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Best Management Practices for Pesticide-Free Connecticut School Landscapes

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INTRODUCTION

In 2010, Connecticut law banned the use of EPA registered pesticides on school grounds (Connecticut General Assembly, 2009). This legislation has compelled school grounds managers (SGM) to think proactively and make fundamental changes to their management programs. SGM must now emphasize sound cultural practices. Pest management (in particular, weed management) has presented a serious maintenance challenge on school ground properties.

Pesticide-free management requires significant alterations to pest control strategy. In the past, many school grounds managers incorporated chemical products into their maintenance regime to manage weeds, insects, and/or diseases, either preventatively or curatively. SGM must now navigate a complex web of information to identify effective methods to manage or control pests. Additionally, pesticide-free school grounds maintenance requires an increase in time, commitment, and labor resources (Bartholomew, Campbell, Wallace, 2015). Lacking a corresponding increase in school maintenance budgets, many SGM struggle with pesticide-free management programs.

Figure 1. Attractive, uncluttered landscaping improves the quality of life for school faculty, staff, and students.

The purpose of this document is to provide guidance for effective maintenance of pesticide-free school landscapes. Research-based information has been utilized throughout this document to provide sound horticultural recommendations.

Implementing realistic, sound cultural practices throughout the year will help improve aesthetics, promote sustainability, and enhance the health of plants on school grounds. Attractive, uncluttered landscaping (*Figure 1*) on school properties reduces stress and improves the quality of life for school faculty, staff, and students (Dyment & Bell, 2007, Matsouka, 2010).

This publication will address the primary cultural practices for managing pesticide-free school landscaped areas: pre-plant practices, fertilization, irrigation, pest management, plant selection, and other maintenance tasks, such as pruning. Sustainable plant selection for both central and periphery areas will be covered.

For guidance and information on school pesticide-free *athletic fields*, refer to Best Management Practices for Pesticide-Free, Cool-Season Athletic Fields, Second Edition (s.uconn.edu/UConnAthleticFieldBMP).

CONNECTICUT'S PESTICIDE LAW

Connecticut state legislation banned the application of all pesticides registered with the U.S. EPA, and labeled for use on lawn, garden, and ornamental sites, on the grounds of public or private day cares (as defined in CGS Sec. 19a-77) and schools with grades K-8. **The text of the law (C.G.S. Sec. 10-231) can be read at** ipm.cahnr.uconn.edu/school-ipm or at portal.ct.gov/deep/pesticides.

The law applies to:

1. **Landscaped areas** around buildings and anywhere on K-8 school grounds, including trees;
2. **Turfgrass areas**: lawns, athletic fields, and recreational areas (*Figure 2)*;
3. High school property that is **shared jointly** and used by day care or K-8 school students.
4. **Playgrounds (school or municipal)**;

5. **Fence lines** around athletic fields, tennis courts, playgrounds, or school property perimeters;
6. **Parking lots and sidewalks** on school grounds;
7. Peripheries/boundaries of the school property.

The term "pesticide" (i.e., products that kill, repel, or control animal or plant pests) includes herbicides, insecticides, fungicides, and rodenticides. Anti-microbial agents, pesticide bait, sanitizers, disinfectants, and aerosol sprays that protect from imminent danger from stinging or biting insects are not prohibited under the law.

EPA exempt, "minimum risk" 25(b) pesticides are the only products allowed at day care and K-8 school properties in CT (*Figure 3*). Exceptions include **the use of some EPA registered pesticide products, including horticultural oils and soaps, and microbial or biochemical pesticides** on K-8 school grounds. For these products to be available for use in CT, they must be registered (and renewed annually) with CT Department of Energy and Environmental Protection (CT DEEP). CT DEEP maintains a list of "minimum risk" pesticide products allowed for use at K-8 schools and day care centers, which can be found at portal.ct.gov/DEEP/Pesticides/Information-Look-up. Learn more at **Biological Pest Control for Connecticut School Grounds** (ipm.cahnr.uconn. edu/school-ipm).

Per CGS Section 22a-63, violators of CT's pesticide law can be fined up to $5000 and/or imprisoned up to one year.

Figure 2. CT's pesticide law applies to all turfgrass areas on the grounds of private and public K-8 grade schools and day care facilities, including lawns, athletic fields, and recreational areas.

Figure 3. Minimum risk products may be an option for control of weeds in parking lots, on sidewalks, or around dugouts.

BEST MANAGEMENT PRACTICES

- **Use all products according to label recommendations.**
- Pesticide products with an EPA registration number, whether synthetic or organic, cannot be used on day care/K-8 school properties (*apart from the exceptions mentioned above*).
    - EPA registered pesticides may be considered a component of the maintenance care program for municipal areas or high schools that are distinct and separated from day care and K-8 school properties and municipal playgrounds.
- While minimum risk products may pose little to no risk to human health or the environment, their exemption from EPA registration means they also are not subject to rigorous, science-based evaluation and testing. Product efficacy cannot be substantiated. **These products are most effective when used in combination with a comprehensive program of best management practices.**
- **Minimum risk 25(b) products, like all pesticides, require a licensed pesticide applicator to apply**

on any/all school properties and municipal playgrounds in the state of CT. There are two levels of pesticide license - supervisor and junior operator. A junior operator works under the direction of a supervisor licensee, who is responsible for deciding whether and how pesticides will be used. Applications can also be contracted to a landscaping/lawn care company that is registered with DEEP as a commercial pesticide application business and whose employees hold commercial pesticide certification.

- **If an IPM policy is in place for the school district, all pesticide products used on school grounds must be referenced in the district's IPM plan**. It is important to include all products that MIGHT be considered or are used, even those that may only be used when an emergency application is necessary. Private schools are not required to have a policy statement or write an IPM plan.
- The law requires that any pesticides used on school grounds are listed annually on the school website.
- **Any pesticide used on school grounds, municipal playgrounds, or day care properties must be registered with the state of CT**. The law requires that all pesticides are used according to label instructions. **Homemade recipes (including those crafted with or containing minimum risk ingredients) are not permitted on school properties.**

Pyramid of IPM Tactics for Connecticut School Grounds

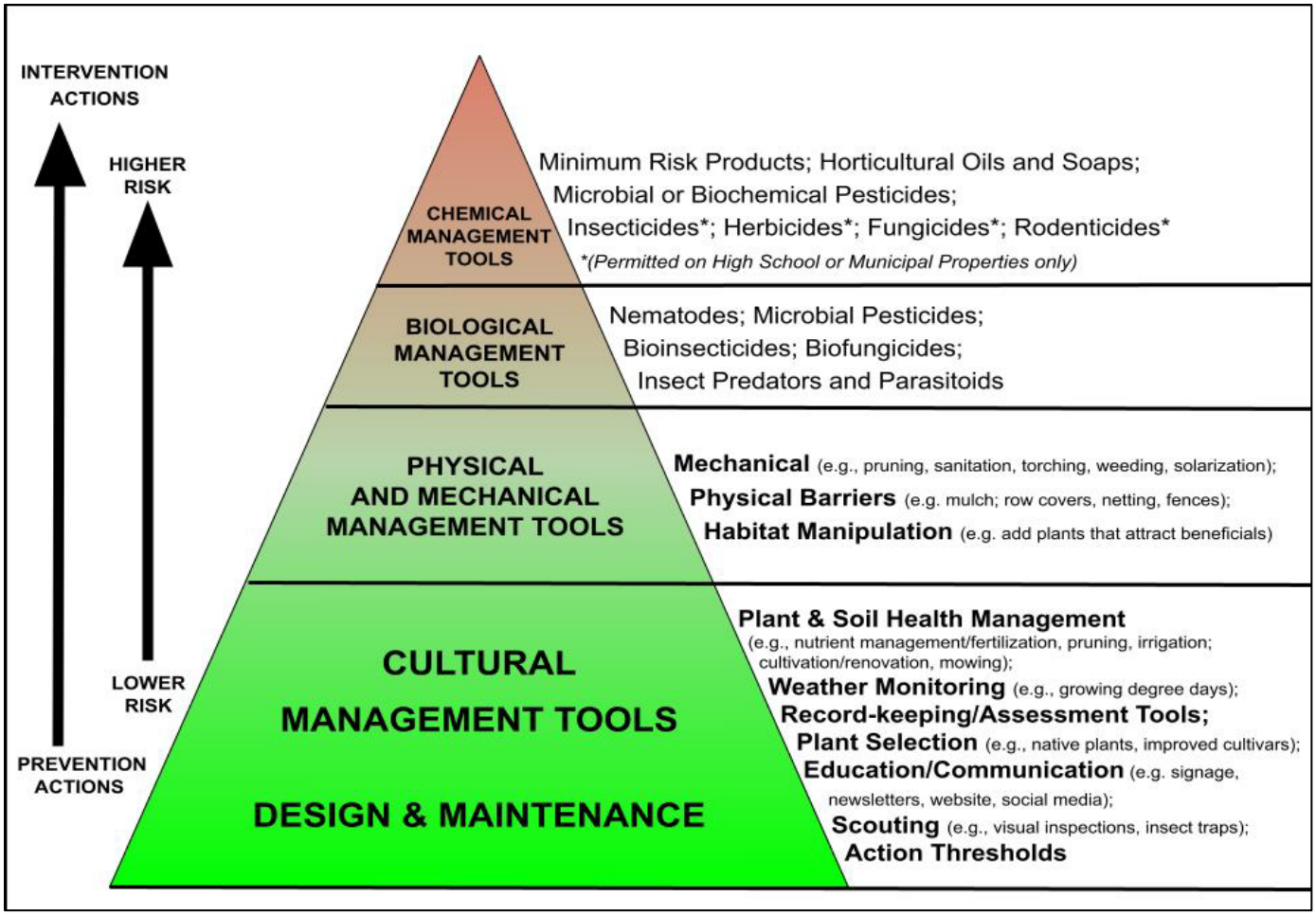

Figure 4. Pyramid of IPM Tactics for School Grounds, revised from IPM for Pennsylvania Schools and Childcares Manual.

For more information on Connecticut's Pesticide Law, see **A School Grounds Manager's Primer: Connecticut's Pesticide Ban on School Grounds (ipm.cahnr.uconn.edu/ct_pesticide_ban_schools).**

SUSTAINABLE LANDSCAPING PRINCIPLES

K-8 school grounds and athletic field managers have utilized Integrated Pest Management (IPM) protocol for many years. Use of sound IPM principles has become even more critical due to the restrictions and limitations of products available for use in a pesticide-free environment. Connecticut is one of only two U.S. states with a state-wide pesticide ban for the grounds of K-8 schools and day care centers.

