	Deciduous	M,P,C	Tolerant	40'	FS	Moist, Dry	T, S 1-6'	Low	50' to 80' - 1 to 2 1/2'	Open Spreading Crown	Seedlings, container (3-15 gal) or Dipple acorns over area	Slow growing, transplants easily, dry, sandy & clay soils of uplands and rocky riverbanks, in mixed forests. Acorns eaten by many species of wildlife.
110	A	Live Oak, Virginia Live Oak	Quercus virginiana	Evergreen	P,C	Tolerant	50'	FS	Moist, Dry	T, S 1-6'	Low Some	40' to 50' - 2 to4'	Very broad, spreading , dense crown	Seedlings, container (3-15 gal) or Dipple acorns over area	Evergreen, large spreading branches, mostly coastal; dry, sandy woods, moist rich woods, & wet woods. Acorns eaten by many species of wildlife.
111	A	Black Locust, Yellow Locust	Robinia pseudo-acacia	Deciduous	M,P	Tolerant	30'	FS	Moist, Dry	Dominant Tap Root, S 1-6'	Low	40' to 80' - 1 to 2'	Open crown, spiney tree	Seeds, seedlings, containers (3-15 gal)	Legume; Fast growing, used in erosion control, deep rooting habit, moist to dry soils, streambanks & uplands.
112	A	Shining Sumac, Winged Sumac, Dwarf Sumac	Rhus copallina	Deciduous	M,P,C	Tolerant	5'	FS	Moist, Dry	Dominant Tap Root	Low	25' -6"	Open flattened crown of a few stout, spreading branches	Seeds, seedlings, containers	Fast growing, erosion control, almost any soil. Berries eaten by many birds.

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TREES

Native Plants

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
113	A	Smooth Sumac, Scarlet Sumac, Common Sumac	Rhus glabra	Deciduous	M,P,C	Tolerant	5'	FS	Moist, Dry	Dominant Tap Root	Low	20' -4"	Open flattened crown of a few stout, spreading branches	Seeds, seedlings, containers	Fast growing, erosion control, almost any soil. Berries eaten by many birds.
114	A	Staghorn Sumac, Velvet Sumac	Rhus hirta (Rhus typhina)	Deciduous	M,P	Tolerant	5"	FS	Moist, Dry	Dominant Tap Root	Low	30' -8"	Open flattened crown of a few stout, spreading branches	Seeds, seedlings, containers	Fast growing, erosion control, almost any soil. Berries eaten by many birds.
115	C	Coastal Plain Willow, Swamp Willow, Southern Willow, Ward Willow	Salix caroliniana	Deciduous	P,C	Tolerant	10'	FS	Wet, Moist	S 1-2' Dense	High	30' -1'	Spreading or drooping branches	Seeds, seedlings, containers (Cuttings are successful)	Fast growing, wet, moist soil, streambank, lowlands, bottomland; used for erosion
116	C	Black Willow, Swamp Willow, Godding Willow, Dudley Willow	Salix nigra	Deciduous	M,P,C	Tolerant	30'	FS	Wet, Moist	S 1-2' Dense	High	60' to 100' - 1 1/2 to 2 1/2'	Spreading or drooping branches	Seeds, seedlings, containers (Cuttings are successful)	Fast growing, wet, moist soil, streambank, lowlands, bottomland; used for erosion control.
117	A	Sassafras, White Sassafras	Sassafras albidum	Deciduous	M,P,C	Tolerant	20'	FS	Moist, Dry	S 1-3' Strong laterials	Low	30' to 60' - 1 1/2'	Narrow spreading crown or thicket forming schrub	Seeds, seedlings, container- Root suckers	Fast growing, streambank, old fields, transplants easily.
118	A	Bladdernut, American Bladdernut	Staphylea trifolia	Deciduous	P	Unknown	10'	FS,P, Shade	Moist	T, S 1-6'	Low	20' -4"	Shrub or small tree	Seeds, seedlings, containers	Understory species of hardwood forests.
119	A	Sweetleaf, Horse Sugar, Yellowwood	Symplocos tinctoria	Deciduous	M,P,C	Tolerant	10'	FS,P, Shade	Moist	T, S 1-6'	Low Some	35' -6"	Shrub or small tree	Seeds, seedlings, containers	Understory species of hardwood forests. Sandy thickets, upland or alluval woods, stream margins. Flowers-yellow fragrant. Ornamental value.
120	D	Bald Cypress, Cypress, Swamp Cypress	Taxodium distichum	Deciduous	P,C	Tolerant	30'	FS	Wet or Moist	Major root system for water	High	100' to 120' -3 to 6'	Crown has widely spreading branches flattened at top	Seeds, seedlings, container 3 to 15 gal.	Slow growing, water tolerant tree-growing in slow moving or poorly drained areas, swamps, lowlands, etc.
121	B	Basswood, American Linden, Bee Tree	Tilia americana var. heterophylla	Deciduous	M,P	Tolerant	40'	FS,P	Moist	Major tap root, S 1 6	Low Some	60' to 100' - 2 to 3'	Dense Crown	Seeds, seedlings, containers 3 to 15 gal.	Fast growing, streambank, moist soils of valleys and uplands.
122	A	Eastern Hemlock, Hemlock Spuce,	Tsuga canadensis	Evergreen	M,P	Tolerant	20'	FS,P, Shade	Moist	Major tap root, S 1 6	Low	60' to 70' - 2 to 3'	Conical Crown	Seeds, seedlings, containers 3 to 15 gal.	Slow growing, long lived, understory or topstory species, moist soil needed.
123	A	Carolina Hemlock	Tsuga caroliniana	Evergreen	M,P	Tolerant	20'	FS,P	Moist, Dry	Major tap root, S 1 6	Low	40' to 60' - 2'	Conical Crown	Seeds, seedlings, containers 3 to 15 gal.	Slow growing, long lived, topstory species, dry slopes, rocky ridges, mixed forests.
124	A	Winged Elm, Cork Elm, Wahoo	Ulmus alata	Deciduous	M,P,C	Tolerant	30'	FS,P	Moist, Dry	T, S 1-6'	Low	40' to 80' - 1 to 2'	Open Rounded Crown	Seeds, seedlings, containers 3 to 15 gal.	Fast growing in open, dry uplands or moist valleys in hardwood forest.
125	A	American Elm, White Elm, Water Elm, Soft Elm, Florida Elm	Ulmus americana	Deciduous	M,P,C	Tolerant	30'	FS,P	Moist, Dry	T, S 1-6'	Low Some	100' -4'	Broad, rounded, flattopped or vase crown	Seeds, seedlings, containers 3 to 15 gal.	Prone to Dutch Elm Disease, moist soils, valleys and floodplains, in mixed hardwoods.
126	B	Slippery Elm, Red Elm, Soft Elm, Gray Elm	Ulmus rubra	Deciduous	M,P,C	Tolerant	30'	FS,P	Moist, Dry	T, S 1-6'	Low Some	70' -2 to 3'	Broad open flat topped crown	Seeds, seedlings, containers 3 to 15 gal.	Fast growing, moist soils on lower slopes, floodplains but can grow on dry uplands.

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	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
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SHRUBS

Native Plants

RIPARIAN ZONE	Common Name	Botanical Name	TYPE	AREA	Rate or	LIGHT	Soil Moisture	SIZE	Seed production	Benefits, Habitat, Special Notes
A - UPLAND BUFFER	*Some shrubs can be considered small trees		Deciduous	Mountain	Spacing	Full Sun,	Condition:	Max.		All shrubs have flowers and produce nuts, fruits or berries
B - UPPER SLOPE			Evergreen	Piedmont	Min.	Partial,		Height,		All shrubs provide benefits of food and habit for wildlife.
C - LOWER SLOPE				Coastal		Shade		Width		
D - WATER'S EDGE										
D	*Common Alder, Hazel or Tag Alder	Alnus serrulata	Deciduous	M,P,C	5'	FS	Wet, Moist	20' -4"	Seeds, seedlings, containers 3 to 15 gal. (Cuttings are successful).	Forms thickets, prefers wet soil, borders streams, bottomlands, floodplains, swamps.
A	Downy Serviceberry, June Berry	Amelanchier arborea	Deciduous	M,P,C	10'	FS,P	Moist, Dry	25' x 6"	Seeds, seedlings, container 1 gal.	Ornamental, fast growing, prefers miost soils, bordering streams, savannahs, low woodlands. Can be found in uplands also. Spring white to red flowers, fruit in summer, prized by humans and birds alike.
A	Hercules Club, Devil's Walking Stick, Angelica Tree, Prickly Ash, Toothache Tree	Aralia spinosa	Deciduous	M,P,C	5'	P,Shade	Moist, Wet	15'x10'	Seeds, seedlings, container 1 gal.	Perennial; Ornamental due to leaf fall color-burgendy, prefers uplands and lowland forest, thickets, streambanks, swamp margins; July-Aug.-Flowers-creamy white. Sept.-Oct.-Fruit-purple to black. Bird, mammal & butterfly & bee food source.
B	Red Chokeberry	Aronia arbutifolia	Deciduous	M,P,C	3'	FS,P	Wet, Moist	5'x4'	Seeds, seedlings, container 1 gal. (Cuttings are successful)	Ornamental, fast growing, prefers miost soils, bordering streams, savannahs, low woodlands. Tolerant of many sites wet to dry. Mar.-May- white flowers, Sept-Feb-purple/black pome (tiny apple), pome eaten by humans and birds alike.
B	Black Chokeberry	Aronia melanocarpa	Deciduous	M,P,C	5'	FS,P	Wet, Moist	6'x6'	Seeds, seedlings, container 1 gal. (Cuttings are successful)	Ornamental, fast growing, prefers miost soils, bordering streams, savannahs, low woodlands. Tolerant of many sites wet to dry. Mar.-May- white flowers, Sept-Feb-purple/black pome (tiny apple), pome eaten by humans and birds alike.
A	Dwarf Pawpaw	Asimina parviflora (8 species in SE)	Deciduous	P,C	5'	FS,P	Dry, Moist	6' x4'	Seeds, seedlings, container 1 gal.	Occurs on moist to dry sites, open to shady habitat, from coastal hammocks to upland forest. Apr.-May-Flowers-greenish purple to maroon. July-Sept.-Fruits/seeds-eaten by birds, mammals, butterflys. Not easily available, hard to transplant.

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A	*Silverling, Eastern Baccharis	Baccharis halimifolia	Both	P,C	6'	FS	Moist ,Dry	16'x12'	Seeds, seedlings, container 1 gal. (Cuttings are successful)	Fast growing, single plants or small colonies, male and female plants (dioecious) prefers moist soils bordering streams, right of ways, open woodlands, shore hammocks, sea beaches. Sept.-Oct-.Flowers-white/silvery. Oct-Nov.-Nutlet eaten by birds. Can become weedy in appearance.
A	American Beautyberry, French mulberry, Beautybush	Callicarpa americana	Deciduous	P,C	3’	FS, P	Moist, Dry	8'x6'	Seeds, seedlings, container 1 gal.	Ornamental, fast growing, prefers dry to moist soils bordering streams, open pine canopies, forest margins, right-of-ways, open woodlands. June-July-Flowers-pinkish/white. Aug-Jan.-Fruit/seeds-color purple or white. Eaten by 40+ species of birds & mammals.
A	Sweet-Shrub	Calycanthus floridus	Deciduous	M,P	6'	FS,P	Dry, Moist	8'x6'	Seeds, seedlings, container 1 gal.	Ornamental aromatic (strawberry or banana scent), forms colonies, fast growing, prefers dry to moist sites, bottomland forests, sheltered forests, bordering streams, hills, open woodlands. Mar.-June-Flowers-maroon to purple/brown. Aug.-Apr.Seeds. Eaten by birds & mammals.
A	*Allegheny Chinkapin	Castanea pumila	Deciduous	M,P,C	10'	FS,P	Moist	20'x12'	Seeds, seedlings, container 1 to 3 gal.	Ornamental, fast growing, prefers dry to moist sitees bordering streams, hills, open woodlands. Hard to find.
A	New Jersey Tea	Ceanothus americanus 4 species in SE	Deciduous	M,P,C	5'	FS	Moist, Dry	4'x3'	Seeds, seedlings, container 1 to 3 gal.	Ornamental, non-legume nitrogen fixer, fast growing, prefers dry to moist soils bordering forest margins, well drained open hardwood forest, roadsides & slearings. May-june-Flowers-creamy white. June-Sept-fruit/seeds. Eaten by bird, mammals, & butterfly. Hard to find.
D	*Buttonbush	Cephalanthus occidentalis	Deciduous	M,P,C	4’	FS,P	Wet, Moist	20'x12'	Seeds, seedlings, container 1 gal.	Ornamental, fast growing, prefers wet soils bordering streams, ponds & lakes. Jun-Aug.-Balls of white flowers resembling pincushions. Aug.-Jan-fruit/seeds-button like balls of nutlets. Eaten by ducks, songbirds, nectar for butterfly & insects. Leaves poisonous to livestock.
B	*Sweet Pepperbush, White Alder, Mountain Pepperbush, Cinnamon Clethra	Clethra acuminata	Deciduous	M	10'	FS	Moist	20'x12'	Seeds, seedlings, container 1 to 3 gal.	Ornamental, forms colonies, fast growing, prefers moist soils bordering streams, swamp margins, hardwood forests. Intolerant of prolonged flooding. Increased by drainage and fire. May-July-Flowers-white/fragrant. Sept.-Feb.-Fruit/seeds-persists till spring. Eaten by mammals, bees, butterflys & insects.

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B	*Sweet Pepperbush, White Alder, Summersweet	Clethra alnifolia	Deciduous	P,C	10'	FS	Moist	20'x12'	Seeds, seedlings, container 1 to 3 gal.	Ornamental, forms colonies, fast growing, prefers moist soils bordering streams, swamp margins,wet savannahs, flatwoods, pocosins, bays & shrub bogs. Intolerant of prolonged flooding. Increased by drainage and fire. May-July-Flowers-white/fragrant. Sept.-Feb.-Fruit/seeds-persists till spring. Eaten by mammals, bees, butterflys & insects.
A	Sweet Fern	Comptonia peregrina	Both	M,P	10'	FS	Moist, Dry	6'x6'	Seeds, seedlings, container 1 to 3 gal.	Fast growing, prefers dry to moist soils in dry woods, abandoned fields, ditches and roadbanks. Can be hard to find.
A	Wax Myrtle	Comptonia cerifera	Evergreen	P,C	10'	FS	Moist, Dry	20'x15'	Seeds, seedlings, container 1 to 3 gal.	Fast growing, prefers dry to moist soils in dry woods, abandoned fields, ditches and roadbanks. High value winter food for birds.
B	Silky Dogwood, Bush Dogwood	Cornus amomum	Deciduous	M,P,C	10'	FS,P	Wet, Moist	10'x 8'	Seeds, seedlings, container 1 to 3 gal.	Fast growing, prefers moist soils bordering streams, swamp borders, hardwood forests.
C	Swamp Dogwood	Cornus stricta	Deciduous	P,C	10'	FS, P	Wet, Moist	10'x8'	Seeds, seedlings, container 1 to 3 gal.	Fast growing, prefers moist soils bordering streams, swamp borders, hardwood forests.
A	*American Hazel, Hazelnut	Corylus americana	Deciduous	M,P,C	10'	FS	Moist	15' x10'	Seeds, seedlings, container 1 to 3 gal.	Ornamental, forms colonies, fast growing, prefers slightly acidic soil-loam soils-rocky slopes, moist to dry sites bordering streams, open hardwood forests, pastures, & clearings. Feb-Apr.-Flowers-male catkins- yellowish brown. Sept.-Jan.-Nut. Eaten by humans, birds & small mammals.
A	*Beaked Hazelnut	Corylus cornuta	Deciduous	M,P	10'	FS	Dry, Moist	15' x10'	Seeds, seedlings, container 1 to 3 gal.	Ornamental, forms colonies, fast growing, prefers slightly acidic soil-loam soils-rocky slopes, moist to dry sites bordering streams, open hardwood forests, pastures, & clearings. Feb-Apr.-Flowers-male catkins- yellowish brown. Sept.-Jan.-Nut. Eaten by humans, birds & small mammals.
A	*Summer Haw, Yellow Hawthorn	Crateagus flava (56 species in SE)	Deciduous	P,C	20'	FS	Dry, Moist	T,S -1-3'	Seeds, seedlings, containers 3 to 15 gal.	Ornamental, forms colonies/thickets, produces thorns, strong root system, prefers moist to dry sites, streambanks, pastures, woodlines, thickets, right-of-ways, etc. Apr.-May-Flowers-white. Aug.-Oct.-Red Pome-Eaten by mammals, game birds, & songbirds.

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A	*Littlehip Hawthorn, red Haw, Sugar Haw	Crateagus spathulata (56 species in SE)	Deciduous	M,P,C	20'	FS	Moist	T,S -1-3'	Seeds, seedlings, containers 3 to 15 gal.	Ornamental-crooked trunk/shrub, forms colonies/thickets, produces thorns, strong root system, prefers moist to wet sites, streambanks, bottonlands, moist slopes. Apr.-May-Flowers-white. Oct.-Dec.-Red Pome-Eaten by mammals, game birds, & songbirds.
A	*Dwarf Hawthorn, One Flowered Hawthorn	Crateagus uniflora (56 species in SE)	Deciduous	P,C	20'	FS	Dry	T,S -1-3'	Seeds, seedlings, containers 3 to 15 gal.	Ornamental, forms colonies/thickets, produces thorns, strong root system, prefers dry sites, open forests & margins, especially sandy ridges. Apr.-May-Flowers-white. Aug.-Oct.-Red Pome-Eaten by mammals, game birds, & songbirds.
A	*Parsley Hawthorn	Crateagus marshallii (56 species in SE)	Deciduous	M,P,C	20'	FS	Wet, Moist	T,S -1-3'	Seeds, seedlings, containers 3 to 15 gal.	Ornamental, forms colonies/thickets, produces thorns, strong root system, prefers moist to wet sites, streambanks, swamps, open moist forests. Apr.-May-Flowers-white. Aug.-Oct.-Red Pome-Eaten by mammals, game birds, & songbirds.
C	*White Titi, Black titi, Leatherwood, Swamp Cyrilla, He-huckberry	Cyrilla racemiflora	Both	C	20'	FS	Wet, Moist	T, S-1-3	Seeds, seedlings, containers 3 to 15 gal.	Fast growing, forms colonies, prefers moist to wet sites, stream margins, seasonally wet forests, flatwoods depressions, shrub bogs, often in pure stands. Deep rooted. May-July-Flowers-white-fragrant, Sept.-Oct-.Seeds. Eaten by birds & butterfly nectar source.
A	Bush Honeysuckle	Diervilla sessilifolia	Deciduous	M	5'	FS	Dry	5'x5'	Seeds, seedlings, container 1 to 3 gal.	Fast growing, prefers upland woods.
B	Hearts A'Bustin, Strawberry Bush, Burning Bush, Bursting-heart	Euonymus americanus	Both	M,P,C	5'	FS,P	Wet, Moist	6'x4'	Seeds, seedlings, container 1 to 3 gal.	Ornamental, fast growing, prefers moist forests including bottomland and bordering small streams & mixed forests. Mar.-May-Flowers-yellowish green. Sept.-Dec. Red/orange fruit/seeds. Eaten by deer, mammals, birds & butterfly nectar. Some shade but mostly shade intolerant.
A	*Carolina Buckthorn, Indian Cherry, Pole-Cat-Tree	Frangula caroliniana	Deciduous	P,C	5'	FS,P	Dry, Moist	8'x4'	Seeds, seedlings, container 1 to 3 gal.	Occures on moist to dry sites, open to semi-shady habitat, new forest plantations, mature forests, open hardwood and bottomland forests. May-June-Flowers-greenish white. Aug.-Jan.-Red Berry/seeds. Eaten by songbirds & mammals.
A	*Wintergreen	Gaultheria procumbens	Evergreen	M,P,C	5'	P,Shade	Dry, Moist	5x5	Seeds, seedlings, container 1 to 3 gal.	Fast growing, prefers upland xeric to mesic woods. Can be hard to find.

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A	Black Huckleberry	Gaylussacia baccata (6 species in SE)	Deciduous	M,P,C	5'	FS	Moist, Dry	5'x5'	Seeds, seedlings, container 1 to 3 gal.	Excellent Groundcover, fast growing, occurs in dry to moist soils in dry woods, abandoned fields, open woodlands. May.-Jun-Flowers-white. June-Oct.-Berry eaten by birds, mammals, reptiles, insects & butterflys.
A	Dwarf Huckleberry, Gopherberry	Gaylussacia dumosa(6 species in SE)	Both	M,P,C	2'	FS	Moist, Dry	2'x2'	Seeds, seedlings, container 1 to 3 gal.	Excellent Groundcover, fast growing, occurs in sandy soils of pine and pine-oak forests & high elevation pine forests to shrub-tree bogs. May.-Jun-Flowers-white. June-Oct.-Berry eaten by birds, mammals, reptiles, insects & butterflys.
A	Blue Huckleberry, Dandleberry	Gaylussacia frondosa (6 species in SE)	Deciduous	P,C	5'	FS	Moist, Dry	5'x5'	Seeds, seedlings, container 1 to 3 gal.	Excellent Groundcover, fast growing, occurs in wet and well-drained flatwoods, sandhills, margins of bays, shrub bogs & cypress depressions. May.-Jun-Flowers-white. June-Oct.-Berry eaten by birds, mammals, reptiles, insects & butterflys.
A	Huckleberry, Buckberry	Gaylussacia ursina (6 species in SE)	Deciduous	M,P,C	5'	FS	Moist, Dry	5'x5'	Seeds, seedlings, container 1 to 3 gal.	Excellent Groundcover, fast growing, occurs in dry to moist soils in dry woods, abandoned fields, open woodlands. May.-Jun-Flowers-white. June-Oct.-Berry eaten by birds, mammals, reptiles, insects & butterflys.
A	*Witch Hazel	Hamamelis virginiana	Deciduous	M,P,C	10'	FS,P	Moist	20'x15'	Seeds, seedlings, container 1 to 3 gal.	Ornamental, can form colonies, occurs on moist sites, open to shady habitats, as an understory plant in mixed forests, bottomland forests, forest margins & bordering streams. Sept.-dec.-Flowers-yellow. Oct.-Nov.-Seeds. Eaten by Mammals, birds & pollinated by Cuculiid moths.
D	Swamp Mallow, Wild Cotton	Hibiscus moscheutos	Deciduous	P,C	8'	FS	Wet, Moist	6'x4'	Seeds, seedlings, container 1 to 5 gal.	Fast growing, prefers moist soils bordering streams, marshes and swamp forests, ditches. June-Oct.-Flowers-cream to yellow to pink. Seeds-Aug-Nov. Bird & butterfly food.
D	Althea, Rose of Sharon	Hibiscus syriacus	Deciduous	M,P,C	10'	FS	Moist, Wet, Dry	6'x5'	Seeds, seedlings, container 1 to 5 gal.	Ornamental, commonly cultivated, fast growing, prefers moist soils bordering streams, marshes and swamp forests, ditches but can grow in dry sites also. June-Oct.-Flowers-cream to yellow to pink. Seeds-Aug-Nov. Bird & butterfly food.
B	Wild Hydrangea, Climbing Hydrangea, Sevenbark, Mountain Hydrangea	Hydrangea arborescens	Deciduous	M,P	5'	FS,P,Shade	Moist	6'x5'	Seeds, seedlings, container 1 to 3 gal.	Ornamental, fast growing, occurs in shady habitats, mostly in rocky sloped forest stands, bordering streams or mixed forests. Can also be considered a vine. May-July-Flowers-white. Oct.-Feb.-Seeds. Eaten by mammals, game birds, songbirds, insects & butterflys.

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B	Oak-leaf Hydrangea	Hydrangea quercifolia	Deciduous	M,P	5'	FS,P,Shade	Moist	6'x5'	Seeds, seedlings, container 1 to 3 gal.	Ornamental, fast growing, occurs in shady to semi-shady habitats, on moist slopes & bottomland forests, bordering streams or mixed forests. May-July-Flowers-white. Oct.-Feb.-Seeds. Eaten by mammals, game birds, songbirds, insects & butterflys.
A	Sweet Gallberry, Gay-ball Bush, Shining Inkberry	Ilex coriacea (13 species in SE)	Evergreen	P,C	5'	FS,P	Wet, Moist, Dry	18'x15'	Seeds, seedlings, container 1 to 3 gal.	Ornamental, forms colonies, fast growing understory shrub in flatwood forests, prefers acidic soils bordering streams, pocosins, bays, sandy woods, & swamps. Apr.-May-Flowers-white. Sept.-Feb.-Fruit-black. Eaten by songbirds, gamebirds, mammals & insects/bees.
A	*Possumhaw	Ilex decidua (13 species in SE)	Deciduous	P,C	8’	FS,P,Shade	Dry	25'x15'	Seeds, seedlings, container 1 to 5 gal.	Ornamental, forms colonies, fast growing understory shrub in flatwood forests, prefers acidic soils bordering streams and forests, fields, open forests, low woodlands, mixed forests. May-June-Flowers-white. Sept.-Feb.-Fruit. Eaten by songbirds, gamebirds, mammals & insects/bees.
A	Inkberry, Bitter Gallberry, Evergreen Winterberry	Ilex glabra (13 species in SE)	Evergreen	C	10'	P, Shade	Dry, Moist, Wet	10'x8'	Seeds, seedlings, container 1 to 5 gal.	Ornamental, forms colonies, fast growing understory shrub in flatwood forests of lower Cp., prefers acidic soils bordering streams, low woodlands, pocosins, bays, mixed forests. May-June-Flowers-white. Sept.-Feb.-Fruit-black. Eaten by songbirds, gamebirds, mammals & insects/bees.
A	*American Holly	Ilex opaca (13 species in SE)	Evergreen	P,C	20'	FS,P,Shade	Dry	25'x15'	Seeds, seedlings, container 1 to 5 gal.	Ornamental, fast growing understory shrub/tree in mixed upland & bottomland forests, prefers acidic soils. May-June-Flowers-white. Sept.-Feb.-Red Fruit. Eaten by songbirds, gamebirds, mammals & insects/bees.
A	Winterberry	Ilex verticillata (13 species in SE)	Deciduous	M,P,C	8'	FS,P	Wet, Moist	10'x6'	Seeds, seedlings, container 1 to 5 gal.	Ornamental, forms colonies, fast growing understory shrub in flatwood forests, prefers acidic soils bordering streams, low woodlands, bogs. May-June-Flowers-white. Sept.-Feb.-Fruit. Eaten by songbirds, gamebirds, mammals & insects/bees.
A	Yaupon Holly	Ilex vomitoria (13 species in SE)	Evergreen	P,C	8’	FS	Moist, Dry	15'x10'	Seedlings, container 3 to 15 gal.	Ornamental, forms colonies, fast growing understory shrub in flatwood forests of lower Cp., prefers acidic soils bordering streams and forests, fields, open forests, low woodlands, mixed forests. May-June-Flowers-white. Sept.-Feb.-Red Fruit. Eaten by songbirds, gamebirds, mammals & insects/bees.

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D	Virginia Willow, Sweetspire, Tassel-white, Washington Plume	Itea virginica	Deciduous	P,C	8'	FS,P, Shade	Wet, Moist	8'x6'	Seeds, seedlings, container 1 to 5 gal.	Ornamental, fast growing, occurs along the water edge of streams, rivers & swamps, forest edges, low woodlands, mixed forests.April-June-Flowers-white. July-Feb.-Fruit. Eaten by mammals, birds, butterflys & insects.
A	Mountain Laurel, Mountain Ivy, Calico Bush, Spoonwort	Kalmia latifolia	Evergreen	M,P	5'	FS,P, Shade	Wet, Moist	6'x5'	Seeds, seedlings, container 1 to 5 gal.	Ornamental, forms thickets, slower growing, occurs in dense thickes in Southern Appalachain St., Infrequent along wooded streams, & shady bluffs in Lower Pd & Cp. Apr.-June-Flowers-white/pinkish white/pink. Sept.-Dec.-Seeds. Eaten by mammals & birds. Needs North facing slope for piedmont areas.
A	Sheep Laurel, Lamb Kill, Wicky	Kalmia augustifolia var. caroliniana	Evergreen	P,C	5'	P,Shade	Wet, Moist	6'x5'	Seeds, seedlings, container 1 to 5 gal.	Ornamental, forms thickets, slower growing, occurs in dense thickes in Southern Appalachain St., Infrequent along wooded streams, & shady bluffs in Lower Pd & Cp. Apr.-June-Flowers-white/pinkish white/pink. Sept.-Dec.-Seeds. Eaten by mammals & birds.
C	Coastal Dog-Hobble	Leucothoe axillaris	Evergreen	C	6'	P,Shade	Wet, Moist	6'x4'	Seedlings, container 3 to 15 gal.	Ornamental, forms colonies, slower growing, prefers wet to moist soils bordering streams, low woodlands, mixed forests, forms thickets.
C	Dog-Hobble	Leucothoe editorum	Evergreen	M,P	6'	P,Shade	Wet, Moist	6'x4'	Seedlings, container 3 to 15 gal.	Ornamental, forms thickets, slower growing, prefers wet to moist soils bordering streams, low woodlands, mixed forests, forms thickets.
C	Fetterbush, Sweetbells	Leucothoe racemosa	Evergreen	P,C	6'	P,Shade	Wet, Moist	6'x4'	Seedlings, container 3 to 15 gal.	Ornamental, forms thickets, slower growing, prefers wet to moist soils bordering streams, low woodlands, bogs, swamps, savannahs.
B	Spicebush	Lindera benzoin	Deciduous	M,P,C	5'	P,Shade	Wet, Moist	6'x5'	Seeds, seedlings, container 1 to 5 gal.	Ornamental, fast growing, prefers moist soils bordering streams, hardwood forests. Red fruit, aromatic. Eaten by mammals, birds, butterflys & insects.
B	Male-Berry, Male-Blueberry	Lyonia ligustrina (5 species in SE)	Deciduous	P,C	10'	FS, P	Wet, Moist	10'x8'	Seeds, seedlings, container 1 to 5 gal.	Ornamental, fast growing, prefers moist soils bordering streams, hardwood forests. Eaten by mammals, birds, butterflys & insects.
C	Fetterbush	Lyonia lucida (5 species in SE)	Deciduous	P,C	5'	FS,P	Wet, Moist	6'x5'	Seeds, seedlings, container 1 to 5 gal.	Ornamental, fast growing, prefers moist soils bordering streams, hardwood forests. Eaten by mammals, birds, butterflys & insects.
A	*Southern Wax Myrtle, Bayberry, Candleberry	Myrica cerifera 5 species in SE	Evergreen	P,C	10'	FS,P	Dry, Moist	25'x20'	Container, 1 to 3 gal.	Non-legume nitrogen fixer, fast growing, useful hedge, spreads rapidly, occurs on wet to dry sites, roadsides, ditches, marshes, has fragrant foliage used to repell insects.Aug.-Feb.-Seeds. Eaten by gamebirds, songbirds, waterfowl & insects.

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A	Ninebark	Physocarpus opulifolius	Deciduous	M,P,C	10'	FS,P	Moist, Wet	10'x8'	Seeds, seedlings, container 1 to 5 gal.	Occures along streams, river banks, bog margins, & moist cliffs. April-July-white-pinkish. June-Sept.-Seeds. Eaten by mammals, bees & insects.
A	Dwarf Azalea	Rhododendron atlanticum	Deciduous	P,C	6'	FS	Moist, Dry	6'x3'	Seeds, seedlings, container 1 to 5 gal.	Fast growing, prefers moist to dry soils in pine woods and savannahs, usually moist situations. Bird and butterfly food.
B	Flame Azalea	Rhododendron calendulaceum	Deciduous	M,P	8'	FS,P	Moist, Dry	12'x8'	Seeds, seedlings, container 1 to 5 gal.	Fast growing, prefers moist soils bordering streams, low woodlands, hardwood forests. Bird and butterfly food.
A	Catawba Rhododendron	Rhododendron catawbiense	Deciduous	M,P	10'	FS	Moist, Dry	15'x10'	Seeds, seedlings, container 1 to 5 gal.	Fast growing, prefers moist to dry soils on rocky slopes, ridges and balds, forms thickets. Hummingbird and butterfly food.
B	*Rosebay Rhododendron, Great Laurel	Rhododendron maximum	Deciduous	M,P	10'	FS	Moist	15'x10'	Seeds, seedlings, container 1 to 5 gal.	Fast growing, prefers moist soils on streambanks and hardwoods. Bird and butterfly food.
A	Pinxterbloom Azalea	Rhododendron nudiflorum var. canescens	Deciduous	M,P	6’	P, Shade	Moist, Dry	6'x3'	Seeds, seedlings, container 1 to 5 gal.	Fast growing, prefers moist to dry soils in upland woods and thickets, borders of bogs and swamps. Bird and butterfly food. Bird and butterfly food.
C	Swamp Azalea	Rhododendron viscosum (R. serrulata)	Deciduous	M,P,C	6’	P, Shade	Wet, Moist	6'x3'	Seeds, seedlings, container 1 to 5 gal.	Fast growing, prefers wet soils bordering streams & swamps. Bird and butterfly food.
A	Fragrant Sumac	Rhus aromatica	Deciduous	P,C	5'	FS	Dry	1' -	Seeds, seedlings, containers	Groundcover, fast growing, occurs on dry sites, right of ways & forest margins, almost any soil. Feb.-May-flowers-greenish white. April-Sept.-seeds. Seeds eaten by mammals, insects & many birds.
A	*Shining Sumac, Winged Sumac, Dwarf Sumac	Rhus copallina	Deciduous	M,P,C	5'	FS	Moist, Dry	25' -6"	Seeds, seedlings, containers	Fast growing; erosion control; forms colonies; occurs on right of ways & forest margins, almost any soil. June-Sept.-flowers-greenish white. Aug.-Jan.-seeds. Seeds eaten by mammals, insects & many birds.
A	*Smooth Sumac, Scarlet Sumac, Common Sumac	Rhus glabra	Deciduous	M,P,C	5'	FS	Moist, Dry	20' -4"	Seeds, seedlings, containers	Fast growing; erosion control; forms colonies; occurs on right of ways & forest margins, almost any soil. June-Sept.-flowers-greenish white. Aug.-Jan.-seeds. Seeds eaten by mammals, insects & many birds.
A	*Staghorn Sumac, Velvet Sumac	Rhus hirta (Rhus typhina)	Deciduous	M,P	5'	FS	Moist, Dry	30' -8"	Seeds, seedlings, containers	Fast growing; erosion control; forms colonies; occurs on right of ways & forest margins, almost any soil. June-Sept.-flowers-greenish white. Aug.-Jan.-seeds. Seeds eaten by mammals, insects & many birds.