IPM is a system of pest management practices that uses all available pest control techniques. The goal of an IPM program is to manage a pest population at or below an acceptable threshold level, while decreasing the overall use of pesticides (*Figure 4*).

Often, preventive, cultural, and mechanical tactics are successful, which can substantially reduce the need for chemical applications. IPM practitioners always strive to address and correct the root causes of pest problems.

Healthy, sustainable school landscapes provide environmental advantages and support educational opportunities for the school community. By necessity, municipal and facility managers that maintain school properties must prioritize compliance with the law and school safety, while managing limited budgets. At the same time, managers can also improve the sustainability and environmental benefits of school landscapes.

School properties are an environmental asset. Well-landscaped school properties (even with modest or limited budgets) are a valuable resource that **enhance learning and improve the quality of life for school constituents.** School landscapes can be stimulating, visually pleasing, and conducive to learning. **School properties can improve biodiversity** by increasing the usage of native plants and decreasing the non-renewable inputs used to maintain the landscape. They can even serve as a pathway for pollinators and other insects or as a habitat corridor for birds and

Essential elements of an IPM program include:

- **Accurate pest and beneficial insect identification**. Incorrect identification of pests is a common source of pest control failure and unnecessary plant damage.
- **Understanding life cycles, including the pest development stage that causes damage.**
- **Understanding the role of beneficials.**
- **Identifying the root cause of any pest problem**, including abiotic factors that can contribute to plant decline (e.g., ensuring that water, sunlight, site and soil conditions are properly matched with plant needs).
- **Ongoing scouting and monitoring** to determine pest severity and presence of beneficials. **Identify the action threshold** - the level of pest population when control of the pest(s) will be required to prevent or minimize unacceptable levels of damage to turf or ornamental plants.
- **Understanding the survival needs of existing or potential pests**, including food, water, and shelter. Pest populations can be successfully managed through proper sanitation and control of environmental conditions (e.g., removing food and water sources that feed pests).
- **Thorough record-keeping**, including weather data, pest and beneficial populations, plant conditions, and management tactics.
- **Evaluating** the success of management tactics.

Learn more at **EPA.gov/managing-pests-schools** and **ipm.cahnr.uconn.edu/school-ipm.**

Figure 5. When plants are included in the learning environment, "students are just smarter and pay more attention," says Dr. Charles Hall, Texas A&M University.

Images source: National Initiative for Consumer Horticulture (NICH) (consumerhort.org)

wildlife (refer to pollinator-pathway.org/connecticut for more information).

Benefits of increasing landscape sustainability on school grounds include:

- **Expansion or creation of an outdoor classroom and learning environment** that provides year-round interest and visual pleasure for students and faculty (*Figure 5*).
- **Support of pollinator habitats** and enhanced biodiversity.
- **Increase of permeable/plant cover, which boosts carbon sequestration**, the capture and storage of carbon dioxide in the plants and soil. Dense, healthy turfgrass and plants in the landscape sequester carbon, which helps moderate air temperatures surrounding the school building and provides an efficient carbon sink, preventing carbon dioxide from entering the Earth's atmosphere. Carbon sequestration benefits the whole community and is enhanced by properly landscaped school properties.
- **Protection of soils**, natural vegetative cover, water resources, and water quality.
- **Opportunity for reduced maintenance** of high visibility and non-priority turfgrass areas, utilizing fewer inputs (i.e., fertilizer, water, chemicals, and fuel).

PLANT SELECTION

PRINCIPLES

- **Proper plant selection is the most important step in designing a sustainable landscape.**
- **"Right plant, right place" is the fundamental principle** for the environmentally sound management of landscapes. Plants should be selected for not only aesthetic value, but also because they are adapted to the existing microclimate, including soil and water conditions.
- **Plants selected should be biologically diverse** and allow for reduced irrigation, fertilizer, and soil amendment inputs, as well as reduced costs associated with labor.
- **Establishing strong, healthy, dense plantings** is crucial for pest management in sustainable school landscapes. A vigorous, healthy, unstressed plant can usually survive, avoid, or outcompete many potential disease, insect, and weed pests without further intervention by grounds managers.
- **Native plants are best adapted** to the local soils and site conditions. Incorporating native plants helps to restore local ecosystems that support a wide variety of indigenous and beneficial insect, bird, and animal species. Whenever new construction or building renovation occurs, the **design** of the landscaped areas, including in the high visibility focal points (*Figure 6*), should be amended to include site-appropriate native plant material. **Over time, as these native plants become established**, they can increase biodiversity and contribute to a reduction in expense and time spent on maintenance.

- **A healthy and diverse landscape supports naturally occurring beneficial insects.** Native predators and parasitoids will help control harmful pests when provided the opportunity and necessary habitat for their survival. Many practices that support pollinators also support beneficial predators.

BEST MANAGEMENT PRACTICES

PREPARATION

- **Complete a detailed site assessment**, such as **the UConn Landscape Assessment Form** (ipm.cahnr.uconn.edu/school-ipm).
- **Perform a soil test** (soiltest.uconn.edu) **when renovating landscapes or when analyzing problems**. If warranted, use organic amendments (e.g., compost, compost tea, or leaf mulch), calibrated as part of the overall nutrient management plan, to build soil organic matter and improve soil health, establish populations of beneficial soil organisms, and extend nutrient release**.**
- **Assess the soil health and growing conditions of each landscape site.** Factors that influence the rate of plant dehydration include soil type, topography, and exposure to wind and sunlight. Different areas of a school property may vary greatly in these characteristics, which will have a significant impact on the plants chosen for each area.
- **Select appropriate plants for the site(s)** based on sunlight requirements, wind, soil conditions, and water availability to ensure successful establishment. Utilize UConn's Native Plant & Sustainable Landscaping Guide as a resource (s.uconn.edu/UConnNativePlantGuide).

DESIGN

- **Landscape design on school properties should:**
  - **Provide a safe, calming environment that fosters learning**, offers an aesthetically appealing design, and does not pose a security concern by physically or visually impeding visibility from within or outside the school.

Figure 6. A small, manageable, attractive planting at a high visibility focal point.

Figure 7. These hostas were planted in an area that received more sunlight than these plants can tolerate, causing leaf scorch.

Figure 8. Plant in floral clumps for maximum benefit to pollinators and aesthetic appeal.

- **Remain economically sustainable, considering both the installation and the *long-term* seasonal maintenance**.
- Protect environmental resources, including water.
- Include plants that remain healthy and attractive all season-long with reduced maintenance.
- Produce limited plant litter for reduced annual maintenance (*refer to Table 3, Appendix*).
- Deter wildlife activity near buildings.
- Minimize bee attraction near key entryways or areas frequently visited by students.
- Ensure that plants are not placed too close to the building foundation, to reduce the ability of ants and termites to travel into the school building.
- Avoid obstructing windows or visibility near entrances.

- **Select plants based on the soil characteristics, climate, sun exposure, water availability, and pest concerns.** Match plants with correct growing conditions, to reduce unnecessary irrigation and fertilizer inputs. Pair plants with their preferred native soil type (i.e., clay, sand, silt) and sun exposure (i.e., sunny vs. shady) (*Figure 7*).
- **Group plants together with similar water, pH, and nutrient requirements** to allow for the most efficient use of resources.
- **Plant in "floral clumps,"** which imitates the way plants naturally seed themselves and is both aesthetically pleasing and beneficial for pollinators (*Figure 8*). It is easier for pollinators to locate and benefit from plantings when there are five or more of each pollinator-supporting species in a group (Credit Valley Conservation, 2017).
- **Utilize a diverse range of plant species.** Choose plants that offer ornamental interest in every season, especially from fall through late spring, when staff, students, and visitors who regularly frequent the building can appreciate them. Bark, foliage, fruit, and fragrance are ornamental characteristics to consider in addition to flowers.
- **Select flowers with a variety of colors, shapes, sizes, heights**, and growth habits to attract pollinators. Choose plants with a wide range of flowering times to extend the forage season and attractiveness of the planting. Native plants that

Monarch Butterfly Conservation Garden Tips and Tricks

- **Make sure milkweeds are easily accessible and visible to butterflies** (e.g., do not plant grasses or other concealers in front of them). Plant milkweeds in an area with open lines-of-sight (especially north and south) and on the perimeter of the garden to increase visibility.
- **Use a variety of milkweed species**. Swamp milkweed (*Asclepias incarnata*) is very attractive to egg-laying butterflies (*Figure 9*), while butterfly milkweed (*A. tuberosa*) supports both butterflies and a wide variety of native bees.
- **Swamp milkweed and butterfly milkweed cultivars** have been found to be as suitable for supporting monarch eggs and larvae development as the straight species (Baker et al., 2020).
- Plant late season flowering plants to support monarch migration (e.g., Mexican sunflower, zinnia, goldenrod).

Adapted from "Monarch Butterfly Conservation Garden Tips and Tricks" by Adam Baker.

Figure 9. Plants that support both butterfly adults and larvae are important in landscapes. This monarch butterfly adult (top) drinks nectar from a native swamp milkweed plant, while a monarch caterpillar (below) eats the leaves of this native common milkweed.

bloom and attract pollinators in spring (e.g., willow, golden alexander) or fall (e.g., ironweed (*Figure 10*), goldenrod, aster) will provide more opportunities for student observation and learning from pollinator activity.

- **Consider including species that support both butterfly/moth larvae and adults.** Many butterfly and moth species are highly specialized, requiring specific foods for their survival (e.g., monarch caterpillars can only survive by consuming milkweed plants). To reap the benefit of supporting pollinators and providing the educational environment for students, it is important to consider some plants that will be tolerated being eaten by these beneficial species. Many trees, too, are butterfly larval host plants, including oak, maple, and willow (*refer to Table 1, Appendix*).
- **Use plants that, once established, will perform well over time.** Select plants that do not require excess care to maintain (e.g., frequent pruning).
    - **Ensure that the mature height and spread of each plant is accounted for** to avoid the need for excessive pruning or regular replacement.
    - Select trees and shrubs that produce minimal litter (e.g., fruit, nuts, berries, seed pods) where children actively frequent, which may pose a potential health hazard and to minimize additional maintenance (*refer to Table 4, Appendix*).
- **For high visibility areas, "nativars" may be of value**. Nativars are cultivars and hybrids derived from native plants. Some nativars provide as much benefit for pollinators as straight species, while others do not. They are often more compact or designed to suit smaller spaces, making them potentially more appropriate for courtyards or entryways where there may be an expectation for a tidy garden.
    - **Avoid cultivars that have been bred as double flowers**: they are typically sterile or it may be difficult for pollinators to access double flowers' nectar and pollen. A sterile plant will not be able to provide seeds for birds that rely on them as a food source.
    - **Each nativar plant is a clone, reducing genetic diversity in the plant stand**. In lower visibility or ancillary areas, consider planting primarily straight species of native plants, where they can provide increased support for pollinators and other wildlife.