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A	Pasture Rose, Wild Rose	Rosa carolina	Deciduous	M,P,C	5'	FS,P	Dry, Moist	5'x5'	Seeds, seedlings, container 1 to 5 gal.	Fast growing, erosion control, upland pastures, woodland borders, almost any soil. Fruits eaten by mammals & many birds.
C	Swamp Rose	Rosa palustris	Deciduous	M,P,C	10'	FS,P, Shade	Wet, Moist	8'x6'	Seeds, seedlings, container 1 to 5 gal.	Fast Growing, prefers wet soils bordering streams, ponds & swamp forests. Berries eaten by many birds
A	Alleghany Blackberry	Rubus s. Eubatus allegheniensis	Deciduous	M,P	5'	FS	Moist, Dry	10'x10'	Seeds, seedlings, container 1 to 5 gal.	Fast growing, prefers moist to dry soils in upland woodlands borders, forms thickets. Butterfly and bird food.
A	Purple Flowering Raspberry	Rubus odoratus	Deciduous	M	5'	FS	Moist, Dry	5'x5'	Seeds, seedlings, container 1 to 5 gal.	Fast growing, prefers woodlandborders, rocky slopes, streambanks, roadcuts and slopes. No thorns. Butterfly and bird food. Can be hard to find.
B	Prairie Willow	Salix humilis	Deciduous	M,P	6'	FS	Moist	6'x5'	Seeds, seedlings, container 1 to 5 gal.	Fast Growing, prefers moist to wet soils bordering streams, marshes, low woods.
B	Silky Willow	Salix sericea	Deciduous	M,P	15'	FS	Moist	15'x10'	Seeds, seedlings, container 1 to 5 gal.	Fast Growing, prefers moist to wet soils bordering streams, woodland borders, roadsides & ditches.
D	Common Elderberry, American Elder, Elderberry, Common Elder	Sambucus canadensis	Deciduous	M,P,C	10'	FS	Wet, Moist	12'x10' -6"	Seeds, seedlings, container 1 gal. (Cuttings are successful)	Fast growing, forms colonies, prefers moist to wet sites, in open habitat. Deep rooted. June-July-white flowers, Aug-Oct-.purple/black prolific berries. Fruit edible to humans. Fruit eaten by mammals & +50 species birds.
D	Meadowsweet & Narrow Leaved Meadowsweet	Spiraea tomentosa & Spiraea alba	Deciduous	M,P,C	10'	FS,P	Wet, Moist	8'x6'	Seeds, seedlings, container 1 to 5 gal.	Fast growing, prefers moist to wet soils, streambanks, lowlands, meadows and bogs.
C	Virginia Stewartia, Silky Camelia	Stewartia malacodendron	Deciduous	P,C	10'	FS,P,Shade	Moist	8'x6'	Seeds, seedlings, container 1 to 5 gal.	Fast growing, prefers moist to wet soils, streambanks, lowwoods, wet meadows and bogs.
C	Mountain Stewartia	Stewartia ovata	Deciduous	M,P	10'	FS,P,Shade	Moist	8'x6'	Seeds, seedlings, container 1 to 5 gal.	Fast growing, prefers moist to wet soils, riverbluffs, streambanks, lowlands.
A	American Snowbell	Styrax americana	Deciduous	P,C	8'	FS,P	Moist, Dry	6'x5'	Seeds, seedlings, container 1 to 5 gal.	Fast growing, prefers dry to moist soils, upland woods, mixed forests.
A	Bigleaf Snowbell	Styrax grandifolia	Deciduous	P,C	8'	FS,P	Moist, Dry	6'x5'	Seeds, seedlings, container 1 to 5 gal.	Fast growing, prefers dry to moist soils, upland woods, mixed forests.

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A	Sparkleberry	Vaccinium arboreum	Evergreen	P,C	8’	FS,P	Moist, Dry	25'x15'	Seeds, seedlings, container 1 to 5 gal.	Fast growing, prefers acidic, dry to moist soils, dry upland, forest understory, and clearings. Fruit eaten by mammals, reptiles, insects, butterflys & many birds.
A	Black Highbush Blueberry	Vaccinium atrococcum	Evergreen	P,C	8’	FS,P	Moist, Dry	8'x6'	Seeds, seedlings, container 1 to 5 gal.	Fast growing, prefers dry to moist soils, dry upland, forest understory, and clearings. Fruit edible to humans. Fruit eaten by mammals, reptiles, insects, butterflys & many birds.
B	Highbush Blueberry	Vaccinium corymbosum (V.virgata, formosa)	Evergreen	M,P,C	8'	FS	Moist, Dry	10'x6'	Seeds, seedlings, container 1 to 5 gal.	Fast growing, prefers wet to moist soils, bogs, pocosins, pine barrens, upland forest understory, and clearings. Fruit edible to humans. Fruit eaten by mammals, reptiles, insects, butterflys & many birds.
A	Creeping Blueberry	Vaccinium crassifolium	Evergreen	P,C	5'	FS	Moist, Dry	2'x1'	Seeds, seedlings, container 1 to 5 gal.	Groundcover; fast growing, prefers moist to dry soils, poccosins, pine barrens, upland forest understory, and clearings. Fruit eaten by mammals, reptiles, insects, butterflys & many birds. Fruit edible to humans.
C	Elliott Blueberry, Mayberry	Vaccinium elliottii	Evergreen	M,P,C	8’	P,Shady	Wet, Moist	10'x8'	Seeds, seedlings, container 1 to 5 gal.	Fast growing, prefers wet to moist soils, along streams and swamp forests. Fruit eaten by mammals, reptiles, insects, butterflys & many birds.
A	Huckleberry, Southern Gooseberry	Vaccinium stamineum	Evergreen	M,P,C	8’	FS	Moist, Dry	20'x15'	Seeds, seedlings, container 1 to 5 gal.	Fast growing, prefers dry to moist soils, dry upland, forest understory, and clearings. Fruit eaten by mammals, reptiles, insects, butterflys & many birds.
A	Lowbush Blueberry	Vaccinium tenellum	Evergreen	P,C	3'	FS	Dry	1'x1'	Seeds, seedlings, container 1 to 5 gal.	Fast growing, prefers dry soils, dry upland, forest understory, and clearings. Fruit eaten by mammals, reptiles, insects, butterflys & many birds.
A	Lowbush Blueberry	Vaccinium vacillans	Evergreen	P,C	3'	FS	Dry	1'x1'	Seeds, seedlings, container 1 to 5 gal.	Fast growing, prefers dry soils, dry upland, forest understory, and clearings. Fruit eaten by mammals, reptiles, insects, butterflys & many birds.
B	Maple Leaf Viburnum	Viburnum acerifolium	Deciduous	M,P	6'	FS	Moist	8'x6'	Seeds, seedlings, container 1 gal. (Cuttings are successful)	Deep rooted, forms colonies, moist soils, especially in valleys, slopes, in thickets and edges of forest. Prolific berries eaten by many species of birds.
B	Southern Arrowwood Viburnum	Viburnum dentatum	Deciduous	M,P,C	6'	FS	Moist, Dry	10'x6'	Seeds, seedlings, container 1 gal. (Cuttings are successful)	Deep rooted, wet to moist soils near streams and swamps, forming thickets. Prolific berries eaten by many species of birds.
B	Possumhaw Viburnum	Viburnum nudum	Deciduous	M,P,C	6'	FS	Wet, Moist	16x10'	Seeds, seedlings, container 1 gal. (Cuttings are successful)	Deep rooted, moist to dry soils, especially sandy, forming thickets. Prolific berries eaten by many species of birds.

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B	Nannyberry	Viburnum lentago	Deciduous	M,P,C	6'	FS	Wet, Moist	20'x10'	Seeds, seedlings, container 1 gal. (Cuttings are successful)	Deep rooted, moist to dry soils. Spring-white flowers, Late summer-fruits reddish/black. Fruit edible to humans. Prolific fruit eaten by many species of birds.
B	Blackhaw Viburnum	Viburnum prunifolium	Deciduous	M,P,C	6'	FS	Moist	25'x16'	Seeds, seedlings, container 1 gal. (Cuttings are successful)	Deep rooted, moist soils, especially in valleys, slopes, in thickets and edges of forest. Spring white flowers, fall-black prolific berries. Fruit edible to humans.
B	Downy Arrowwood	Viburnum rafinesquianum	Deciduous	P	6'	FS	Moist	20'x16'	Seeds, seedlings, container 1 gal. (Cuttings are successful)	Deep rooted, moist soils, valleys, slopes, in thickets and edges of forest. Prolific berries eaten by many species of birds.
B	Rusty Blackhaw	Viburnum rufidulum	Deciduous	P,C	6'	FS	Moist	20'x16'	Seeds, seedlings, container 1 gal. (Cuttings are successful)	Deep rooted, moist to dry soils uplands and edges of forest, forming thickets. Prolific berries eaten by many species of birds.
D	Yellowroot	Xanthorhiza simplicissima	Deciduous	M,P,C	4'	P,Shade	Wet, Moist	3'x3'	Seeds, seedlings, container 1 gal. (Cuttings are successful)	Deep rooted, wet to moist soils at waters edge, streambanks.

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Grasses, Sedges, Rushes

RIPARIAN	Common Name	Botanical Name	Mountain,	Seed Rate or	Light	Soil Moisture	Height	Benefits: Habitats:
A - UPLAND BUFFER	**Grasses**		**Piedmont**	**Spacing Min.**	**Full Sun**	**Condition:**		All these plants provide food and/or habitat for wildlife. All are stress tolerant.
B - UPPER SLOPE	**Sedges**		**Coastal**		**Partial**	**Wet**		**Seed @ 10 Lbs / Ac**
C - LOWER SLOPE	**Rushes**		**Coastal plain**		**Shade**	**Moist**		**Fertilize @ 10 lb./Ac (5-10-10) at Planting**
D - WATER'S						**Dry**		Seeds, Seeds per lb.=40,000 -- Use 1 1/2 to 2 lbs. per 1000 sq.ft.
E - AQUATIC								
A	Broom Sedge, Broomstraw	Andropogon virginicus (11 species in SE)	M,P,C	20%	FS	Dry, Moist	3'	Perennial; Bunchgrass; dry soil in clearings, old fields, disturbed areas. Eaten by small mammals, game & songbirds. Provides excellent nesting sites.
A	Big Blue Stem	Andropogon gerardii (11 species in SE)	M,P,C	10%	FS	Dry	6.5'	Perennial; Bunchgrass; occurs in dry soil in clearings, old fields, disturbed areas. Eaten by small mammals, game & songbirds. Provides excellent nesting sites.
A	Bushy Blue Stem	Andropogon glomeratus	M,P,C	10%	FS	Dry	3' to 5'	Perennial; Bunchgrass; low wet sites, along ditches, pond margins, & swamps without tree canopy. Eaten by small mammals, game & songbirds. Provides excellent nesting sites.
A	Little Blue Stem	Andropogon scoparius (Schizachyrium	M,P,C	10%	FS	Dry	3' to 5'	Perennial; Bunchgrass; dry soil in clearings, old fields, disturbed areas. Eaten by small mammals, game & songbirds. Provides excellent nesting sites.
A	Red Top, Bent Grass	Agrostis stolonifera (6 species in SE)	M,P,C	10%	FS	Moist, Dry	8 - 30"	Perennial; occurs in dry soil in clearings, old fields, roadsides & disturbed areas. Eaten by small mammals, game & songbirds.

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Grasses, Sedges, Rushes

A	Wire Grass	Aristida beyrichiana (16 species in SE)	Cp	10%	FS,P	Dry	1'	Perennial Tufted Grass: prefers fields, roadsides, open woods, longleafed pine stands, savannahs, bogs. **Keystone species**. Eaten by songbirds and used by gopher tortoise.
A	Giant Cane, River Cane, Switch Cane	Arundinaria gigantea (1 species, 3 subspecies in SE)	M,P,C	50'	FS,P	Moist	3' to 20'	Woody Perennial; forms colonies, used to control erosion; occurs in moist soils in bogs, low woods, savannahs & commonly on streambanks, can occur on uplands next to bottomlands, even dry sites. Eaten by livestock, mammals, birds & insects. Excellent bird nesting sites.
A	Woodland Sedge	Carex flaccosperma (122 species in SE)	M,P,C	10%	P, Shade	Moist, Dry	2'	Perennial; stems with triangular cross-section (3 edged-sedges have edges) occurs in shaded moist areas & dry shady areas. Eaten by small mammals and songbirds.
A	Gray's Sedge	Carex grayi (122 species in SE)	M,P	10%	P, Shade	Moist, Dry	2'	Perennial; stems with triangular cross-section (3 edged-sedges have edges) occurs in shaded moist areas & dry shady areas. Eaten by small mammals and songbirds.
A	Pennsylvania Sedge	Carex pensylvanica (122 species in SE)	M,P	10%	FS,P	Dry	1'	Perennial; stems with triangular cross-section (3 edged-sedges have edges) occurs in dry woods. Eaten by small mammals and songbirds.
A	Plantain-leaved Sedge	Carex plantaginea (122 species in SE)	M,P	10%	FS,P	Moist	8-10"	Perennial; stems with triangular cross-section (3 edged-sedges have edges) occurs in rich woods, hardwood forest. Eaten by small mammals and songbirds.
A	Upland Sea Oats, River Oats	Chasmanthium latifolium (4 species in SE)	M, P,C	8 lb / acre	FS,P	Moist	2'	Perennial Grass; roadsides, dry fields, disturbed abandoned places, used for erosion control. Eaten by mammals, insects & songbirds.
B	Wood Reed	Cinna arundinacea	M,P,C	10%	FS	Moist, Wet	2'	Perennial Grass, occurs in rich or low woods, forest margins & ditches. Important food source for ground feeding songbirds, gamebirds & mammals.
A	Silky Oatgrass, Downy Oatgrass	Danthonia sericea	M,P,C	10%	FS,P	Dry	1'	Perennial Grass; ocurrs in open forests, dry woods and roadsides. Eaten by birds and insects.

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Grasses, Sedges, Rushes

A	Poverty Oatgrass	Danthonia spicata	M,P,C	10%	FS,P	Dry	1'	Perennial Grass; ocurrs in open forests, dry woods and roadsides. Eaten by birds and insects.
A	Panic Grass	Dichanthelium commulatatum -26 species in SE	M,P,C	20%	FS,P	Dry	1'	Perennial Grass, occurs in open habitat, open forests, right of ways, forest margins, old fields. Important food source for ground feeding songbirds, gamebirds & mammals.
B	Purple Lovegrass, Tumblegrass	Eragrostis spectabis (16 species in SE)	M,P,C	20%	FS	Dry, Moist	1'	Perennial or Annual Grass; open woods, clearings, disturbed areas; flowers; adds nitrogen to soil. Seeds eaten by gamebirds, songbirds, small mammals & insects.
C	Giant Plumegrass	Erianthus giganteus	P,C	10%	FS	Moist, Wet	3 to 15'	Perennial; moist soils in ditches, savannahs, streambanks, meadows, and woodline borders.
B	Bottlebrush Grass	Hystrix patula	M,P,C	10%	FS	Moist	2' to 5'	Perennial Grass, occurs in rich or low woods, forest margins, old fields. Important food source for ground feeding songbirds, gamebirds & mammals.
D	Rush	Juncus effusus (28 species in SE)	M,P,C	10%	FS	Wet	2' to 3'	Rush-Grass-like Perennial; ponds, swamps,stream margins, roadside ditches. Eaten by small mammals, birds & insects.
D	Rush	Juncus acuminatus (28 species in SE)	M,P,C	10%	FS	Wet	3' to 5'	Rush-Grass-like Perennial; miost soil, usually open areas, essentially throughout SE. Eaten by small mammals, birds & insects.
A	Melic Grass	Melica mutica	M,P,C	10%	FS	Dry	6"+/-	Perennial Tufted Grass; occurs in open woods, old fields, roadsides. Eaten by gamebirds, songbirds, small mammals & insects.
A	Hairgrass, Muhly Grass, Nimblewill	Muhlybergia capillaris (10 species in SE)	M,P,C	10%	FS	Dry	2'	Perennial Grass; colonizes, occurs in open forests, forest clearings & edges, right of ways, river & stream banks, old fields, disturbed areas. Eaten by mammals & songbirds.
A	Switch Grass, Panic Grass	Panicum spp. (16 species in SE)	M,P,C	10%	FS	Dry	1' to 2'	Perennial or Annual Grass; occurs in open forests, forest openings & edges, right of ways, old fields, disturbed areas. Important source of food for mammals, ground feeding songbirds, gamebirds & insects.

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Grasses, Sedges, Rushes

A	Nutrush, Nutgrass, Egg Sedge	Scleria triglomerata (10 species in SE)	P,C	5%	FS	Wet to Dry	1'	Perennial or Annual Clump Forming Grass; occurs in open forests, forest plantations openings & edges, right of ways, old fields, disturbed areas. Important source of food for mammals, songbirds & insects.
D	Bulrush	Scirpus tabernaemontani (20 species in SE)	M,P,C	10%	FS	Wet, Moist	5'	Perennial or Annual Clump Forming Grass-like Herb; Colonizes; occurs in open areas with seasonal or year-long standing water, margins of ponds, marshes & streams. Important source of food for mammals, waterfowl, shorebirds & insects.
A	Indian Grass	Sorghastrum nutans (4 species in SE)	M,P,C	10%	FS	Dry	3' to 8'	Perennial Tufted Grass; occurs in open woods, roadsides, alluvial and low woods and fields, upland sites and sandhills; can take periodic flooding. Eaten by small mammals, songbirds & insects.
A	Pineywoods Dropseed	Sporobolus junceus (17 species in SE)	P,Cp	10%	FS,P	Dry	1'	Perennial Tufted Grass: prefers fields, roadsides, open woods, longleafed pine stands, savannahs, bogs. Readily eaten by songbirds.
A	Needle Grass	Stipa avenacea	M,P,C	10%	FS	Dry	1' to 2'	Perennial Tufted Grass; occurs in open woods, old fields, roadsides. Eaten by gamebirds, songbirds, small mammals & insects.
A	Purple Top	Tridens flavus (4 species in SE)	M,P,C	10%	FS	Dry, Moist	1'	Perennial Tufted Grass; occurs in open woods, old fields, roadsides. Eaten by gamebirds, songbirds, small mammals & insects.

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Native Plants

RIPARIAN ZONE	Common Name	Botanical Name	Mountain	Rate or	Full Sun	Soil Moisture	Benefits
A - UPLAND BUFFER			**Piedmont,**	**Spacing Min.**	**Partial, Shade**	**Condition:**	Preferred planting in Spring, otherwise add 10 lb./ac. annual ryegrass to mix.
B - UPPER SLOPE			**Coastal**	% of mix or		**Wet, Moist, Dry**	Fertilize with 10-15 pounds of (5-10-10) per acre at time of seeding. Mulch seeded area lightly with certified seedless straw. Scarify top 3 inches before planting.
C - LOWER SLOPE				distance apart			These plants provide food and habitat to many species of wildlife.
D - WATER'S EDGE				**Seed @ 10 Lbs / Ac**			*Rare; purchase only from reputable nurseries. Do not collect from wild. May be Federal or State protected.
E - AQUATIC							Most annuals have good tap roots.
A	Yarrow	Achillea millefolium	M,P,C	10%	FS	Dry, Moist	Perennial; old fields, meadows, roadsides, borders of woods; white, yellow.
B	Monkshood	Aconitum uncinatum	M,P,C	10%	P,Shade	Moist, Wet	Perennial; streambanks, low woods, damp slopes; violet.
E/D	Sweetflag	Acorous calamus	M,P,C	10%	FS	Aquatic	Perennial; swamps, marshes, streambanks, riverbanks; greenish yellow.
B	White Baneberry, Doll's-eyes	Actaea pachypoda	M,P	5'	P,Shade	Moist	Perennial; streambanks, shaded woodlands; white. Poisonous to humans.
B	Indigobush, False Indigo	Amorpha Fruticosa	M,P,C	5'	FS	Wet, Moist	Perennial; Legume; streambanks, showy flowers, used for erosion control, forms thickets; yellow.
B	Blue Star	Amsonia tabernaemontana	P,C	10%	P, Shade	Wet, Moist	Perennial; streambanks, shaded woodlands, bottomlands; blue.
A	Wind Flower	Anemone caroliniana	M	5%	P, Shade	Moist	*Perennial; rocky woods, pale blue to white. Hummingbird & butterfly food.

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A	Wood Anemone	Anemone quinquefolia	M	5%	P, Shade	Moist	Perennial; rich woods and wood borders; white. Hummingbird & butterfly food.
A	Thimbleweed	Anemone virginiana	M,P,C	10%	P,Shade	Moist	Perennial; dry or rocky open woods or thickets; white. Hummingbird & butterfly food.
A	Rue Anemone, Windflower	Anemonella thalictroides	M,P	10%	FS,P, Shade	Moist	Perennial; open woods or thickets; white to pinkish.
A	Field Pussytoes	Antennaria solitaria	M,P,C	5%	FS,P	Moist, Dry	Perennial; groundcover; open woods or thickets; white. Can be hard to obtain.
A	Pussytoes	Antennaria plantaginifolia	M,P,C	5%	FS,P	Dry	Perennial; groundcover; open woods, thickets, borders of fields; white.
A	Spreading Dogbane	Apocynum androsaemifolium	M,P,C	10%	FS	Moist, Dry	Perennial; borders of dry woods, meadows, thickets, fields, roadsides; pink. Butterfly Food, 43 Species.
A	Wild Columbine	Aquilegia canadensis	M,P,C	10%	FS,P	Moist, Dry	Perennial; rocky, wooded or open woods or slopes; yellow and red. Hummingbird food.
A	Wild Sarsaparilla	Aralia nudicaulis	M,P	5%	P,Shade	Moist, Dry	*Perennial; wooded or open woods or slopes; greenish white.
A	Spikenard	Aralia racemosa	M,P	5%	P,Shade	Moist, Dry	Perennial; rich woods or open woods or slopes; white.
B	Goat's-Beard	Aruncus dioicus	M,P	5%	P,Shade	Moist	Perennial; streambanks, ravines, shaded woodlands; whitish-cream.
B	Wild Ginger	Asarum canadense	M,P	5'	P, Shade	Moist	Perennial; groundcover; streambanks, shaded woodlands; marroon to brown.
A	Butterfly Weed	Asclepias tuberosa	M,P,C	10%	FS,P	Dry, Moist	Perennial; dry, open soil-roadsides, open fields; orange. Butterfly Food, 9 Species.
D	Swamp Milkweed	Asclepias incarnata	M,P	10%	FS,P	Wet, Moist	Perennial; moist to wet soils of swamps, streamsides, rivers and thickets; pink. Butterfly Food, 20 Species.
A	Common Milkweed	Asclepias syriaca	M,P	10%	FS,P	Dry, Moist	Perennial; dry, open soil-roadsides, open fields; pink to purple. Butterfly Food, 42 Species.

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A	Eastern Silvery Aster	Aster concolor	P,C	10%	FS,P	Dry, Moist	Perennial; dry, open soil-roadsides, open fields; pink to purple. Butterfly Food, 19 Species.
A	Heart-leaved Aster	Aster cordifolius	M,P	10%	FS,P	Dry, Moist	Perennial; dry, open soil-roadsides, open fields; pink to purple. Butterfly Food, 19 Species.
A	White Wood Aster	Aster divaricatus	M,P	10%	FS,P	Dry	Annual; dry open woods, roadsides, old open fields; white. Butterfly Food, 19 Species.
B	New England Aster	Aster novae-angliae	M	10%	FS,P	Moist	Annual; swamps, streambank, wet meadows and thickets; variable color. Butterfly Food, 19 Species.
A	Large-flowered Aster	Aster grandiflorus	P	10%	FS,P	Dry, Moist	Perennial; dry, open soil-roadsides, open fields; pink to purple. Butterfly Food, 19 Species.
A	Stiff-leaved Aster	Aster linariifolius	M,P,C	10%	FS,P	Dry, Moist	Perennial; dry, open soil-roadsides, open fields; pink to purple. Butterfly Food, 19 Species.
A	New York Aster	Aster novi-belgii	C	10%	FS,P	Dry, Moist	Perennial; dry, open soil-roadsides, open fields; pink to purple. Butterfly Food, 19 Species.
A	White Heath Aster, Field Aster	Aster pilosus	M,P,C	10%	FS,P	Dry, Moist	Perennial; dry, open soil-roadsides, open fields; pink to purple. Butterfly Food, 19 Species.
B	Flat-top White Aster	Aster umbellatus	M,P	10%	FS,P	Wet, Moist	Annual; swamps, streambanks, wet meadows and thickets; white. Butterfly Food, 19 Species.
B	Vetch	Astragalus canadensis	M,P	5%	FS,P	Wet, Moist	Perennial; rich woods, streambanks; greenish white to creamy. Hummingbird & butterfly food.
A	White Wild Indigo	Baptisia alba	P	10%	FS	Dry	Perennial; Legume;open woods, thickets, open fields; yellow. Hummingbird & butterfly food.

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A	Carolina Wild Indigo	Baptisia cinerea	C	10%	FS	Dry	Perennial; Legume; open woods, thickets, open fields; yellow. Hummingbird & butterfly food.
A	Yellow Wild Indigo	Baptisia tinctoria	M,P,C	10%	FS	Dry	Perennial; Legume; sandy woods, thickets, open fields; yellow. Hummingbird & butterfly food.
A	Bur Marigold	Bidens aristosa	P,C	10%	FS	Moist, Wet	Annual; marshes, meadows, and ditches; yellow.
A	Nodding Bur Marigold	Bidens frondosa	M,P,C	10%	FS	Moist, Wet	Annual; streambanks, marshes, meadows, fields, pastures, and ditches; yellow.
A	Marsh Marigold	Caltha palustris	M,P	10%	FS, P	Moist, Wet	Perennial; streambanks, swamps, marshes, wet meadows; yellow.
C	Tall Bell Flower	Campanula americana	M,P	10%	P,Shade	Moist, Wet	Perennial; streambanks, shaded woodlands; blue/pink.
C	Harebell, Bluebell	Campanula divaricata	M,P	10%	P,Shade	Moist, Wet	Perennial; streambanks, shaded woodlands; blue/pink.
C	Wild Senna	Cassia hebecarpa	M,P,C	8 lb./acre	FS	Moist	Perennial; Legume; moist soil in open woods and disturbed areas, flowers, stabilizing perrenial; yellow. Hummingbird & butterfly food.
A	Wild Senna, Partidge Pea	Cassia marilandica (Senna marilandica)	M,P	10%	FS	Dry	Perennial; Legume; streambanks, disturbed areas, shaded woodlands,stabilizing perrenial; yellow. Hummingbird & butterfly food.
A	Indian Paintbrush	Castilleja coccinea	M,P	10%	FS	Dry, Moist	Perennial; meadows, roadsides, woodland margins; red/yellow.
A	Blue Cohosh	Caulophyllum thalictroides	M,P	5'	P, Shade	Moist	Perennial; rich mixed forests, streambanks, hardwood coves; green or shaded w/ maroon.
A	Spurned Butterfly Pea	Centrosema virginianum	M,P,C	10%	FS	Dry	Perennial; Legume; open woods or slopes, thickets, old fields; violet.
A	Blazing Star	Chamaelirium luteum	M,P,C	5%	FS,P,Shade	Dry	Perennial; wooded slopes and coves, rich forest; white.
B	White Turtlehead	Chelone glabra	M,P,C	10%	FS,P	Moist, Wet	Perennial; streambanks, wet thickets, low pastures, and woodlands; white. Hummingbird & butterfly food.
A	Green-and-Gold	Chrysogonum virginianum	P,C	1'	FS	Moist, Dry	Perennial; groundcover; open woods; yellow.

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B	Black Cohosh	Cimicifuga racemosa	M,P	5'	P, Shade	Moist, Wet	Perennial; streambanks, rich shaded woodlands; white; used as bug repellent. Hummingbird & butterfly food.
B	Pine Hyacinth, Dwarf Clematis	Clematis baldwinii	P,C	5'	P, Shade	Moist, Wet	Perennial; groundcover; streambanks, rich shaded woodlands; pink to bluish lavender.
B	Virgin's Bower	Clematis virginiana	M,P	5'	P, Shade	Moist, Wet	Perennial; groundcover; vine; streambanks, rich shaded woodlands; white.
A	Speckled Wood Lilly	Clintonia umbellulata	M,P	3'	FS,P,Shade	Moist	Perennial; bulb; mixed hardwoods, streambanks; white.
A	Butterfly Pea	Clitoria mariana	M,P,C	10%	FS	Dry	Perennial; Legume; open woods or slopes, thickets; lavender pink. Hummingbird & butterfly food.
C	Goldthread, Canker-root	Coptis groenlandica	M,P	5'	FS,P	Moist, Wet	Perennial; groundcover; streambanks, cool woods, swamps, bogs; white.
A	Coreopsis	Coreopsis auriculata	P	10%	FS,P	Moist, Dry	Perennial; dry open woods, roadsides, old open fields: yellow. Hummingbird & butterfly food.
A	Lance-Leaved Coreopsis	Coreopsis lanceolata	P,C	10%	FS	Dry	Perennial; dry, open soil-roadsides, open fields; yellow. Hummingbird & butterfly food.
A	Tall Creopsis	Coreopsis tripteris	M,P	10%	FS	Moist	Perennial; open woods, meadows, uplands; red. Hummingbird & butterfly food.
A	Threadleaf Coreopsis	Coreopsis verticillata	P,C	10%	FS	Moist, Dry	Perennial; open woods, meadows, uplands; yellow. Hummingbird & butterfly food.
A	Cosmos	Cosmos bipinnatus	M,P,C	20%	FS,P	Dry	Annual; roadsides, abandoned fields and waste places; varied color, some reseeding.
A	Rattlebox	Crotolaria spectabilis	P,C	10%	FS	Dry	Perennial; Legume; roadsides, abandoned fields and waste places; yellow.
A	Larkspur	Delphinium ajacis	M,P	10%	FS,P,Shade	Moist	Annual; roadsides, fields, waste places; blue or violet.
B	Spring Larkspur	Delphinium tricorne	M,P	10%	P,Shade	Moist	Perennial; streambanks, rich shaded woodlands; blue or violet.
A	Beggar Lice, Beggar Ticks	Desmodium nidiflorum	M,P,C	5%	FS,P	Dry	Perennial; legume; dry woodlands, roadsids, fields; rose to purple.

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B	Dutchman's Breeches	Dicentra cucullaria	M,P	5'	P,Shade	Moist	Perennial; streambanks, rich shaded woodlands; white.
A	Wild Bleeding Heart	Dicentra eximia	M	5'	P,Shade	Moist	Perennial; *rare; streambanks, rich wooded slopes, coves, and gorges; pink.
B	Obedient Plant	Dracocephalum virginianum	M,P	10'	FS,P	Moist, Wet	Perennial; bogs, low meadows, streambanks; pinkish.
A	Purple Coneflower	Echinacea purpurea	P	10%	FS,P	Moist, Dry	Perennial; open woodlands, roadbanks; purple/pink. Hummingbird & butterfly food.
A	Fleabane Daisy	Erigeron philadelphicus	M,P,C	5%	FS	Dry	Perennial; old fields, meadows, waste places; blue.
A	Coral Bean	Erthrina herbacea	P,C	8 lb./acre	FS	Dry, Moist	Perennial; Legume; pinewoods, hummocks, and thickets; showey flowers, adds nitrogen to soil.
A	Rattlesnake Master	Eryngium yuccifolium	M,P,C	1'	FS,P	Dry	Perennial; roadsides, open woods, fields, meadows; white to greenish. Hummingbird & butterfly food.
D	Mistflower	Eupatorium coelestinum	P,C	10%	FS	Moist, Wet	Perennial; streambanks, wet meadows, bogs, marshes; bluish to violet. Butterfly Food, 9 Species.
D	Joe-Pye-Weed	Eupatorium fistulosum (maculatum)	M,P,C	5'	FS,P	Moist, Wet	Perennial; streambanks, meadows, bogs, marshes; pink. Butterfly Food, 9 Species.
B	Boneset	Eupatorium perfoliatum	M,P,C	5%	SF,P	Wet, Moist	Perennial; streambanks, meadows, bogs, marshes; pink. Butterfly Food, 9 Species.
A	Wild Strawberry	Fragaria virginiana	M,P	1'	FS	Moist, Dry	Annual; edges of woods, roadsides, old open fields: white. Fruit edible to turtles, birds &
D	Fringed Gentian	Gentiana crinita	M,P,C	5%	FS	Moist, Wet	Perennial; *rare; wet thickets and wet meadows; bluish purple.
D	Soapwort Gentian	Gentiana villosa	M,P,C	5%	FS	Moist	Perennial; *rare; upland woods; bluish purple.
A	Carolina Geranium	Geranium carolinianum	M,P,C	10%	FS,P	Moist	Annual; taproot, disturbed habitats, fields, pastures, roadsides, granite outcrops; lavender.
A	Wild Geranium	Geranium maculatum	M,P	10%	FS,P	Moist	Perennial; streambanks, rich wooded slopes; lavender.

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A	American Ipecac	Gillenia stipulata	M,P	10%	FS,P	Moist	Perennial; rich woods, streambanks, slopes; pinkish or white.
A	Bowman's Root	Gillenia trifoliata (Porteranthus trifoliatus)	M,P	10%	FS,P	Moist	Perennial; rich woods, streambanks, slopes; pinkish or white.
A	Gaillardia	Gaillardia pulchella	P,C	10%	FS	Dry	Annual; dry open woods, roadsides, old open fields: yellow, orange.
A	American Pennyroyal	Hedeoma pulegioides	M,P,C	10%	FS,P	Dry, Moist	Annual: disturbed habitats, fields, pastures, streambanks, edges of woodland; blue
D	Sneezeweed	Helenium autumnale	M,P,C	10%	FS	Moist, Wet	Perennial; streambanks, wet meadows, ditches, marshes; yellow.
D	Swamp Sunflower	Helianthus angustifolius	M,P,C	10%	FS, P	Wet, Moist, Dry	Perennial; streambanks, wet meadows, ditches, marshes, open woods, uplands; red/purple. Butterfly Food, 10 Species.
A	Sunflower	Helianthus atrorubens	M,P,C	10%	FS,P	Moist, Dry	Perennial; open woodlands, roadbanks; yellow. Butterfly Food, 10 Species.
A	Ten-petaled Sunflower	Helianthus decapetalus	M,P	10%	FS,P	Moist, Dry	Perennial; open woodlands, roadbanks; yellow. Butterfly Food, 10 Species.
A	Woodland Sunflower	Helianthus divaricatus	M,P,C	10%	FS,P	Moist, Dry	Perennial; open woodlands, roadbanks; yellow. Butterfly Food, 10 Species.
A	Ox-eye Sunflower	Heliopsis microcephalus	M,P	10%	FS,P	Moist, Dry	Perennial; open woodlands, roadbanks; yellow.
A	Jerusalem Artichoke	Heliopsis tuberosus	M,P	10%	FS,P	Moist, Dry	Perennial; tuber; streambanks, hardwoods; pink/purple. Edible by humans.
C	Sharp-lobed Hepatica	Hepatica acutiloba	M	10%	P, Shade	Moist	Perennial; streambanks, slopes, rich woodlands; blue or pinkish.
C	Round-lobed Hepatica	Hepatica americana	M,P	10%	P,Shade	Moist	Perennial; streambanks, slopes, rich woodlands; blue or pinkish.
A	Maryland Golden Aster	Heterotheca mariana	M,P,C	10%	FS	Moist, Dry	Perennial; open woodlands, old fields, roadbanks, pine barrens; yellow.
A	Alumroot	Heuchera americana	P,C	1'	FS,P,Shade	Moist	Perennial; groundcover; rich woods, shaded slopes and rock outcrops; yellowish green.