Figure 10. Native plants, such as ironweed, provide sustenance for many pollinators and other beneficial insects.

Figure 11. Non-native, non-invasive plants, such as Zinnia, that are attractive and supportive to pollinators are beneficial additions to the landscape.

While numerous studies suggest that many pollinators prefer to forage from native plants (White, 2017), **some non-native plants are also attractive and supportive to pollinators**. As long as they are not invasive, these plants are good contenders for a sustainable garden, including:

- Allium	- Catmint	- Salvia
- Hydrangea	- Lavender	- Sedum
- Russian sage	- Sweet clover	- Zinnia

- **Choose salt tolerant plants** in areas near sidewalks and parking lots that receive winter ice melt treatments.
- **Select plant material not regularly browsed by deer**. Refer to Table 5 in the Appendix and the fact sheet Strategies to Minimize Deer Damage on School Grounds (ipm.cahnr.uconn.edu) for more information.

UConn's Native Plant & Sustainable Landscaping Guide (ipm.cahnr.uconn.edu) and Connecticut's Pollinator Pathways are useful resources for information on plant selection.

SUSTAINABLE HIGH VISIBILITY AREAS

High visibility areas of the school (e.g., around school entrances, gateways to athletic fields) should be **attractive focal points**. The landscaping around buildings makes a lasting impression on teachers, students, and the school community. School ground landscapes contribute to the educational environment and foster school pride. All areas require some degree of maintenance.

MANAGED AREAS OF SCHOOL PROPERTIES

High Priority:

- School building landscape(s)
  - Lawn Areas
  - Courtyards
  - Memorial gardens
  - Pollinator and rain gardens
  - Outdoor classrooms
- Entryways/egresses
- Parking lots, walkways
- Athletic Fields, Infields
- Playgrounds
- Dugouts/Bleacher Seating
- Recreational areas (tennis courts, basketball courts, trails, bike paths, skate parks, ice rinks)

Lower/Non-Priority:

- Property boundaries
- Fencelines
- Meadows, Naturalized areas

BEST MANAGEMENT PRACTICES

- **Maintain ornamental plantings in high-visibility areas at school entrances** (*Figure 12*).
- **Reduce the size and scope of large, labor-intensive landscaped areas**. A large expanse of foundation plants, managed as pesticide-free, requires more labor, effort, and time devoted to keeping areas weed free. Scale down the area of plantings to reduce weeding and mulching tasks.
  - Utilize turfgrasses, rather than foundation plants or ornamental plantings, along the side of buildings and in less prominent areas. Mowing is often less labor intensive than weeding of landscape beds.

Figure 12. Focus the ornamental area that must be weeded and mulched on smaller, high visibility areas, such as at entrances.

Figure 13. Choose plants that provide ornamental interest in all seasons, especially from fall through late spring, when students are present. For example, winterberry has red berries in fall and winter (top), while creeping phlox flowers in spring (bottom).

  - Where possible, **utilize electric equipment** to reduce the carbon footprint and noise pollution. Consider updated technologies when purchasing equipment (e.g., lithium-ion batteries).

- **Prioritize tasks that make a positive and immediate difference** in high-traffic areas, such as school entryways, the parent pick-up line, and playgrounds.
  - Weed plant beds consistently.
  - Add mulch to bare soil areas.
  - **Maintain a straight and consistent mown edge where turfgrasses meet landscape beds.** Crisp, neat edges have the most impact. Whether straight or curved, clean edge lines will demonstrate orderliness, which allows for less formal plantings behind the edge.
- **School grounds allow many opportunities to create pollinator habitat.** Provide an outdoor classroom area for students by including pollinator-friendly plants in landscape areas where they will not interfere with safety or recreational activity.
- **Integrate native plants** into the landscape wherever possible, staggering flowering times throughout the growing season (especially spring and fall, when school is in session) to maintain season-long color and aesthetic interest (*Figure 13*).
- **Provide a list of preferred plants**, such as Recommended Sustainable Plants for Connecticut Schools (ipm.cahnr.uconn.edu) to parent and garden groups that may purchase plants for the schools. Identify appropriate plants that are proven to tolerate the challenging conditions found in school landscapes.
- **In addition to native perennials, plant annuals that support biological pest control in school landscapes** (*refer to Table 2, Appendix)*.
  - Planting annuals and native perennials that attract beneficial predators is a viable method to maintain populations of beneficial insects on school grounds.
  - **Utilize a range of colors.** Reds and oranges attract butterflies and hummingbirds. Purples, blues, yellows and whites attract bees.
  - Refer to Biological Pest Control for Connecticut School Grounds (ipm.cahnr.uconn.edu) for more information.
- **Birds are also beneficial predators of many insect pests.** Insects make up a huge portion of

Communication is Critical

- **Communicating plans and timely progress reports to the school community is essential** when making significant landscape renovation or design changes. New plantings may take years to mature and reach the desired aesthetic effect.
- **Ensure that the school community has an understanding of the timeline for plant maturation.** Many native plants grow more slowly than the introduced popular non-native plants common to contemporary landscapes. Any changes to the landscape design should blend in with existing site features.
- **Decisions about improvements to site biodiversity must be balanced with the needs of the school environment (e.g., student safety and labor/maintenance requirements).**
  - **Safety considerations will always be the highest priority** (e.g., security site lines prevent tall plants from being grown near windows).
  - **Communication by town/school administration is important** to building a consensus that prioritizes student health and safety.
  - **Biodiversity efforts, safety and liabilty concerns, and budgetary requirements must always be balanced** in the decision-making process, including input from community stake-holders.
  - **Balance aesthetics with biodiversity concerns.** Grounds managers must determine which needs are most appropriate for the property. For example, for the management of beneficial "weeds" like milkweed: Some high visibility locations may not be suitable for such plants if they pose a visual hazard in locations that impede window/entrance site lines or present safety concerns.
  - **Remember – a weed is a plant out of place.** School grounds managers must decide how to balance a school's priorities against stakeholder desires or concerns.

most birds' diets, especially when they are nurturing hatchlings. By supporting and attracting birds with native perennials and appropriate annuals, it is possible to not only support vulnerable bird species, but also control unwanted pests.

- **Integrate low-maintenance turfgrasses into areas** around school buildings. Consult the National Turfgrass Evaluation Program (NTEP.org), Alliance for Low Input Sustainable Turf (A-LISTturf.org), and Turfgrass Water Conservation Association (TGWCA.org) for cultivars of turfgrasses with improved drought tolerance or that are suitable for non-irrigated, non-priority areas (fewer inputs to maintain).
- **Where irrigation is necessary, utilize high-efficiency irrigation systems** (e.g., drip irrigation) in all landscaped areas to conserve water. As with all new plantings, direct access to water should be part of the landscape design. If possible, incorporate recycling water features into the design and collect rainwater for onsite graywater use.
- **Minimize the use of impervious surfaces and increase permeable features**. Where possible, recycle, reuse, or use locally sourced materials for plants and hardscapes.
- **Slow water movement and replenish groundwater** by adding rain gardens, green roofs, bioswales, and other permeable surfaces. Install gravel pathways or borders that permit water infiltration, but have low evaporation potential. Develop the design of any water features based on how water moves on the site to ensure that water will drain away from the building and not into school entryways.

COURTYARDS

Consider the unique characteristics of various school areas, such as courtyards:

- **Be mindful of security issues and required access often needed by personnel for courtyard maintenance**. Courtyards are frequently a challenge for grounds management staff to access, both during and after school hours. Courtyard maintenance should be as simple as possible, as it may be assigned to the school custodians, who are also challenged with responsibilities of interior school maintenance.
- Direct access to water is critical and must be available if plantings are included in a courtyard area.
- **Care of complicated plantings may be required outside of school hours during the school year or when school is not in session.** If care beyond school facility staff is required, the maintenance directives need to be clear and free of liability concerns. Alternatives to direct faculty or student involvement can be assigned to a student service learning project, Parent-Teacher Organization (PTA or PTO) or a school club.
    - **Mature tree size and maintenance should be considered in landscaped courtyards.** Many trees will grow too large for limited courtyard spaces. Consider shrubs or ornamental grasses as alternatives near buildings.
    - Besides trees, consider other structures that may offer shade, including trellises, roof overhangs, arbors, or pergolas.
    - **Ensure that plants in the courtyard do not** minimize natural light from entering classrooms or **provide a security concern** by blocking site lines.
    - Snow removal may need to be considered, if courtyard egress is used for fire emergencies.
    - For more information about designing courtyards, refer to Maryland's Practical Guide to Courtyards.

LAWNS

A dense, healthy stand of turfgrass that is managed in a sustainable way is a net benefit to the environment. Care of turfgrass lawns on school properties may be considerably different from the maintenance of athletic fields, since general lawn areas are subject to less foot traffic and repeated wear. Maintaining lawns with fewer inputs helps the environment by conserving water and reducing chemical/nutrient and runoff. It also creates a healthy, sustainable turf, while reducing expenses and labor in the long term (Guillard, 2002).

BEST MANAGEMENT PRACTICES

- **Mow properly** to maintain turfgrass health.

- **Maintain a consistent high height of cut for maximum turfgrass health and optimal root growth.** For general lawn areas, a 3-4" height of cut is preferred. Longer leaf blades generate a greater capacity for photosynthetic activity and translocate more energy into root production, which produces healthier roots.
- **Mow regularly during the growing season at a consistent height of cut**, particularly in spring and fall, when turfgrass growth is most active.
- **Remove no more than 1/3 of the leaf surface** per each mowing event.
- **Return clippings to the turfgrass canopy to reduce fertilizer requirements**, particularly nitrogen (up to 50%) (Kopp, Guillard, 2002).
- **The higher a turfgrass is mowed, the more healthy and greater the mass of the root system**, which increases the soil capacity for accumulating carbon (Guillard et. al, 2018). A healthy lawn that sequesters more carbon than is used in its maintenance will be a carbon sink for greenhouse gases rather than a source.
- Where possible, utilize electric equipment to reduce the carbon footprint and noise pollution during mowing events.

- For overseeding existing lawns or establishing new lawn areas, select turfgrass species and cultivars that have improved turf qualities, including drought tolerance, as well as wear and pest resistance. Select species adapted for reduced maintenance, such as tall or fine fescue.
- **Cool season turfgrass lawns that are not irrigated will naturally go dormant in the summer, and recover when adequate moisture returns in the fall**. Mature, established lawns that are irrigated should be watered deeply and infrequently throughout the summer, optimally when turfgrass begins to show signs of drought stress. Turfgrasses should be irrigated based on their need for water, rather than on an arbitrary schedule.
- **Cool season turfgrasses that are not used for recreational or athletic activities can be mowed and fertilized less frequently.**

Figure 14. Worn turfgrass was replaced with gravel in this high traffic area at an athletic field entrance.

- **For non-athletic field turfgrasses**, applications of N should be less than 2 lb N/1000 ft^2/year. **Cool season turfgrasses should be fertilized** when they are actively growing **(in the spring and/or fall**).
- Fall fertilizer applications should be made in September, and no later than mid-October.
- **When possible, use slow release fertilizer products** (synthetic or organic) to extend the delivery of nutrients.

- Fertilizer spreader calibration and application data can be easily completed and captured using the **UConn FertAdvisor smart phone app**. The app can store historical data for record keeping and future retrieval. The app is available for both Android and Apple platforms.
- **Integrate electrical equipment when possible**. Given limited budgets, equipment upgrades and purchases may need to be phased in over time. When new equipment is purchased, consider electrical equipment, which has advanced considerably in the last decade. Lithium-ion batteries now allow for longer run times and more power. Electrical equipment has many benefits, including:

- Produces zero emissions, reducing the carbon footprint of the management program
- Less noise and fewer vibrations than conventional equipment
- No odor, as is emitted by gas equipment
- Fewer maintenance requirements
- Good return on investment – efficiency, reduction in fuel costs

However, the cost of the initial investment in new equipment may be prohibitive. Staff also must be current on training and have familiarity with electric equipment. Acclimation to new technology is an ongoing process as electric equipment becomes more commonplace and costs go down, increasing availability. In the future, other new technology will become more commonplace, including autonomous mowers.

Charging stations and access to available electrical outlets and infrastructure also require consideration. Battery lifespan should be considered and discussed with manufacturers before transitioning from conventional gas powered equipment to electric equipment. Scrutiny should include consideration of the life expectancy of the major components, particularly batteries.

Follow maintenance operations protocols for equipment care and employee safety for all equipment.

- **Repurpose challenged turfgrass areas**.
  - **Identify lawn areas that should be maintained as mown turf** (for either school community use or aesthetics) and **those low-priority areas that can be left unmown.** Unused or difficult to mow (e.g., steep banks) areas can be non-irrigated and, potentially, left unmown.
  - **Alternative landscapes (e.g., meadows, expanses of drought tolerant groundcovers, or rain gardens)**, which do not require supplemental irrigation once established, are an option for areas that are too dry, wet, shady, compacted, or otherwise challenging to maintain as mown turfgrass.
  - **Consider gravel or pavers** in locations where turfgrass is challenged by continual foot traffic (*Figure 14*).
  - **Consider installing buffer strips**, using permanent vegetation such as perennial grasses, to intercept runoff and enhance water filtration (*Figure 15*).
  - **Turfgrasses grown under trees** compete for water, light, nutrients, and space. Consider using mulch or groundcovers under shallow-rooted trees if mowing is difficult or if the turfgrass stand is a challenge to maintain.
  - **Consider using trees as a low maintenance solution to repurposing turfgrass areas** in non-priority locations where mowing may be a challenge (e.g., slopes). Like turfgrass, trees sequester carbon; in addition, trees mitigate heat islands, drawing people to them for shade and beauty. Trees are some of the strongest keystone plants in the food web (providing a critical food source for native pollinators). They often require less maintenance than most other plants in the landscape.

Figure 15. Low maintenance buffer strips planted in a turfgrass area to enhance water filtration.

For more information, refer to Cultural Practices for Turfgrasses (ipm.cahnr.uconn.edu).

SUSTAINABLE NATURALIZED AREAS

PRINCIPLES

- **Naturalized areas can be maintained sustainably and protect the environment while improving school safety and meeting maintenance budget requirements.**
- Using alternative landscape features in selected areas can result in substantive water, nutrient, labor, and other maintenance cost savings, over time.
- Property boundaries, outlying areas, and right-of-way locations must be managed with minimal labor and financial inputs. Nevertheless, school properties can make a positive and significant impact on wildlife diversity and also offer "outdoor classroom" opportunities for students.
- **These Multifunctional Field Margin (MFFM) areas can restore, preserve, and enhance biodiversity.** Property margins of schools can support multiple functions for the benefit of the school community.
    - **Property boundaries are valuable space** that can provide habitat for pollinators and wildlife and serve as corridors that may connect to other natural habitats.
    - **Native property margins play a vital role** in the protection of soil and water resources around schools.

Figure 16. Native plants that are too aggressive and unruly for high visibility areas, but which are beneficial to pollinators (e.g., milkweed [inset] and goldenrod, pictured above), may be allowed to flourish in out-of-way areas on school landscapes.

Figure 17. Beneficial "weeds," such as common milkweed, are often allowed to grow on school peripheries or on the edges of school playgrounds.

BEST MANAGEMENT PRACTICES

PLAN APPROPRIATELY

- **The design of the school landscape, including plant selection,** must not interfere with security, school activities, recreational events, or traffic flow.
    - **Areas modified for lower maintenance** should not significantly affect student/ staff safety or disrupt recreational play or the "quality of life."
    - **Develop and use a map** of the school property to help identify, define, or situate natural areas.
    - **Keep children away** from tall grass/meadow areas, where ticks, wasps, and/or poison ivy may be health hazards.
- **Use signage** to designate sustainable natural areas.
    - **Signs can communicate important information** about the benefits to the community and increase the visibility of your efforts in non-play areas.
    - **Post signs in areas used for educational purposes or environmental areas**, including rain gardens, pollinator gardens, and low-maintenance sections of the landscape to promote their value.
    - **Highlight the benefits** that native areas, etc. add to the landscape and the opportunities for education, along with recreation, that they provide.

- **Protect existing native habitats**: retain or restore existing native vegetation, where possible (e.g., leave the existing understory - brush and young trees - and native grasses in place).
- **Allow beneficial "weeds"** (e.g., milkweed, which supports the survival of monarch butterflies) to grow and mature in naturalized (*Figure 16*) or non-priority areas (*Figure 17*).
- **Nuisance and invasive plants should be removed and replaced** with native species adapted to the site. Open space areas should be actively managed to support native habitats and avoid introduction and re-establishment of invasive species. Refer to Connecticut's List of Invasive Species (cipwg.uconn.edu).
- **Consider leaving perennials (in non-priority and less visible areas) uncut through winter** to enhance their habitat value.
  - Seedheads provide food for birds and other animals.
  - Seedpods offer aesthetic interest in fall or winter.
  - Beneficial insects use the plant material for shelter.
  - Snow collected on stalks of perennials helps to insulate plant roots.
- **Consider incorporating bee-nesting sites in natural areas,** if possible, ***only*** where the health risk to students would be minimized, as students may not be permitted to enter naturalized areas (if areas are off limits, signage may be required).

MEADOWS/TALL GRASS AREAS

A meadow is an area of natural grasses and/or native wildflowers that, over time, becomes self-sustaining.

- **Replacing or reducing the area of mown turfgrass in non-priority or periphery areas with native vegetation** reduces mowing inputs and provides essential habitat for many species that are threatened by encroaching suburban development.
  - Keep children out of tall grass/meadow areas, where ticks, wasps, and/or poison ivy may be health hazards.
- **Meadows that are successfully incorporated** into landscape management programs**,** over time, may alleviate a portion of property maintenance expenses.

Figure 18. A successfully established meadow with thriving grasses and perennials.

Figure 19. A meadow next to a school athletic field. Photo by Tom Barry.

- **Meadow areas incorporated into school environments** may be required to be maintained as low-growing to keep visibility of areas clear for safety and security requirements.
- **Attention to plant selection**, **site preparation, and maintenance** is critical to designing, establishing, and sustaining a flourishing, beautiful meadow (*Figure 18*). Refer to the fact sheet Meadows: An Alternative Management Strategy for School Landscapes (ipm.cahnr.uconn.edu) for a list of recommended meadow plants.
- **Most meadow plants prefer full sun**. Select an area for a meadow that receives no less than half a day of direct sunlight to ensure success with sun-loving plants (*Figure 19*).
- **Slow growing, non-competitive grasses also should be incorporated into the meadow design,** in order to grow between perennials, preventing soil erosion and weed seed germination.

- **For multi-year health of a meadow area, include both short-term species (nurse grasses, annuals, and biennials) and long-term perennial species** that require multiple years to establish.
- **Time spent on site preparation in the early years of meadow development, to rid the site of competing vegetation, leads to fewer weeds in the meadow in subsequent years.** Soil surface disturbance should be minimized whenever possible, to prevent unnecessary weed germination at the soil surface. Less disturbance to the site will also maintain soil structure and integrity.
- **The first three years of meadow establishment require both a focused and patient effort.** Meadow areas are not maintenance-free. As part of the overall meadow establishment protocol, an effective maintenance plan should be developed before planting and implemented for the successful longevity of the meadow.
    - **In the first growing season**, **perennial meadow plants will grow slowly,** with an average overall height of 2-6", depending on the species. Annual weeds will proliferate and grow quickly if given the opportunity (*Figure 20*). To prevent weeds from growing too tall and outcompeting the desired perennials, mow the site every 4-6 weeks to a height of 4-6". Remove invasive weeds.
    - Repeated spot treating of aggressive weeds with a minimum risk product that is approved for use on school properties (or other products on municipal properties where pesticide use is permitted) may be an option. These minimum risk products will burn down vegetative growth, but will not kill the roots of well-entrenched perennial weeds. Over time, the plant will be weakened as top growth is knocked back, which will allow surrounding plants the opportunity to fill in the space.
    - **In the second and subsequent years**, **mow meadow vegetation to a height of 2-3" annually,** either in late fall/early winter or early spring, before the new season's growth begins. Mowing in late March or early April (as late as possible before the growing season begins) is optimal, as it will support the survival of insects that overwinter in stems or attached to plant debris.

Figure 20. A newly seeded meadow in spring, with heavy weed pressure.

- **As an alternative method to meadow establishment, schools may simply stop mowing an area near recreational areas or on the periphery of the school property**. Aesthetic expectations should be minimal, and **the site should be monitored for invasive plants, which must be removed.** An annual mowing in late fall or early spring, to maintain the site free of woody plants, is required.

WETLANDS

- **Wetlands serve as habitat for many species of birds, insects, fish, and other aquatic organisms and act as filters for pollutant removal**. Wetland buffers**:**
    - Trap and remove upland sources of sediments, nutrients, and chemicals.
    - Protect fish and wildlife by supplying food, cover, and shade.
    - Preserve healthy coastal and riparian (area between land and a river or stream) ecosystems and a stable stream channel.
    - May increase infiltration and ground water recharge.