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B	Wild Ginger, Heartleaf	Hexastylis arifolia	M,P,C	1'	P,Shade	Moist, Dry	Perennial; forests, woods, shaded slopes; maroon to brown.
D	Halbeard-leaved Marsh Mallow	Hibiscus militaris	P,C	10%	FS	Moist, Wet	Perennial; streambanks, wet meadows, ditches, marshes; white. Hummingbird Food.
C	Wild Cotton	Hibiscus moscheutos	M,P,C	10%	FS	Moist, Wet	Perennial; streambanks, wet meadows, ditches, marshes; white. Hummingbird Food.
D	Rose Mallow	Hibiscus palustris	M,P,C	10%	FS	Moist, Wet	Perennial; streambanks, marshes, bogs; white/red or purple centers. Hummingbird Food.
D	Althea, Rose of Sharon	Hibiscus syriacus	M,P,C	5'	FS	Moist, Wet, Dry	Perennial; streambanks, roadsides, commonly cultivated; white, pink or lavender. Hummingbird Food.
D	Flower of an Hour	Hibiscus trionum	M,P,C	10%	FS	Moist, Wet	Annual; streambanks, marshes, bogs; yellow w/ red or purple base.
A	Rattlesnake Weed	Hieracium venosum	M,P,C	10%	FS	Moist, Dry	Perennial; dry open woods, thickets, clearings; yellow.
C	Bluets	Houstonia spp.	M,P,C	5%	FS	Moist, Wet	Perennial; decidious woodlands, meadows, clearings, streambanks, roadsides; blue. Butterfly Food.
A	Green Violet	Hybanthus concolor	M,P	1'	FS,P,Shade	Moist	Perennial; rich woods, slopes, ravines, streambanks; green.
A	Golden Seal	Hydrastis canadensis	M	5'	P,Shade	Moist	Perennial: *rare; rich woods; white, cream.
A	St. John's Wort	Hypericum spp.	M,P,C	10%	FS	Dry, Moist,Wet	Perennial; several species; most are found in dry woods, borders, waste places, old fields; a couple are found in wet areas; Flowers yellow. Hummingbird & butterfly food.
D	Touch-Me-Not, Jewel Weed	Impatiens pallida	M,P,C	10%	FS,P	Moist, Wet, Dry	Annual; streambanks, swamps, meadows; orange/yellow color. Hummingbird Food.
D	Spotted Touch-Me-Not, Jewel Weed	Impatiens capensis	M,P,C	10%	FS,P	Moist, Wet, Dry	Annual; streambanks, swamps, meadows; orange/yellow color. Hummingbird Food.
C	Dwarf Crested Iris	Iris verna var. cristata	M,P	1'	FS,P	Moist	Perennial; streambanks, rich wooded slopes; blue. Hummingbird Food.

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D	Blue Flag Iris	Iris virginica	M,P,C	1'	FS,P	Moist, Wet	Perennial; streambanks, wet meadows, ditches, marshes; blue. Hummingbird Food.
A	Twinleaf	Jeffersonia diphylla	M	1'	FS,P	Moist	Perennial; rich, damp open woods; white.
E	Water Willow	Justicia americana	M,P	5%	FS	Aquatic	Perennial; rocky and sandy streambeds, margins of shallow streams, lakes, and ponds, wet shores; white w/ purple.
D	Seashore Mallow	Kosteletskya virginica	C	10%	FS,P	Moist, wet	Perennial; brackish marshes; pink.
A	Everlasting Pea	Lathyrus latifolius	M,P,C	5%	FS	Dry, Moist	Perennial; legume, roadsides and waste places; purple
C	Blazing Star	Liatris graminifolia or microcephala	M,P,C	10%	FS	Moist, Dry	Perennial; open woodlands, roadbanks, meadows; purple.
C	Spiked Blazing Star	Liatris spicata	M,C	10%	FS	Moist, Wet	Perennial; streambanks, open woodlands, roadbanks, ditches; purple. Hummingbird Food.
A	Plains Blazing Star	Liatris squarrosa	P,C	10%	FS	Moist, Dry	Perennial; upland woodlands, old fields, roadbanks; purple. Hummingbird Food.
C	Cardinal Flower	Lobelia cardinalis	M,P,C	10%	P,Shade	Moist, Wet	Perennial; streambanks, shaded woodlands; red.Hummingbird Food.
C	Great Blue Lobelia	Lobelia siphilitica	M,P	10%	P,Shade	Moist, Wet	Perennial; streambanks, shaded woodlands; blue. Hummingbird Food.
C	Spiked Lobelia	Lobelia spicata	M,P	10%	P,Shade	Moist, Wet	Perennial; streambanks, shaded woodlands; blue. Hummingbird Food.
A	Trefoil	Lotus helleri	P,C	5%	FS	Dry, Moist	Perennial; Legume; roadsides, open fields, gardens: pink.
A	Lupine	Lupinus perennis	P,C	10%	FS	Dry	Perennial; Legume; roadsides, open fields, gardens: blue.
A	Cheeses	Malva neglecta	M,P,C	10%	FS	Moist, Dry	Perennial; creeping groundcover; disturbed habitats; white.
B	Indian Cucumber Root	Medeola virginiana	M,P	1'	P,Shade	Moist	Perennial; streambanks, shaded wooded slopes, meadows; yellowish green.

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C	Monkeyflower	Mimulus ringens	M,P	10%	FS,P	Moist, Wet	Perennial; streambanks, wet meadows, roadsides, open woodlands; pink/lavender to
B	Partridgeberry	Mitchella repens	M,P,C	5'	FS,P,Shade	Moist, Dry,Wet	Perennial; Groundcover; streambanks, rich or low woods; April-June-Flowers-white. June-Jan.-Red berry. Eaten by mammals, birds and insects.
C	Bee Balm, Oswego Tea	Monarda didyma	M,P	10%	FS	Moist, Dry	Perennial; streambanks, wet meadows, shaded woodlands; red. Hummingbird food.
A	Wild Bergamot	Monarda fistulosa	M,P	10%	FS	Moist, Dry	Perennial; streambanks, shaded wooded slopes, meadows; pink/lavender.Hummingbird food.
D	Forget-Me-Not	Myosotis laxa	M,P	10%	FS,P	Moist, Wet	Perennial; roadsides, open fields, gardens: blue.
A	Forget-Me-Not	Myosotis sylatica	M,P	10%	FS,P	Moist, Dry	Perennial; roadsides, open fields, gardens: blue.
A	Evening Primrose	Oenothera biennis	M,P,C	10%	FS	Dry	Perennial; dry woods, roadsides, slopes, meadows; yellow. Hummingbird & butterfly food.
A	Sundrops	Oenothera fruticosa	M,P,C	10%	FS	Dry	Perennial; dry woods, roadsides, slopes, meadows; yellow. Hummingbird & butterfly food.
A	Eastern Prickly Pear	Opuntia compressa (O. humifusa)	P,C	5'	FS	Dry	Cactus; sandy areas and open rocky habitats; yellow. Eaten by small mammals, reptiles, songbirds, insects & moths.
E	Golden Club	Orontium aquaticum	M,P,C	1'	FS	Aquatic	Perennial; pools, ponds and sluggish streams, marshes, swamps; yellow.
A	Sweet Cicely	Osmorhiza claytonii	M	5'	P,Shade	Moist	Perennial; mixed forests, coves, alluvial woods; white.
A	Anise Root	Osmorhiza longistylis	P	5'	P,Shade	Moist	Perennial; mixed forests, low woodlands, streambanks; white.
A	Ginseng	Panax quinquefolium	M,P	5'	P,Shade	Moist	*Perennial; streambanks, rich shaded wooded slopes; greenish white or greenish yellow.
A	Dwarf Ginseng	Panax quinquefolium	M	5'	P,Shade	Moist	*Perennial; streambanks, rich shaded wooded slopes; greenish white or greenish yellow.
A	Grass of Parnassus	Parnassia glauca	M	2%	FS,P	Moist,Wet	*Perennial; bogs and seepage slopes, streambanks.

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B	Smooth Beardtongue	Penstemon laevigatus	P,C	10%	FS,P	Moist	Perennial; streambanks, wet meadows, forest edges; purple and white. Hummingbird Food.
A	Beardtongue	Penstemon smallii	M	10%	P	Dry	Perennial; edges of woods, cliff banks; 1/2 day sunlight; purple and white.Hummingbird Food.
A	Thick-leaved Phlox, Carolina Phlox	Phlox carolina	M,P	10%	FS	Moist, Dry	Perennial; roadsides, open woods, savannahs, clearings, fields, gardens: lavender, pink or white. Hummingbird Food.
A	Blue Phlox	Phlox divaricata	M	10%	FS	Moist, Dry	Perennial; open woods; lavender. Hummingbird Food.
A	Smooth Phlox	Phlox glaberrima var. triflora	M	10%	FS	Moist, Wet	Perennial; low meadows and woodland borders; lavender, pink or white. Hummingbird Food.
C	Summer Phlox	Phlox paniculata	M,P	10%	FS	Moist	Perennial; streambanks, roadsides; lavender to pink or white. Hummingbird Food.
B	Creeping Phlox	Phlox stolonifera	M,P	10%	P, Shade	Moist	Perennial; groundcover; streambanks, rich woods; lavender. Hummingbird Food.
C	Mayapple, Mandrake	Podophyllum peltatum	M,P,C	5'	P,Shade	Moist	Perennial; streambanks, woodlands, meadows, roadsides; white.
B	Solomon's Seal	Polygonatum biflorum	M,P,C	5'	FS,P,Shade	Dry , Moist	Perennial; streambanks, woodlands, thickets; greenish white.
E	Pickerelweed	Pontederia cordata	P,C	12 O.C.	FS	Aquatic	Perennial; ditches, marshes, stream & pond margins, can tolerate flooding, plant in first 6 inches of water.
A	Snakeroot	Psoralea psoralioides	P,C	10%	FS	Dry	Perennial; Legume; open woods, clearings, fields; purpleish.
A	Hoary Mountain-Mint	Pycnanthemum incanum	M,P,C	10%	FS	Moist, Dry	Perennial; streambanks, wet meadows, shaded woodlands; purple/pink. Hummingbird & butterfly food.
D	Narrow-leaved Mountain Mint	Pycnanthemum tenuifolium	M,P,C	10%	FS,P	Moist, Wet	Perennial; meadows, pastures, thickets, woodlands, clearings: lavender/white. Hummingbird & butterfly food.

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D	Virginia Meadow-beauty	Rhexia virginica	M,P,C	10%	FS	Moist, Wet	Perennial; streambanks, bogs, low meadows, open woods; white/pink.
D	Meadow-beauty	Rhexia mariana	M,P,C	10%	FS	Moist, Wet	Perennial; streambanks, bogs, low meadows, open woods; rose/purple.
A	Blackberry	Rubus argutus, Rubus cuneifolius, Rubus flagellaris, Rubus trivialis, etc. (spp.17 species in SE)	M,P,C	10%	FS,P	Wet, Moist, Dry	Perennial; Erect, arching or trailing plants; forms colonies; often with thorns. Occurs on wet to dry sites, right of ways & forest edges. April.-July-Flowers-white to pink. April-Aug.-Fruit & seeds are one of the most important group of plants in the SE. The soft fruit (mast) is eaten by a long list of species including: large & small mammals, gamebirds, songbirds, reptiles and insects.
A	Common Eastern Coneflower	Rudbeckia fulgida	P	10%	FS	Moist, Dry	Perennial; streambanks, bogs, marshes, ditches; purple/white.
A	Black-Eyed Susan	Rudbeckia hirta	M,P,C	10%	FS	Moist, Dry	Perennial; meadows, pastures, thickets, woodlands: purple flowers. Hummingbird & butterfly food.
D	Cut-leaved Coneflower	Rudbeckia laciniata	M,P,C	10%	FS,P	Moist, Wet	Perennial; meadows, pastures, thickets, woodlands: orange/yellow. Hummingbird & butterfly food.
A	Three-lobed Coneflower	Rudbeckia triloba	M,P	10%	FS	Moist, Dry	Perennial; streambanks, bogs, marshes, swamps, ditches; white flowers. Hummingbird & butterfly food.
A	Wild Petunia	Ruellia caroliniensis	M,P,C	10%	FS,P	Moist, Dry	Perennial; dry woods, fields, roadsides, slopes, meadows; yellow. Humminbird Food. Hard to find.
A	Nettle-leaved Sage	Salvia urticifolia	M,P	10%	FS,P	Moist, Dry	Perennial; thickets, woodlands: blue/violet.
A	Blue Salvia	Salvia azurea	P	10%	FS,P	Moist, Dry	Perennial; thickets, woodlands: blue/violet. Hummingbird Food.
A	Sage	Salvia lyrata	M,P,C	10%	FS,P	Moist, Dry	Perennial; thickets, sandy or rocky woodlands: blue/violet. Hummingbird Food.

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A	Bloodroot	Sanguinaria canadensis	M,P,C	1'	FS,P,Shade	Moist	*Perennial; rich woods, meadows, open woodlands: white.
E/D	Lizard's-tail	Saururus cernuus	P,C	5'	P,Shade	Moist, Wet, Aquatic	Perennial; ground cover; streambanks, marshes, bogs; white.
A	Swamp Saxifrage	Saxifraga pensylvanica	M,P	5'	FS,P	Moist,Wet	Perennial; groundcover; wet meadows and prairies, swamps, bogs, streambanks; yellowish
A	Early Saxifrage	Saxifraga virginiensis	P	1'	FS,P	Wet, Dry	Perennial; rocky slopes and outcrops; white.
A	Wild Stonecrop	Sedum ternatum	M,P	1'	P, Shade	Moist	Perennial; ground cover; rich, rocky woods, streambanks; white.
B	Golden Ragwort	Senecio aureus	M,P	10%	FS,P,Shade	Moist, Wet	Perennial; ground cover; rich, rocky woods, streambanks; yellow. Hummingbird & butterfly food.
A	Starry Campion	Silene stellata	M,P	10%	FS,P	Moist	Perennial; streambanks, rich woods; white. Hummingbird food.
A	Fire Pink	Silene virginica	M,P	10%	FS,P	Moist, Dry	Perennial; streambanks, rich or dry woods; purple to crimson. Hummingbird Food.
A	Rosin-weed	Silphium compositum	M,P,C	10%	FS	Moist, Dry	Perennial; roadsides, meadows, pastures, open woodlands: yellow. Hummingbird & butterfly food.
A	Starry Rosin-weed	Silphium dentatum	P	10%	FS	Moist, Dry	Perennial; roadsides, meadows, pastures, open woodlands: yellow. Hummingbird & butterfly food.
B	False Solomon's-seal	Smilacina racemosa	M,P,C	5'	FS,P	Moist, Dry	Perennial; rich woods, hardwood forests, edges of meadows; white to green.
D	Bluestem Goldenrod	Solidago caesia	M,P,C	10%	P,Shade	Moist	Perennial; streambanks, bogs, marshes, wet woodlands; yellow. Butterfly Food, 18 Species.
A	Sweet Goldenrod	Solidago odora	M,P,C	10%	FS	Moist, Dry	Perennial; streambanks, coves, moist woods; yellow. Butterfly Food, 18 Species.
A	Pineywoods Goldenrod	Solidago pinetorum	P,C	10%	FS	Moist, Dry	Perennial; roadsides, meadows, open woodlands; yellow. Butterfly Food, 18 Species.
D	Downy Goldenrod	Solidago puberula	M,P	10%	FS,P	Moist, Wet	Perennial; roadsides, old fields, open woodlands: yellow. Butterfly Food, 18 Species.

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D	Rough-stemmed Goldenrod	Solidago rugosa	M,P,C	10%	FS,P	Moist, Wet	Perennial; streambanks, bogs, marshes, wet woodlands; yellow. Butterfly Food, 18 Species.
D	Seaside Goldenrod	Solidago sempervirens	C	10%	FS	Moist, Wet	Perennial; brackish marshes, bogs: yellow. Butterfly Food, 18 Species.
A	Venus Looking Glass	Specularia perfoliata	M,P,C	5'	FS	Moist	Perennial; roadsides, old fields, cultivated gardens; bluish violet.
A	Indian Pink	Spigelia marilandica	M,P,C	10%	FS,P	Moist	Perennial; rich woodlands, streambanks, fields, meadows; scarlet.
A	Pencil Flower	Stylosanthes biflora	M,P,C	10%	FS, P	Dry, Moist	Perennial; Legume; open woods & borders, roadsides, waste places; orange/yellow.
A	Columbo	Swertia caroliniensis	M	5%	FS,P	Moist	Perennial; rich woodlands; yellowish to white.
A	Skunk Cabbage	Symplocarpus foetidus	M,P	5'	FS,P	Moist, Wet	Perennial; groundcover; open swamps, marshes, streambanks, wet woodlands; brownish purple & green; flower stinks but beneficial for nesting
B	Early Meadowrue	Thalictrum dioicum	M,P	10%	P,Shade	Moist	Perennial; rich woods, hardwood forests, seepage slopes; white to pinkish.
B	Windflower	Thalictrum thalictroides	M,P	10%	P,Shade	Moist	Perennial; rich woods, hardwood forests, streambanks, slopes; white to pinkish.
A	Clumping Foamflower	Tiarella cordifolia var. collina	M,P	1'	FS,P	Moist, Dry	Perennial; groundcover; rich woods, hardwood forests, streambanks, slopes; white to pinkish.
A	Spreading Foamflower	Tiarella cordifolia var. cordifolia	M	1'	FS,P	Moist, Dry	Perennial; groundcover; rich woods, hardwood forests, streambanks, slopes; white to pinkish.
A	Vervain	Verbena spp.	M,P,C	5%	FS	Dry, Moist, Wet	Perennial; marshes, mesic woodlands, old fields, waste places; purple. Hummingbird & butterfly food, 9 Species.
D	Tall Ironweed	Vernonia altissima	M,P,C	10%	FS, P	Moist, Wet	Perennial; streambanks, marshes, wet woodlands; purple. Butterfly Food, 9 Species.
D	New York Ironweed	Vernonia noveboracensis	M,P,C	10%	FS, P	Moist, Wet	Perennial; streambanks, marshes, wet woodlands; purple. Butterfly Food, 9 Species.

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D	Culver's Root	Veronicastrum virginicum var.speciosa, var. erecta	M,P	10%	FS,P	Moist, Wet	Perennial; streambanks, wet woodlands, wet meadows, bogs; white or cream. Hummingbird & butterfly food.
D	Sweet White Violet	Viola blanda	M	1'	FS,P,Shade	Moist	Perennial; groundcover; rich moist wooded slopes, streambanks; white.
D	Marsh Blue Violet	Viola cucullata	M	1'	FS,P,Shade	Moist, Wet	Perennial; groundcovers; streambanks, wet woodlands, wet meadows, bogs; blue-violet.
C	Yellow Violet	Viola eriocarpa	P	1'	FS,P,Shade	Moist	Perennial; groundcovers; streambanks, rich woodlands, meadows, fields; yellow.
A	Bird's-foot Violet	Viola pedata	M,P,C	1'	FS,P,Shade	Moist, Dry	Perennial; groundcover; rocky or sandy upland woods; blue-violet.
A	Pansy, Johnny Jump Up	Viola tricolor	M,P,C	1'	FS,P,Shade	Moist, Dry	Annual; groundcover; rich woodlands, seepage slopes; modern hybrids are from this species; blue, violet or yellow.
D	Yellow Root, Bitters	Xanthorhiza	M,P	2'	FS,P,Shade	Moist,Wet	Perennial; groundcover at water edge; shaded stream banks; greenish yellow.
A	Common Yucca, Beargrass	Yucca filamentosa- 6 species in SE	M,P,C	5'	FS	Moist, Dry	Perennial; open or thinnly wooded, xeric habitats; flower-white to cream. Hummingbird food.
D	Golden Alexanders	Zizia aurea	M,P,C	1'	P,Shade	Moist,Wet	Perennial; allivial woods, meadows, swamp forests, streambanks; yellow.
	Bulbs						
B	Green Dragon	Arisaema dracontium	M,P,C	5'	FS,P,Shade	Moist, Wet	*Perennial; bulb; streambanks, shaded woodlands, bottomlands; green, purple, striped or mottled.
B	Jack-in-the-Pulpit, Jack & Jill	Arisaema triphyllum	M,P,C	3'	FS,P,Shade	Moist, Wet	Perennial; bulb; streambanks, shaded woodlands, bottomlands; green, purple, striped or mottled.

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	Spring Beauty	Claytonia virginica				Moist, Wet	Perennial; bulb;groundcover; streambanks, shaded woodlands, bottomlands; pink to white.
A	American Lily-of-the-Valley	Convallaria montana (C. majuscula)	M	5'	P,Shade	Moist	Perennial; bulb; rich woods, slopes and coves; white with green.
C	Swamp Lilly	Crinum americanum	C	5'	FS	Moist,Wet	Perennial; bulb; marshes and streambanks; white
D	Spider Lilly	Hymenocallis liriosme	M,P,C	2'	FS	Moist, Wet	Perennial; bulb; marshes, ditches, low woods, and swamp forest borders; white.
A	Yellow Star Grass	Hypoxis hirsuta	M,P,C	5%	FS	Moist, Dry	Perennial; bulb; open woods, dry meadows, fields; yellow.
D	Carolina Lily	Lilium michauxii	M,P,C	1'	FS	Moist, Wet	*Perennial; bulb; wet meadows, bogs, upland woods and thickets; orange spotted.
D	Turk's-cap Lily	Lilium superbum	M,P	1'	FS	Moist,Wet	Perennial; bulb; wet meadows and coves; orange spotted.
A	Catesby's Trillium	Trillium catesbaei	M,P	1'	P,Shade	Moist	*Perennial; bulb; groundcover; rich woods, hardwood forests, streambanks, slopes; white to pinkish.
A	Little Sweet Betsy	Trillium cuneatum	M,P	1'	P,Shade	Moist	*Perennial; bulb; groundcover; rich woods, hardwood forests, streambanks, slopes; maroon-red.
A	Wake Robin	Trillium erectum	M	1'	P,Shade	Moist	*Perennial; bulb; groundcover; moist wooded slopes, streambanks; maroon-red or white.
A	Large-flowered Trillium	Trillium grandiflorum	M,P	1'	P,Shade	Moist	*Perennial; bulb; groundcover; moist wooded slopes, streambanks; white to pinkish.
A	Bellwort	Uvularia perfoliata	M,P	1'	P,Shade	Moist	Perennial; bulb; groundcover; streambanks, slopes, woodlands; straw-yellow.
B	Atamasco Lily	Zephranthes atamasco	P,C	1'	FS,P,Shade	Moist	Perennial; bulb; streambanks, low woods, wet meadows; white.
C	Camas	Zigadenus leimanthoides	P,C	1'	FS	Moist	Perennial; bulb; sandy pinelands, bogs, wet meadows; yellow or cream.

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C	Death Camas	Zigadenus nuttalii	M,P,C	1'	FS	Moist	Perennial; bulb; prairies, open woodlands, meadows; yellow or cream.
	Vines						
B	Peppervine	Ampelopsis arborea	P,C	20'	FS,P	Moist, Wet	Woody vine; occurs in bottomland forests, along streams & rivers & forest margins. June-Oct.-Flowers-yellow-green. Sept.-Dec.-Black fruit with seeds. Important food source for mammals, songbirds, gamebirds & insects. A native vine alternative to porcelain berry.
A	Cross Vine	Anisosthichus capreolata	M,P,C	20'	FS,P	Moist, Dry	Woody Vine; low woods, upland woods, streambanks, fencerows, commonly found; orange. Eaten by mammals & hummingbird nectar food.
A	Field Pea Vine	Apios americana	M,P,C	5%	FS,P	Dry, Moist	Herbaceous Vine; Legume; bottomland, woods , thickets; purple
B	Dutchman's Pipe	Aristolochia durior	M,P	5'	P, Shade	Moist	Perennial; vine; streambanks, shaded woodlands; marroon to brown.
A	Rattanvine, Supplejack	Berchemia scandens	P,C	20'	FS, P	Wet, Moist, Dry	Woody vine; occurs in a wide range of sites, swamps, wet forests, bottomland forests, plantation forests as groundcover, upland mixed forests & fencerows. April-May-Flowers. Aug.-Nov.-Blue/black berries with seeds. High in crude fiber and calcium. Important food source for mammals, gamebirds, songbirds & insects.
A	Trumpet Vine	Campsis radicans	M,P,C	5'	FS,P	Moist, Dry	Woody Vine; Can become invasive, low woods, thickets, fences, fields; reddish-orange. Eaten by mammals & hummingbird nectar food.
B	Wild Yam	Dioscorea villosa	M,P,C	5'	FS,P,Shade	Moist	Perennial; vine; streambanks, open woodlands, swamp forests; yellowish green.

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B,A	Yellow Jessamine, Jassamine Vine	Gelsemium sempervirens	M,P,C	5'	FS,P	Moist, Dry	Woody Vine; Ornamental; Groundcover; thickets, fences, roadsides, open woodlands; Feb.-May-Flowers-yellow. Oct.-Jun-Seeds. Eaten by mammals, hummingbirds & butterflys.
A	Coral Honeysuckle, Trumpet Honeysuckle, Mailbox Vine	Lonicera sempervirens	P,C	10'	FS,P	Moist, Dry	Woody Vine; groundcover; thickets, fences, roadsides, open woodlands; yellow. Eaten by mammals, butterflys & hummingbird nectar source.
D	Moonseed	Menispermum canadense	M,P	10%	P,Shade	Moist, Wet	Woody vine; streambanks, rich thickets; white.
A	Passion Flower, Maypops	Passiflora incarnata	M,P,C	5%	FS	Moist, Dry	Perennial; Vine; fences, thickets, fields, roadsides, meadows; Spring-purple flowers, summer-yellow fruit. Fruit edible by humans.
A	Virginia Creeper	Parthenocissus quinquefolia	M,P,C	10'	FS,P	Moist, Dry, Wet	Woody vine; dry rocky woods, low woods, upland woods, fences, roadsides, commonly found; May-Aug.-Flowers-yellowish green. Oct.-Feb.-blue Berry. Eaten by mammals, birds & insects.
A	Catbriar, Greenbriar	Smilax bona-nox (14 species in SE)	M,P,C	2' to 6"	FS,P	Dry	Woody thorny vine; dry rocky woods, low woods, upland woods, fences, roadsides, commonly found everywhere; yellowish green flowers, black berries. Very valuable food source to 40+ species of birds.
B,A	Cat Sawbriar	Smilax glauca (14 species in SE)	M,P,C	2' to 6"	FS,P	Wet, Moist, Dry	Woody thorny vine; dry rocky woods, low woods, upland woods, fences, roadsides, commonly found everywhere; yellowish green flowers, bluish black berries. Very valuable food source to 40+ species of birds.
B,A	Roundleaf Greenbriar	Smilax roundifolia (14 species in SE)	M,P,C	25'	FS,P	Moist	Woody thorny vine; dry rocky woods, low woods, upland woods, fences, roadsides, commonly found everywhere; yellowish green flowers, bluish black berries. Very valuable food source to 40+ species of birds.

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C,B,A	Catbriar, Greenbriar	Smilax walteri (14 species in SE) cultivar without thorns	M,P,C	2' to 6"	FS,P	Moist, Wet	Woody thorny vine; swamp forests and alluvial woods, low woods, commonly found Coastal plain; yellowish green flowers, red berries. Very valuable food source to 40+ species of birds.
C	Muscadine Grape, Summer Grape, Sweet Winter Grape	Vitis rotundifolia, Vitis aestivalis, Vitis cinerea (10 species in SE)	M,P,C	20'	FS,P	Moist,Dry,Wet	Woody Vine; low woods, upland woods, streambanks, roadsides, commonly found; Apr.-June-Flowers-greenish white. July-Oct.-Fruit with seeds. Very important soft mast producers eaten by many large and small mammals, reptiles, birds and insects. Edible to humans.
B,A	American Wisteria	Wisteria frutescena	M,P,C	20'	FS,P	Moist, Wet, Dry	Woody Vine; legumes; not invasive like Asian, low woods, upland woods, streambanks, roadsides; April-Aug.-Flowers-purple or white. Butterfly food
B,A	Kentucky Wisteria	Wisteria macrostachya	M,P,C	20'	FS,P	Moist, Wet, Dry	Woody Vine; legumes; not invasive like Asian, low woods, upland woods, streambanks, roadsides; April-Aug.-Flowers-purple or white. Butterfly food
	FERNS-Groundcovers						
B	Southern Maidenhair Fern	Adiantum capillus-veneris	M,P	1"	P,Shade	Moist	Rhizome: humus rich woods and shady slopes.
B	Maidenhair Fern	Adiantum pedatum	M,P	1"	P,Shade	Moist	Rhizome: humus rich woods and shady slopes.
A	Ebony Spleenwort	Asplenium platyneuron	M,P,C	1'	FS,P	Moist,Dry	Rhizome: rocky woods, old fields, roadbanks, thickets.
C	Southern Lady Fern	Athyrium asplenioides	M,P,C	1'	P,Shade	Moist,Wet	Rhizome: streambanks, humus rich woods, swamps, shady slopes.
B	Southern Grape Fern	Botrychium biternatum	M,P,C	1'	P,Shade	Moist	Rhizome: streambanks, humus rich woods, thickets.
B	Common Grape Fern	Botrychium dissectum	M,P	1'	P,Shade	Moist	Rhizome: streambanks, humus rich woods, thickets.
A	Rattlesnake Fern	Botrychium virginianum	M,P,C	1'	P,Shade	Moist	Rhizome: streambanks, humus rich woods, thickets.

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A	Hayscented Fern	Dennstaedtia punctilobula	M,P	1'	P,Shade	Moist,Dry	Rhizome: rocky slopes, dry woods.
A	Fancy Fern	Dryopteris intermedia	M	1'	P,Shade	Moist,Dry	Rhizome: rocky woods and slopes, streambanks.
A	Mountain Wood Fern	Dryopteris campyloptera	M	1'	P,Shade	Moist,Dry	Rhizome: rocky woods and slopes, streambanks.
A	Southern Shield Fern	Dryopteris ludoviciana	C	1'	P,Shade	Moist,Dry	Rhizome: rocky woods and slopes, streambanks. Evergreen.
A	Marginal Shield Fern	Dryopteris marginalis	M,P	1'	P,Shade	Moist,Dry	Rhizome: rocky woods and slopes, streambanks.
D	Sensitive Fern	Onoclea sensibilis	M,P,C	1'	FS,P	Moist,Wet	Rhizome: ditches, marshes, swamps, streambanks and seepage areas.
D	Cinnamon Fern	Osmunda cinnamomea	M,P,C	1'	FS,P	Moist,Wet	Rhizome: streambanks, muddy ditches, marshes, swamps.
B	Interrupted Fern	Osmunda claytoniana	M	1'	FS,P	Moist,Wet	Rhizome: streambanks, muddy ditches, marshes, swamps.
D	Royal Fern	Osmunda regalis	M,P,C	1'	FS,P	Moist,Wet	Rhizome: streambanks, ditches, marshes, swamps.
B	Christmas Fern	Polystichum acrostichoides	M,P,C	1'	FS,P	Moist,Dry	Rhizome: streambanks, shaded slopes, swamp edges. Eaten by game birds.
A	Bracken Fern	Pteridium aquilinum	M,P,C	1'	FS,P	Moist,Dry	Rhizome: secondary woods, old fields, throughout. Eaten by small mammals.
B	Southern Beech Fern	Thelypteris kunthi	P,C	1'	FS,P,Shade	Moist	Rhizome: Groundcover; moist, rich woodlands.
B	Beech Fern	Thelypteris hexagonoptera	M,P,C	1'	FS,P,Shade	Moist	Rhizome: moist, rich woodlands.
B	New York Fern	Thelypteris noveboracensis	M,P,C	1'	FS,P,Shade	Moist	Rhizome: moist, rich woodlands.
D	Marsh Fern	Thelypteris palustris	M,P,C	1'	FS,P	Moist,Wet	Rhizome: streambanks, ditches, marshes, edges of swamps & bogs.
D	Netted Chain Fern	Woodwardia areolata	M,P,C	1'	FS,P,Shade	Moist,Wet	Rhizome: streambanks, ditches, marshes, swamps & bogs.
D	Virginia Chain Fern	Woodwardia virginica	P,C	1'	FS,P,Shade	Moist,Wet	Rhizome: acid swamps, bogs, wet pinelands.
A	Blunt-lobed Woodsia	Woodsia obtusa	M,P	1'	FS,P, Shade	Moist,Wet	Rhizome: Groundcover; moist, rich woodlands.