- **Existing wetlands** with native vegetation on school, park, or municipal properties should be identified and maintained as protected areas and separated from managed turf areas (naturally or via structural buffers). **Constructed or disturbed wetlands** may require a permit to be included as an integral part of the stormwater management system.
- **Protect and maintain existing vegetation as natural buffers** during new or required construction, building renovation, or general maintenance. Ensure that wetland boundaries have been properly delineated before renovation projects or working in and around them.
- **Develop, enhance, restore or protect wetland buffers.**
    - **Wetland buffers may be natural or manmade.** Where manmade, improve habitat diversity with well-designed riparian buffers. Include a mixture of fast and slow-growing native trees, shrubs, or grasses to provide a diverse habitat for wildlife.
    - Riparian buffer areas above the high-water mark should be left in a natural state and not fertilized. Mowing at the water body edge should be substantially minimized. If necessary, direct clippings to upland areas.
- **Management of aquatic plants may be regulated** under construction permitting and regulatory licensing requirements. If required, obtain necessary permits before working on designated tidal or non-tidal (i.e., marshes, swamps, inland bogs) wetlands or 100-year floodplains. Consult with local, state, and federal agencies if undergoing construction or renovation. Develop an approved management plan before:
    - Altering natural aquatic areas or wetland areas.
    - Performing cultural practices in wetland areas: fertilization; installation of plants; hand removal of plants or mechanical harvesting.

PLANT HEALTH CARE, CULTURAL PRACTICES, AND MAINTENANCE

Growing and maintaining healthy, attractive plantings without the general use of pesticides at CT schools requires a shift in the standard landscape maintenance protocol. Schools that have reduced the size and scale of their high-maintenance landscape areas have achieved success with revised maintenance protocols.

Often, early season care of the landscaped areas is sidelined or delayed, while athletic field maintenance is prioritized. Prior to the pesticide ban, weed populations present in landscape beds were easily controlled with pre-emergent herbicide applications. Late-emerging spring weeds were not targeted until summer, once students and staff had departed for the summer recess.

Now, public school districts that successfully maintain aesthetically pleasing school grounds, with limited budgets, have most efficiently allocated their finite resources to also support landscape maintenance of high visibility areas. Many school grounds managers have intentionally scaled down the scope of the school's ornamental bed areas, increased the size of mown natural turfgrass areas around buildings and re-directed labor efforts to smaller landscaped areas with fewer plants in high visibility areas, such as school entrances. Smaller bed size reduces labor requirements and time associated with repeated maintenance chores, such as weeding and mulching.

BEST MANAGEMENT PRACTICES

GENERAL CARE PRACTICES

- **Proper care of landscape plants is essential to their health.** Evaluate and assess the health of existing plants in the landscaped areas. **Use the Landscape Assessment Form** (ipm.cahnr.uconn.edu) **developed by UConn Extension as a**

tool for monitoring the health of landscape plants, documenting regular landscape maintenance, and keeping records of ongoing pest and beneficials monitoring and pesticide applications, whether routine (minimum risk) or emergency (EPA registered). Use the form to help evaluate management protocols and justify budgetary changes regarding the landscape design and respective maintenance practices to the Superintendent and Board of Education. Assessment tools can help guide sports field and grounds managers to achieve the goals of their management program (Wallace and Siegel-Miles, 2020).

- **Promptly remove** dead or dying plants.
- **Maintain sharp blades** on pruners, shears, and loppers.
- **Regularly remove weeds** (*Figure 21*), which compete with desired plants for water, nutrients, light, and space. Pay particular attention to weeds that may be hazardous to student health, such as poison ivy or barberry, which may provide a habitat that encourages tick populations.
- **Refresh tree rings and limb up trees** with low branches every two years to ensure that low branches are not damaged by lawn mowing and to prevent the need for weed whacking around trees.
    - Remove weeds, spread mulch, and prune lower branches to clear the tree ring line.
    - Employ tree guards around trees to create a no-mow area.
    - Inspect trees regularly for root girdling.

Figure 21. Prioritize the prompt removal of weeds. Photo by Gregory Foran.

IRRIGATION

- **When supplemental irrigation is an available component in the outdoor landscape, best management practices should be followed** to maximize plant health and reduce water consumption.
- **Evaluate the water needs of the landscape.**
    - Consider plant selection in initial design and again at planting to support minimal irrigation needs once all plants become established.
    - Group plants according to soil and water needs.
- **If an irrigation system is used, prioritize water conservation with the irrigation maintenance program.**
    - **Install soil moisture sensors to determine water needs** in landscape plantings. Drip irrigation systems, rather than sprinkler systems, are recommended for landscape plantings.
    - **Audit the irrigation system** annually to inspect and measure the effectiveness of the system.
    - **Annually confirm that all irrigation systems are distributing water uniformly** and inspect, repair and/or adjust in-ground or drip watering systems throughout the growing season.
- **Irrigate when both the soil and the plant conditions merit the need, rather than irrigating on a schedule.**
    - This practice helps to avoid overwatering, conserves water, and protects plants from extended drought stress. Drought stress symptoms include leaf wilt (leaf folding and rolling) and leaf scorch (brown leaves).
    - Consider soil type in irrigation-need equations: coarse (e.g., sandy) soils, finer-textured (e.g., loam, clay) soils hold more water and require less frequent irrigation.
- **Water plants deeply and infrequently to encourage deeper, healthier rooting.**
    - Deeply-rooted and established plants can extract water from a greater volume of soil, making them more drought tolerant than shallow-rooted species or juvenile plants.

- **Use of wetting agents as a water management tool in turf areas or landscape beds may improve water infiltration, plant health, and surface firmness.** Wetting agents are surfactants (soaps) that loosen surface tension of water molecules to allow for improved water movement into soils. They can be applied in a liquid or granular form, and can be watered in or applied through the irrigation system. Products can be applied for season-long effect or applied for short term use.
- **Established landscape plants (trees, shrubs, and perennials):**
  - **Established plantings may not require supplemental water**, if at least moderately drought tolerant. However, in very dry and hot summers, some supplemental watering may be necessary. Plants are usually considered established after 1-3 years, depending on the species and type of plant.
  - **Saturate the root zone at the base of the plant**. Wetting the leaves and stems is of no benefit, as water is only absorbed through the roots in the soil. Watering is needed less frequently when the soil around each plant is saturated at each watering. Excessively dry soils may repel water, causing erosion and water waste.
  - **Low water pressure irrigation systems** (drip irrigation) allow water to trickle into the soil slowly for optimal absorption.
- **Annual flower and vegetable plantings:**
  - Irrigate similarly to established plantings: **saturate the soil around the plants**. For young plantings, watering may be required more frequently during drought conditions, depending on plant type and weather conditions. Monitor plants closely for signs of wilting to determine if more water is needed.

NEW PLANTINGS

- **The best time to plant trees, shrubs, and perennials is in the early fall**, when rainfall supports establishment and less frequent supplemental irrigation is required. Planting in early fall avoids the stress of summer heat in the early months of establishment, allowing plants adequate time to develop roots before the onset of winter. Plantings established in spring may be challenged to grow in areas where water is limited. Temperatures will stress plants during the hot summer months.
- **Ensure that all plants are installed correctly. The top surface of the root ball should be level with the soil surface. Do not plant too deeply**, which will deprive the plant's root system of oxygen and lead to plant disease or death. Conversely, shallow plant placement will lead exposed roots to become dehydrated. Check the root balls of plants grown in containers, which may need to be pruned or loosened if root-bound (*Figure 22*).

Figure 22. A root-bound container-grown plant (left).

- **Water plants thoroughly before planting**; saturate the root ball with water to aid the plant in adapting to its new environment.
- **Water is critical for new plants during establishment**. Plants with a juvenile root system (generally, plants under 1-2 years of age) will need more water than established plants. During the first couple of months of a new planting, watering may need to be done at least twice a week. Then, watering may need to be done once a week, depending on plant species, sun exposure, and weather, for the first year. Wetting agents may be considered to improve the absorption of water on new plantings.
  - **Mound a ring of soil or gravel around each plant**, so that water applied near the root zone is contained and has the opportunity to be absorbed into the soil. This is especially important if the plants are located on a slope.
  - **Even drought tolerant plants need care during establishment.** During the first

growing season, a plant's root system is small and can draw water from only a limited area. Young plants require supplemental irrigation until the root system becomes established, usually by the second growing season, depending on the plant. Use the same technique as with established plants to **saturate the soil around the root zone**.

- **To aid establishment of newly planted trees, use water bags** (gator bags) or tree diapers. These bags are beneficial for the establishment of trees up to 10 years of age, especially during periods of drought stress and for trees planted in areas where soils heat up quickly, such as parking lot islands.

PRUNING

- **Prune to remove old, diseased or damaged wood** to promote vigorous new growth, flowering or fruiting.
- **Properly prune** or trim trees, shrubs and other woody plants to maximize the plants' health and minimize invasion by pests. **Use the proper tool** for the size and type of pruning being done.
  - Hand pruners: for branches less than ¾" in diameter.
  - Loppers and pruning saws: for larger cuts 1-2" in diameter.
  - Hand saws and chain saws: for stems over 2".
- **Selectively thin** branches of overcrowded trees and shrubs once a season.
- **Prune flowering ornamental plants** at the correct time of year to avoid removing flower buds. The proper time to prune woody plants is determined by the plant's growth habit, bloom time, and health or condition (*Refer to Table 6, Appendix*). General pruning rules include:
  - Prune spring-flowering trees and shrubs soon after they bloom.
  - Prune summer-flowering trees and shrubs, which bloom on new wood, 4-6 weeks before spring growth begins.
  - Avoid pruning woody plants during the fall or early winter, which may encourage tender new growth that is not sufficiently hardened before the onset of the winter season.
  - Ornamental plants grown for foliage, rather than flowers, can be pruned in late winter-early spring or summer.
- **Multi-stemmed shrubs**: remove one or more of the oldest stems at the base each year in order to stimulate new shoots to grow from the base and promote improved flowering on younger shoots.
- **Where necessary, consult a licensed arborist to evaluate tree health**. Some Parks and Recreation departments have arborist(s) on staff. *Note*: A staff person maintaining trees on the property that is under his/her own management, or that of their employer, and is performing work as part of regular duties (not for hire specifically as an arborist), is not required to be licensed.

FERTILIZATION

- **Take a soil test of each landscape bed area** to determine if added nutrients are required to support plant health. Each landscape bed or surrounding lawn area may have different fertility requirements.
- **If additional fertility is recommended, slow-release fertilizers**, which extend the release of nutrients for a longer duration, are preferred. Follow all fertilizer bag application guidelines.
- **Compost** incorporated into the soil should also be factored into the nutrient requirements based on soil test results for the landscape area.
  - **Use reputably-sourced compost that has been adequately heated to prevent the introduction of invasive pests** (e.g., jumping worms, weeds).

Applications for soil tests and protocol for sampling can be obtained through UConn Extension.

- **Find instructions at the UConn Soil testing lab's website, soiltest.uconn.edu/sampling, or call (860) 486-4274; or contact the UConn Home and Garden Education Center toll-free at (877) 486-6271.**
- **To determine the percent organic matter in the soil, request that the soil test also include an organic matter evaluation.**

- **Use of organic products** is recommended in late spring to early fall, when soil temperatures are warm and soil microbes are actively using and converting nitrogen. Microbial activity declines when soil temperatures are cool in early spring and late fall.

IMPROVE & PROTECT SOIL STRUCTURE

- **Healthy topsoil** is composed of different sized soil aggregates and ample pore space for gas and water exchange. Finer-textured soil with smaller pore spaces will hold more water than coarse soils.
- **Improvement in soil structure** should be made, where possible, prior to new construction or renovation, before plants are selected and placed.
- **Compost added to the soil should always be based on soil test results** and included as part of an overall nutrient management program.
    - **Incorporate organic matter** (such as dry, well-aged, heat-treated compost) into topsoil of new landscaping beds to improve soil bulk density. Improving organic matter content can increase water retention in sandy soils, and enhance porosity in clay soils.
- **A well-structured soil with appropriate levels of organic matter reduces the need for frequent irrigation.** Soil in landscape beds and in turfgrass areas should be able to absorb and retain water from irrigation or rain events.

Figure 23. Shallow tree roots may make maintenance a challenge.

- **In established landscapes**, soil structure improvements can be made, but with greater challenges. **Complete a soil test every 2 to 3 years** to monitor changes in the percentage of organic matter and soil nutrient levels. **A minimum of 5% organic matter in the soil is recommended** for woody and herbaceous landscape plantings. Organic matter must be regularly added to the soil, since it is continually used by soil microflora.
- **No-till maintenance practices** in garden beds protect soil structure, keep root systems intact, and achieve improved infiltration.

REDUCE SOIL COMPACTION

Reduce soil compaction to promote deeper plant root growth, improve water infiltration rates, and enhance nutrient movement in the soil.

- **Compacted soil leads to poor plant health**, as well as shallower root development. When possible, soil cultivation should be considered in mature landscapes where large trees dominate the landscape beds, and where tree roots have encroached into nearby lawns. Trees with shallow roots may make mowing and cultivation difficult (*Figure 23*).
- **Aerate planting beds** every 1-3 years to decrease compaction and improve infiltration of water, air and nutrients into root zones. The soil around existing plants may be cultivated (loosened and broken up) by hand, with a hoe, or with a cultivation machine for larger areas. Air spading around trees can also be beneficial to reduce compaction, if equipment is available.
- **In new sites/landscapes, if soil is compacted**, till soil to a depth immediately below the compaction layer to improve water penetration. Limit soil compaction and disturbance by designating paths for machine and foot traffic.

CONTROL EROSION

- **Maintain healthy, dense turfgrass areas and groundcover plantings**. Use mulch around plantings to help keep soil in desired location.
- Eliminate or minimize the potential for water runoff.

- **Divert runoff** from building roofs, sidewalks, and driveways into rain gardens, buffer strips, or yard areas where it can recharge groundwater rather than become lost as runoff.
- **Use porous materials** for walkways and patios that allow water to remain in place and slowly infiltrate into the soil to prevent wasteful runoff (*Figure 24*).
- **All water should infiltrate easily into the soil**, so that it may become available to plants or for recharge of groundwater.

MULCH

- **Place mulch around plants, especially around new plantings**, to reduce soil erosion and help reduce water lost through evaporation.
  - Unmulched bare soil is exposed to desiccating winds and baking sun, which dries soil quickly.
  - A 2-4" layer of mulch keeps the soil moist, decreases evaporation, reduces weed growth, and slows soil erosion.
- **Use caution to avoid piling mulch too high around trees** *(Figure 25).*
  - **Do not place mulch directly against the plant crown or trunk base and flare.** Trunk base and exposed roots should be left uncovered to avoid plant suffocation.
  - Ensure that mulch is not placed up against school buildings, to avoid attracting ants and termites to the building foundation.
- **A mulch application should permit water to soak into the soil**. The upper mulch layer may dry out and repel water, rather than retain it. **Wetting agents** may be sprayed on mulches to improve water flow through the mulch layer.
- **Common organic materials used for mulch** include straw, salt marsh hay, aged bark mulch, composted wood chips, and chopped up leaves. Consider combining materials, such as pine bark mulch and compost.
  - As organic mulches decompose, they replenish nutrients in the soil and support overall plant health. They must be reapplied regularly.

Figure 24. Pavers allow water to infiltrate the soil.

Figure 25. Improper and excessive mulch (e.g., piled at the trunk base) will be harmful to the health of the tree.

  - **Purchase mulch from a reliable source**. Yard waste and ground up pallets are not recommended.
  - **Leaf compost is commercially available for use as mulch.** Use leaf mulch around large tree areas to add nutrients and reduce compaction. Wood chips used as mulch around tree species that are shallow-rooted and prone to compaction problems helps to reduce the load of equipment around trees.
- **Inorganic mulches**, such as gravel, stone, or pebbles, also can be used. **Inorganic materials should be avoided near building foundations** and in full sun areas, as they absorb sunlight, and often contribute excess reflected heat that can

Figure 26. Stone mulch.

prematurely dry out surrounding plant material or impact building structure. Landscape fabric, cardboard, or newspaper can be placed at the soil surface and covered with an organic mulch for extra weed protection.

LEAF DISPOSAL/MULCH MOWING

The disposal of leaf litter in fall can be a labor-intensive task, but **fallen leaves can provide an untapped and valuable nutritional amendment**. Just as returned turfgrass clippings provide nutrients to the lawn, fallen leaves can also supply organic matter and nutrients to the lawn and landscape beds, contributing to reducing the maintenance efforts of a low-input sustainable landscape (*Figure 27*).

Mulching and incorporating a 2" layer of fallen leaves ***over the course of the fall season*** into the turfgrass canopy in non-priority areas adds approximately 150 lbs. of nitrogen, 20 lbs. of phosphorus, and 65 lbs. of potassium per acre (Ferree, 2016) (*equal to approximately 3.44 lbs. of nitrogen, 0.46 lbs of phosphorus, and 1.5 lbs of potassium per 1,000 sq. ft*.).

For established turfgrass areas, **the rate or amount of a fall fertilizer application may be reduced or eliminated by annually incorporating finely chopped leaf litter into the turfgrass lawn canopy**. When mulched, the very fine leaf fragments will quickly decompose and mineralize (the natural process of nitrogen release from organic matter into forms that are available to turfgrass plants), resulting in less reliance on supplemental fertilizers. In non-priority areas that do not receive a supplemental application of fertilizer, mulched leaves return important nutrients.

Successful leaf mulching requires more frequent mowings to sufficiently reduce the leaves to a size small enough to settle into the turfgrass canopy without covering the leaf blades. Sunlight must be able to penetrate through the fallen leaf layer while turfgrass plants are still actively growing. If the chopped leaf layer is too thick or the mulching fragments too large, then the turfgrass plants can be deprived of sunlight needed for growth at a time when the intensity and duration of available sunlight is diminishing.

On turfgrass areas:

- **Mulching finely chopped tree leaves into an existing turfgrass stand may be considered part of a leaf-litter disposal strategy.**
  - Mulching mowers cut and shred leaves during the mowing process. These machines can easily finely chop up to 6" of leaves at a time.
  - Traditional mowers can be used by raising the mower deck to the highest setting and making several passes over the area in a crisscross pattern.
- **Frequent mulching of leaves directly on lawns during each mowing event is recommended while mowing at the correct height of cut with no more than 1/3 of the leaf blade removed**. To keep finely mulched leaves in the turfgrass canopy, the frequency of fall mowing events may need to increase.
- **Finely mulched leaf fragments will provide the lawn with essential nutrients,** retain soil moisture, shade the soil surface to reduce the germination and growth of winter annual weeds, moderate the soil temperature as the weather cools, and provide a continued source of food for

soil microflora actively feeding on the decomposing organic matter.

- Fallen leaves can block sunlight and limit turfgrass growth, so **no more than 20% of the turfgrass lawn should be covered by tree leaves after each mulching event** (Trappe, 2018).
- **Fallen leaves are an excellent source of carbon**; most deciduous leaves are composed of approximately 2% nitrogen (Trappe, 2018). When mown into lawns, leaf particles mix with grass clippings. Both break down quickly and efficiently, and combined, create a compost of optimal composition.
    - If a thick layer of leaves remains on the top of the turfgrass surface during the late fall and winter, it will provide an environment that may encourage disease (snow mold), which may subsequently thin or kill the turfgrass.

Figure 27. Leaf residue left behind on the surface of the lawn after mulching over leaves. Photo by Kevin Frank, MSU

    - In the spring, a layer of leaves remaining on the turfgrass surface will also block the sun from warming the canopy surface, slow spring green up and delay active growth. An early spring clean up will encourage healthy growth.
- **Research has shown that mulching leaves into the turfgrass canopy increases organic matter at the soil surface, but does not contribute to the direct buildup of thatch (Horton, 2014).**
    - Thatch is composed of portions of the turfgrass plant (rhizomes, stolons, senescing leaves) that accumulate at the soil surface and are slow to decompose.
    - **Thatch is a normal component of an actively growing turfgrass system**. Some species develop thatch more rapidly than other species.
    - **Regular maintenance of thatch is important** in both athletic field and non-athletic field settings to maintain a healthy thatch layer.
    - In areas of heavy wear, such as on athletic fields, thatch can increase the resilience of the turf canopy.
- **Always mow the turfgrass canopy and fallen leaves when the surface is dry**. Wearing a dust mask is recommended to avoid inhaling small particles.
- Mulch mowing up to tall vegetation or woodland edge may help to reduce tick habitat (Wickings, 2015).
- Variations in the degradation process of leaves based on tree species has been observed. Leaves of ash and maple are more difficult to mulch than oak leaves (Trappe, 2018).