References:

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Aquatics

RIPARIAN ZONE	Common Name	Botanical Name	Mountain	Stress	Rate or	Full Sun	Soil Moisture	
			Piedmont	Tolerant	Spacing Min.	Partial	Condition:	Benefits: Habitats:
			Coastal			Shade	Wet, Moist, Dry	All these plants provide food and/or habitat for wildlife.
D - WATER'S EDGE								
D	Sweetflag	Acorous calamus	M,P,C	Tolerant	1'	FS	Wet	Perennial; swamps, marshes, streambanks, riverbanks; greenish yellow.
D	Bentgrass	Agrostis perennans	M,P,C	Tolerant	0.1	FS	Moist, Wet	Perennial; wet to moist soil in marshes, ditches and roadsides.
D	Swamp Milkweed	Asclepias incarnata	M,P	Tolerant	0.1	FS,P	Wet, Moist	Perennial; moist to wet soils of swamps, streamsides, rivers and thickets; pink.
D	Long Hair Sedge	Carex crinita	M,P,C	Tolerant	0.1	FS,P	Moist	Perennial; moist soils in ditches, low woods, meadows, streambanks.
D	Sallow Sedge	Carex lurida	M,P,C	Tolerant	0.1	FS	Moist	Perennial; moist soils in ditches, marshes, meadows, streambanks.
D	Tussock Sedge	Carex stricta	M,P,C	Tolerant	12" O.C.	FS	Moist, Wet	Perennial: marshes and meadows, can tolerate flooding.
D	Dwarf Bamboo	Dulichium arundinaceum	M,P,C	Tolerant	50'	FS	Moist, Wet	Perennial; moist soils in ditches, marshes, meadows, streambanks, bogs.
D	Virginia Wild Rye	Elymus virginicus	M,P,C	Tolerant	0.1	FS	Moist, Wet	Perennial; moist soils in ditches, savannahs, streambanks, wet meadows, and low woods.
D	Scouring Rush	Equisetum hyemale	M,P	Tolerant	0.1	FS,P	Aquatic	Perennial; aquatic, streambanks, ditches; evergreen.
D	Southern Blue Flag Iris	Iris virginica	M,P, C	Tolerant	24" O.C.	FS,P	Moist, Wet	Perennial: marshes, swamps, stream margins, can tolerate flooding.
D	Soft Rush	Juncus effusus	M,P,C	Tolerant	0.1	FS	Moist, Wet	Perennial; moist soils in ditches, swamps, ponds, streambanks, wet meadows, and low woods.

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D	Rice Cutgrass	Leersia oryzoides	M,P,C	Tolerant	0.1	FS	Moist, Wet	Perennial; moist soils in ditches, swamps, ponds, streambanks, wet meadows, and low woods.
D	Switch Grass	Panicum virgatum	M,P,C	Tolerant	0.1	FS	Moist, Wet	Perennial; moist soils in ditches, swamps, ponds, streambanks, wet meadows, and low woods.
D	Woolgrass	Scirpus cyperinus	M,P,C	Tolerant	0.1	FS	Wet	Perennial; marshes.
D	American Bur-reed	Sparganium americanum	M,P	Tolerant	0.1	FS	Wet	Perennial; shallow ponds and streams, streambanks.
D	Gama Grass	Tripsacum dactyloides	M,P,C	Tolerant	0.1	FS	Wet	Perennial; roadsides, fields, meadows, low woods, ditches.
D	Common Cattail, Broad-leaved Cattail	Typha latifolia	M,P,C	Tolerant	18” O.C.	FS	Wet	Helps stop eat-outs of land bordering water caused by muskrat.
D	Narrow-leaved Cattail	Typha angustifolia	M,P,C	Tolerant	18” O.C.	FS	Wet	Helps stop eat-outs of land bordering water caused by muskrat.
D	Arrow Arum	Peltandra virginica	M,P,C	Tolerant	12” O.C.	FS,P	Moist, Wet	Perennial: marshes, swamps, bogs, stream margins, can tolerate flooding.
D	Arrowhead	Sagittaria spp.-lancifolia	P, C	Tolerant	18” O.C.	FS	Moist, Wet	Perennial: marshes, swamps, bogs, stream margins, ponds, can tolerate flooding.
D	Mistflower	Eupatorium coelestinum	P,C	Tolerant	0.1	FS	Moist, Wet	Perennial; streambanks, wet meadows, bogs, marshes; bluish to violet.
D	Joe-Pye-Weed	Eupatorium fistulosum	M,P,C	Tolerant		FS,P	Moist, Wet	Perennial; streambanks, meadows, bogs,
D	Fringed Gentian	Gentiana crinita	M,P,C	Tolerant	0.05	FS	Moist, Wet	Perennial; *rare; wet thickets and wet meadows; bluish purple.
D	Soapwort Gentian	Gentiana villosa	M,P,C	Tolerant	0.05	FS	Moist	Perennial; *rare; upland woods; bluish purple.
D	Swamp Sunflower	Helianthus angustifolius	M,P,C	Tolerant	10	FS, P	Wet, Moist, Dry	Perennial; streambanks, wet meadows, ditches, marshes, open woods, uplands; red/purple.
D	Sneezeweed	Helenium autumnale	M,P,C	Tolerant	0.1	FS	Moist, Wet	Perennial; streambanks, wet meadows, ditches, marshes; yellow.
D	Halbeard-leaved Marsh Mallow	Hibiscus militaris	P,C	Tolerant	0.1	FS	Moist, Wet	Perennial; streambanks, wet meadows, ditches, marshes; white.
D	Rose Mallow	Hibiscus palustris	M,P,C	Tolerant	0.1	FS	Moist, Wet	Perennial; streambanks, marshes, bogs; white/red or purple centers.

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D	Althea, Rose of Sharon	Hibiscus syriacus	M,P,C	Tolerant	0.1	FS	Moist, Wet, Dry	Perennial; streambanks, roadsides, commonly cultivated; white, pink or lavender.
D	Flower of an Hour	Hibiscus trionum	M,P,C	Tolerant	0.1	FS	Moist, Wet	Annual; streambanks, marshes, bogs; yellow w/ red or purple base.
D	Spider Lilly	Hymenocallis liriosme	M,P,C	Tolerant	0.05	FS	Moist, Wet	Perennial; bulb; marshes, ditches, low woods, and swamp forest borders; white.
D	Touch-Me-Not, Jewel Weed	Impatiens pallida	M,P,C	Tolerant	0.1	FS,P	Moist, Wet, Dry	Annual; streambanks, swamps, meadows; orange/yellow color.
D	Spotted Touch-Me-Not, Jewel Weed	Impatiens capensis	M,P,C	Tolerant	0.1	FS,P	Moist, Wet, Dry	Annual; streambanks, swamps, meadows; orange/yellow color.
C	Dwarf Crested Iris	Iris verna var. cristata	M,P	Tolerant	0.1	FS,P	Moist	Perennial; streambanks, rich wooded slopes; blue.
D	Blue Flag Iris	Iris virginica	M,P,C	Tolerant	0.05	FS,P	Moist, Wet	Perennial; streambanks, wet meadows, ditches, marshes; blue.
D	Seashore Mallow	Kosteletskya virginica	C	Tolerant	0.1	FS,P	Moist, Wet	Perennial; brackish marshes; pink.
D	Carolina Lily	Lilium michauxii	M,P,C	Tolerant	0.1	FS	Moist, Wet	Perennial; bulb; wet meadows, bogs, upland woods and thickets; orange spotted.
D	Turk's-cap Lily	Lilium superbum	M,P	Tolerant	0.05	FS	Moist, Wet	Perennial; bulb; wet meadows and coves; orange spotted.
D	Moonseed	Menispermum canadense	M,P	Tolerant	0.1	P,Shade	Moist, Wet	Woody vine; streambanks, rich thickets; white.
D	Forget-Me-Not	Myosotis laxa	M,P	Tolerant	0.1	FS,P	Moist, Wet	Perennial; roadsides, open fields, gardens: blue.
D	Monkeyflower	Mimulus ringens	M,P	Tolerant	0.1	FS,P	Moist, Wet	Perennial; streambanks, marshes, bogs, wet meadows; lavender to white.
D	Narrow-leaved Mountain Mint	Pycnanthemum tenuifolium	M,P,C	Tolerant	0.1	FS,P	Moist, Wet	Perennial; meadows, pastures, thickets, woodlands, clearings: lavender/white.
D	Virginia Meadow-beauty	Rhexia virginica	M,P,C	Tolerant	0.1	FS	Moist, Wet	Perennial; streambanks, bogs, low meadows, open woods; white/pink.
D	Meadow-beauty	Rhexia mariana	M,P,C	Tolerant	0.1	FS	Moist, Wet	Perennial; streambanks, bogs, low meadows, open woods; rose/purple.

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D	Cut-leaved Coneflower	Rudbeckia laciniata	M,P,C	Tolerant	0.1	FS,P	Moist, Wet	Perennial; meadows, pastures, thickets, woodlands: orange/yellow.
D	Duck-potato, Arrowhead	Sagittaria latifolia	P,C	Tolerant	24" O.C.	FS	Wet,Aquatic	Perennial; streambanks, bogs, marshes, low meadow; can tolerate flooding, plant in first 6 inches of water; white.
D	Lizard's-tail	Saururus cernuus	P,C	Tolerant	0.2	P,Shade	Wet,Aquatic	Perennial; ground cover; streambanks, marshes, bogs; white
D	Bluestem Goldenrod	Solidago caesia	M,P,C	Tolerant	0.1	P,Shade	Moist, Wet	Perennial; streambanks, bogs, marshes, wet woodlands; yellow.
D	Downy Goldenrod	Solidago puberula	M,P	Tolerant	0.1	FS,P	Moist, Wet	Perennial; roadsides, old fields, open woodlands: yellow.
D	Rough-stemmed Goldenrod	Solidago rugosa	M,P,C	Tolerant	0.1	FS,P	Moist, Wet	Perennial; streambanks, bogs, marshes, wet woodlands; yellow.
D	Seaside Goldenrod	Solidago sempervirens	C	Tolerant	0.1	FS	Moist, Wet	Perennial; brackish marshes, bogs: yellow.
D	Tall Ironweed	Vernonia altissima	M,P,C	Tolerant	0.1	FS, P	Moist, Wet	Perennial; streambanks, marshes, wet woodlands; purple.
D	New York Ironweed	Vernonia noveboracensis	M,P,C	Tolerant	0.1	FS, P	Moist, Wet	Perennial; streambanks, marshes, wet woodlands; purple.
D	Culver's Root	Veronicastrum virginicum	M,P	Tolerant	0.1	FS,P	Moist, Wet	Perennial; streambanks, wet woodlands, wet meadows, bogs; white or cream.
D	Sweet White Violet	Viola blanda	M	Tolerant	0.1	FS,P,Sha	Moist, Wet	Perennial; groundcover; rich moist wooded slopes, streambanks; white.
D	Marsh Blue Violet	Viola cucullata	M	Tolerant	0.1	FS,P,Sha	Moist, Wet	Perennial; groundcovers; streambanks, wet woodlands, wet meadows, bogs; blue-violet.
D	Yellow Root, Bitters	Xanthorhiza	M,P	Tolerant	0.1	FS,P,Sha	Moist, Wet	Perennial; Groundcover at water edge; shaded stream banks; greenish yellow.
D	Golden Alexanders	Zizia aurea	M,P,C	Tolerant	0.1	P,Shade	Moist, Wet	Perennial; Allivial woods, meadows, swamp forests, streambanks; yellow.
D	Sensitive Fern	Onoclea sensibilis	M,P,C	Tolerant	1'	FS,P	Moist, Wet	Rhizome: ditches, marshes, swamps, streambanks and seepage areas.
D	Cinnamon Fern	Osmunda cinnamomea	M,P,C	Tolerant	1'	FS,P	Moist, Wet	Rhizome: streambanks, muddy ditches, marshes, swamps.
D	Royal Fern	Osmunda regalis	M,P,C	Tolerant	1'	FS,P	Moist, Wet	Rhizome: streambanks, ditches, marshes, swamps.

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D	Marsh Fern	Thelypteris palustris	M,P,C	Tolerant	1'	FS,P	Moist, Wet	Rhizome: streambanks, ditches, marshes, edges of swamps & bogs.
D	Netted Chain Fern	Woodwardia areolata	M,P,C	Tolerant	1'	FS,P,Sha	Moist, Wet	Rhizome: streambanks, ditches, marshes, swamps & bogs.
D	Virginia Chain Fern	Woodwardia virginica	P,C	Tolerant	1'	FS,P,Sha	Moist, Wet	Rhizome: acid swamps, bogs, wet pinelands.
E - INUNDATED	**Perennial**							
E	Long Hair Sedge	Carex crinita	M,P,C	Tolerant	0.1	FS,P	Aquatic	Perennial; moist soils in ditches, low woods, meadows, streambanks.
E	Sallow Sedge	Carex lurida	M,P,C	Tolerant	0.1	FS	Aquatic	Perennial; moist soils in ditches, marshes, meadows, streambanks.
E	Dwarf Bamboo	Dulichium arundinaceum	M,P,C	Tolerant	50'	FS	Aquatic	Perennial; moist soils in ditches, marshes, meadows, streambanks, bogs.
E	Virginia Wild Rye	Elymus virginicus	M,P,C	Tolerant	0.1	FS	Aquatic	Perennial; moist soils in ditches, savannahs, streambanks, wet meadows, and low woods.
E	Soft Rush	Juncus effusus	M,P,C	Tolerant	0.1	FS	Aquatic	Perennial; moist soils in ditches, swamps, ponds, streambanks, wet meadows, and low woods.
E	Rice Cutgrass	Leersia oryzoides	M,P,C	Tolerant	0.1	FS	Aquatic	Perennial; moist soils in ditches, swamps, ponds, streambanks, wet meadows, and low woods.
E	Switch Grass	Panicum virgatum	M,P,C	Tolerant	0.1	FS	Aquatic	Perennial; moist soils in ditches, swamps, ponds, streambanks, wet meadows, and low woods.
E	Woolgrass	Scirpus cyperinus	M,P,C	Tolerant	0.1	FS	Aquatic	Perennial; marshes.
E	American Bur-reed	Sparganium americanum	M,P	Tolerant	0.1	FS	Aquatic	Perennial; shallow ponds and streams, streambanks.
E	Common Cattail, Broad-leaved Cattail	Typha latifolia	M,P,C	Tolerant	18” O.C.	FS	Aquatic	Helps stop eat-outs of land bordering water caused by muskrat.
E	Narrow-leaved Cattail	Typha angustifolia	M,P,C	Tolerant	18” O.C.	FS	Aquatic	Helps stop eat-outs of land bordering water caused by muskrat.

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Aquatics

E	Square-stem Spikerush	Eleocharis quadrangulata	M,P,C	Tolerant	12” O.C.	FS	Aquatic	Perennial: ditches, marshes, stream & pond margins, can tolerate flooding, plant in first 6" of water.
E	Pickerelweed	Pontederia cordata	P,C	Tolerant	12" O.C.	FS	Aquatic	Perennial: ditches, marshes, stream & pond margins, can tolerate flooding, plant in first 6" of water.
E	Duck Potato	Sagittaria latifolia	P,C	Tolerant	24” O.C.	FS,P	Aquatic	Perennial: ditches, marshes, stream & pond margins, can tolerate flooding, plant in first 6" of water.
E	Softstem Bulrush	Scirpus validus	M,P, C	Tolerant	18” O.C.	FS	Aquatic	Perennial: marshes, low meadow, stream & pond margins, can tolerate flooding, plant in first 6" of water.
E	Three-square Bulrush	Scirpus americanus	M,P,C	Tolerant	18” O.C.	FS	Aquatic	Perennial: rocky streams, marshes, can tolerate flooding, plant in first 6" of water.
E	Wild Rice	Zizania aquatica	C	Tolerant	0.1	FS	Aquatic	Perennial; brackish and freshwater marshes.
E	Golden Club	Orontium aquaticum	M,P,C	Tolerant	0.1	FS	Aquatic	Perennial; pools, ponds and sluggish streams, marshes, swamps; yellow.
E	Arrow Arum	Peltandra virginica	M,P,C	Tolerant	12" O.C	FS,P	Aquatic	Perennial; streambanks, marshes, bogs, wet meadows; can toterate flooding; white.
E	Pickerelweed	Pontederia cordata	P,C	Tolerant	12 O.C.	FS	Aquatic	Perennial; ditches, marshes, stream & pond margins, can tolerate flooding, plant in first 6 inches of water.
E	Lizard's-tail	Saururus cernuus	P,C	Tolerant	0.2	P,Shade	Wet, Aquatic	Perennial; ground cover; streambanks, marshes, bogs; white
E	Water Willow	Justicia americana	M,P	Tolerant	0.05	FS	Aquatic	Perennial; rocky and sandy streambeds, margins of shallow streams, lakes, and ponds, wet shores; white w/ purple.
E	Yellow Pond Lily	Nuphar luteum	M,P,C	Tolerant	0.1	FS	Aquatic	Perennial; pools, ponds and sluggish streams; yellow.
E	American Water Lily	Nymphaea odorata	M,P,C	Tolerant	0.1	FS	Aquatic	Perennial; pools, ponds and sluggish streams; white or pink.

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Aquatics

References:

Cherri Smith, Resource Management Specialist.1998. Planting Guidelines: Choosing the Appropriate Trees, Shrubs, Herbs, and Seeds to Plant in our Parks. Department of Environment and Natural Resources, Division of Parks and Recreation, P.O. Box 27687, Raleigh, NC 27699-1615

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Organisms evolve in response to the physical, chemical, climatalogical and biological processes characteristic of a particular region. Native species are those taxa that occur in the region, or regions where they evolved. (Within a region there may be local site adaptation that creates ecotypes and other subspecific taxa.) The Nature Conservancy divides the continental United States into 63 ecological regions ("ecoregions"), based on climate and geology, rather than by artificial political boundaries.
Roughly eight ecoregions occur in the southeastern U.S. that are either partly or wholly in the states of Alabama, Arkansas, Delaware, the District of Columbia, Florida, Georgia, Kentucky, Louisiana, Mississippi, Maryland, North Carolina, Pennsylvania, South Carolina, Tennessee, and Virginia. We consider **any plant taxon that occurs within these ecoregions as native to the southeastern US., and those that occur outside of these boundaries as exotic.**

We will determine which taxa are native to the southeastern U.S. based on the available floristic assessments of this region that began in the early 1500s. Thus, native species are roughly those taxa that occurred in the southeast at the time of the European exploration. We will make determinations using available literature, primarily the Synthesis of the North American Flora (Kartez and Meacham, 1999) and other regional and local floras. Determination of uncertain taxa will be made by consulting with the appropriate primary literature sources and/or individual systematics.

Exotic Species Verses Invasive Exotic Species

According to the United States Department of the Interior (1997), **exotic species** (also called alien, introduced, non-native, and non-indigenous species) are those taxa that occur "in a given place as a result of direct or indirect, deliberate of accidental actions by humans." **Invasive exotic species** are taxa outside of their native range that threaten the survival or reproduction of native plants or animals or threaten to reduce biological diversity.

Each Southeastern State has an identified listing of invasive exotic plants.
See: Southeast Exotic Pest Plant Council www.se-eppc.org

FOR MORE COMPLETE INFORMATION ON INVASIVE EXOTIC PLANTS

Check the following web sites:

- Executive Order –Invasive Species, February 3, 1999

http://refuges.fws.gov/FICMNEWFiles/FICMNEWHomePage.html

- Southeast Exotic Pest Plant Council

www.se-eppc.org

- National Invasive Species Council Website

www.invasivespecies.gov

- Plants Database (US Department of Agriculture)

www.plants.usda.gov/plants/indes/html

- Wildland Invasive Species Program (Nature Conservancy)

http://tncweeds.ucdavis.edu/

- Alien plant invaders of natural areas (National Park Service)

http://www.nps.gov/plants/alien/factmain.htm

- Listed Noxious Weeds and Invasive Non-Native plants - Eastern Region, USDA-Forest Service

http://www.fs.fed.us/r9/weed/

Pretty Is As Pretty Does

BY JOHNNY RANDALL AND ROB GARDNER

Chinese privet and Japanese grass invading a southeastern wetland.

Most Southerners are familiar with the saying: “Pretty is as pretty does.” This phrase is generally associated with human manners or attractive behavior, and how these relate to physical beauty. Pretty is as pretty does is also a desirable attribute of landscape plants, both native and non-native. Plants with weedy tendencies, no matter how pretty, can quickly lose their charm. How many of us have planted goose-necked loosestrife (Lysimachia clethrafolia), money plant (Lunaria annua), or any number of so-called pass-along plants, only to lament the day they went in the ground or curse the person who brought the start as a gift?

In some circumstances this exotic plant material might naturalize. This phenomenon is called “getting around” by ecologist Frank Eglar- adapting to the local conditions to the extent that survival and reproduction is not dependent upon human hands. In fact, many gardeners seek out plants that will naturalize because they do spread on their own. However, a small percentage of these naturalized species get around so well that they have jumped the fence, as it were, and taken up residence outside the garden.

Most of these waifs are relegated to roadsides, abandoned agricultural fields and other human-disturbed sites.

But a small percentage of naturalized plants have found their way into natural communities. Poorly behaved and bad-mannered, naturalized exotic plants can wreak havoc on natural communities as well as agricultural lands, scenic mountain vistas, the economy, and in some cases, human health. And upsetting the ecological balance of a natural community is not pretty.

Invasive exotic species are certainly a hot-button topic for many home gardeners, professional horticulturists and the nursery industry. Much of this conflict is the result of misunderstanding. Ecologists have, for example, labeled an entire species as invasive
when it’s actually only one variety that is causing problems. Horticulturalists, on the other hand, continue to propagate and market clearly invasive plants.

Extreme viewpoints are also often held on both sides of the issue. Some conservationists recommend planting only natives while some nurserymen endorse planting anything. What people on both sides of the issue want, which is often not available, are good data showing or discounting ecological harm.

Photo by Johnny Randall

English ivy wandering unchecked across a natural woodland.

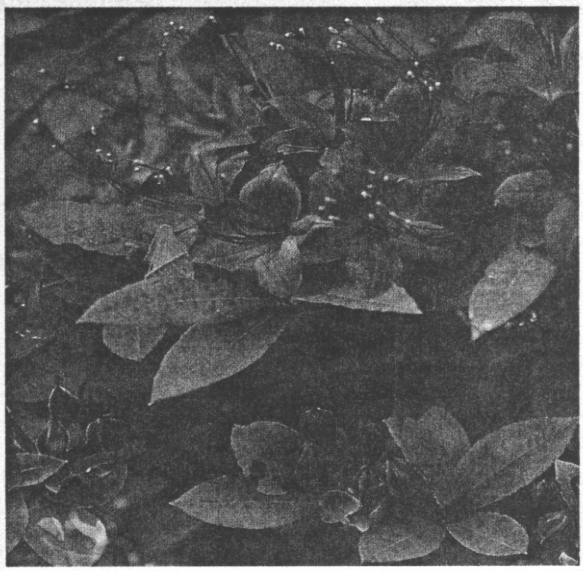
Benign Versus Invasive

Perhaps the first stumbling block for many is appreciating the distinction between an exotic plant and an invasive exotic plant. According to the U.S Department of the Interior, exotic species (also called alien, introduced, non-native, and non-indigenous species) are those plants that occur in a given place as a result of direct or indirect, deliberate or accidental actions by humans. Invasive exotic species, on the other hand, are non-natives that threaten to reduce biological diversity. Biological diversity is reduced, for example, when invasive exotics out-compete natives for space or other resources or by actually changing habitat quality by influencing soil ph, nutrient ratios and moisture levels.

It is nevertheless, sometimes difficult to draw a clear distinction between benign exotics and invasive exotics. Benign exotics include, for the most part, plant species that depend on humans for their survival (i.e., most cultivated plants). A continuum exists between these two extremes and serves to complicate benign or invasive exotic determination. Moreover, a seemingly benign exotic species can become invasive if, for example, it begins to produce fruits that it did not previously form because a specific pollinator was absent, as in the example of the strangler figs in south Florida.
On the other hand, an invasive exotic species can become less invasive if it incurs predators or pathogen sufficient to limit its spread.

One clear predicament is that many of the ornamental plant characteristics sought by horticulturists contribute to invasive plant potential. Some of these characteristics include drought tolerance, pest and disease resistance, and attractive fruits (that are often bird-dispersed). Sara Reichard, urban horticulturist at the University of Washington in Seattle, has done extensive analyses on invasive plant characteristics and developed programs for predicting invasiveness. She indicates that of the 235 woody plant invasives in North America: 54 percent also invade other parts of the world; 44 percent spread by vegetative means, such as rhizomes and root suckers; most have shorter juvenile periods (the time from germinating to fruiting); 51 percent produce seeds that will germinate without pretreatment; and only 3 percent have been introduced from other parts of North America.

Native Plants for Shade to Part-Sun



The plum-leaf azalea, Rhododendron prunifolium.

PERENNIALS

Creeping Phox, Phlox stolonifera “Bruces’s White’
Eastern Columbine, Aquilegia Canadensis
Foamflower, Tiarella cordifolia
Great Blue Lobelia, Lobelia siphilitica
Jacob’s Ladder, Polemonium reptans
Northern Maidenhair Fern, Adiantum pedatum
Soloman’s Plume, Maianthemum racemosum
Southern Shield Fern, Thelypteris kunthii
White Wood Aster, Aster divaricata
Woodland Stonecrop, Sedum ternatum

TREES AND SHRUBS
Carolina Hemlock, Tsuga Carolina
Flame Azalea, Rhododendron calendulaceum
Florida Anise Tree, Illicium floridanum
Florida Hobble-Bush, Agarista populifolia
(formerly called Leucothoepopulifolia)
Oak Leaf Hydrangea, Hydrangea quercifolia
Piedmont Azalea, Rhododendron canescens
Pinxter Flower, Rhododendron periclymenoides
Plum-leaf Azalea, Rhododendron prunifolium
Silver Leaf Hydrangea, Hydrangea radiata
Smooth Azalea, Rhododendron viscosum

Sister Species

The vast majority of our most serious invasive exotics in the Southeast (excluding sub-tropical Florida) were introduced from Japan and China. Many of these introductions are called sister species, which are closely related plants that occupy similar habitats in their respective continents. You will probably recognize some of the more notorious of these: Japanese honey-suckle *(Lonicera japonica),* Chinese privet *(Ligustrum sinense),* Oriental bittersweet *(Celastrus orbiculata),* porcelain berry *(Ampelopsis brevipedunculata)* and Japanese grass *(Microstegium vimineum).*

We have also exported our native plant species to the matched habitats of other continents. For example, our own southeastern native, Canada goldenrod (Solidago Canadensis), is presently the scourge of Japanese wetlands.

The Coker Arboretum of the North Carolina Botanical Garden, at the University of North Carolina at Chapel Hill, prominently features many of these North American natives and their Asian relatives. The close relationship of many of these species is obvious as they are interfertile. Some examples are tulip poplars *(Liriodendron tulipifera and L. chinense)*, catalpas or Indian cigar trees *(Catalpa bignonioides and C. ovata)*,and sweetgums *(Liquidambar styraciflua and L. formosana).*

Now, having taken the ecological side of the issue, we would like to reemphasize that the preponderance of ornamentals are ecologically benign and pose no current threat to our local ecology or threaten natural area sustainability. Ornamental plants provide spectacular arrays of color, texture and form to our human-crafted landscapes.


Rudbeckia peeks through a fence.


Purple coneflower is a favorite.

Our public and private gardens radiate with examples from the Earth's splendid floral diversity. We enjoy the benefits of cultivated vegetable and fruit crops and the gustatory sensations provided by culinary herbs. In short, we depend on innumerable exotic plants to enhance our quality of life. Caution is required, however, when searching for additions to our existing exotic plant repertoire.

One fundamental conflict to resolve is whether new introductions should be considered innocent until proven guilty or vice versa. Environmentalists argue that if we wait to see if a new introduction becomes invasive, then the cows will be out of the barn with no chance of "Roundup-ing", so to speak. The nursery industry, on the other hand, argues that a fabulous new introduction could be held back from the public in addition to their losing potential revenue.

Working Towards an Answer

So what are the solutions to the problem of possibly introducing the next Chinese privet or kudzu? Many are looking toward risk assessment of new introductions. As mentioned above, there are programs available for predicting a plant's invasive potential. The programs are entirely workable, but do require access to information generally available at a well-equipped library. The data can be found in local floras, regional floristic manuals, and horticultural books (such as *Hortus Third*). If an individual has access to the Internet, an Australian web site: (www.agric.wa.gov.au/progserv/plants/weeds/ weeds/weedlist.htm) lists over 9,000 species that are invasive outside their native habitats.

Let's look, for example, at English ivy (*Hedera helix*), which is perhaps the most widely planted vine in the South. It is a bread-and-butter plant for many nurserymen, but it has become a serious problem in some natural areas. And once again, the very characteristics that make it a good landscape plant make it a potential pest in natural areas and the home landscape. It is evergreen (and can photosynthesize year-round), grows rapidly, can tolerate sun or deep shade, and grows under a variety of conditions. The key factor that makes it a real threat to natural areas is that the adult form flowers and fruits. The black fleshy fruits (drupes) are eaten by birds and deposited far and wide. Seedlings germinate in undisturbed areas, such as forest interiors, where they begin their onward and upward journey, smothering herbs, shrubs and trees alike.

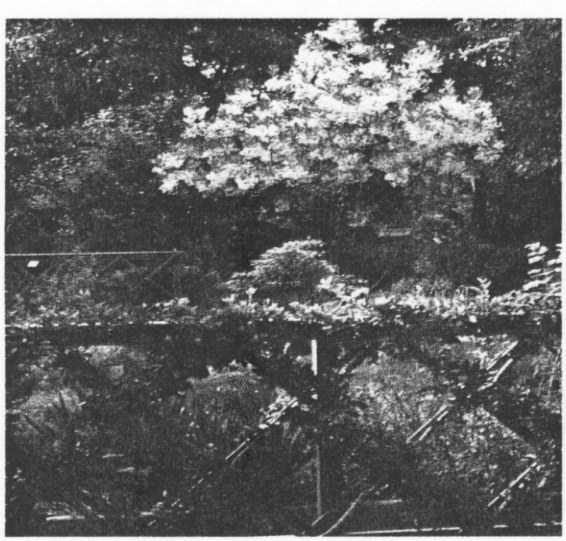


Photo by Rob Gardner

The white fringetree (Chionanthus virginicus) is an excellent, restrained native to add to the landscape.

So where does this leave us? Could we live without English ivy in our landscape? Could the nursery industry find alternatives or substitutes? Or is there a compromise? Are perpetually juvenile cultivars available that never flower or fruit? These and other hard questions need to be confronted and resolved. The work awaits us on this front.

One clear solution is to use tried and true ornamentals that aren't invasive. This array of plants comprises the vast majority of existing landscape plants. Another clear solution is to use native plants, both straight species and their cultivars.

Human nature will continue to compel us to garden and modify our human-crafted landscapes. However, it only makes sense to use ecologically responsible plant material for these endeavors. Helping to protect natural ecosystems from the biological pollution caused by invasive exotic plants is a vital step in protecting indigenous biological diversity and preserving our natural heritage. The nursery industry, botanical gardens and arboreta, and the gardening public should all be encouraged to adopt the credo, "Pretty is as pretty does", for landscape plant selection.

(*Johnny Randall, Ph.D., is an assistant director, and Rob Gardner is a curator at the North Carolina Botanical Garden, The University of North Carolina at Chapel Hill.)*

PERENNIALS

Beard Tongue, *Penstemon digitalis 'Husker Red'*
Black-eyed Susan, *Rudbeckiahirta*
Blazing Star, *Liatris spicata*
Boltonia, *Boltonia asteroids* 'Snowbank'
Climbing Aster, *Aster carolinianus*
Eastern Aromatic Aster, *Aster oblongifolius var angustatus*
Purple Coneflower, *Echinacea purpurea*
'Purple Smoke' Wild Indigo,Baptisia x *'Purple Smoke'*
Rough-leaf Goldenrod, *Solidago rugosa 'Fireworks'*
Seashore Mallow, *Kosteletskya virginica*
Thread-leaf coreopsis, Coreopsis *verticillata 'Zagreb'*

TREES AND SHRUBS

American Holly, Illexpaca
Americian Snowbell, Styraxamericana
Carolina Allspice, Calycanthus floridus 'Athens'
Carolina Silverbell, Halesia Carolina
Highbush Blueberry Vaccinium corymbosum
Swamp Haw, Viburnum nudum
Sweet Pepperbush, Clethera alnifolia 'Ruby Spice'
Sweetbay Magnolia, magnolia virginiana
White Fringetree, Chionanthus virginicus
Witch Alder, Fothergilla major
Yellowwood, Cladrastis kentuckea

Native Plants for Sun to Part-Shade

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oriental bittersweet
Photo by Chris Evans, The University of Georgia, www.invasive.org

State Chapters

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Affiliate and other Regional Organizations

Michigan Invasive Plant Council
Mid-Atlantic EPPC
New England Invasive Plant Group
National Association of EPPCs

* NOTE - in 1999 the Tennessee Exotic Pest Plant Council joined with groups and individuals throughout the Southeast to form the Southeast Exotic Pest Plant Council. The geographic scope of this new group includes Louisiana, Mississippi, Alabama, Georgia, Florida, South Carolina, North Carolina, Virginia, Tennessee, and Kentucky *

A Non-Profit Organization Established to:

- Raise public awareness about the spread of exotic plants into the southeast's natural areas
- Facilitate the exchange of information concerning management and control of invasive exotic plants
- Provide a forum for all interested parties to participate in meetings, workshops, and an annual symposium, and to share the benefits from the information provided by SE-EPPC
- Serve as an educational, advisory, and technical support council on all aspects of exotics
- Initiate campaign actions to prevent future introductions

For more information about SE-EPPC, write to:
Southeast Exotic Pest Plant Council
P.O. Box 40692
Nashville, Tennessee 37204

Upcoming events can be announced on this page and in SE-EPPC News. Send to sek@dcr.state.va.us

Exotic Pest Plants and Their Effects on Our Natural Areas

> "We must make no mistake: We are seeing one of the great historical convulsions in the world's flora and fauna. We might say, with Professor Challenger, standing on Conan Doyle's 'Lost World,' with his black beard jutting out: 'We have been privileged to be present at one of the typical decisive battles of history-the battles which have determined the fate of the world.'"
>
> Charles Elton, *The Ecology of Invasions by Plants and Animals (1958)*

Although some non-native plant species display colorful flowers and are popular as garden ornamentals, they can be highly invasive and destructive to a; natural environment. Many introduced, or "exotic" plants were planted to decorate homes and gardens. Over the years, they have escaped cultivation and have infested natural areas. Because they are growing in an environment that lacks natural controls (diseases, predation), they have an advantage over native species and can easily out compete them for habitat. This causes an imbalance in the ecosystem and threatens the biodiversity of the area.

What you can do

Promote responsible landscaping practices by learning about native plants. Natives are generally defined as plants that occurred in North America before European settlement. Large-scale changes in flora have resulted since European settlement and the introduction of exotic plants. Native plants help sustain native wildlife like butterflies, birds, mammals, reptiles, beneficial insects, and other fauna. Migrating birds depend on the food and cover, while resident species find high quality nesting sites among native trees and shrubs.

Know the habits of the species you plant. In addition to potential threats to biodiversity in natural areas, some exotics become pests in carefully planned landscapes and gardens. They may be very time-consuming to remove or control.