In landscape beds:

- If mulched fallen leaves are desired around plants in landscape beds, use a mulch mower with a bag component to collect, transport, and disperse the mulched leaves with minimal effort.
- Whole unshredded leaves can also be distributed or left unmown, if desired.
    - **Strategies of a sound environmental management program** include strategically not mowing leaves where possible to reduce mowing emissions and fuel consumption.
    - **Preserving intact leaves, to which insects may have become attached, protects and allows beneficial insects to complete their life cycle within the garden**. Many beneficial insect species rely on fallen leaves for protection during winter (e.g., many insect species spend the winter months protected in leaf litter on leaves as cocoons or pupa).

Figure 28. Combine green and dry brown plant materials for composting. Photo by Rosie Lerner, Purdue Extension

Whether finely chopped or whole, distribute leaves around plants in a 4-6" layer, while maintaining a 6" circle of space around the crown of each plant. This space allows moisture the opportunity to filter easily into the soil, while also preventing damage from rodents or suffocation of the roots. A heavily mulched landscape bed may be a welcoming environment for voles and other **burrowing pests.**

Collected leaves can also be composted or piled in out of the way locations to allow them to break down over time (*Figure 28*).

Pest Management Considerations:

Correct leaf management plays an important role in pest management strategies within a sustainable landscape.

There may be circumstances when mulching with leaves may not be beneficial. Overwintering insects, disease pathogens, and weed seeds may be protected in leaf litter. If insects or diseases have been a repeated problem, it may be necessary to temporarily bag and dispose of leaves in the trash to reduce future outbreaks. Always follow local municipal yard waste regulations.

Jumping worms (*see pg. 44*) can be moved around the property by moving leaves from one area to another or adding them to compost. If jumping worms are present on the property, avoid moving infested leaves into uninhabited areas.

PREVENT SALT DAMAGE

- **Place and set back plants away from roads and sidewalks** that may be subject to winter applications of ice melt.
- **Replace salt sensitive shrubs** (e.g., boxwood) and shrubs easily disfigured by snow piles with salt tolerant perennials or ornamental grasses in areas that are subject to applications of salt and regularly piled with snow in winter (sidewalks and parking lot curbs) (*refer to Table 4, Appendix*).
- **When planting in coastal locations or areas that are regularly subject to tidal flooding**, select plants with high salt tolerance. Refer to UConn Extension's CT Native Plant and Sustainable Landscaping Guide (ipm.cahnr.uconn.edu) for plant suggestions and information.
- Use all ice melt products judiciously. Avoid overapplication (*Figure 29).*
    - **Salt on impervious surfaces** can affect groundwater quality and cause stormwater drainage problems.
    - **Consider using calcium chloride**, instead of magnesium chloride, on sidewalks. Calcium chloride is less likely to harm plants unless it is overapplied (Cantaluppi, 2016). It works quickly and is more effective than rock salt (sodium chloride), but be aware that it may produce slippery, slimy surfaces on concrete sidewalks.

Figure 29. Avoid over-application when applying salt-based ice-melting products.

PEST CONTROL

School grounds and lawns may be managed without the use of pest control products, although the threshold level for pests may vary based on the intensity of use and priority level of each area.

Cultural practices (the purposeful manipulation of the landscape to discourage pest invasion through sanitation, plant selection, and plant care activities) are of utmost importance. Preventive methods to reduce the occurrence of pest problems is critical in a pesticide-free environment.

Following proper maintenance, to encourage healthy, actively growing plants, is the best defense to mitigate pest issues. Continually scout for weed, insect, and disease pests, as well as beneficial insects, during routine outdoor maintenance.

BEST MANAGEMENT PRACTICES

BE PROACTIVE AND ACTIVELY COMMUNICATE

- **Make a plan** to optimize cultural management of all school grounds and lawns.
- **Communicate this plan to administrators, staff and stakeholders**. Include all persons who may be impacted by the grounds maintenance program (i.e., school staff, teachers, parents, school board, and other interested community members).

REGULARLY EDUCATE AND TRAIN STAFF

- **Regularly revise standard practices with up-to-date technologies.**
- **Work with Extension Specialists and attend UConn Extension educational trainings**: School IPM Workshops, Turf Field Days, Municipal and School Grounds Turf Academy are offered annually or biannually.

SCOUT/MONITOR

- Make regular inspections of the plant material in the landscape areas and recreational turf. Gather and record site-specific information on plant health, pests present. Base pest management decisions on documented conditions.
- **Monitoring enables IPM practitioners to:**
  - Identify pest(s) and beneficials.
  - Apply preventive methods to reduce the occurrence of pest problems.
  - Determine if, where, when, and what kind of treatments are needed.
- Be aware of and recognize common pest (insects, weeds, and diseases) of the landscape. Learn about their life cycles and how to recognize them. Consistent scouting of all pests is recommended for the duration of the growing season.

MAINTAIN GOOD RECORD-KEEPING PRACTICES

- **Use the UConn** Landscape Assessment Form (ipm.cahnr.uconn.edu/school-ipm), or other appropriate assessment documents, to monitor pest management.
- **Maintain a record-keeping archive** for pest monitoring and routine (minimum risk) or emergency (EPA registered) pesticide applications.
- **Identify and evaluate management protocols** to justify budgetary changes regarding the landscape design to the Superintendent and Board of Education.
- **Review the site history and acknowledge ongoing potential pest problems** on an annual basis. Adjust plans to manage turf or landscaped areas accordingly.
- **Maintain records** of all pesticide applications (including those of minimum risk products) for 5 years, as required by law. Records must include:
  - Name(s) and certification number(s) of the licensed commercial supervisor and operator;
  - Name and amount of pesticide used, and amount of acreage treated for each application;
  - Date and location of application; site treated;
  - The identified pest requiring treatment.

WEATHER STATIONS

Weather stations are a valuable tool that can support Connecticut school grounds managers in

their efforts to make timely and skilled pest management decisions. The ability to scout to prevent pest problems before they occur, and to correct problematic management practices as early as possible, helps grounds managers better manage all components of their school properties.

Many grounds managers have used calendar dates or phenological markers as a basis for pest management programs. **Using Growing Degree Day (GDD) units, based on information collected from weather stations, is a precise way to track plant and insect development and growth.** GDDs are used with biological and other pest control measures to time corrective treatments with insects' life cycle developmental stages in order to apply product at the point of optimal pest vulnerability.

Free tools are available online for assistance in using GDD information to schedule PGR applications (UMass, New Hampshire GDD Resources). Find GDD calculators at NEWA Cornell and Climate Smart Farming. Check your regional Extension and university services for local GDD information.

Find growing degree day information for common Connecticut pests at s.uconn.edu/CTinsectsGDD.

For more information about weather stations, refer to Using Weather Station Data on Connecticut School Grounds and Athletic Fields (ipm.cahnr.uconn.edu).

WEED PREVENTION AND CONTROL

It is easier to prevent the introduction of weeds than it is to control them after establishment. **Important practices to reduce weed populations** include:

- Eradicate newly emerging weeds before they become extensive problems.
- **Mechanically remove weeds**: When possible, promptly remove weeds that require attention. Prioritize the removal of weeds before they flower and produce seeds. For large areas (e.g., playgrounds), use specialized equipment to enhance the mechanical removal of weeds.
- **Clean mowing and landscape equipment** before transporting them to other locations. If weed populations are identified and present in the general lawn areas, mow the least weedy areas first, before mowing the weedier areas, where practical.
- **Control or eliminate weeds around buildings**, in landscape areas, and along fences and property perimeters.
- **Reduce the introduction of weed seeds onto school properties.** Minimize introduction of topsoil contaminants and weeds moving into landscape beds and turfgrass areas.
    - **Remove weeds from plant material or containers** to prevent the introduction of weeds to a new landscape site and to reduce future problem populations.
    - **Use only weed-free compost, mulch, and seed**.
    - **Purchase high quality plants or turfgrass seed**. Examine all seed labels for the least amount of weed and crop seed present.
- **Increase plants' ability to compete with weeds** by planting more densely than is common in conventional landscapes in order to shade the soil surface and reduce weed seed germination. Accounting for plants' mature size, place plants so that their tips will overlap over time, instead of requiring mulch to cover large, open areas.
- **Consistent, diligent weed control in the first 1-2 years** is required in order to establish a weed-free planting.

Figure 30. This highly visible memorial garden was mulched with newspaper and bark mulch. Newspaper was placed under the mulch to extend weed-suppressing effects.

- **Recognize that weed seeds can establish on the surface of mulch**. Refresh the mulch layer in landscape beds every 1-3 years to prevent germination of seeds that may contaminate the mulch surface.
- **Prevent or minimize the production of seed** or vegetative spread of annual and perennial weeds on site with prompt physical removal or application of allowable minimum risk herbicide products.
- **Weed barriers**, such as mulch, are useful in playgrounds or landscape areas to prevent weed infiltration in unplanted areas. 4-6" of wood chips, bark, cardboard/newspaper, or fabric mulches are recommended (*Figure 30*).
- **The presence of weeds often indicates** poorly timed or improper establishment or a stressed and unhealthy landscape planting or turfgrass stand.
    - **Look for indicator weeds**, which may provide clues to soil health in the landscape or turfgrass stand (*Figure 31*). For example, annual bluegrass thrives in moist, excessively irrigated, or poorly draining soils; crabgrass thrives in hot, dry soils; prostrate knotweed favors compacted areas.
    - **Weeds will always be a challenge in poorly seeded turfgrass areas or bare, open soils.** When poor growing conditions or activity creates voids in the turfgrass canopy, weeds inevitably fill those spaces. The conditions encouraging weed growth must be corrected to successfully manage weed populations.
    - **Modifying cultural practices**, or amending soil conditions that favor the health of the plant, will reduce weed populations.
- **Minimum risk herbicides** may be used as part of a comprehensive weed control program. **Minimum risk herbicides are typically non-selective, post-emergent products.**
    - They may injure or kill vegetative tissues that come in contact with the herbicide, but they are not translocated to the roots. Since these contact herbicide products lack residual activity and vary in efficacy, repeat applications are needed to control new flushes of growth.
    - They generally are more effective on juvenile weeds, particularly annuals, while often achieving minimal success on established perennial weeds.
    - **CT DEEP provides a list of minimum risk products which have been approved for use on K-8 properties.** This list can be found at: portal.ct.gov/DEEP/pesticides.
- **Heat treat**: Handheld propane flamers or steam weeding devices can be used as a spot treatment for non-selective vegetation control in non-priority turfgrass areas and landscape beds, along fencelines and in parking lots, graveled areas, or cracks in sidewalks.
    - **Most effective on annuals and juvenile, small weeds** (fewer than 4-5 leaves; less than

Figure 31. Red (sheep) sorrel indicates dry, acidic, low fertility soils (top). Yellow nutsedge indicates wetter soils (bottom).