Buy nursery-propagated plant material. Never dig plants from the wild. When landscaping with natives, match the plants with the site conditions. Consider using plants that occur together in natural habitats. You can easily learn plan relationships by visiting natural areas and observing how plants grow.

Maintained by Stephen Killeffer. Last modified: July 1999 Send comments and suggestions about this site to sek@dcr.state.va.us

Example of Invasive Exotic plants in North Carolina:

PLANTS TO AVOID

Invasive Exotic Plant Species of the Southeastern United States
North Carolina Botanical Garden
UNC-CH,CB#3375, Totten Center, Chapel Hill, NC 27599 (962-0522)
Compiled by Allison E. Schwarz
Spring, 1999

PLANTS TO AVOID is a compilation from lists published by various regional and state agencies for North Carolina, South Carolina, Tennessee, and Virginia. Sub-regional distinctions (i.e., coastal plain, piedmont, mountains) are not made. Lists such as these are primarily based on expert observational data and not on extensive research. These data are nonetheless the most accurate approximation of the invasive exotic species in our region.

This list is intentionally extensive in order to give the public a reasonable degree of confidence that any landscape plants *not* listed have a low potential for invasiveness. For more information on invasive exotic plant species please request the Invasive Exotic Plants Resource Notebook in the reference section of the Totten Library at Chapel Hill, NC.

SCIENTIFIC NAME	COMMON NAME	FAMILY
Acer platanoides	Norway maple	Aceraceae
Ailanthus altissima	Tree-of-heaven	Simarouvaceae
Ajuga reptans	Bugleweed; Common bugle	Lamiaceae
Akebia quinata	Chocolate Vine; Fiveleaf akebia	Lardizabalaceae
Albizia julibrissin	Mimosa, Silk Tree	Fabaceae
Alliaria officinalis	see *Alliaria petiolata*	
Alliaria petiolata	Garlic mustard	Brassicaceae
Allium vinale	Wild garlic, Field garlic, Crow garlic	Liliaceae
Alternanthera philoxeroides	Alligatorweed	Amaranthaceae
Ampelopsis brevipedunculata	Amur peppervine; porcelain-berry	Vitaceae
Ampelopsis herterophylla	see *Ampelopsis brevipedunculata*	
Artemisia vulgaris	Common wormwood; Mugwort	Asteraceae
Arthraxon hispidus	Hairy jointgrass; Joint grass	Poaceae
Arundo donax	Giant reed; Elephant Grass	Poaceae
Berberis thunbergii	Japanese barberry	Berberidaceae
Broussonetia papyrifera	Paper mulberry	Moraceae
Cardiospermum halicacabum	Ballon vine; Love in a puff	Sapindaceae
Carduus nutans	Thistle, Musk, Nodding-Plumeless	Asteraceae
Carduus vulgaris	see *Cirsium vulgare*	
Carex kobomugi	Jananese sedge; Asiatic sand sedge	Cyperaceae
Celastrus orbiculata	Oriental bittersweet vine	Celastraceae
Clematis paniculatus	see *Clematis terniflora*	
Clematis terniflora	Leatherleaf clematis, Sweet autumn Virgin's bower	Ranunculaceae
Commelina communis	Common dayflower	Commelinaceae
Convolvulus purpurea	see *Ipomoea purpurea*	
Coronilla varia	Crown Vetch	Fabaceae

Cynodon dactylon	Bermuda grass	Poaceae
Dactylis glomerata	Orchard grass	Poaceae
Dioscorea batatas	see *Dioscoria oppositifolia*	
Dioscorea oppositifolia	Chinese yam, Cinnamon vine	Dioscoreaceae
Dipsacus fullaonum	Fuller's Teasel	Dioscoreaceae
Dipsacus fullaonum ssp. sylvestris	Common Teasel, Wild Teasel	Dioscoreaceae
Dipsacus laciniatus	Cutleaf Teasel	Dioscoreaceae
Dipsacus sylvestris	See *Dipsacus fullaonum ssp. sylvestris*	
Egeria densa	Brazilian Waterweed, Elodea	Hydrocharitaceae
Elaeagnus angustifolia	Russian Olive	Oliaceae
Elaeagnus pungens	Thorny Olive	Oliaceae
Elaeagnus umbellata	Autumn Alive	Oliaceae
Eleutherococcus pentaphyllus	Ginseng Shrub, Fiveleaf Aralia	Araliaceae
Elodea densa	see *Egeria densa*	
Eragrostis curvula	Weeping Lovegrass	Poaceae
Euonymus alata	Winged Spindletree, Burning bush	Celastraceae
Euonymus fortunei	Wintercreeper, Climbing euonymus	Celastraceae
Euphorbia esula	Leafy spurge, Wolf's milk	Euphorbiaceae
Fallopia japonica	Japanese Knotweed	Polygonaceae
Festuca pratensis	see *Lolium pratense*	
Foeniculum vulgare	Sweet Fennel	Apiaceae
Glechoma hederaceae	Ground Ivy or Gill-Over-the-Ground	Lamiaceae
Hedera helix	English Ivy	Araliaceae
Hesperis matronalis	Dames Rocket	Brassicaceae
Hieracium aurantiacum	Orange Hawkweed	Asteraceae
Holcus lanatus	Velvet-grass	Poaceae
Humulus japonicus	Japanese Hops	Cannabaceae
Hydrilla verticillata	Hydrilla, Waterthyme	Hydrocharitaceae
Imperata arundinaceae	see *Imperata cylindrica*	
Imperata cylindrica	Cogongrass	Poaceae
Ipomoea coccinea	Morningglory, Red, Redstar	Convolvulacee
Ipomoea hederaceae	Ivyleaf Morninglory	Convolvulacee
Ipomoea purpurea	Common, Tall Morningglory	Convolvulacee
Iris pseudacorus	Yellow Flag, Paleyellow Iris	Iridaceae
Lespedeza bicolor	Bicolor Lespedeza	Fabaceae
Lespedeza cuneata	Chinese or Sericea Lespedeza	Fabaceae
Lespedeza sericea	see *Lespedeza cuneata*	
Leucanthemum vulgare	Ox-eye Daisy	Asteraceae
Ligustrum obtusifolium	Border or Blunt Leafed Privet	Oleaceae
Ligustrum sinense	Chinese Privet	Oleaceae
Ligustrum villosum	see *Ligustrum sinense*	
Ligustrum vulgare	European or Commmon Privet	Oleaceae
Lolium pratense	Tall Fescue	Poaceae
Lonicera x bella	Whitebell, Bell's Honeysuckle	Caprifoliaceae
Lonicera fragrantissima*	January Jasmine or Sweet Breath of Spring	Caprifoliaceae
Lonicera japonica	Japanese Honeysuckle	Caprofoliaceae
Lonicera maackii	Amur Honeysuckle	Caprofoliaceae
Lonicera morrowii	Morrow's Honeysuckle	Caprofoliaceae
Lonicera standishii	Standish's Honeysuckle	Caprofoliaceae

Lonicera tatarica	Tartarian Honeysuckle	Caprofoliaceae
Lotus corniculatus	Birdsfoot Deervetch, Birdsfoot Trefoil	Fabaceae
Ludwigia uruguayensis	Primrosewillow, Hairy Water-Primrose	Onagraceae
Lysimachia nummilaria	Moneywort, Creeping Jenny	Primulaceae
Lythrum salicaria	Purple Loosestrife	Lythraceae
Lythrum virgatum	European Wand Loosestrife	Lythraceae
Melia azedarach	Chinaberry	Meliaceae
Mekilotus alba	White Sweet Clover	Fabaceae
Mekilotus albus	see *Melilatus officinalis*	
Melilatus officinalis	Yellow Sweet Clover	Fabaceae
Microstegium viminium	Japanese Grass or Nepal	Poaceae
Miscanthus sinensis	Giant Plume Grass	Paoceae
Morus alba	White or Common Mulberry	Moraceae
Morus papyrifera	see *Broussonetia papyrifera*	
Mosla dianthera	Miniature Beefsteak	Lamiaceae
Murdannia keisak	Asian Spiderwort or Anelima	Commelinaceae
Myriophyllum aquaticum	Parrot Feather or Watermilfoil	Haloragaceae
Myriophyllum brasiliense	see Myriophyllum aquaticum	Haloragaceae
Myriophyllum spicatum	European or Spiked Watermilfoil	Haloragaceae
Nasturtium officicale	see Rorippa nasturtium-officinale	
Paulownia tomentosa	Empress or Princess Tree	Scrophulariaceae
Perilla frutescens	Beefsteak Plant	Lamiaceae
Phalaris arundinaceae	Reed Canarygrass	Poaceae
Phleum pratense	Timothy	Poaceae
Phragmites australis	Common Reed	Poaceae
Phyllostachys aurea	Golden Bamboo	Poaceae
Picea abies	Norway Spruce	Pinaceae
Pinus thunbergiana	Japanese Black Pine	Pinaceae
Poa compressa	Canada Bluegrass	Poaceae
Polygonum cespitosum	Bunchy or Oriental Knotweeed	Polygonaceae
Polygonum cuspidatum	see *Fallopia japonica*	
Polygonum perfoliatum	Mile-A-Minute	Polygonaceae
Polygonum sachalinense	Giant Knotweeed	Polygonaceae
Populus alba	White or Silver Poplar	Salicaceae
Populus balsamifera Ssp. Balsamifera	Balsam Poplar or Balm of Gilead	Salicaceae
Populus candicans	see P. balsamifera spp. Balsanifera	
Pot amogeton crispus	Curly Pondweed	Potamogetonaceae
Prunus avium	Sweet Cherry	Rosaceae
Pseudosasa japonica	Arrow Bamboo	Poaceae
Pueria montana	see *Pueraria lobata*	
Pueraria lobata	Kudzu	Fabeceae
Quercus acutissima	Sawtooth Oak	Fagaceae
Ranunculus ficaria	Lesser Celandine or Fig Buttercup	Ranunculaceae
Raphanus raphanistrum	Wild Radish or Jointed Charlock	Brassicaceae
Rhamnus alnus	Glossy Blackthorn	Rhamnaceae
Rhamnus cathartica	Common Buckthorn	Rhamnaceae
Rhamnus frangula	see *Rhamnus alnus*	
Rorippa nasturtium-Aquaticum	Watercress	Brassicaeae
Rosa multiflora	Multiflora Rose	Rosaceae

Rubus phoenicolasius	Wineberry or Wine Raspberry	Rosaceae
Rumex acetosella	Red Sorrel or Common Sheep Sorrel	Polygonaceae
Senna obtusifolia	Coffeeweed or Sicklepod	Fabaceae
Setaria faberi	Japanese Bristlegrass or Giant Foxtail	Poaceae
Setaria pumila	Yellow Bristlegrass orSmooth Millet	Poaceae
Setaria viridis	Green Bristlegrass or Green Millet	Poaceae
Solanum viarum	Tropical Soda Apple Or Tropical Nightshade	Solanaceae
Sorghum halepense	Johnson Grass	Poaceae
Spiraea japonica	Japanese Meadowsweet	Rosaceae
Stellaria media	Common Chickweed	Caryophyllaceae
Torilis arvensis	Hedge-parsley	Apiaceae
Trapa natans	Water Chestnut	Trapaceae
Tribulus terrestris	Puncturevine	Zygogpyllaceae
Tussilago farfara	Coltsfoot	Asteraceae
Ulmus pumila	Siberian Elm	Ulmaceae
Verbascum thapsus	Common Mullein	Scrophulariaceae
Veronica hederaefolia	Ivyleaf Speedwell	Scrophulariaceae
Viburnum dilatatum	Linden Arrowwood	Caprofoliaceae
Vinca major	Bigleaf Periwinkle	Apocynaceae
Vinca minor	Common Periwinkle	Apocynaceae
Wisteria floribunda	Japanese Wisteria	Fabaceae
Wisteria sinensis	Chinese Wisteria	Fabaceae

For questions about this list or for additional information on invasive exotic plant species, please contact Johnny Randall at the North Carolina Botanical Garden (962-0522 or jrandall@email.unc.edu)

Managing Lawns Environmentally

By Mary Stauble, Master Gardener, Master Composter and Mecklenburg County (NC) Solid Waste Management PLANT Instructor

Having a beautiful lawn is a high priority for many home gardeners. Numerous people love and take pride in a well-maintained lawn, which can add to the value of their property. Unfortunately, lawns can be very labor intensive, costly, use large amounts of water and can even harm the environment. Mowing adds to noise and air pollution. Chemicals used on lawns such as lime, fertilizer, herbicides, pesticides and fungicides may affect water quality and some have probable chronic health affects. Still, lawns are a big business. People in the USA spend billions of dollars yearly on lawn care. How do we Master Composters advise people to manage lawns in an environmentally responsible way?

Lawns have limited environmental appeal though people like them for aesthetic and practical reasons. They don't provide habitat for wildlife. Some fescue lawns are actually poisonous to animals (fescue toxicosis). Many, which are managed chemically, are wastelands as the chemicals have killed most of the earthworms and soil microorganisms. "Perfect" lawns lack biodiversity with the aim being a grass monoculture. Besides being dull, they require a constant struggle to maintain.

Some avid gardeners have made two conscious choices. One is to completely eliminate their lawn, replacing it with mulched natural areas and plants they enjoy. Others have lawns, but upon closer inspection one realizes it is a diverse community of plants and weeds. They mow it and manage it minimally. Yet, a third path – to manage a lawn ecologically – produces an attractive lawn with minimal chemical use.

Books and information on lawn care are easy to find, but beware, different approaches exist. How does one sort through all the information to find what is good?

For all gardening, including lawn care, I advocate three environmental principles to reduce maintenance and increase success.

GARDEN WHERE YOU ARE. What works well in California, Florida or Maine, may not be right for the Southeast. (Always read national gardening magazines with a critical eye.)

WORK AT LONG-TERM SOIL FERTILITY. Have a soil test done. Feed the soil, not the plants. People with poor soils can especially benefit from adding a half-inch layer of compost over the lawn in fall.

CHOOSE THE RIGHT PLANT FOR THE RIGHT PLACE. Grow grass only where it will grow well. This takes some research as well as trail and error. Many people should shrink their lawns. Smaller, well-chose turf areas would reduce labor, water use and chemicals, while still providing soothing transition areas. Don't grow turf under trees in heavy shade where there is lots of root competition. That's a recipe for a constant battle. These areas will likely need reseeding yearly. Any area that needs yearly renovation likely has an underlying problem that needs to be addressed before the struggle will be over. Common problems include too much shade, improper pH, soil compaction, low fertility and erosion due to drainage problems.

Realize one type of grass doesn't fit all situations and personal needs. There are many types of turf with different looks and care regimes. Cooperative Extension will recommend that best ones for a given area. Dr. Bruneau, turf expert at North Carolina State University, suggests three questions folks need to ask themselves:

1. What are the environment and the purpose of that particular lawn? (Sun/partial shade, degree of traffic)
2. What is your level of expectation?
3. How much time, money and effort do you intend to spend on your lawn?

Answers to these questions will help determine which grass variety is right for their needs.

Proper cultural practices are the best aid to promoting a beautiful lawn. Homeowners should learn what kind of grass they have – a cool or warm season variety – and the name of it. For assistance, they may take a sample into Cooperative Extension for plant identification, obtain the State maintenance calendar for their type of turf, and then follow the recommendations carefully.

Poor lawns are often created by ignorance. The problem is the homeowner who cuts too low, fertilizes at the wrong time of year, and waters too frequently. As the lawns looks more and more ravaged, the vicious cycle of chemical use starts into high gear. Don't react to problems in a knee jerk way. Often a solution to one problem can create other unintended side effects. (Most pesticides kill good bugs as well as bad ones.) Manage your yard for healthy grass, seeing the big picture to prevent problems from occurring.

Practice Grasscycling, which is merely leaving clippings on the grass. This can save time and money, as it is unnecessary to bag clippings or use as much fertilizer. Fertilizer recommendations can be cut back by 25%. As the clippings decompose, they return needed nutrients back to the soil, being especially high

in nitrogen. Learn the art of proper mowing. Always mow a dry lawn. Remove no more than a third of the blade of grass at a time as more than this can stress the turf. Different kinds of grass have different optimum cutting heights. Know the recommendations for your turf type. Mow on the high side to help shade out weeds. A strong stand of grass is the best defense again weeds.

Read and follow the label when using fertilizer or any type of chemicals. More is not better. Don't apply before a rain. Consider using slow release or organic fertilizers. Take care to avoid application on nonporous surfaces, as these will likely feed into storm water drains and contaminate surface water.

Proper lawn mower maintenance can also help the grass and the environment. Have the lawnmower blade sharpened routinely. A dull blade makes a ragged cut, which promotes plant stress and disease. Air pollution will be reduced with a well-tuned machine. Always gas up mowers on nonporous surfaces. Spilled gasoline is a quick way to kill a patch of turf.

Beautiful lawns take an investment of time, money and resources. Still, they can be managed wisely to increase soil fertility using a minimum of added chemicals, which helps protect our environment. The process builds a healthy lawn. For more comprehensive coverage of this topic check out some books on organic lawn care.

Grasscycling & Lawn Care

What is Grasscycling?

Grasscycling is leaving grass clippings on the lawn to decompose. Grass clippings are 75% to 85% water. When you mow regularly, clippings quickly decompose and release nutrients to fertilizer the lawn.

Why Grasscycle?

There are many benefits – both financial and ecological – to grasscycling. You'll

- ❖ Reduce yard waste by 20% - 40% or more. (North Carolina legislation prohibits yard waste from being discarded in landfills)
- ❖ Save time, trouble and expense of bagging or putting yard waste in cans
- ❖ Save gas and energy required to transport and process grass clippings
- ❖ Reduce the need for fertilizer by one-third
- ❖ Reduce the demand for water
- ❖ Reduce negative impact on water quality from erosion and pesticide application
- ❖ Provide moisture and nutrients to the soil and cushioning layers to reduce wear

→ **Using grass clippings as a source of fertilizer for your lawn can save time and money and help protect the environment.**
Leaving grass clippings on your lawn can generate up to 25% of the lawn's yearly fertilizer needs and reduce the amount of time and money you spend fertilizing and bagging. Lawns stay greener and healthier when clippings are left on them.

→ **Grass clippings don't cause thatch.**
Thatch is caused by excessive growth from over-fertilizing; by allowing grass to get too high before mowing; or by incorrect watering. Too much thatch leads to uneven mowing, scalping, and drought stress.

Mowing

Any mower that is in good working condition and has a sharp blade can be used to grasscycle. Mulching mowers may be better than traditional mowers for those who can not mow on a regular basis. These mowers tend to cut grass into finer pieces, allowing it to filter down among the standing plants. With either mower, best results can be expected if the lawn is dry.

Tips for Mowing

√ Mow at the appropriate height. Refer to table for guidelines for mowing heights.

LAWNGRASS	HEIGHT after mowing (inches)
Bermuda grass – warm season	¾ to 1
Centipede grass – warm season	1
St. Augustine grass – warm season	3 to 4
Bahiagrass – warm season	3 to 4
Zoysiagrass – warm season	¾ to 1 ½
Tall Fescue – cool season	3 to 4
Kentucky Bluegrass – cool season	1 ½ to 2 ½
Fine Fescue – cool season	1 ½ to 2 ½
Perennial Ryegrass – cool season	1 ½ to 2 ½

(Warm season grasses will go dormant in the winter, cool season grasses will go dormant in the summer if not watered)

√ **Keep the blade sharp.** A dull blade tears the grass tips instead of mulching them. Dull blades can give the lawn a ragged appearance and may increase disease problems.

√ **Keep the deck clean**. Wash the underside of the mower after each use. A clogged deck won't mulch or discharge well.

√ **Cut as often as necessary** to insure that only 1/3 of the blade needs to be removed. During times of rapid growth, you may need to mow every 5-6 days.

√ **Cut when the grass is dry** in order to avoid a wet, sticky mess on your lawn and inside the mower deck. Mowing the lawn when the grass is dry will allow better distribution of the clippings and less chance of clogging the mower.

√ **Always keep others, ESPECIALLY CHILDREN, at a safe distance while mowing.**

√ **Mow regularly.** A basic rule is not to remove more than 1/3 of the growth at one time. Tall grass stems stimulate deep root growth, since grass roots grow as deep as the blade grows high.
Occasionally, prolonged rains make it impossible to mow regularly. In theses cases, raise the mower for the initial cutting and gradually lower the mower to the proper height. You can mow just once and recycle the longer clippings if:

- the clumps of grass are spread evenly over the lawn to allow them to disintegrate; or

- the clippings are allowed to dry for a day or two, and then mowed again to distribute them evenly

If you have not been able to mow for a while and the quantity is too great to leave on the lawn, clippings can be used as mulch (no more than 1 inch deep) in tree and shrub beds. Mowing frequency will vary with temperature, fertility, moisture, season and natural growth rate of the lawn.

Tips for Mulching with a Non-mulching Mower

Preferences for mowers and lawn treatment vary among individuals. It's possible that the mower you now own can be used for mulching. (Before using your mower for mulching, consult your local equipment dealer or your owner's manual concerning safe operational practices.)

√ If you have a mower with a trap door over the discharge chute, you may be able to use it for mulching. A mulching blade or adapter kit may be available for your mower (typical cost: $10 - $40). Never remove the bag from the mower without assuring protection from flying rocks and sticks or other materials.

√ Manual push mowers with easy-roll wheels do not use gasoline or discharge fumes into the air and are popular for use on small lawns. Use hand-powered or electric lawn care equipment whenever possible. If you must use gas-powered equipment, wait until after 6:00 pm.

√ Tune up your mower once a year. Well maintained engines are more fuel efficient and emit less air pollutants.

Basic Watering Checklist

- **Don't water** fescue, bluegrass, or ryegrass lawns in the summer unless you plan to do so all season. Be consistent with your watering routine; your lawn can't go on vacation with you. Do not be alarmed at brown, withered leaves as a result of drought. These are normal signs of dormancy on cool season grasses. Lawns allowed to go dormant should only be watered every three weeks in the absence of rainfall.
- **Water your lawn, if needed, at night**. To maximize the efficiency of the water system, water your lawn at night. The least water will be lost to evaporation at this time. (This watering schedule can increase the incidence of brown patch disease in tall fescue. The use of fungicides may be required to maintain turf quality.)
- **Lawns grown on heavy clay soils should receive a total of 1 inch of water per week. Lawns on sandy soils get ½ inch of water when irrigating**. Measure irrigation water by placing a can or two on

your lawn to catch the water. Compacted soils may take several shorter of periods of irrigation to allow the water to be absorbed. *Avoid surface runoff.*

- **Don't water until you see first signs of wilt**. Wilted lawns have a blue-green appearance, leaf curl, or footprints that remain on the lawn. Look along sidewalks or roadside surfaces for first signs of wilt. Light, frequent watering promotes shallow roots and weakens turf.
- **Don't over-water**. This promotes diseases and excessive growth. Make sure that sprinklers are watering only the yard, not the street, driveways or sidewalks.

Fertilizing

√ **Fertilize according to recommendations.** Most soils in the South East are acidic and require lime. This can be determined by a soil test, refer to the table below for proper fertilizing schedule.

Basic Fertilizing Schedule

Lawngrass	Pounds of Nitrogen Per 1,000 sq.ft. Per application*	When to Apply
Bahia grass	½	May, July
Bermuda grass	1	May, June, July, August
Centipede grass	½	May *
St. Augustine grass	½	May, June, July, August
Zoysia grass	½	April, July, August
Fescue, Bluegrass	1	February, September, November

*Use a complete balanced (N-P-K) fertilizer in which some of the nitrogen is slowly available. Fertilize centipede grass using a low phosphorus, high potassium fertilizer.

√ ***Determine the amount of fertilizer needed.*** Follow directions on the fertilizer label, or follow the procedure described below. Guard against over-fertilization.

How to Determine Fertilizer Requirements: To apply 1 pound of nitrogen per 1,000 square feet: 100 divided by the first number on the fertilizer bag equals the amount of product to be used per 1,000 square feet. Example: A 16-4-8 fertilizer. 100 divided by 16 equals 6.25. Therefore, 6.25 pounds of fertilizer per 1,000 square feet will deliver 1 pound of nitrogen.

√ ***Apply fertilizer when grass is dry.*** This prevents the foliage from being burned and allows the fertilizer to fall around the plants where it can be watered in.

√ ***Utilize natural management controls.*** Use heavy mulch for weed control. Buy pest and disease resistant plants; and encourage beneficial insects and wildlife.

√ ***Reduce potential for surface and groundwater contamination.*** Select the least toxic fertilizers and pesticides; choose products that are least persistent in the environment; and opt for slow release granular compounds as opposed to liquids.

√ ***Use products responsibly.*** Always follow label directions. Never apply before a rain, adjacent to storm drains or ditches, or within 50 feet of lakes and streams. Keep pesticides off pavement and other impervious surfaces. Store pesticides and fertilizers in a locked, dry place safe from flooding and accidental spillage; and dispose of them properly.

Use Grass Clippings in the Yard

If it's necessary to collect grass clippings, recycle them in your yard. Spread clippings over a layer of newspaper in the vegetable or flower garden. Use clippings as much under bushes. Be careful to not use clippings that have been treated with herbicides.

Never allow grass clippings to be released into the storm sewer system that discharges directly to creeks and lakes in your County. Surface water quality is negatively impacted when the trash and organic materials (grass clippings, leaves, and limbs) are left along creek banks or dumped, blown or washed directly into steam drains and creeks. Grass clippings and leaves contain residual pesticides/fertilizers; clog storm drains and grates; and decompose slowly, which decreases the amount of dissolved oxygen available to aquatic life.

Yard Waste Pick Up

Municipalities and counties that collect yard waste from the curb typically require that:

◊ Limbs: Limbs must be no longer than 5 feet in length and no larger than 4 inches in diameter. Limbs should be separated into piles small enough for one individual to handle.

◊ Stumps/Logs: Stumps and logs larger than 4 inches in diameter are usually disposed of by the generator.

◊ Contracted work: Limbs placed at curbside for collection resulting from a commercial landscaping service are usually not collected by the local government.

TOXICITY REDUCTION:
Things don't always stay where you put them

By Mary Stauble, Master Gardener, Master Composter and Mecklenburg County (NC)
Solid Waste Management PLANT Instructor

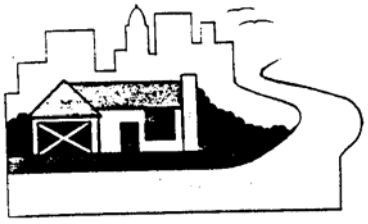
TOXICITY REDUCTION, LEARNING A NEW WAY OF THINKING

In the Southeast today (2005), many of our streams are unfit for human contact. A shocking statistic, especially when many of our streams originate within our own borders. Who's responsible? Unfortunately we all play a part in the problem, but we can be part of the solution by learning new habits.

When people have problems in their yard, many reach for a chemical fertilizer, pesticide or herbicide to solve their problems. This short term solution often leads to more problems down the road. Pesticides kill insects, both good and bad ones. Yard chemicals often pose a threat to animals, plants, and insects beyond the intended pests. They can be transported by storm water runoff and deposited into our lakes and streams, killing wildlife and contaminating drinking water supplies.

Why do plants get "sick"? Many experts believe stressed plants are more prone to attack from diseases and pests. When a plant is having problems, first examine the culture requirements the plant needs. Are they growing where they are adapted (sun, shade), is the soil fertile and the water supply adequate. Maybe you should consider growing disease resistant plant varieties. If a plant has chronic problems consider eliminating it from your landscape in favor of something proven to do well in your region.

Integrated pest management (IPM) is a better way to solve yard problems. It is an ecological approach which integrates cultural, mechanical, biological and as a last resort chemical control methods. The following articles look at this topic in more depth.



Yard Care and the Environment

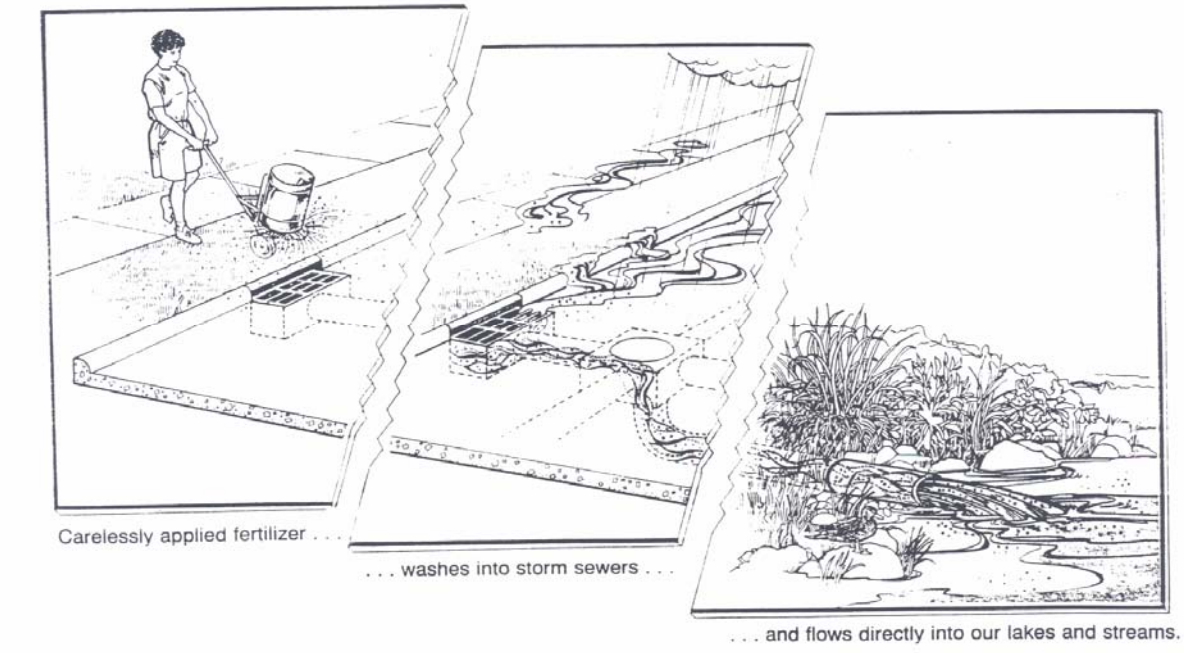
Lawn and Garden Fertilizers

A SERIES OF WATER QUALITY FACT SHEETS FOR RESIDENTIAL AREAS

Healthy lawns, trees and shrubs add to the beauty and value of a home. They also keep our lakes and streams clean by allowing rainwater to filter into the soil rather than running into the storm sewers. Maintaining healthy lawns and landscape plants, however, often requires the use of fertilizers; and improper fertilizer use can cause water pollution. Many fertilizer materials, including leaves and grass clippings, contain nitrogen and phosphorus. When these nutrients wash into lakes and streams they

- promote unsightly algae blooms and aquatic weed growth.
- lower dissolved oxygen levels in the water, and
- may release ammonia – which is toxic to fish

This pollution describes fertilizer practices that will help maintain healthy lawns and gardens, while protecting water quality in your community.



IT ALL ADDS UP

Fertilizer carelessly applied on one lawn can be a waste of the homeowner's money but may otherwise seem insignificant. On hundreds or thousands of lawns, however, careless applications can add up to a major problem for local streams and lakes.

FERTILIZER SELECTION

The label on a fertilizer bag has three numbers indicating the percentage (by weight) of the three nutrients most essential to healthy lawns. Nitrogen (N) is always listed first, following by phosphate (P_2O_5), which supplies phosphorus, and potash (K_2O), which supplies potassium. Therefore, a 25 lb. bag of 25-4-5 fertilizer contains 25% (6.25 lbs.) nitrogen, 4% (1 lb.) phosphate, and 5% (1.24 lbs.) potash. The remainder is made of ingredients such as sand or ground limestone.

Plants do not distinguish between nutrients supplied by liquid, granular or organic fertilizers. However, most organic fertilizers contain relatively low concentrations of plant nutrients compared to synthetic fertilizers, and release nutrients more slowly.

Slow-release fertilizers provide a lower concentration of nutrients over a longer period of time. Fast-release fertilizers do the opposite. Thus, the right selection of fertilizer type(s), concentrations, and frequency of application is necessary for balancing both plant needs and environmental risks. On heavy (clay) or compacted soils, fast release fertilizers are better than slow release fertilizers. The longer a fertilizer granule remains undissolved, the greater the chances of it being washed into waterways. On sandy soils, however, nitrogen can leach through the soil into the groundwater. On these soils, slow release nitrogen is preferred. Slow release nitrogen sources provide soluble nitrogen over a period of time so a large concentration of nitrogen is not available for leaching.

LAWN FERTILIZERS

In some areas, you may have a lawn planted in a cool season grass (tall fescue) or a warm season grass (St. Augustine, bermuda, centipede). Each requires a different fertilizer and care program, and each has advantages and disadvantages.

Whichever type you prefer, take care to site your lawn where it receives plenty of sun and water. In shady areas

under trees, you may find that mulch or a ground cover give better looking results for much less effort. A growing number of gardeners are 'shrinking' their lawns, even in sunny areas, and replacing them with flowers, natural landscapes, meadows and vegetable gardens-benefiting their families, their wallets and the environment.

For both types of lawns, Cooperative Extension recommends leaving grass clippings on the lawn, which reduces the need for nitrogen fertilizer by 20-30 percent. Sweep clippings off paved surfaces and back onto the lawn; otherwise, storm water can wish clippings into streams and lakes where they fertilizer the water. Keep in mind that over-fertilizing and poor timing-not grass clippings-are primary reasons for thatch problems in lawns.

Tall fescue lawns, which grow most vigorously in the fall and spring, dominate in some areas. Keep these lawns tall, 3 ½", to shade out competing weeds. Apply fertilizer, ½ to 1 lb. N, in January, September and November, for a total of 1.5 to 3 lb. per year. Summer and late spring applications can actually harm lawn by promoting more top (leaf) growth than root growth. Shallow root systems are unable to sustain lawns through dry hot spells in late summer and early fall. Cool season fertilizer applications promote deep, healthy root systems and hardy lawns.

Cooperative Extension also recommends a liming program for fescue, based on a soil test, due to our acidic soils. A good time to apply lime is December or February (not with fertilizer). Soil testing is free or at a very low cost, contact your local Cooperative Extension.

Warm season lawns, like bermuda grass, go dormant (brown) in the winter, but thrive under Southern summer conditions. They create less clippings than fescue. However, bermuda can invade garden beds and become a very annoying weed, and requires twice as much N as fescue. Centipede, in contrast, requires little fertilizer or mowing, but can be slow to establish. Fertilizer bermuda and other warm season grasses during the spring and summer. For bermuda, apply ½ - 1 lb. N per month from April to September.

GARDENS, TREES, AND SHRUBS

Start with a soil test. The nutrient requirements for garden plants vary. In general, nitrogen promotes leafy top growth; phosphorus is used for root development; and potassium is necessary for winter hardiness, disease resistance, and general plant durability. Specific recommendations can be found in publications available at your county Extension office.

Healthy trees and shrubs in well-drained, fertile soils do not require annual fertilizer applications. If they appear unhealthy, the problem may be caused by insects, disease, or the weather. Fertilizers should be applied when trees and shrubs are growing poorly and the problem cannot be traced to other causes. If plants do not

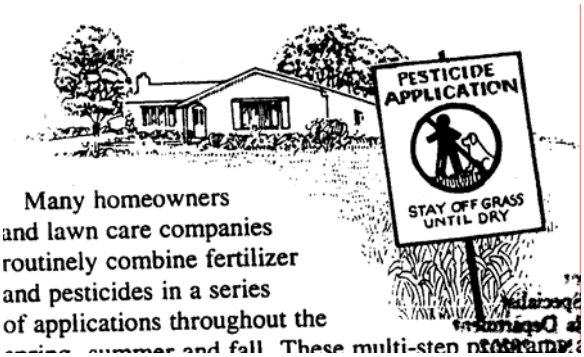
respond to fertilization, the problem may be soil related.

In general, trees and shrubs should be fertilized when they are dormant, in late fall or early spring. Fertilizing in early fall stimulates growth that might be killed in winter, providing an entrance for insects and disease organisms. Similarly, fertilizing in late spring stimulates growth that depletes stored food supplies and weakens the plant. (However, if trees and shrubs are stressed by environmental conditions, fertilizer can be applied in June.)

Healthy gardens, trees and shrubs add beauty and value to a home, allow stormwater to soak into the ground and help filter impurities from the water.

When planting gardens, trees or shrubs, cover the bare soil with a mulch to prevent erosion and *sweep (don't wash)* soil off paved areas. Phosphorus is often attached to soil particles. When these particles are washed into lakes or streams the phosphorus stimulates excess weed and algae growth.

A Note of Caution on Fertilizer-Pesticide Combinations



Many homeowners and lawn care companies routinely combine fertilizer and pesticides in a series of applications throughout the spring, summer and fall. These multi-step programs, promoted as the sure and easy path to the perfect lawn. The pressure to have a perfect lawn, however, has clouded a number of issues and literally mixed ingredients that should be kept separate. Areas of caution include:

Routine insecticide applications. Most insects found on a lawn are beneficial, and insecticides should rarely be part of a lawn care program. Insecticides can harm these beneficial insects, as well as birds, pets and people. Research indicates that only about one lawn in 200 will need an insecticide application in a given year. Even on lawns where harmful insects exist, natural controls or better lawn care practices will reduce the threat. For example, chinch bugs can be pests during a dry year, but proper watering (or even a good rain) can minimize their effects.

Routine herbicide applications. Weeds are not the cause of unhealthy lawn, they are the result. The best defense against weeds is a thick healthy lawn that comes from proper watering, fertilizing and mowing. Routine herbicide applications are unnecessary and their effects can be misleading. For example, "Weed n' Feed" products are widely used to kill dandelions in spring, when the flowers are so noticeable. The curling weeds seem to indicate that the herbicide has been effective, but in fact the herbicide may kill only the top of the weed, not the roots.

Unnecessary nutrient applications. Most commercial fertilizers contain phosphorus, a major water pollutant. Yet many soils already contain enough phosphorus for a healthy lawn. This underscores the need for a soil test before applying fertilizers. Low-phosphorus or phosphorus-free fertilizers can provide necessary nutrients while avoiding the threat to water quality.

In short, applying unneeded pesticides and nutrients in a generic, multi-step fertilizer program can be expensive for the homeowner and harmful to the environment.

Fertilizing for Healthy Plants and Clean Water

A good fertilization program promotes healthy plants that are more resistant to drought, insects and diseases. Healthy plants can also out-complete weeds and filter pollutants carried by runoff water. Indiscriminate use of fertilizers, however, can damage plants and pollute lakes and streams. To maintain a healthy lawn and garden and protect our water resources, remember:

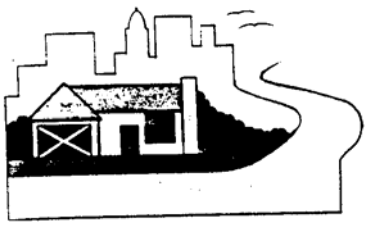
- **Test the soil**
  Before planting a garden or fertilizing your lawn, have the soil tested. A soil test takes the guesswork out of fertilizing.

- **Fertilize lawns at the correct time of year**
  Correct fertilization promotes healthy lawns with deep roots.

- **Healthy trees and shrubs do not require annual fertilizer application**
  Over fertilized shrubs, in fact, will produce more growth and require more pruning.

- **Sweep all fertilizers, soil, and vegetation off paved surfaces**
  Fertilizers, soil particles, grass clippings and leaves contain nitrogen and phosphorus which can cause nuisance weed and algae growth if washed through storm sewers into nearby waterways. In addition, decomposing leaves and grass clippings can rob aquatic life of oxygen.

- **Contact your county Extension Office**.
  Soil testing information and fertilizer recommendations for lawns and gardens, as well as suggestions for selecting the right plants, are available at your county Extension Office.



Yard Care and the Environment

Lawn and Garden Pesticides

A SERIES OF WATER QUALITY FACT SHEETS FOR RESIDENTIAL AREAS

Pesticides are chemicals used to kill or repel pests. Pesticides includes herbicides (which kill plants), insecticides (which kill insects) and fungicides (which kill fungi).

The pesticides used in a yard are poisons and may pose a health threat to the person applying them if not handled carefully. They also pose a threat to animals, plants, and insects beyond the intended pests. Honeybees are an example of non-target organisms. They are very susceptible to many household pesticides such as carbaryl (Sevin) and chlorppyrifos. Other non-targets include ladybug beetles, which are a natural biological pest control, and fish, which can suffer direct poisoning from the household insecticides permethrin, resmethrin, pyrethrin, and rotenone washed into a stream or lake.

Until recently, groundwater was thought to be immune from the many chemicals used on lawns and gardens. However, what we apply to the land surface can affect the groundwater. Contamination may occur when polluted surface water moves through the soil to the water table.

This fact sheet describes a variety of non-chemical methods of pest control. It also provides tips for using pesticides in an environmentally sound way. In virtually every case, non-chemical methods should be tried before resorting to pesticides.

INTEGRATED PEST MANAGEMENT

When we see weeds or insects invading our favorite plants, our first response is often to apply a pesticide. Some people even apply a pesticide to *prevent* invasions by pests. Both of these automatic responses lead to unnecessary pesticide use. A better approach is Integrated Pest Management (IPM).

IPM is an ecological approach to pest management that integrates cultural, mechanical, biological and, as a last resort, chemical control methods.

Steps to follow in IPM:

1. Learn about plants and their pests.
2. Select the right plants for the location.
3. Frequently inspect plants to see if pest levels are increasing or decreasing. Usually each plant species will be attacked by only a few insect pests and pathogens.
4. Identify pest symptoms. Knowledge of pests, their life cycle, and the damage they cause is essential for effective pest management.
5. Determine if control measures are really needed. For example, this can be determined by counting the number of insects present and looking carefully at the amount of damage they are causing. Most plants can tolerate a considerable amount of feeding by insects before any serious damage occurs.
6. When treatment becomes necessary, select methods that are least disruptive to natural controls and least hazardous to human health and the environment. Start with cultural, mechanical, or biological controls.
7. Evaluate your treatment to see which methods worked best.

PEST CONTROL OPTIONS

CULTURAL

Cultural pest control methods attempt to create optimal growing conditions for plants and unfavorable conditions for pests. They include:

For Gardens ...

- Select disease-resistant varieties.
- Plant varieties adopted to the geographic and soil conditions.
- Maintain a rich, fertile soil, with the proper pH for the plants being grown.
- Rotate plants to disrupt the life cycle of pests (called crop rotation).
- Plant and harvest early to promote healthier, stronger plants and avoid peak insect populations.
- Remove pest-infected plant residue in the fall.
- Plant a wide variety of crops to reduce potential pest problems (known as crop diversification).
- Evaluate plant success against water required during the growing season and the availability of sunlight. Most garden plants need plenty of each to help control pest problems.

For Lawns...

- Proper mowing heights are important. Set the mower to cut 2 to 2 ½ inches. Mow often, each time the grass reaches 3 to 4 inches. (It's important not to cut more than one-third of the height.)
- On troublesome spots, remember that improper light, moisture or soil conditions discourage good turf. Use of shade-tolerant grasses, bringing in topsoil, or switching to alternative groundcovers may be the answer.

BIOLOGICAL

Numerous organisms feed upon or infect insect pests. These biological controls frequently prevent the insect population from reaching damaging levels. Three types of natural enemies are:

- Predators – such as ladybird beetles, ground beetles and birds that consume many pests in their lifetime.
- Parasites – such as the trichogamma wasp, which will generally consume one individual insect pest during its own lifetime.
- Pathogens – such as fungi, bacteria, and viruses – which infect many insect pests simultaneously.

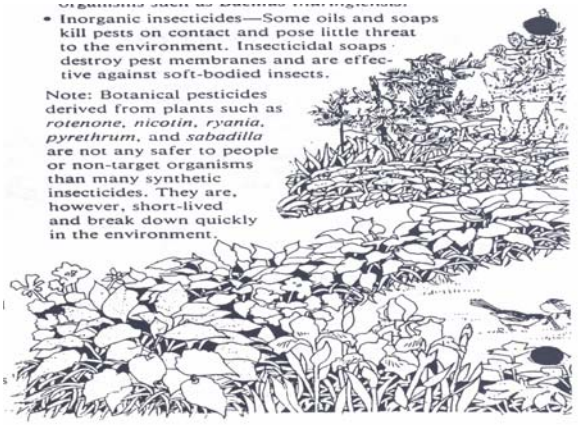
Minimizing the use of pesticides on lawns and gardens allows these natural enemies to thrive, helping to keep pest populations in check.

MECHANICAL

- Practice the vanishing art of hand-weeding. When health, expense, environmental consequences, and even time are considered, small problems with lawn weeds are handled in no better way.
- Use tillage of the soil in weedy areas, rather than herbicides
- Like hand-weeding, a few large insects (such as certain caterpillars) may be easily removed by hand in little time, and at no expense or environmental/health risk.
- Use mulches to reduce weed problems, conserve moisture, and prevent soil erosion.

CHEMICAL

When you have accurately identified a pest in damaging numbers (above the plant's tolerance threshold) and other



controls have failed or are impractical, carefully choose a pesticide. Pesticides are usually effective only during certain stages of a pest's life and at specific concentrations. If possible, select a pesticide that is "pest-specific," that is, design to kill **only** the insects, weed and disease organisms causing the damage.

Less toxic pest control products are available and include:

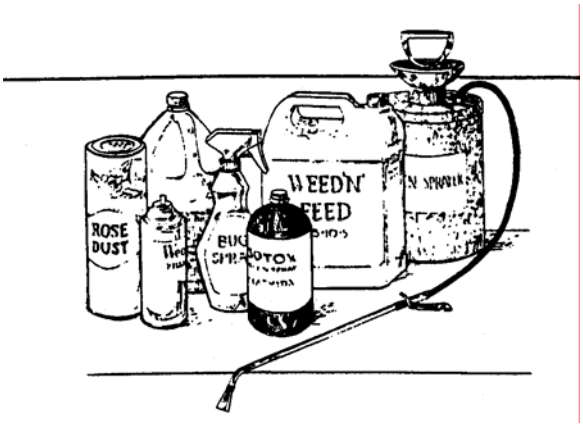
- Microbial insecticides – Those derived from micro-organisms such as *Bacillus thuringiensis*.
- Inorganic insecticides – Some oils and soaps kill pests on contact and pose little threat to the environment. Insecticidal soaps destroy pest membranes and are effective against soft-bodied insects.

GUIDELINES FOR PESTICIDE USE

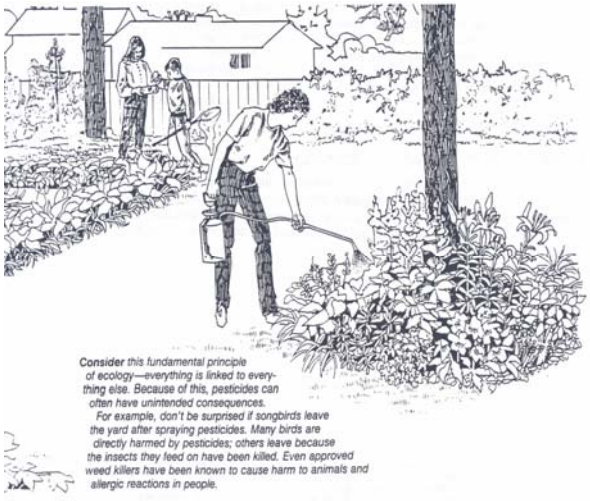
PESTICIDE APPLICATION

Use pesticides only when other control methods fail. Extensive use of pesticides can kill beneficial organisms that help keep pest populations under control.

- Read the label carefully – it tells how, when, and where to use the product.
- Apply the amount specified on the label and apply only to the plants and areas listed. Over-application is a waste of money and an environmental hazard.
- Wear protective clothing as directed on the label. Do not wash clothing contaminated with pesticides with other clothing.
- Make sure the pesticide is designated for use on the pest you want to control.
- Do not mix different pesticides unless instructed by the product directions.
- Keep pesticides in their original containers, so you know what they are and how to use them. (It's also the law)



- Do not apply pesticides if rain is forecast (unless specified on the label). Some pesticides do need to be water-in after application, but rain or watering cans wash others off plants, decreasing effectiveness, and contaminating lakes and streams. (Read the labels!)
- Never spray pesticides on breezy days. The spray drifting in the wind poses a serious danger to non-target plants and animals – including those in the neighbor's yards.
- Never apply pesticide to bare ground or eroded areas. When it rains, pesticides can easily be washed off these sites with eroding soil.
- Never apply pesticides to bare ground or eroded areas. When it rains, pesticides can easily be washed off these sites with eroding soil.
- Never apply pesticides near wells, streams, ponds or marshes unless instructions specifically allow for such uses.



PESTICIDE STORAGE AND DISPOSAL

- Don't buy more pesticide than you need. Disposal can be a problem.
- Store pesticides where children and pets can't get at them.
- Never dispose of excess pesticides by dumping them on the ground. While pesticides are broken down to non-toxic compounds by microorganisms, excessive amounts applied to the soil can "overload" this natural system. They can contaminate drinking water.
- Consider sharing left-over pesticides with neighbors, as long as they have a properly diagnosed pest problem that is not easily treatable through other means. (The pesticides must be in their original containers and registered for use in your state.) If you cannot give them away, apply them later according to label instructions.
- Never dispose of unwanted pesticides in the ditch, gutter, or storm sewer. Such practices allow the hazardous chemicals to move directly into streams and lakes where they can harm fish and wildlife. In addition, pesticides dumped down the drain can kill beneficial organisms that help purify the waste water in treatment plants or a septic system.
- Participate in a Clean Sweep Program for collection of unused pesticide products if your county sponsors one. If there is no special collection of household hazardous waste, call your local County Solid Waste Department for recommendations.

- When a pesticide container is empty, fill it up with water three times, each time pouring the rinse water into the spray tank when preparing the solution for final application. Triple-rinsing is important, because some chemical residues may remain in a container even though it appears empty.
- Dispose of empty, triple-rinsed pesticide containers as instructed on the label. Small containers can be wrapped in layers of newspaper or in a plastic bag and placed in the garbage on the day of pickup. *Never* burn or bury empty pesticide containers. The fumes from burning pesticide residues may be toxic. Buried containers could leak pesticides into drinking water.

THINKING TWICE AND ACTING SENSIBLY

When pests invade lawns and gardens, consider the full range of pest control options. In many cases pesticides will not be necessary. When pesticides *must* be used, follow label directions carefully to minimize harm to people and beneficial plants and animals.

For more information on alternative pest control methods and proper application of pesticides, contact your County Extension Office.

Pesticide Selection for Water Quality Protection

(Note: The following information is a supplement to the Water Quality Water Management series and replaces the Pesticide Leaching Potential Rating! Tables found in publications WQWM-154, 155 and 156.)

While research has shown that pollution of surface and groundwater supplies from turfgrass pesticide application is uncommon, the turf manager should still strive to avoid potential environmental contamination when choosing a pesticide. Unfortunately, there is little information available to aid in choosing a chemical control based upon minimizing potential leaching into groundwater. Although several computer models exist to evaluate leaching potential, they are difficult to use and require extensive training. In an effort to provide a relatively simple method for identifying pesticides with the least potential for contaminating groundwater, R.L. Warren and J. B. Weber of NC State University have developed a pesticide ranking system known as the **P**esticide **L**eaching **P**otential (**PLP**) Index. The index uses several pesticide characteristics to estimate leaching potential to groundwater. These characteristics include the ability to bind to soil organic matter, time required for the pesticide to degrade (persistence), rate of application, and the amount of an application that actually penetrates the turf canopy and reaches the soil.

The PLP index for various turfgrass pesticides labeled for use in North Carolina can be found on the reverse side. The index is based on a scale of 0 - 100 with a higher number indicating an increased likelihood for leaching. For example, a rating of 5 would indicate that a material had a very low potential for leaching while a pesticide with a PLP index of 95 would have a very high probability for leaching and should be avoided, especially in environmentally sensitive areas.

It is important to note that the PLP index is determined primarily based on characteristics of the pesticide and that other factors in the turfgrass ecosystem also affect leaching potential. Potential leaching into groundwater is also affected by soil pH, soil type, photo decomposition (degradation by sunlight), microbial decomposition, volatilization (pesticide evaporation), and other factors.

To minimize leaching potential, it is generally best to choose pesticides which have a low PLP index when possible. If two possible pesticide choices have a similar PLP index (within 5 points of each other) their leaching potential is fairly similar. As a rough guideline, materials having a PLP index less than 40 would have a low leaching potential while a PLP index greater than 70 would indicate that potential leaching was a concern. Also, pesticides are more likely to leach in soils which are sandy, low in organic matter, and which have a pH of 6.0 or greater.

You should also keep in mind that leaching is only one of many considerations in selecting a pesticide. There will be some instances where a pesticide exhibits low leaching potential but because of its high potential toxicity to wildlife, such as fish, extra precautions may be necessary around water. These precautions should be mentioned on the label.

Choosing pesticides with low leaching potential is only one of many tools available to turfgrass managers to help protect water quality. Contact your local Cooperative Extension Office for free publications regarding water quality protection.

Pesticide Leaching Potential (PLP) Index

Common Name	Trade Name	Rate *	PLP **		Common Name	Trade Name	Rate *	PLP **
Herbicides					**Fungicides**			
Fenoxaprop	Acclaim	0.18	0		Vinclozolin	Curlan	2.70	20
Prodiamine	Barricade	0.75	1		Fosetyl-AI	Aliette	17.40	25
Diclofop	Illoxan	1.50	10		Thiophanate methyl	Clearys 3336	2.70	31
Pendimethalin	Pre-M	3.00	18		Anilazine	Dyrene	5.40	31
Dithiopyr	Dimension	0.50	20		Iprodione	Chipco	2.50	33
Metolachlor	Pennant	4.00	22		Mancozeb	Fore	8.70	36
Sethoxydim	Vantage	0.28	26		Triadimefon	Bayleton	1.30	43
MSMA	MSMA	3.00	27		Propiconazole	Banner	1.50	45
Trifluralin	Treflan	3.00	32		Chlorothalonil	Daconil	19.60	46
Pronamide	Kerb	1.50	34		Metalaxyl	Subdue	1.36	50
Benefin	Balan	3.00	36		Propamocarb	Banol	7.24	51
Bentazon	Basagran	2.00	36		Fenarimol	Rubigan	2.00	51
Glyphosate	Roundup	4.00	36		Chloroneb	Terraneb	7.00	51
Oxadiazon	Ronstar	3.00	36		Benomyl	Tersan	2.70	55
DCPA	Dacthal	10.50	38		Maneb	Manzate	13.00	56
DSMA	2,4-D	5.00	41		Etridiazole	Koban	6.50	65
2,4-D	Methar	0.75	41		**Insecticides**			
Ethofumasate	Prograss	1.00	41		Cyfluthrin	Tempo	0.09	-7
Metsulfuron	DMC	0.10	42		Permetrin	Astro	0.90	12
Isoxaben	Gallery	1.00	44		Fenoxycarb	Award	1.50	19
Oryzalin	Surflan	3.00	44		Chlorpyrifos	Dursban	1.00	19
Bensulide	Betasan	10.00	44		Fenamiphos	Nemacut	10.00	36
Napropamide	Devrinol	3.00	46		Acephate	Orthene	3.00	36
Asulam	Asulox	2.00	47		Fonofos	Crusade	3.90	37
Metribuzin	Sencor	0.50	48		Bendiocarb	Turcam	4.10	38
Atrazine	Aatrex	2.00	52		Carbaryl	Sevin	2.10	39
Triclopyr	Turflon	2.00	53		Diazinon	Diazinon	4.30	41
Simazine	Princep	2.00	54		Isofenphos	Oftanol	1.90	44
Dicamba	Banvel	0.50	54		Isazofos	Triumph	2.00	44
Imazaquin	Image	0.50	58		Methomyl	Lannate	1.90	51
Mecoprop	MCPP	1.75	61		Trichlorfon	Proxol	8.16	52
Siduron	Tupersan	10.00	64		Ethoprop	Mocap	4.90	55
					Propoxur	Baygon	8.10	76

* Lb AI/Acre
** Index 0-100

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Soaps and Oils for Use as Pesticides in the Landscape

Insecticidal soaps and horticultural oils are considered to be gentler on the environment than conventional pesticides and perhaps less toxic to non-target organisms. Organic gardeners use soaps and oils, and they can play an important role in Integrated Pest Management program.

Insecticidal Soaps

Use: Effective against soft bodied insects such as aphids, mites, whiteflies, thrips and immature scales. Some soaps are labeled for turf applications on young caterpillars.
Mode of Action: Insecticidal soaps work by impairing the waxy layer of the insect's exoskeleton. This causes desiccation and eventual death of the insect.
Precautions: Do not use insecticidal soaps on water stressed plants or on plants with hairy leaves. Do not spray when temperatures exceed 85 degrees F. Soaps must come into contact with the pest to be effective, so the spray must be directed up under the plant leaves. Concentrated soap solutions may cause plant damage.
Application: There are several insecticidal soap products on the market, including Safer's Insecticidal Soap and M-pede. A home-made solution of 2 Tbsp of ivory soap thoroughly mixed with a gallon of water may be used.

Horticulture Oil

Also called narrow range oil, superior oil, supreme oil or summer oil.
Some oils are so damaging to plants that they are used as herbicides. An oil's safety to plants is determined by: 1) the amount of unsulfonated residue (UR) in the oil, 2) the density, and 3) the viscosity of the oil. Horticulture oils have 92-96% UR and a minimum of 60% paraffin. Dormant oils have 90% UR, and are therefore not safe for application to green plant tissues.
Use: Exposed eggs and soft bodied insects such as scales, mealybugs, whiteflies and aphids may be controlled by horticulture oil. A late dormant spray (after buds swell but before leaves emerge) will prevent many of these pest problems from becoming established in the landscape.
Mode of Action: Horticultural oils smother insects by clogging their spiracles, which are the tiny openings through which insects breathe. They also disrupt cell membranes, interfering with cell metabolism.
Precautions: Do not use horticultural oils on Arbor vitae, Juniper, Maple, Spruce or ferns. Do not use when temperatures exceed 85 degrees or when plants are under stress for moisture. Thorough coverage is essential.
Application: Horticultural oils are available under the labels Volk, Sunspray and Supreme. Summer oil sprays are typically a 1-4% mixture with water (i.e. 1-4 parts oil with 99-96 parts water). In commercial formulations, an emulsifier is added to disperse the oil. Home-made concoctions using plant derived oils such as cottonseed oil may be used, but mixing oil and water may be a problem. Some Master Gardeners have had success using Murphy's Oil Soap at a dilution of one part Murphy's to one part water.
SET 3/98

HOW TO KEEP PESTICIDES AND FERTILIZERS OUT OF STORM WATER

Improperly applied pesticides and fertilizers are transported by storm water runoff and deposited into our lakes and streams where they can kill aquatic insects and fish and contaminate drinking water supplies. This contamination can significantly degrade the quality of our valuable surface water resources.

Making good decisions and following a few easy guidelines can significantly improve water quality and minimize the effects that pesticides and fertilizers have on our aquatic environment.

WHAT YOU CAN DO?

Limit the amount and frequency of pesticide and fertilizer applications by utilizing natural management controls including:

- using heavy mulch for weed control
- using pest and disease resistant plants
- encouraging beneficial insects and animals
- leaving grass clippings on the lawn to reduce the need for nitrogen.

When fertilizers and pesticides have to be used, select those which are:

- least toxic to the life in our lakes and streams
- least persistent in the environment
- liquid as opposed to granular.

Always follow label directions, but in addition you should:

- never apply when rain is expected within 12 hours
- never apply in or immediately adjacent to storm drains or ditches
- never apply within 50 feet of lakes and streams
- keep pesticides and fertilizers off pavement or other impervious surfaces
- spot spray whenever possible
- mix liquids on grass surfaces
- mix granules on smooth surfaces for easy cleanup
- apply quick release fertilizers in the spring and summer at half rate a few weeks apart followed by light watering
- apply slow release fertilizers in the fall and winter
- test soils once every two years to prevent over fertilizing.

Always store pesticides and fertilizers in a locked, dry place, safe from flooding and accidental spillage.

Improving Water Quality with Vegetated Stream Buffers

Mecklenburg County Case Study

In November of 1999, Mecklenburg County and the City of Charlotte passed the *Surface Water Improvement and Management* (*S.W.I.M.) Stream Buffer Ordinance*. This ordinance requires the establishment of buffers along Charlotte-Mecklenburg streams in order to protect the integrity of the stream system and ensure that streams and their adjacent lands fulfill their natural functions. By the summer of 2000, each of the surrounding towns have adopted similar versions of this ordinance.

Mecklenburg County is fortunate to have abundant surface water resources including over 3,000 miles of streams. Unfortunately, the water quality of these streams has been compromised by sediment, polluted storm water runoff, land development and habitat destruction. Increases in impervious surfaces (parking lots, roads, etc.) have further contributed to the problem. Adherence to the new S.W.I.M. Stream Buffer Ordinance and voluntary participation in buffer enhancement projects will prove critical to the future protection and restoration of water quality in Mecklenburg County's streams.

In general, the new S.W.I.M. Stream Buffer Ordinance requires forested buffers on streams draining 100 or more acres. A buffer is defined as the forested/vegetated area on both sides of the stream. The width of the buffer will vary according to the size of the watershed. (see chart below)

Drainage Area	Stream Side Zone	Managed Use Zone	Upland Zone	Total Width of Buffer on each side of stream
≥ 100 acres	20 feet	None	15 feet	35 feet
≥ 300 acres	20 feet	20 feet	10 feet	50 feet
≥ 640 acres	30 feet	45 feet	25 feet + 50% of the area of the FEMA fringe beyond 100 feet	100 feet + 50% of the area of the FEMA fringe beyond 100 feet

**Buffer widths are measured horizontally on a line perpendicular to the surface water, landward from the top of the bank on each side of the stream.*
**This chart represents the City of Charlotte and unincorporated portions of Mecklenburg County buffers only.*

Newly restored or young forested buffers may appear "brushy" at first, however, over time the forest appearance will improve as a result of natural succession. Thick understory growth will naturally be replaced by rich woodland plants and moisture-loving, hardwood trees.

Voluntary efforts to restore vegetated buffers in established neighborhoods is encouraged. Stream banks that are currently covered in grass can be easily converted to forested buffer habitat. Please contact the Mecklenburg County Department of Environmental Protection at 704-336-5500 for more information.

Natural Functions of Stream Buffers

√ Decrease velocity of storm water, thereby reducing risk of erosion
√ Store flood waters.
√ Allow streams to meander, creating a diversity of habitats.
√ Filter out pollutants, sediment and excess nutrients.
√ Shade stream channels, thereby decreasing water temperature.
√ Provide wildlife habitat and corridors.
√ Greenspace for parks.

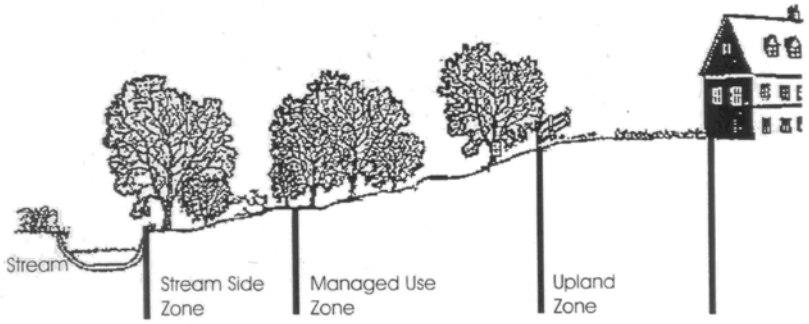
Three Zoned Urban Stream Buffer

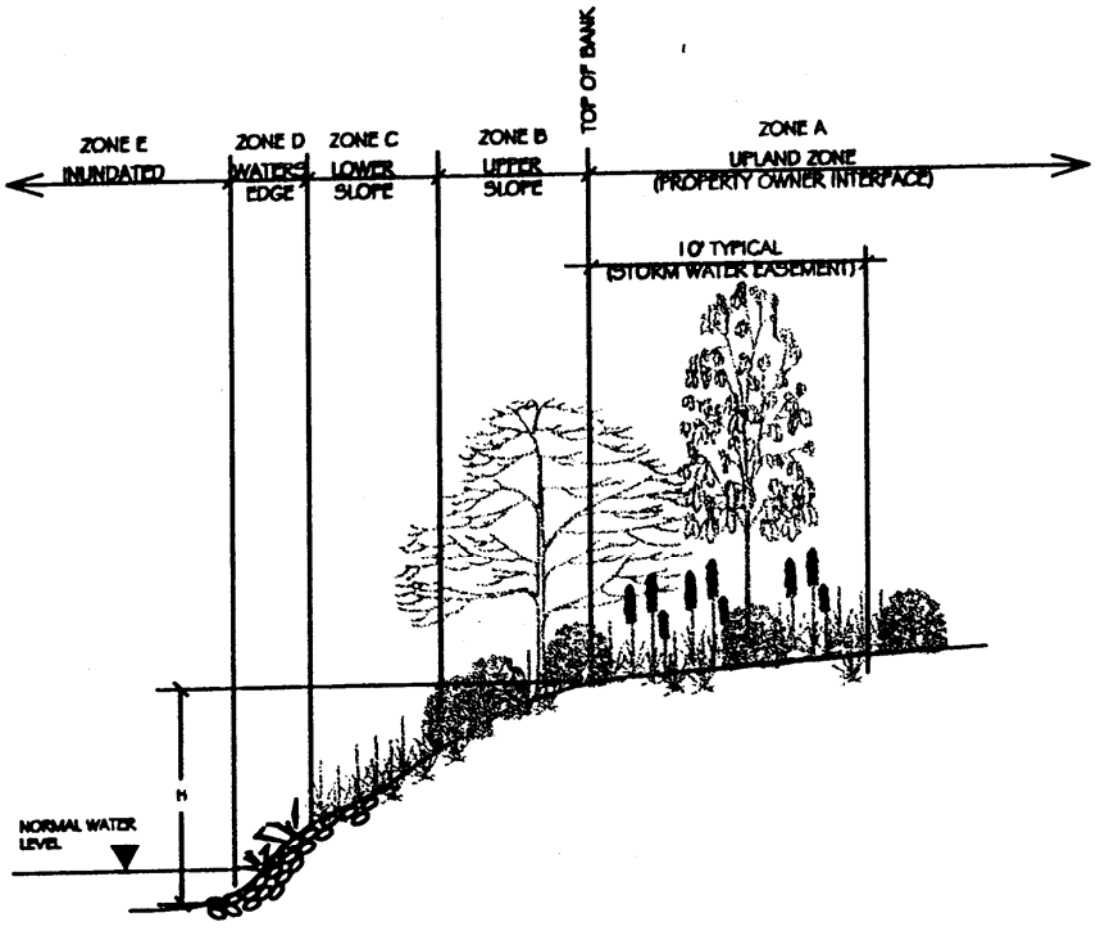
The City of Charlotte, Mecklenburg County and all the surrounding towns have adopted the "Three Zoned Urban Stream Buffer" design which offers a good balance of land use and stream protection.

Stream Side Zone: the stabilization and protection of this zone is critical to water quality; *clearing and cutting of vegetation is not allowed*, permitted uses include-flood control structures, bank stabilization, utility/road crossings.

Managed Use Zone: this area provides space for the storage of flood waters and the filtering of pollutants; limited clearing is allowed but existing tree density must be retained to a minimum of 8 healthy trees (minimum 6"caliper) per 1000 square feet, greenway trails/bike paths are allowed.

Upland Zone: area located furthest from stream, grass is allowed; gardens, gazebos, decks and storage buildings (<150 sq. ft. in size) allowed.





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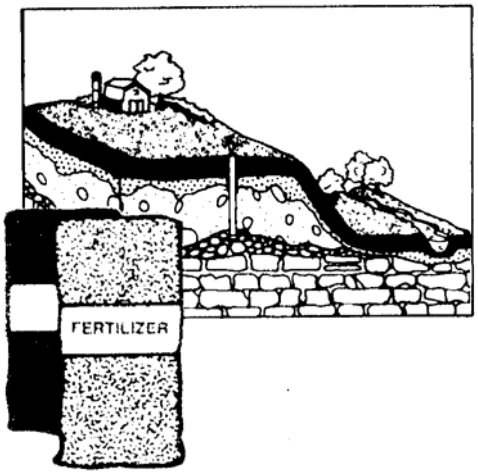

Soil Facts

Managing Lawns and Gardens to Protect Water Quality

Water quality is a major environmental issue. Society has been quick to point fingers at industry, agriculture, forestry, and other large land-disturbing activities as the culprits of groundwater and surface water contamination. Soil eroded from lawns and gardens may carry many contaminants to surface water. Water quality, therefore, is everyone's responsibility.

Normally, the contribution of water pollutants from a homeowner's lawn, the grounds of a business establishment, or recreational turf, such as golf courses or athletic fields, is small. However, when millions of small inputs are added together, the impact on water quality may be significant. The key to minimizing this collective impact is reducing the levels of pollutants that enter the system.

The purposes of this fact sheet are to identify several major pollutants that often originate in our lawns and gardens, to describe the problems they may cause, and to outline some things we can do to minimize their adverse effects on water quality. This information should benefit home gardeners, landscape developers, contract lawn care specialists, athletic field managers, and others who manage soil to grow plants for food, pleasure, or profit.

Water Quality: A Cause for Concern

One might ask why a single family with only a home lawn or garden should be concerned about the effects of their activities on water quality. The reason for concern is that the effects are not always confined to their land. Soil is a common pathway to groundwater, and soil characteristics determine the rate at which chemicals move through it. Once contaminants reach groundwater, they can travel long distances with the water. Thus, you should be sensitive to the off-site effects caused by the whole neighborhood's activities.

Soil eroded from a homestead may carry many contaminants to surface water. Contaminants may include certain kinds of fertilizers and pesticides, petroleum-based products, the residue of automobile emissions, and atmospheric deposition. Clearly, soil erosion generates a variety of serious water quality problems. Furthermore, sediment (deposits of eroded soil and organic matter) detracts from the appearance of a neighborhood. By being part of a

neighborhood, you assume responsibility as a contributor to the cumulative impact of land use on water quality.
Mecklenburg County residents depend on Charlotte Mecklenburg Utilities to provide water for their homes and businesses. Utilities relies on Mountain Island Lake and Lake Norman to provide the water supply for users. Surface water, via the Catawba river is the sole source of drinking water for the Utilities. In Mecklenburg County, an urban setting, where surface runoff is collected from streets and road surfaces and channeled to nearby creeks, contaminants from lawns and gardens affect water quality. Contaminants increase the degree of treatment required to purify the water before using, reusing it or discharging it into a public stream. Additional water treatment means an increased cost to a municipality, which passes the cost on to its residents. Thus, water quality affects the pocket books of all taxpayers.
Perhaps the threat of greatest concern is damage to human health through groundwater contamination. Residents in many rural and suburban areas rely on groundwater for their drinking water supply. In North Carolina, for example, over 50 percent of the population uses groundwater as a source of drinking water. Use of excessive amounts or improper application of fertilizers and pesticides may result in harmful chemical contamination of groundwater. For example, nitrate (NO_3) can cause methemoglobinemia ("blue-baby syndrome"), a health threat to infants. Although nitrate has been detected in our groundwater, the amounts are generally well within safe limits; on the other hand, the fact that it is present in groundwater is reason to use good judgment in applying fertilizers containing nitrogen. Although the quantities of dangerous pesticides that have been detected in North Carolina's groundwater are very small, expressed as parts per billion or even less, the fact that they are present is sufficient cause for concern.

Even in urban settings, where surface runoff is collected from streets and road surfaces and channeled to a water treatment plant, contaminants from lawns and gardens affect water quality. Contaminants increase the degree of treatment required to purify the water before reusing it or discharging it into a public stream. Additional water treatment means an increased cost to a municipality, which passes the cost on to its residents. Thus, water quality affects the pocket books of all taxpayers.

Sources of Pollution

Clusters of housing, mobile home parks, convenience stores, recreation facilities, and other types of development increase the amount and diversity of pollutants cast into the community's watershed. Three main threats to water quality can be identified.

Soil Erosion. Whenever water, as intensive rainfall or irrigation, falls on bare soil surfaces in gardens or lawns, sand, silt, clay, and organic matter may be moved away from the site. The potential for erosion increases with slope, but unless there is runoff, raindrops cannot do much damage. It is the transportation of soil particles and organic matter in runoff that causes concern. This transported sediment can choke lakes and carry chemicals into

waterways, making them unsuitable for recreational fishing, boating, or swimming. Everyone, including the urban resident, farmer, gardener, recreational enthusiast, and taxpayer must pay for the damage.

Nutrient Management. An attractive lawn, vigorously growing shrubs and flowers that show off the house, and a productive garden are the pride and joy of many homeowners. Fertilizer nutrients, especially nitrogen, phosphorus, and potassium, contribute to the health and beauty of these plants. Nitrogen and phosphorus, however, must be managed carefully to ensure that excessive amounts do not degrade water quality. Too much nitrogen and phosphorus along with carbon in surface water cause eutrophication (death from excessive algae growth) in rivers, lakes, and ponds. High nitrogen levels in groundwater and surface water can lead to the ingestion of nitrogen in its nitrate (NO_3) form, which can cause health problems in humans and livestock. Phosphorus accumulates in lakes and ponds primarily from inflow of sediment that has phosphorus attached to it. Preventing erosion greatly reduces the likelihood of phosphorus being a threat to water quality. Nitrogen whether from compost or fertilizer may leach past plant roots and accumulate in groundwater or eventually move out to surface impoundments if not used completely by grass, shrubs, or garden crops.

Pesticide Management. In addition to fertilizers, many homeowners use numerous conveniently packaged pesticides (herbicides, insecticides, and fungicides) to ward off pests around their house, lawn, and garden. Excessive use of these products could lead to their deposition in lakes and streams if they are carried off with sediments. Water-soluble pesticides may leach in sandy soils with subsequent movement to groundwater or surface water.

Reducing Water Pollution

Strategies for reducing or preventing water contamination by sediment, fertilizers, and pesticides are based on common sense. Homeowners, gardeners, and professional plant managers should determine whether their activities cause sediment, fertilizers, or pesticides to move and concentrate in an environmentally unacceptable manner.

Erosion Control. Land-disturbing activities, uncovered soil surfaces, and the absence of water-retention structures may contribute to excessive amounts of sediment in creeks and streams and on streets, playgrounds, and neighbors' property. Try to hold soil in place so that the amount of sediment generated from water erosion is small and does not become a nuisance.

Nitrogen Management. Nitrogen is classified as a "mobile nutrient," meaning it is water soluble and moves with surface water. To reduce the risk of water contamination when applying nitrogen to lawns, shrubs, flowers, trees, or vegetables, use modest amounts.

Application Recommendations:

□ North Carolina State University turf specialists suggest that for fescue you should apply no more than 3 pounds of nitrogen per thousand square feet per

year. This amount should be split into three applications: one-third applied in February, one-third in September, and one-third in November.

□ For vigorous summer grasses, such as the various kinds of Bermudagrass, use no more than 6 pounds of nitrogen per thousand square feet per year. Apply 1/2 pound in April, 1 1/2 pounds in May and June, 1 pound in July and August, and 1/2 pound in September. Centipedegrass should receive only 1/2 pound of nitrogen per thousand square feet in July. These suggestions will minimize the amount of unused nitrogen.

□ For garden vegetables, use no more than 3 to 4 pounds of nitrogen per thousand square feet. In most cases, splitting nitrogen applications for vegetables into at least two or even three applications during the early part of the growing season will ensure that adequate nitrogen is applied throughout the growth period in contrast to applying all of it early in the season before maximum growth and nutrient uptake occur. Unused nitrogen is susceptible to leaching and therefore more likely to accumulate in surface water or groundwater.

Literature from the Cooperative Extension Service, suggestions from reliable garden store operators, or suggestions from soil-testing laboratories will help guide you in the amount to apply.

Pesticide Management When applying pesticides:

□ Read container labels correctly.
□ Use the lowest effective rate listed on the label for any one application. The thought that "if a little will do a little good, a lot will do a lot of good" is a fallacy.
□ Identify pests correctly so that you use the proper pesticide and do not wastefully apply inappropriate materials.
□ Sweep granules of fertilizer or pesticide that may fall on sidewalks, patios, and driveways off onto the lawn.
□ Calibrate spreaders and sprayers so that you know how much pesticide you are applying to the area.
□ Learn about alternative pest control measures, such as beneficial insects, crop rotation, residue destruction, varietal resistance, proper planting dates, and companion cropping systems that may be good alternatives for your pest management problem.
□ Develop some tolerance of weeds, insects, and disease. A low level of pests will not detract from the overall beauty of lawns and gardens and may help guard against the temptation to use pesticides unnecessarily.

Irrigation

□ Irrigate turf, gardens, and ornamentals carefully. In deep, sandy soils, excessive irrigation may leach soluble pesticides and nutrients deep into the soil and may contaminate groundwater.
□ Guard against irrigation runoff on sloped sites or soils (clay) with severely compacted surfaces. The practice of "coring" (punching holes in soil surfaces) may help to reduce the amount of runoff.

Disposal of Chemicals

One potentially serious source of groundwater and surface water contamination is the disposal of unused pesticides. It is tempting to flush them into sinks and toilets or to pour concentrates in the woods or on the edges of home lots. Serious health or water quality hazards may be caused by these practices. Pesticides and other hazardous chemicals greatly reduce the performance efficiency of home, community, or municipal waste treatment systems. A safe way to dispose of unused or old pesticides is to accumulate them in plastic-lined boxes or in metal or plastic pails and deposit them at a qualified and properly designed hazardous waste storage facility. Many cities and towns throughout the South East are now systematically collecting hazardous wastes (including pesticides) at a central point for proper disposal. In your county, call the County Solid Waste Management or Public Works Dept. to ask about disposal collection sites. With proper storage, pesticides will keep their effectiveness for several seasons. Use them properly and completely, purchase the smallest quantity possible, and you will avoid the problem of disposal.

Conclusion

Fortunately, you do not have to choose between having an attractive lawn or garden and protecting water quality. The key to achieving both goals is to use chemicals only when needed and then use them judiciously. Reduce soil erosion by keeping soil covered with mulches, matting, and ditch liners. Manage the application of nutrients to keep phosphorus and nitrogen out of the water.

Contact your county Extension office whenever you have questions about lawn and garden products and their possible impact on water quality.

References and Suggested Readings

North Carolina Agricultural Chemicals Manual (published annually)
Carolina Lawns (AG-69)
Tall Fescue and Kentucky Bluegrass Athletic Field Maintenance Calendar (AG-430)
Bermuda Athletic Field Maintenance Calendar (AG-429)
Tall Fescue Farm Maintenance Calendar (AG-367)
Centipedegrass Lawn Maintenance Calendar (AG-381)
Zoysiagrass Lawn Calendar (AG-431)

Soil Science Fact Sheets

Soils and Water Quality (AG-439-1)
Nitrogen Management and Water Quality (AG-439-2)
Pollutants in Groundwater: Risk Assessment (AG-439-8)

Good Soil Management Helps Protect Groundwater (Ag-439-9)
Pollutants in Groundwater: Health Effects (AG-439-14)

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Published by
The North Carolina Cooperative Extension Service
North Carolina State University at Raleigh, North Carolina Agricultural and Technical State University at Greensboro, and the U.S. Department of Agriculture, cooperating, State University Station, Raleigh, NC., R.C. Wells, Director. Distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914. The North Carolina Cooperative Extension Service is an equal opportunity/affirmative action employer. Its programs, activities, and employment practices are available to all people regardless of race, color, religion, sex, age, national origin, handicap, or political affiliation.
7/91-7M-TMD-210341 AG-439-21
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AG 439-21 Published by: North Carolina Cooperative Extension Service
Publication Number: AG 439-21
Last Electronic Revision: March 1996 (JWM)
Edited by D. Ann Gill, Sr. Environmental. Specialist..

Ask those fly predators to stick around!

Strategies for Encouraging Beneficial Insects in the Field

FIRST POSTED: October 2001
RELATED ARTICLE: Managing filth flies with parasitic wasps

By Dr. Richard McDonald
Imagine you've just received an invitation in the mail to attend a banquet being held in your honor. The menu accompanying the invitation lists all your favorite foods. Are you going to come? You bet you are!!
The gist of this analogy is that just like us, beneficial insects need sources of food and shelter in order to stick around. You can weave "web of life" in your garden or farm by planting specific plants. Also, by thinking ahead and anticipating the types of pest problems you might have, you can encourage the right beneficial insects to be there when you need them to attack the pests. My motto is: "If you plant it, they will come. Or, I will buy them (beneficials) once and have them here forever after..."

In fact, in keeping with this perspective, think of two terms:

1) **Farmscaping**, which is the deliberate planting or modification of an agricultural environment with specific plants to encourage populations of beneficial insects, and
2) **"IPPM"** - Rather than the term IPM (Integrated PEST Management), I encourage you to be thinking "IPPM" - Integrated PARASITE and PREDATOR Management (This term comes from Dr. Everett Dietrich, the grandfather of beneficial insect rearing).

These two comparisons are equal to the difference between Eastern and Western medical thought--Western medicine treats the illness or its symptoms, while Eastern medicine, with its use of tonics, focuses on keeping you *well in the first place*. It is the same with your garden or farm. By using IPPM and having the beneficials there IN THE FIRST PLACE, you can *nip many of your pest problems in the bud before they ever have a chance to become a problem.* So let's look at a few ecological principals to make your garden/growing area more attractive to beneficial insects:

1) **Have something blooming all the time -** This may be impractical in the winter months, but if you have a greenhouse, let some of your crops bloom. For example, crucifers like broccoli have flowers that are very appealing to beneficial wasps. It also turns out that these flowers are prime mating sites for the wasps, too. This is good news, because if a female wasp is not mated, she lays all male eggs, the population crashes, and so does your beneficial wasp population. Also, if you have a greenhouse, you can "jump start" your beneficial insect populations there, and then let them out into the garden or farm to welcome the pests as they arrive.

2) **Nectar** - Many beneficials, from parasitic wasps to ladybugs, need to have nectar around. Some of the best plants you can have for this purpose are those in the wild carrot family (also known as Umbellifera), such as dill, fennel, tansy, queen Anne's lace, caraway, coriander, parsnip, etc. Also, other plants have "extrafloral nectaries," or nectar glands that are not associated with flowers.

A good example of this is the peony or sweet potatoes. Peonies have extrafloral nectaries located on their leaves, which is why they are usually covered with ants, which are guarding and hoarding the nectaries for themselves against other insects. Sweet potato plants have these extrafloral nectaries too. Parasitic wasps

and parasitic flies use these extrafloral nectaries as important food sources. For fly parasites, their favorite food plants are in the wild carrot family (*Umbellifera*). By planting a variety of these types of plants – dill, fennel, Queen Anne's Lace, Patrinia, Tansy, Coriander, etc., near your fly breeding areas (along fences or other out of the way places), you can ensure that some of these plants are in bloom during the seasons you need them - which with flies is nearly year round. Make sure your fly parasite wasps are getting their minimum daily adult requirement of nectar. Studies have shown that wasps well fed by nectar lay 3-fold to 5-fold more eggs than "normal" wasps.

3) **Pollen** - When certain predatory insects (which beneficials often are) have eaten almost all of their prey population, they will leave unless there is an alternative form of protein around. Once again, many plants in the wild carrot family can provide pollen. Another good pollen producer is the corn plant, with its big tassels on top showering everything around it with pollen. In fact, many fruit farmers in California are now planting corn in their orchards to keep the beneficials there.

4) **Overwintering sites for beneficials** - It turns out that many beneficials make cocoons and hibernate in or very near the plants where they find their hosts. For example, let's take broccoli again. By leaving some broccoli plants to overwinter, the cocoons of parasitic wasps can survive on the plant, and then become the starter colonies of beneficials to ride herd on the first pests that attack broccoli, like the imported cabbage worm, Pieris rapae (L.). It might look a little messy to leave the plants in the field and not compost them, but, hey, who says pest management comes without a price? If this strategy is not to your liking, another would be to pull the broccoli plants up and set them aside somewhere (until mid- to late-April or so) in order to make sure that the beneficials have emerged, before you compost the plants. Recent research has shown that yarrow and comfrey are also excellent overwintering plants for parasitic wasps.

Finally,

5) **Encourage Biodiversity!** - Remember that insects are part of the web of life in your garden or farm (or compost facility). The beneficial insect complex is not only composed of parasitic wasps and flies, predatory beetles, lacewing larvae, ladybugs and so on, but ALSO the pollinators, antagonists/competitors that occupy and compete for space and food with potential pests, and finally the saprophytes and decomposing insects that help complete the food cycle back to the soil so the cycle can start again. And remember, "if you plant it, they will come...."

FARMSCAPING: Top Fall Appalachian Plants for Beneficials

Patrina, Autumn joy sedum, vetches, chrysanthemum (Pacifica), tansy, bronze fennel, garlic chives, yarrow, Comfrey, and some of the last broccoli for overwintering on/underneath, Queen Anne's Lace/other wild carrot family plants and Goldenrod.

For further information on Farmscaping, go to the ATTRA web site (www.attra.org) and click on the publications section.

Symbiont Biological Pest Control, 194 Shull's Hollar, Sugar Grove NC 28679
(828) 297-BUUG or email:
the_edge@boone.net
www.drmcbug.com

Beneficial Insects

Think before you spray a pesticide: you may kill the insects that are helping you keep pests in check. This means you will have to spray more in the future.

Natural predators, such as lady beetles, green lacewings, and parasitic wasps, can help you control pests. While you can buy many of these predators, it's probably cheaper and more effective to encourage the ones already in your garden. Many beneficial insects need to sip flower nectar to survive. Plan your garden to feed beneficial insects by choosing a variety of plants that will bloom as many months of the year as possible.

Birds can also be very helpful with controlling pests in your garden. Trees, shrubs with berries, birdhouses and water features all encourage birds to visit your yard.

Here are some ways to help your natural helpers: Plant nectar-producing flowers to further increase the food supply. Plants in the cabbage, carrot, sweet potato, and sunflower family are especially attractive to beneficial insects. Control ants, which may prevent predators from controlling pests. Don't use persistent, broad-spectrum, contact insecticides. These provide only temporary pest control and are likely to kill more of the natural enemies than the pests. When their enemies are gone, pest populations may soar and become more of a problem than before they were sprayed.

Some plants that attract beneficial insects: (Adapted from Organic Ag Advisors, Colfax, CA.)

Angelica, bee balm, buckwheat, calendula, candytuft, ceanothus, chervil, cilantro, clover, Daisy, dill, erigeron, evening primrose, fennel, goldenrod, gypsophila lovage, parsley, Queen Anne's lace, rue, snowberry, sunflower, sweet alyssum, sweet cicely, thyme, valerian, and yarrow.

Consider learning more about beneficial insects by visiting these websites:

Biological Control Virtual Information Center http://www.anbp.org/

The Beneficial Insect Company Buglogical Control Systems http://www.thebeneficialinsectco.com

Biocontrol Network http://www.biconet.com/

Bug Farm Biocontrol Network http://www.bugfarm.com

Gardens Alive http://www.gardensalive.com

Extremely Green Gardening Company http://www.extremelygreen.com

NC Horticultural Oils as Insectides http://www.ces.ncsu.edu/depts/ent/notes/Other/not45.html

Chemical Alternatives Advisor http://www.panna.org/resources/advisor.html#ants

Companion Planting for Beneficial Insects

Plant	Beneficials Attracted
Anise *(Pimpinella anisum)*	Ladybugs, parasitic mini-wasps, tachinid flies
Basket-of-Gold *(Aurinia saxatilis)*	Ladybugs, hoverflies
Bee balm *(Monarda* spp.)	Bees, parasitic mini-wasps, beneficial flies
Coreopsis *(Coreopsis tinctoria)*	Spined soldier bugs, hoverflies, tachinid flies
Cosmos *(Cosmos bipinnatus)*	Parasitic mini-wasps, hoverflies, tachinid flies, bees
Dill *(Anethum graveolens)*	Lacewings, hoverflies, ladybugs, parasitic mini-wasps, tachinid flies
Fennel *(Foeniculum vulgare)*	Lacewings, hoverflies, ladybugs, parasitic mini-wasps, tachinid flies
Feverfew *(Tanacetum parthenium)*	Hoverflies
Golden Marguerite *(Anthemis tinctoria)*	Lacewings, ladybugs, hoverflies, parasitic mini-wasps, tachinid flies
Lovage *(Levisticum officinale)*	Beneficial wasps, ground beetles
Painted daisy *(Chrysanthemum coccineum)*	Tachinid flies, parasitic mini-wasps
Sweet alyssum *(Lobularia maritima)*	Hoverflies
Tansy *(Tanacetum vulgare)*	Ladybugs, predatory wasps, many other beneficials
Yarrow *(Achillea spp.)*	Lacewings, hoverflies, ladybugs, parasitic mini-wasps
Zinnia *(Zinnia elegans)*	Ladybugs, parasitic mini-wasps, bees

http://www.organicgardening.com/library/companion_planting.html

Rodale Organic Gardening

Alternatives to Chemicals Links

Below is a listing of websites with alternatives to chemicals listed on each:

The Healthy Home http://www.care2.com/channels/lifestyle/home/#55
Agricultural Resources Center and Pesticide Education Project
http://www.pested.org/informed/factsheets.html
NC Integrated Pest Management Network
NC Cooperative Extension
US EPA Office of Pesticide Programs
Center for Integrated Pest Management
NC Department of Agriculture and Consumer Services-Pesticide Section
Residential Integrated Pest Management
http://frugalliving.about.com/
http://www.dirtdoctor.com/newhome.php
http://www.soilandhealth.org/01aglibrary/01aglibwelcome.html

Ecology for Gardeners

Brookland Botanical Gardens, http://www.bbg.org/index.html
Edited by D. Ann Gill

Our gardens, as Rachel Carson showed us in her book *Silent Spring*, are inextricably linked with the larger landscape. It's our task as stewards of the Earth to make sure that the ecological role our gardens play is a positive one.

Introduction

***Ecology**: The science of the relationships among living organisms and between organisms and their environments.*
***Ecosystem**: A functioning unit of nature that combines biological communities and the environments with which they interact. Ecosystems vary greatly in size and characteristics.*
The science of ecology had been developing for over a century, yet most people never heard the word until the 1960s and the publication of Rachel Carson's book, *Silent Spring*, which documented how chemical pesticides were spreading insidiously through the food chain and threatening the survival of many bird species. The book brought into sharp focus the ease with which the natural balance of plants, animals, and the environment that comprises life as we know it on this planet can be tipped. From the oil crises of the 1970s to the nuclear fallout from the Chernobyl reactor in the 1980s to the more recent evidence of ozone depletion and climate change on a global scale, we continue to be reminded of the need to protect the biosphere.

Gardeners are mainly concerned with plants, specifically the ones we grow in our gardens. But our gardens, as Rachel Carson showed us, are inextricably linked with the larger landscape. As cities and suburbs spread, gardens and other human-influenced environments predominate. It is our task as stewards of the Earth to assure that the role our gardens play is a positive one. This requires an understanding of ecological relationships.

The first step in understanding ecological relationships in the garden is understanding those in plant communities in the wild. Have you ever wondered why oaks grow in some woods and not others? Why the East is covered largely with deciduous trees, while in the West conifers dominate? For decades, scientists have been studying vegetation associations, the distinctive mixes of species that predominate in different areas of different regions. Over the past century or so, ecologists have learned that such natural systems are defined by two major kinds of order: structural and functional. A terrestrial ecosystem's structure, or form, depends primarily on its vegetation: the structure of a grassland is very different from that of a forest, for example, because of the form of the predominant plant life. By the same token, the functions of these two plant communities - how they respond to fire, wind damage, and other types of disturbance, how they use and recycle water, nutrients, organic matter, and so on - also differ because the physical environment, the soils, climate, and other conditions that give rise to them, are different.

What follows is a basic introduction to the structure and function of the major vegetation associations of the Southeast, particularly North Carolina, and how gardeners in these various regions can use them as models for transforming the garden landscapes that sustain us, without destroying the creatures and natural communities with whom we share the Earth.

Eastern Deciduous Forest

This vast province, which stretches from the Atlantic Ocean to the tall-grass prairies of the Midwest, encompasses many associations. Eastern forest associations are determined by climate, soils, and moisture. The common denominator is the dominance of deciduous canopy species. In rare instances, there are co-dominants that are coniferous, usually pines or hemlock. Meadows occur as scattered breaks in the forest where the soil is too wet or dry to support trees. Old-field meadows occur on abandoned agricultural land.

Maple-Basswood/Beech-Maple Forest

American beech, *Fagus grandifolia*
Basswood, *Tilia americana*
Canada hemlock, *Tsuga canadensis*
Northern red oak, *Quercus rubra*
Sugar maple, *Acer saccharum*
White oak, *Quercus alba*

Mixed Mesophytic/ Western Mesophytic Forest

American Beech, *Fag's grandifolia*
Basswood, *Tilia americana*
Black oak, *Quercus velutina*
Hickories, *Carya* species
Sugar maple, *Acer saccharum*
Tulip tree, *Liriodendron tulipifera*
White oak, *Quercus alba*

Oak/Hickory Forest (including the former Oak/Chestnut Forest)

American chestnut, *Castanea dentata*
(devastated by chestnut blight)
Black oak, *Quercus velutina*
Bur oak, *Quercus macrocarpa*
Yellow chestnut oak, *Quercus muehlenbergii*
Hickories, *Carya* species
Northern red oak, *Quercus borealis*
Northern pin oak, *Quercus ellipsoidalis*
White oak, *Quercus alba*

Floodplain Forest

Cottonwood, *Populus deltoides*
Green ash, *Fraxinus pennsylvanica*
River birch, *Betula nigra*
Silver maple, *Acer saccharinum*
Sycamore, *Platanus occidentalis*

Coastal Plain

The Coastal Plain of the East and Gulf coasts is a vast area with a variety of climates, soils, and moisture regimes. On rich soils, mesic forests of oaks and other hardwoods dominate, similar to forests in the Eastern Deciduous Forest province. In sandy and waterlogged soils, savannahs are found, with open pine woodlands with well-defined shrub or grassy ground layers. Bottomlands are dominated by deciduous trees interspersed with shrubs, wetland sedges, and forbs.

Northern Pine Barrens

Pitch pine, *Pinus rigida*

Upland Hardwood Forest

American beech, Fagus grandifolia

Scrub oak, *Quercus ilicifolia*
Shortleaf pine, *Pinus echinata*

Bullbay magnolia, *Magnolia grandiflora*
Live oak, *Quercus virginiana*
Loblolly pine, *Pinus taeda*
Red maple, *Acer rubrum*
Southern red oak, *Quercus falcata*
Sweet gum, *Liquidambar styraciflua*
Water oak, *Quercus nigra*
White oak, *Quercus alba*

Xeric Pine Forest
Blackjack oak, *Quercus marilandica*
Bluejack oak, *Quercus incana*
Slash pine, *Pinus elliottii*
Longleaf pine, *Pinus palustris*
Turkey oak, *Quercus laevis*
Wiregrass, *Aristida stricta*

Mesic Pine Forest
Loblolly pine, *Pinus taeda*
Longleaf pine, *Pinus palustris*
Saw palmetto, *Serenoa repens*
Scrub oak, *Quercus inopina*
Slash pine, *Pinus elliottii*

Savannah and Pocosin
Loblolly bay, *Gordonia lasianthus*
Longleaf pine, *Pinus palustris*
Lyonia, *Lyonia lucida*
Pond pine, *Pinus serotina*
Titi, *Cyrilla racemiflora*
Wax myrtle, *Myrica cerifera*
Zenobia, *Zenobia pulverulenta*

Bottomland Forest
Atlantic white cedar, *Chamaecyparis thyoides*
Bald cypress, *Taxodium distichum*
Laurel oak, *Quercus laurifolia*
Overcup oak, *Quercus lyrata*
Pond cypress, *Taxodium ascendens*
Red bay, *Persea borbonia*
Red maple, *Acer rubrum*
Swamp tupelo, *Nyssa sylvatica* var. *biflora*
Tupelo, *Nyssa aquatica*
Water hickory, *Carya aquatica*

Maritime Communities
Beach grass, *Ammophila breviligulata*
Groundsel bush, *Baccharis halimifolia*
Junipers, *Juniperus horizontalis* and *Juniperus virginiana*
Live oak, *Quercus virginiana*
Poison ivy, *Toxicodendron radicans*
Red bay, *Persea borbonia*
Sea oats, *Uniola paniculata*
Wax myrtle, *Myrica cerifera*

Plant Community Ecology Basics

Plant community ecology is the science that explores the processes that form and influence plant communities and the patterns of distribution within them. For example, plant communities are constantly changing in a process often called *succession*. As young grasslands and forests comprising a certain mix of species mature, new assemblages of species take over, until storms, fires, diseases, or insects disturb them and the process begins anew. Healthy ecosystems are also characterized by biodiversity, a mixture of many different individuals of many different species. In any given plant community, there are dominant, subdominant, and subordinate species. Dominance refers to the one or more species that are most essential to the life and character of the plant community.

Gardens are plant communities, too. Successful gardening requires an understanding of the ecological processes at work on cultivated land. Our models for understanding these processes are local plant communities. Of course, structure and change in the garden are orchestrated by the gardener, not the forces of nature alone. The closer a gardener works with nature, however, the less work and the more successful the garden will be.

The Physical Structure of Plant Communities

Every native plant community has a recognizable, and somewhat predictable, structure based on the dominant and subordinant vegetation. A forest has a towering canopy of trees that influence what can and cannot grow beneath them. A grassland has a similar structure, but the plants are herbaceous instead of woody, and this vertical structure is re-created above ground each growing season, not over decades and centuries as in a forest.

Plants within a given community also create patterns of distribution on the landscape as a result of environmental factors such as soil, moisture, and light. Different species thrive with different amounts of moisture, for example. In a prairie, shrubs will grow in the wettest areas, grasses and forbs on the slightly higher and drier land. As a result of these factors, plant communities have recognizable vertical and horizontal structure.

Ecological gardeners use the structure of the native plant community as the basis for structuring their gardens. In the eastern forest region, for example, canopy trees lend a grand vertical scale to the garden, creating a cathedral-like enclosure, while understory trees add a more intimate, human-scale "ceiling." Shrubs can become "walls" that divide spaces horizontally and create privacy. The ground layer is where gardeners can create a tapestry of wildflowers, ferns, and grasses in beds and borders. Ecological gardeners know that structuring a garden like the native plant community also helps support birds and butterflies and other wildlife by offering them an array of spaces for feeding, breeding, resting, and nesting.

Vertical Structure

All plant communities have a vertical structure based on the size and growth pattern of the dominant species. This pattern is called vertical stratification, or vertical layering. Vertical structure is most obvious in a forest. The tallest layer is called the canopy. It is composed of mature trees that cover the entire forest. The tallest canopy trees may be one hundred feet in height or more. The lowest canopy trees grow to about 30 feet. The canopy is interwoven, forming a fairly continuous ceiling over the entire forest. The canopy sets the stage for everything that happens in the layers below it.

The next layer down is called the understory. This layer is composed of saplings of canopy tree species as well as smaller flowering trees such as dogwoods, redbud, shadblow, ironwood, and hop hornbeam in the eastern United States. The understory extends from 30 to 12 feet.

The shrub layer is the lowest layer of woody vegetation. It occupies the area between 12 and 3 feet above the ground. Shrubs grow in patches where light and space are sufficient. A variety of forest birds, including vireos and some warblers, use the shrub layer for foraging and nesting. Many shrubs produce edible fruits that enable birds to lay on fat reserves in preparation for migration.

The lowest above-ground layer of the forest, below 3 feet, is called the ground layer. Here, wildflowers, ferns, grasses, and sedges grow in often-spectacular assemblages. Plants in the ground layer also partition their environment vertically. The spring ephemerals bloom first, typically raising their foliage only a few inches above the leaf litter. As they are going dormant the taller ferns, trilliums, and other herbs overtop them.

The age of a plant community affects its structure. Young forests have a well-defined shrub layer and understory. The canopy becomes more distinct as the forest ages. Different forests have different structures. Deciduous forests have the most elaborate structure, as described above. By contrast, coniferous forests, with their dense stands of tall and narrow trees, typically have very little understory, but can have a dense shrub layer and ground layer of herbs and mosses. Pine forests have the most open canopies of the coniferous forests, with scattered understory trees and a well-defined shrub layer. Ground-layer species are scattered in the sunny openings. Oak woodlands have a structure similar to that of the pine woods, except the trees are smaller in stature and the canopies are wider. The ground layer of grasses and annual wildflowers is exceptional during the rainy season.

Shrub communities have mixed layers of different-sized shrubs, with a ground layer of herbs, grasses, and sedges. In communities dominated by herbaceous plants, the vertical structure is no less distinct. The plants resprout from their roots each year. The earliest plants to emerge in the spring are low to the ground. Each successive emerging plant overtops the next, culminating with the tallest grasses and late-blooming composites that end the growing season.

Reestablishing Broken Connections

Horizontal structure is important to the long-term health of ecosystems. As we have parceled, subdivided, and cleared the land, we have interrupted or destroyed the horizontal connectivity of plant communities. When we do this, we cut off vital links used by wildlife and plants to move freely across the landscape. In effect, we create islands or pockets, isolated fragments of vegetation surrounded by cities, suburbs, and farm fields. The health of the plant community, both locally and globally, depends on the connections we have severed. In isolated pockets, plants and animals interbreed, reducing genetic diversity and endangering their survival over the long haul. Isolated patches are also more vulnerable to destruction by pests and diseases. Once plants are eliminated, the island cannot be re-colonized by many species, and the diversity of plant life is reduced

forever. As gardeners, we have the ability to repair these broken connections. Our gardens, one by one, can re-establish links to parks, nature preserves and other green spaces, and restore the health of the environment.

Horizontal Structure

Light, moisture, slope, and soil have a direct effect on where a plant or groups of plants grow in a forest, grassland, wetland, or other plant community. Plants form horizontal patterns of distribution in response to these environmental and edaphic, or soil-related, factors, better known to gardeners as microclimates. The resulting diversity of associations and species across the landscape is called horizontal heterogeneity.

In deciduous forests, oaks are found on the drier sites such as sunny slopes, while maple and basswood grow in the moister soil on east and north slopes. Individual trees are spaced according to their canopy size and shape. In marshes, sedges dominate the wettest areas, shrubs the intermediate regions, and wet meadow or woodland plants the upland zones.

Ecotones

Ecotones are the transitions between two plant communities. Because they include species from both communities and often their own unique species as well, ecotones are usually the most diverse ecosystems. In the Midwest, the eastern deciduous forest grades into the prairie in an ecotone called oak savannah. In the West, conifer forests grade into pinyon, juniper, or oak woodlands or into shrubby grassland ecotones. Ecotones also occur at a smaller scale, where wind throw has created an opening in the forest, for example, or at the edges of small tracts of woods. Ecotones support not only a variety of plants but also generalist animals such as skunks, deer, robins, and jays.

Today, the most common ecotones occur on abandoned agricultural land. These fields are first overtaken by pioneer species, generally a mixture of native and naturalized annuals that colonize open or disturbed ground. As the soil stabilizes and grows richer, an increasing variety of plants parades across the landscape, depending upon soil, moisture, and exposure. In forested regions, canopy trees ultimately become dominant. This new edge of grasses, shrubs, and young trees becomes an ecotone between open field (meadow) and forest.

The Biological Structure of Plant Communities

The biological structure of plant communities gives them the character we observe in nature. A deciduous forest dominated by tall, slender oaks looks very different from one composed of wide-spreading beech trees and rich evergreen hemlocks. A prairie dominated by grasses is altogether different from a forest of stately trees. Within different plant communities a vast diversity of species is found. In a tallgrass prairie dominated by three grass species, you may find more than nine different grasses and up

to three hundred different forbs. A mixed mesophytic forest may have over thirty different tree species, even though only two or three are codominant. Ecological health depends on diversity. Plant communities are naturally diverse, but our gardens are comparatively barren. A typical garden has one grass, bluegrass turf, a dozen perennial plants, three different shrubs, and one or two different trees. If we are to make our gardens as attractive to wildlife as they are to us, we must understand biological structure and put that knowledge to work. We must learn to appreciate both biological and visual complexity.

Species Dominance

Dominance refers to the influence of species that contribute the most cover and/or biomass (total mass or weight) to a plant community. In a forest, the dominant species is the tree that contributes the most cover to the canopy. In a prairie it is a grass or a forb. If more than one species make up the dominant cover, then individuals in the suite of species are called codominants. Dominant species are often called visual essence species, for they are the ones that give a plant community its unique look.

Dominance is determined by density in a plant community - that is, the total number of stems or individual plants within a given area. Ecologists use precise sampling techniques to determine dominance. One common technique is the use of quadrats, or plots of land with fixed dimensions. Within each quadrat, the trees, saplings, shrubs, and herbs are counted and measured. In forests, relative density, relative cover, and relative frequency are weighted to determine dominance. In herbaceous communities, dominance is determined by relative cover and frequency.

The Benefits of Biodiversity

Do you ever wonder why you don't see as many birds and butterflies as you used to? You need look only as far as your garden for the answer to this question. The typical North American garden consists of bluegrass or some other turf, a dozen annuals and perennials, and a few shrubs and shade trees. If you are a bird looking for food, visiting the typical garden is like going to a restaurant where there is only one dish on the menu. Nature offers a smorgasbord to animals. The diversity of ecosystems and species within them offers a complete menu for a rich variety of creatures.

Our gardens can do a lot better. Plant thirty or even fifty perennials instead of a dozen. Use many different fruiting shrubs and trees. Choose half a dozen shade trees. Not only will this diversity help wildlife, it will make your property more interesting. A hidden benefit of diversity is resistance to outbreaks of pests and diseases. It is harder for an epidemic to spread if an infected plant is surrounded by other species that are not susceptible. It is also more likely that some of the plants will be resistant if you have many individuals with diverse genetic makeup’s, not just a group of the same cultivars or clones. Instead of choosing several plants of Aster novae angliae 'Purple Dome', a

cultivar of New England aster with a compact habit, for example, opt for a genetically diverse collection of New England aster plants that have been propagated by seed.

Biodiversity

Biodiversity, a much used term these days, refers to a healthy mixture of ecosystems, communities within the ecosystems, species within the communities, populations within the species, and individuals within the population. An individual is a single plant of a given species -- a barrel cactus, for example. A population is all the barrel cacti in the area. The community is the barrel cacti, along with associated vegetation such as prickly pears, palo verde trees, ocotillo, and mesquite. The ecosystem is the Sonoran Desert. The Sonoran Desert is one of the four associations in the Western Deserts province.

Ecosystem diversity is the broadest aspect of biodiversity. Globally, as well as within North America, the variety of ecosystems contributes to the health and stability of the biosphere. Forests, grasslands, deserts, and other vegetation formations comprise the global ecosystem. On a smaller scale, biodiversity is important to the health and resilience of ecosystems as well. For example, food chains are built on the foundation of a healthy, diverse ecosystem of many different native plant species. This is referred to as species diversity. Native plants provide food and cover for insects. Insects in turn are a vital food source for many birds and mammals. The greater the diversity of plants, the greater the diversity of other species the ecosystem can support.

Species diversity is a measure of both richness and evenness. Richness refers to the total number of different species in an area or community, while evenness is a measure of the number of individuals of each species. In general, diversity increases with richness and evenness. In other words, the more different species and the more evenly distributed the individuals of each species, the more diverse the community.

On the smallest scale, the genetic diversity of individual species is also critical. Species with the largest number of populations with large numbers of individuals generally have the broadest genetic base. The more diverse its gene pool, the more resilient the species. Species with few populations and few individuals are more likely to lack the genetic diversity necessary to enable them to adapt to environmental change, disease, or other types of stress. In other words, genetic diversity enables a species to adapt and survive.

The Functions of Plant Communities

Living systems do not function in isolation. Interactions are the hallmark of healthy ecosystems. Some interactions have positive, others seemingly negative consequences. Not everything that we see as negative is detrimental to the long-term function of ecosystems, however. An animal eats a plant to survive. This is good for the animal, but bad for the plant. Or is it? Some plants respond well to being grazed, while others may die. Death is part of natural renewal. A dead tree feeds insects, provides a home for birds, and ultimately falls to the ground and creates humus. Catastrophic floods and

hurricanes can alter the landscape in the blink of an eye. These disturbances set changes in motion that over time alter the nature and composition of plant communities. The landscape as we see it today is the product of all this change, seen and unseen, dramatic and subtle, fast and slow. Ultimately, the system prevails in spite of the individual and local dramas that are played out over time. Without dynamic interaction, there would be no healthy function.

Disturbance and Succession

Succession is the term that scientists use for the vegetation changes in plant communities over time. Succession works at many scales, from the thousands of acres burned in Yellowstone National Park several years ago to the comparatively tiny gap in the canopy left when a tree routinely topples in a forest.

Early ecologists believed that there was a fixed and predictable end point to succession, which they termed the *climax stage*, and that this climax stage was stable and self-perpetuating for long periods of time. They believed that vegetation changes in a plant community are inherent in the community itself, and outside factors such as storms or fire play little or no role in the process. Today, ecologists realize that no self-perpetuating end point is ever really reached, and that periodic disturbance - fire, flooding, damage by insects and diseases, and windstorms, to name a few - plays a critical role in maintaining the diversity of species and habits in a region. Rather than an anomaly that occasionally disrupts climax communities, disturbance is now viewed as the key recurring factor that keeps a mosaic of habitats in different stages of vegetation development in fairly close proximity to one another. This, in turn, assures the presence of a diverse mixture of plants and animals that characterize each phase of the change from, say, bare land to mature forest.

Although *how* vegetation succession or change occurs is more complicated than previously thought, *what* will ultimately happen in most places is still generally predictable. It certainly is true that specific types of vegetation will eventually predominate on most sites in particular floristic provinces.

In the Eastern Deciduous Forest province, vegetation change on abandoned farmland left undisturbed for many years will work something like this, with regional variations: Millions of seeds that lay dormant in the exposed soil germinate, causing an explosion of physiologically tough, aggressive annuals like horseweed and common ragweed. These plants, called *pioneer species*, dominate the first season. In a few years, biennials (today, many of them non-natives such as common mullein, chickweed and Queen Anne's lace) become common, along with a few perennial wildflowers like asters and goldenrods. After five years or so, grasses and wildflowers turn the area into a meadow. Within a few years young maples, ashes, dogwoods, cherries, pines, and cedars, many present as seedlings in the earliest stages, rapidly transform the meadow into "old field," an extremely rich, floriferous blend of pioneer trees, shrubs, and herbaceous species particularly favored by wildlife. Given enough time without major disturbance, perhaps several centuries, a mature or old-growth forest will once again be found on the site.

Succession and Disturbance in the Garden

The twin forces of succession and disturbance are constantly at work in the garden, just as they are in the native landscape. When you plant on bare earth you are creating a plant community. This community is a human invention, but it will change with time. You not only set in motion the forces of succession but ultimately become the agent of disturbance as well.

In traditional ornamental gardening, the hand of the gardener must always be at work to quell the influence of the dominant native plant community. Consider what happens when you weed your flower border. When you weed, you are thwarting succession. Annual weed seeds exposed by tilling and planting germinate and grow to cover the bare soil. Wildflowers such as goldenrods may blow in as seeds on the wind and find an empty spot in the garden. In forested regions, tree seedlings germinate and start the long process of reforestation. Without constant tending, weeds, unplanted wildflowers, and tree saplings would quickly overtake the garden, turning it into a thicket.

Even in the natural habitat garden, it is often beneficial for the gardener to guide change by thwarting succession, in this case by substituting for natural agents of disturbance such as fire. Meadows remain open grasslands because annual mowing keeps trees out. A meadow would otherwise soon start to become a forest. Prairies are renewed by wildfires that burn off the thatch, clearing the soil and releasing nutrients. Thankfully, most of us do not have wildfires in our gardens. To keep a prairie healthy, however, we must either mow it, or do a careful prescribed burn. We must lend Mother Nature a helping hand. The California chaparral is still another fire-dependent community. One of the reasons wildfires are so devastating in southern California is that regular fires are suppressed. Without regular burning, the large amounts of flammable litter accumulate. When a fire finally does come, it has so much fuel that it spreads out of control, consuming houses as well as native vegetation.

When we build a garden in a woodland, we are acting as agents of disturbance, too. If we thin the canopy or remove a tree, we are initiating what ecologists call gap phase succession. We let in more light and alter the dynamics of that piece of forest. When we plant, we disturb the soil, allowing new seeds to germinate. All our actions as gardeners have consequences. In the interests of both low maintenance and environmental harmony in the garden, it is important to understand and work with natural forces like succession.

Water and Nutrient Cycles

Energy and nutrients are constantly flowing through ecosystems unseen. Water is taken up by plants, transpired through their leaves, and given off to the atmosphere. This invisible process called *evapotranspiration* can influence global weather patterns. Eventually, the water falls back to the earth as precipitation. Similarly, the nutrients that sustain every living creature on Earth are transformed and distributed by a perpetual

cycle of decay and renewal. The movement of chemical elements among the planet's living organisms and the physical environment is called the biogeochemical cycle. Nutrient and water cycles are two of the most important *biogeochemical* processes.

Nutrient Cycling

The nutrient cycle is the basis of life. Plants are the foundation of the nutrient cycle. Plants convert the energy of the sun and atmospheric carbon into biomass through a process called *photosynthesis*. Plants are called *primary producers*, because they are the starting point, where energy and nutrients enter the system. Animals that eat plants are called *herbivores*. They vary from the krill in the sea to the bison on the prairie. Herbivores are the lynchpin of the food chain, which is built upon production and consumption. Herbivorous animals are fed upon by meat-eating predators called *carnivores*. Wolves eat the deer that eat woody twigs and leaves, grasses and forbs. People are also part of the predator/prey system. People also eat the deer or, more likely, the cattle that have replaced them on the farms. Carnivores are at the top of the food chain.

Not all biomass is consumed in a living state. When a plant or animal dies, or when a portion of a plant dies, the nutrients are still recycled. When leaves fall from trees in autumn, for example, the nutrients are released by soil insects, fungi, and microbes, which break down this dead living material, called *organic matter*, through a process called decay, or *decomposition*. Decomposition of organic matter forms humus, a stable colloidal material that provides a variety of nutrients to plants. Colloids bind nutrients tightly until they are utilized by plants. Some of the nutrients are lost through movement of water down through the soil in a process called *leaching*. As any good gardener knows, the more organic matter and humus in the soil, the less leaching of water and nutrients there is. In such an efficiently operating ecosystem, most nutrients can be taken up by plants and become new biomass -- new plant growth -- and thus the cycle begins anew.

Nitrogen, an important nutrient for plant growth, also enters the ecosystem directly from the atmosphere through a process called *fixation*. Nitrogen fixation is the conversion of atmospheric nitrogen into a form usable by plants. Fixation occurs during thunderstorms, when electricity converts nitrogen into a soluble form that dissolves in rainwater, which then falls to the ground. Fixation also occurs in the roots of some higher plants, made possible by bacteria that live symbiotically in thick swellings on the roots called *nodules*. These bacteria absorb nitrogen gas and convert it directly to a form the plants can use. The forests and prairies are filled with native legumes (nitrogen-fixing plants) like wisterias, baptisias, indigobush, locust trees and redbuds.

Restoring the Nutrient Cycle

In the typical yard, the nutrient cycle is interrupted. A primary reason for this is that most gardeners like to keep things neat. Raking and disposing of leaves and lawn clippings eliminates the natural source of nutrients. As a result, fertilizer must be added to the soil to keep the lawn and garden healthy. Fertilizers typically release massive amounts of nutrients to the garden ecosystem at once. The soil cannot store them, nor can plants use them fast enough, and so they leach away. Leached nutrients, especially nitrogen and phosphorous, are a major source of water pollution.

Gardeners can repair the natural nutrient cycling process in their backyard ecosystems. Fallen leaves, lawn clippings, and other potential organic matter can be left in place in many areas of the yard. For a tidier look, leaves can be chopped with a mower or shredder and applied in flowerbeds and around shrubs as a natural mulch. Leaves removed from areas that must be raked can be added to a compost pile. There, along with other garden trimmings and kitchen scraps, they will be transformed into compost that is rich in humus - nature's soil conditioner and natural, slow-release plant food. This not only saves money that otherwise would be spent on fertilizer, but also helps prevent pollution of wetlands and streams. Another way to restore the natural nutrient cycle is to integrate some beautiful native legumes (nitrogen-fixing plants) to beds, borders, and lawn areas. They will increase the soil's fertility while adding aesthetically to plantings.

Water Cycling

The movement of water through the environment is called the *water cycle*. Precipitation falls to earth, and moves through the landscape in a variety of different ways. Some of the water is intercepted by the canopy of trees and other vegetation, where it evaporates before it hits the ground. Evaporation also occurs from the ground itself. Most of the water infiltrates into the ground, where it is either taken up by the roots of plants or seeps into the ground and enters the water table. Some of the water runs off the surface into wetlands, streams, ponds, and, today, storm sewers.

A portion of the water that is absorbed by the roots of plants is returned to the atmosphere by the process called *transpiration*. This loss of water through the leaves of plants draws water into the roots and pulls it up the stem or trunk of the plant. Even water that flows to the water table eventually reaches the atmosphere, but it is a longer journey. Groundwater moves with the topography of the land until it reaches the lowest point in the water table - a pond, stream, or wetland. Water from these wetlands and waterbodies is constantly evaporating as it moves downstream through the watershed and ultimately to the ocean. Evaporation from the world's oceans returns massive amounts of water to the atmosphere, where it joins the water lost via transpiration, and returns to the earth as rain. Thus the cycle is renewed.

Modern cities and suburbs, with their impervious pavement, wreak havoc with the natural water cycle. In natural systems, surface runoff is minimal. By contrast, parking lots, sidewalks, and rooftops often produce torrents of runoff that never infiltrate into the ground. There are two serious consequences of reduced infiltration. Flooding is the most dramatic, and destructive. As water runs off roofs and streets, it collects in storm sewers and is rapidly deposited in streams and rivers. This fast-moving, enormous volume of water causes massive erosion of stream and river banks. Widespread and damaging flooding also occurs, in the worst cases washing away houses and crops. An ecologically sensible regional landscape would be designed to reduce runoff and maximize infiltration from the top of the watershed to the bottom. Since water accumulates in volume and speed as it runs through the system, the key to reducing flooding is to catch the water at the top of the watershed. This can be accomplished in many ways. The most obvious is to reduce or eliminate runoff. Reducing paved areas, using porous pavement that allows infiltration and running downspouts into the ground are a few solutions. Where this is not possible, storm-water retention basins can be used to trap water. Keeping natural wetlands intact also reduces runoff.

Reducing Home Runnoff

When rain or melting snow wash materials off the ground and into streams and lakes, the result is called non-point discharge. Runoff water can carry pesticides, fertilizers, soil, leaves, oil, and other pollutants that cause serious problems for our waters. Non-point source pollution can come from both urban and rural areas; however this information focuses on home landscape practices that can improve water quality. You can make a difference right away by preventing pollutants from being washed off your garden and into streams and rivers. The roof of a house, as well as sidewalks and driveways, and other impervious surfaces keeps water from infiltrating into the ground and contributes to erosion and flooding problems. Even lawns absorb less water than more diverse types of cover. Gardeners, homeowners and landscape designers can minimize runoff by designing holding areas (planting beds) where water is encouraged to infiltrate into the ground over a 48 hour period. Planting beds provide an ideal location to direct downspout runoff where it can soak into the soil to be used by your plants. Planting beds can also replace selected mowed areas with an attractive alternative. Reducing the amount of yard area that is heavily maintained normally reduces the need for fertilizers and pesticides, which cause water pollution if misapplied. When it comes to chemicals, more is not better! Follow the directions exactly. Areas left to go “natural” or planted to create a prairie or woodland appearance require very low maintenance after the initial planting. Natural areas can supply their own nutrient requirements and absorb rainfall to reduce runoff problems. Properties that have a stormdrain located near them can release pollutants just like properties that have waterfront drainage. You can help prevent pollution by preventing anything except stormwater from washing down stormdrains. Buffer strips are vegetated areas along ditches, water courses, streams, or lakes, allowed to revert, or planted, to a natural state. They may be 5-to-15-to-25 feet or wider, depending on the site. Grass left unmowed in these areas or prairie or woodland

plantings slow runoff of rainfall, settling out soil particles (sediment) and other pollutants before they enter surface waters. Well-planned buffer strips can be used to frame good views or screen unsightly ones. There are native plants that can help absorb pollutants from the runoff and even help neutralize the pollutants. Some of the natural functions of stream buffers are to decrease velocity of storm water, thereby reducing the risk of erosion; store flood waters; allows streams to meander, creating a diversity of habitats; filter out pollutants, sediment and excess nutrients; shade stream channels, thereby decreasing water temperature; provide wildlife habitat and corridors and provide greenspace for parks.

Plant/Animal Relationships

Plants and animals adapted together, so it is not surprising that there are many complex plant/animal relationships. Some relationships are beneficial to both parties, while others have a clear benefit for one at the expense, or even death, of the other. Four important plant/animal interactions are explored here: plant/herbivore, plant/pollinator, plant/disperser, and other examples of mutualism.

Plant/Herbivore Relationships

Herbivory is an interaction in which a plant or portions of the plant are consumed by an animal. At the microscopic scale, herbivory includes the bacteria and fungi that cause disease as they feed on plant tissue. Microbes that break down dead plant tissue are also specialized herbivores. Browsers and grazers, from aphids and caterpillars to deer and bison, are more familiar herbivores. Even insects and animals that eat seeds are considered herbivores.

Some herbivores consume entire plants, or enough to kill them. Others only eat a portion of the plant, and so the plant can recover. The plant/herbivore relationship traditionally has been seen as lopsided, with the animal as the beneficiary and the plant as the loser. Current research, however, is revealing that herbivory has some potential benefits to plants. One example is canopy grazing by insects, which allows more light to penetrate into the lower layers of the forest. Gypsy moth grazing on canopy trees in some areas of North Carolina's Blue Ridge Mountains, for instance, has resulted in more light penetration and therefore a more diverse and productive ground layer.

Herbivores and Their Food Plants

Bison, sheep, and other grazers - Succulent forbs, grasses, grass-like plants
Deer and other ungulate browsers - Leaves and twigs of woody plants such as willows, arborvitaes, forbs
Beaver - Tree bark, young shoots, leaves
Rodents - Succulent forbs, grasses, grass-like plants

Rabbits - Succulent forbs, grasses, bark
Voles - Roots, bark
Caterpillars - Leaves; in some cases, of specific species
Monarch butterfly - Milkweeds
Gypsy moth - Oaks and other hardwoods
Aphids - Plant juices; in some cases, of specific species
Many birds – Seeds, fruits, nectar and insects
Locusts - All plants; seeds, leaves, and stems

Some Animals and the Plants They Disperse

Ants - Many wildflowers, such as trilliums, bloodroot, violets
Birds - Fleshy fruits and grains, such as baneberry, viburnums, blueberries, ash
Woodpeckers - Poison Ivy, Fleshy fruits and grain seeds
Mammals - Fruits, grains, nuts, berries
Squirrel - Nuts, such as those of oaks, hickories, pines
Fox - Berries, such as blackberry, grapes
Humans - Weeds such as plantain, dandelion, lamb's-quarters
Reptiles - Fleshy fruits, especially berries such as strawberry, groundcherry, jack-in-the-pulpit

Plants and Their Pollinators

Pollination is the transfer of the pollen from one flower to the stigma, or female reproductive organ, of another, which results in fertilization and, ultimately, the formation of seeds. The earliest plants were pollinated by wind, and for some modern plants this is still the most expedient method. Many trees, all grasses, and plants with inconspicuous flowers are designed for wind pollination. Bright, showy flowers adapted for another purpose - to attract a pollinator.

Many plants depend on animals for pollination. Insects, birds, even bats are important for perpetuating plants. The flowers of these plants evolved in concert with their pollinators, and their form reflects the form and habits of their pollinators. Bee-pollinated plants are often irregular in shape, with a lip that acts as a landing pad to facilitate the bee's entry into the flower. Butterfly-pollinated flowers are often broad and flat, like helicopter pads. The flowers of many plants are brightly colored to attract their insect pollinators, and many offer nectar as an enticement. Hummingbirds, with their long beaks, pollinate tubular flowers. Bats require open flowers with room for their wings, such as those of the saguaro cactus.

In the tropics, birds and bats take the place of insects as pollinators. Hummingbirds and honeycreepers, for example, have distinctive beaks that have evolved to exploit flowers. Often, a beak may be so specialized that it is only effective on a small group of flowers. The pollinators, in turn, have evolved to take advantage of the flowers. A successful

pollinator typically has good color vision, a good memory for finding flowers, and a proboscis, or tongue, for attaining nectar.

Animal pollination has obvious advantages for plants. Many pollinators cover great distances, which insure genetic diversity through outcrossing, or the transfer of pollen to unrelated individuals. The pollinator benefits as well by gaining access to a source of food. The relationship of pollinator and plant is an example of mutualism.

Plants and Their Dispersers

No two plants can occupy the same spot. In order to have room to grow, seeds must be dispersed away from the parent plant. Seed dispersal is accomplished by a variety of means, including wind, water, and animals. Animal dispersal is accomplished by two different methods: ingestion and hitch-hiking. Animals consume a wide variety of fruits, and in so doing disperse the seeds in their droppings. Many seeds benefit not only from the dispersal, but the trip through the intestine as well. Digestive acids scarify seeds, helping them to break out of thick seed coats.

Some seeds are armed with hooks and barbs that enable them to lodge in the fur of animals that brush past them. Beggar's ticks and bur marigold are two examples. Eventually, the seeds are rubbed or scratched off, and may find a suitable spot on which to germinate and grow. People are important for dispersing plants, too. The common weed plantain was called "white man's footsteps" by Native Americans because wherever settlers walked, the plantain came in the mud on their shoes.

Mutualism

Mutualism is an obligate interaction between organisms that require contributions from both organisms and in which both benefit. There are many examples in nature. Pollination and dispersal, discussed above, are mutualistic because both plant and pollinator or disperser benefit from the relationship. The relationship between mycorrhizal fungi and many higher plants is another common example of mutualism. The bodies of the fungi, called *hyphae*, live on or in the tissues of plants, and make nutrients available for the plants to absorb. The plants provide the fungi with amino acids and other complex compounds. One of the most celebrated examples is the orchids. Whereas some plants may support as many as 100 different fungi, orchids have quite specific mycorrhizal associations (see "The Lovely Lady Slipper"). Different plant communities have different mycorrhizal associations. The microflora of a grassland is different from that of a forest. These differences, at least in part, may influence the distribution of plant communities.

The Lovely Lady Slipper

The reason lady-slipper orchids are so hard to grow in a garden is that the needs of both the orchid and its fungus must be attended to. The growing conditions in the garden must duplicate exactly those in the orchid's native habitat.

Anyone who tries to cultivate these beautiful plants learns before long that the pink lady-slipper (*Cypripedium acaule*) is much harder to grow than the yellow lady-slipper (*Cypripedium calceolus*). This is because of the fungus. Yellow lady-slippers grow in slightly acidic, rich soils. Their associated mycorrhizal fungus thrives under the same conditions as those in woodland and shade gardens. The pink lady-slipper, on the other hand, grows in sterile, acid soil, not the typical garden variety. Plant the pink lady-slipper in rich garden soil, and its associated fungus cannot survive. As a result, the pink lady-slipper slowly languishes and eventually dies. Most lady-slipper orchids are still collected from the wild, harming native populations. Buy them only from nurseries that propagate their plants.

Imperiled Pollinators

All is not well in the realm of pollinators. The age-old relationships between plants and pollinators are threatened, especially in urbanized and agricultural regions. Habitat destruction and fragmentation, pesticide abuse, and disease all have taken their toll on pollinators. As more land is cleared for human habitation, bees, butterflies, bats, and birds are left homeless. Our gardens offer little to sustain them. They need a constant source of nectar and pollen throughout the entire season. The few flowering plants most people grow will not suffice.

A related problem is fragmentation of plant communities. Plants must be pollinated in order to set seed for the next generation. Without pollinators, no seed is set and the plants eventually die out, leading to local extinction. Isolated patches of forest, grassland, or desert are particularly vulnerable. A small patch may not sustain enough pollinators, or may be too far from other patches for pollinators to travel. As a result, plants do not reproduce.

Pesticides have also reduced pollinator populations. Bees are often killed by chemicals applied to eliminate other pests. Honeybees are being destroyed by diseases and parasitic mites. The crisis is not just affecting native ecosystems. Fruit trees and many other food crops depend on pollination for production. We stand to lose over three quarters of our edible crops if we lose pollinators.
What can be done? Encourage pollinators by planting a diverse mixture of adult and larval food plants in your garden. Erect bat and bird houses, and where practical, place bee hives. Reduce or eliminate pesticide use. Help restore native plant communities not only in your yard, but also in parks and along roadways, and connect them through corridors and greenways to preserves and other natural areas.

Site Assessment: Points to Consider

The first step towards designing your yard or garden can be to do a site assessment. The points listed below are things to consider when planning for the long-term management of your garden. With a good site assessment, your garden can result in cost savings, less work, and more success.

- Historical information, regional characteristics, local characteristics, site characteristics, project limits.

- Climate: macro, micro, rainfall, winds/breezes, aspect/orientation, shade patterns, hardiness zone, heat zone.

- Topography (landform): drainage, geology, slopes <4% = flat or >10% = steep, orientation, water features: surface drainage, gutter drainage, stream buffers, ditch buffers, storm drainage.

- Soils: native, fill, clay, loam, sand, pH, water holding capacity, compaction, topsoil.

- Vegetation: maturity/health of principal trees/shrubs, native, introduced, existing buffers/screening/background, lawn/groundcover, upland-raparian gradient.

- Wildlife: positive (birds, beneficial insects) or negative (pests).

- Program: code requirements, users-who & when, function, adjacent users, vehicular circulation (to and through site), pedestrian users (to and through site), and handicap access.

- Spatial/Visual: visual values, relationships, moods inspired, social factors, spatial characteristics/determinants, size of space, visual enclosure, views out, views within.

- Miscellaneous: pollution sources on and off site, noise, utilities: power, gas, phone/data, cable, sanitary sewer, storm drains, gas, water, irrigation, others: future land use, burial of waste on site, etc.

- Real World considerations: your maintenance capabilities, budget, safety, security, conventional/traditional practices.

CAROLINA RECYCLING ASSOCIATION

Carolinas COMPOSTING COUNCIL

Naturescaping 3

Yes You CAN!

(Compost and Naturescape!)

Training Program

www.wipeoutwaste.com

I accept the Wipe Out Waste Challenge!

I pledge to Reduce, Reuse, Recycle and Rebuy.
I pledge to commit to the following actions:

Waste Reduction Actions:
____Opt Out of Junk Mail
____Practice Shop SMART (Enviroshopping)
____Buy a Recycled Product
____Use a Holiday Waste Reduction Tip
____Donate/Buy Used Goods (Goodwill, etc.)
____Attend a Recycle Event (Earthday,etc)
____Reuse by Making a Craft Project
____Rent or Borrow instead of Purchasing
____Teach Someone How to Reduce Waste

P.L.A.N.T. Actions:
____Take a PLANT Yardcare 4 Hr. Workshop.
____Take the Master Composter 40 Hr. Training
____Compost Yard & Food Waste
____Grasscycle & Practice Waterwise Yardcare
____Use Native Plants, Remove Invasive Plants
____Purchase Compost (USCC STA tested) or Mulch
____Invite one Person to take the PLANT Yardcare Program

Recycle Actions:
____Learn What I Can & Can't Recycle
____Recycle at Home
____Recycle at Work
____Recycle at School
____Take Recyclables to a Drop-Off Center
____Recycle as Many Things as Possible
____Buy Least Toxic Chemical or Use an Alternative
____Recycle Cooking Oils and Grease at a Full Service Drop-off Center
____Properly Dispose of all Chemicals at a Full Service Drop-off Center
____Teach Someone what to Recycle

Litter Actions:
____Clean up Litter
____Tarp/Cover/Secure my Truck/Trailer
____Report a Litterbug

Name:_____
Address:_____
_____
Telephone:_____
Email:_____

www.wipeoutwaste.com

Mecklenburg County LUESA
Solid Waste Reduction
700 North Tryon St.
Charlotte, NC 28202
Attention: D. Ann Gill

EXAMPLE Action Plan

I, _____, plan to change my yard care techniques by taking a class to learn to compost leaves and to compost food waste. I will only purchase compost from a company that uses the STA seal. I will remove invasive plants from my yard and replace with Native plants. I will implement these changes.

Name:_____
Address:_____
Telephone:_____
Email:_____

Yes You CAN*! (*Compost & Naturescape)
Train-the-Trainers Course

Field Exercises – Day Two

1. **Monitoring Compost Pile Temperatures**
2. **Site Assessment & Soil Testing**
3. **Native & Invasive Plant Identification**

A Council of the Carolinas Recycling Association
P.O. Box 1578, Pittsboro, NC 27312 TEL: 919-545-9050 FAX: 919-545-9060
WEB: www.carolinascompostingcouncil.org

Carolinas Composting Council
Carolina Recycling Association

Compost Training Course
Field Exercise #3

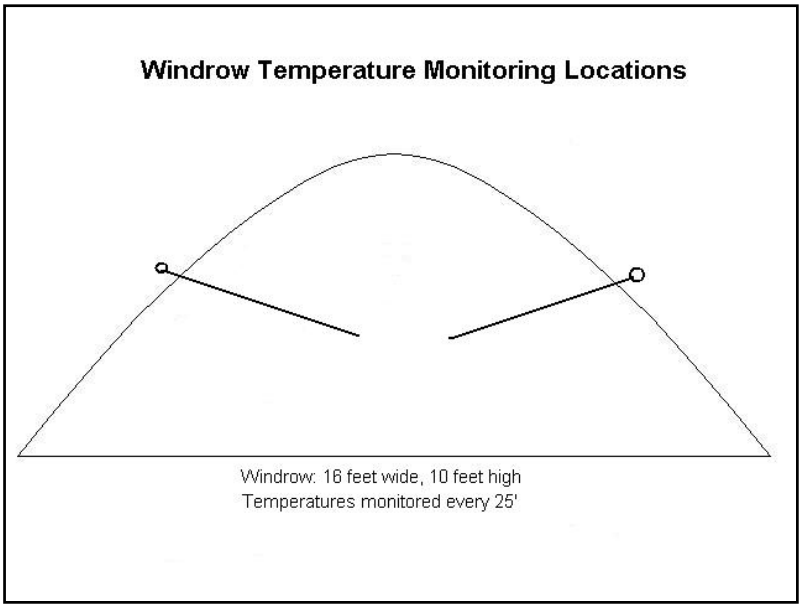
Temperature Monitoring

Monitoring compost pile temperature is one of the most important process control parameters in composting. Monitoring temperature is needed to verify that internal compost pile temperatures reach levels (above 131° F. or 55° C.) to ensure destruction of pathogens and the vast majority of weed seeds.

Equipment Needed: 36" dial-type thermometer (available at www.reotemp.com)

1. Place thermometer into compost pile so that tip is at least two (2) feet into the pile, but not so far that the tip reaches the bottom of the pile (see diagram below).
2. Allow 3-5 minutes for the temperature reading to stabilize and note reading on chart below:

Windrow No. ___			Windrow No. ___		
Distance (ft)	Temp. (°F.) (left)	Temp. (°F.) (right)	Distance (ft)	Temp. (°F.) (left)	Temp. (°F.) (right)
0			0		
25			25		
50			50		
75			75		
100			100		
125			125		
150			150		



Yes You CAN*! (*Compost & Naturescape)

Train-the-Trainers Course

Please give us your feedback on the quality of this course so we may make any needed improvements for future courses. Thank you in advance for your valuable input.

Using the following scale, please respond to questions 1-13 by circling the corresponding number to the right.

1=Strongly Agree 2=Agree 3=Undecided 4=Disagree 5=Strongly Disagree 10=Not Applicable

1.	The objective(s) of this program were made clear.	1	2	3	4	5	10
2.	The objective(s) of this program were achieved.	1	2	3	4	5	10
3.	The program material was presented at the proper level of difficulty.	1	2	3	4	5	10
4.	The instructor(s) was/were well prepared.	1	2	3	4	5	10
5.	The instructional materials (handouts, notebooks, slides, etc) were clear.	1	2	3	4	5	10
6.	The instructional materials were effective.	1	2	3	4	5	10
7.	Training Room	1	2	3	4	5	10
8.	Refreshments/Break service	1	2	3	4	5	10
9.	Lodging accommodations (Clarion Hotel)	1	2	3	4	5	10
10.	Audio Visual services	1	2	3	4	5	10
11.	Program speakers	1	2	3	4	5	10
12.	Local Transportation for tours	1	2	3	4	5	10
13.	Length of Program/Course	1	2	3	4	5	10

Please respond to the following in the space provided below each question.

14. What did you like **best** about the program?

15. What did you like **least** about the program?

(OVER)

16. How could we improve our service to you?

17. Which session was the most beneficial or useful?

18. Which session was the least beneficial or useful?

19. Why did you attend this program (please check all that apply)?

☐ To improve my current job skills
☐ To learn new skills
☐ To learn more about my field of expertise
☐ To prepare for a promotion
☐ To further my personal development
☐ To earn credit
☐ To make contacts with others in my field
☐ Other (Please Specify)

20. How did you hear about this program (please check all that apply)?

☐ CRA Newsletter, "R-Word"
☐ Brochure sent to work
☐ Brochure sent to home
☐ Professional association advertisement
☐ Newspaper _____(title?)
☐ Email
☐ Journal or other professional publication _____(title?)
☐ Word-of-mouth
☐ Other: (please specify)_____

21. Overall, how would you rate this Continuing Education experience?

☐ Excellent ☐ Good ☐ Fair ☐ Poor ☐ Very Poor

22. Please tell us anything else which you believe would assist us in providing better service in the future.