a few centimeters tall) **in spring or early summer**. The intense heat more successfully injures or kills young plants that do not have well-developed root systems.
    - Heat the leaves only long enough to destroy the waxy cuticle of the leaf in order to disrupt and destroy the plant's cells (slowly pass over plant; do not linger on each plant).
    - Weeds are more susceptible to heat treatments in dry conditions.
    - **Note: Flaming can be used to control weeds in landscape beds and turfgrass stands, but** recognize that damage to surrounding plants will occur, so re-seeding of turfgrass around the targeted weed may be required to prevent germination of new weeds.
- **Solarization**: primarily used as a broad-spectrum pest control technique in small to medium sized areas. A clear plastic sheet can be spread over the soil to trap solar heat. The intense heat will primarily kill pests found in the top 6" of the soil, although the heat may reach a depth of 12-18", killing many soil borne diseases, insects, nematodes, and weed seeds.
    - **The treatment should be timed** to occur during 4-6 weeks during the heat of summer when solar radiation is most intense.
    - **Keep the soil damp during the solarization process**, as wet soil conducts heat better than dry soil. Solarization may also improve soil health by increasing the release of nutrients and by beneficially altering the soil microbiome.
    - Once the plastic is removed, the area must be promptly planted, as the open area created by the process will be subject to rapid infestation by weeds that thrive in nutrient-rich soils (Tu *et al*.).
- **Till**: Useful in heavily weed-infested landscape areas. More successful eradication is possible with annual weeds. **Tilling the soil is preferred in spring or fall**, when the soil is at least 60°F and easily crumbles. Tilling may need to be repeated. Disturbance of the soil and exposure to sunlight may encourage germination of surface weed seeds. Measures should also be taken to minimize soil erosion by wind and water in and around the tilled site.

Correct identification is paramount. Excellent identification guides include:

- Weeds of the Northeast, by Richard H. Uva, Joseph C. Neal, and Joseph M. DiTomaso
- Invasive Plant List - CT Invasive Plant Working Group (CIPWG) (cipwg.uconn.edu)
- Landscape Weed Identification; Turf Weed Identification - UConn IPM (ipm.cahnr.uconn.edu)
- New Jersey Weed Gallery – Rutgers Agricultural Experiment Station
- Weed Management in Turf – Penn State Extension
- Weed Herbarium – UMass Extension
- Weed Identification & Management - University of Wisconsin-Madison

SPECIAL CONCERN: INVASIVE WEEDS

An invasive plant is a non-native species that has been introduced or escaped cultivation into non-managed habitats and causes environmental harm. For a complete list of Connecticut invasive species and their identification and management, visit the Connecticut Invasive Plant Working Group (CIPWG) at cipwg.uconn.edu. **Plants become invasive because they possess one or more of the following characteristics:**

- They are prolific seed producers and can easily establish new plants and grow rapidly under a wide variety of site conditions.
- They are able to re-populate new areas due to fragments of roots, rhizomes, or stems that are transported within soil.
- Once introduced, they lack any natural predator that can manage populations.

Some of the most common invasive weeds found on Connecticut school grounds landscapes include:
Herbaceous Perennials and Annuals:

- Common mugwort (*Artemisia vulgaris*)
- Garlic mustard (*Alliaria petiolata*)
- Japanese knotweed (*Fallopia japonica*)
- Japanese stiltgrass (*Microstegium vimineum*)
- Swallow-wort, black (*Vincetoxicum nigrum*) or pale (*Vincetoxicum rossicum*)

Woody Vines, Trees, and Shrubs:

- Asiatic bittersweet (*Celastrus orbiculatus*)
- Autumn Olive (*Elaeagnus umbellata*)
- Burning Bush (*Euonymus alatus*)
- Japanese barberry (*Berberis thunbergii*)
- Japanese Honeysuckle (*Lonicera japonica*)
- Multiflora rose (*Rosa multiflora)*
- *Tree-of-heaven (*Ailanthus altissima*)

**Note that Tree-of-heaven is the preferred host plant of another invasive species of concern, the Spotted Lantern Fly (SLF). Follow CT DEEP guidance on what to do if you find SLF.*

For control information of invasive plants, refer to UConn Fact Sheets at ipm.cahnr.uconn.edu.

SPECIAL CONCERN: POISON IVY

Poison ivy is not an invasive plant; it is native to the United States. It is, of course, problematic in a school environment, if encountered by students or staff, due to the itchy, painful rash caused by urushiol, an oil secreted by all parts of the plant. Poison ivy can appear significantly different depending on the time of year and age of the plant (*Figure 32*). Key identification characteristics include:

- *Leaves*: compound with three leaflets. **The middle leaflet's stalk is significantly longer than the stalks of the two side leaflets.** Edges can be smooth or coarsely toothed. Surface can be glossy or dull.
- *Stems*: reddish-brown; mature vines often have aerial roots that appear fuzzy.
- *Flowers*: inconspicuous clusters on mature vines.
- *Fruit*: Clusters of hard cream-colored from August to winter.
- *Growth Habit*: typically grows as a climbing or crawling vine; can appear shrub-like.

Best Management Practices

It is important, and much easier, to manage poison ivy populations when plants are small. Poison ivy grows and spreads quickly. Prompt removal of an infestation reduces the amount of physical effort and resources required to manage the population, as well as the need for a pesticide exemption.

- **Always wear protective clothing or equipment when removing or working near poison ivy.**
  - Wear a long-sleeved shirt, pants, and waterproof gloves to reduce contact with the oil from the plant.
- **Small plants may be pulled or dug out**. All parts of the underground roots and rhizomes must be removed from the soil to prevent regrowth.
- **Repeated cutting, mowing, or tilling** will slowly kill poison ivy. Beginning in early spring, as growth becomes evident, cut back the plants to ground level every 1-2 weeks or whenever new growth appears.
- **Plants may be smothered** with cardboard or black plastic.
- If a poison ivy infestation on school property is located near where students frequent (*Figure 33*), CT DEEP can be consulted for assistance to determine if an emergency exemption may be

Figure 32. The appearance of poison ivy can be quite variable, depending on the time of year and age of the plant. Tender new growth in spring, with some red foliage visible (top left). Dark green foliage of an older plant (top right). Yellow fall color (middle). Flowers (bottom).

warranted. If pesticide use is considered necessary at a public school, the Superintendent of Schools is authorized to approve an emergency treatment. For private schools, the local health department would need to make the determination for emergency treatment. If an exemption is approved, a licensed, professional applicator should be hired to provide the appropriate treatment.

Figure 33. Poison ivy at a school entrance.

Poison ivy located away from school entrances or playgrounds that does not qualify for an exemption should be identified, blocked off to discourage human contact, and, if possible, removed using mechanical and cultural means.

CULTURAL PRACTICES FOR INSECT AND DISEASE PREVENTION AND CONTROL

On school properties, limited labor and budgets dictate that insect pest and disease management of ornamental/landscape plants is usually a lower priority than that of athletic fields. **Landscape pests must be managed using sound cultural practices**, including:

- **Right plant, right place.** Healthy, vigorous plants can better fend off disease and pest attacks.
- Evaluate the site and select appropriate plants. **Plants that are not appropriate to the site will become stressed**, unhealthy, and more susceptible to attack by insects and diseases.
    - Help plants resist and tolerate pests by providing proper amounts of nutrients and water.
    - **Optimize timing of maintenance activities to prevent introduction of pests**. For example, pruning some plant species in fall can encourage tender shoots of growth, which may be susceptible to frost damage in winter. Damaged and stressed plants are more susceptible to pest pressure.
    - **Select disease and insect resistant species and cultivars**.
- **Encourage beneficial insects and natural enemies of pests** by selecting plants that attract them to the landscaped area, thereby reducing or eliminating the use of pesticides**.**
- **Practice good sanitation**.
- Remove and dispose of diseased or infested plant parts and dead plants.
- Rake up and dispose of diseased leaves and fruits.
- Clean up and compost garden debris in the fall.
- **Prevent the introduction and spread of pests.** Use disease-free and insect-pest free seed and plant material to prevent introduction of pests to the landscape.

TURFGRASS INSECTS

Insects can cause substantial damage to plants in the landscape and to turfgrass lawns. In turfgrass, symptoms of insect damage can be indiscriminate or resemble large patches of dead turfgrass. Depending on the insect, feeding damage can be evident on the turfgrass leaves, the crown area, or roots. **The larvae of scarab beetle grubs** (e.g., Japanese beetle, Oriental beetle, European chafer, and Northern masked chafer) can feed extensively on turfgrass roots and quickly destroy large expanses; the turfgrass initially appears drought-stressed and eventually dies. Japanese beetles cause damage in the landscape as both adults and as larvae. While the larvae feed on turfgrass roots, the adults skeletonize leaves of leaves of landscape plants, causing significant damage.

Life cycles of the different scarab beetles vary slightly, depending on the species, within one generation per year. Typically, adults emerge and lay eggs in late June/early July, with first instar grubs

Figure 34. Chinch bug lawn damage. Photo by David Shetlar, The Ohio State University, Bugwood.org.

Figure 35. Sod webworm moth. Photo source: Lebanon Turf.

hatching in late July/early August. Second and third instar larvae continue to feed until they move down in the soil for the winter. In the spring, they resume feeding, and pupate before emerging as adults in early summer. Rastral patterns (arrangement of hairs on the grub hind end) can be used to identify the species.

Scouting for grub presence in late summer is critical to detect their presence before substantive feeding damage occurs. Often, the presence of grubs is detected only when large areas of turf are destroyed by mammals that feed on the grubs.

Here in the northeast, damage to cool-season turfgrass areas can also be attributed to surface feeding insects. The most prevalent are hairy chinchbug, bluegrass billbug, and sod webworm.

- **Chinchbugs**, which have 2 generations per year, overwinter in turfgrass thatch. Nymphs and adults feed at the base of the turfgrass plant during the growing season. Their sucking mouthparts are able to remove nutrients from turfgrass leaves, causing the turfgrass to appear drought-stressed. **Typically, damage is observed after the summer dry season**, when the turfgrass does not appear to green up as the cooler weather returns (*Figure 34*). Damage will be evident in full sun locations where turfgrass is drought-stressed. More information: Michigan State University Extension.
- **Sod webworm** larvae actively feed at night at the base of turfgrass plants. Silky tunnels are evident in the thatch, especially in early morning when dew is present. The larvae feed on leaves and stems at the turfgrass crown and prefer turfgrass that has been consistently fertilized. **Damage thins the turf and patches of brown, drought-stressed turf can be evident**. Most damage will be evident in full sun. Adults (*Figure 35*) typically can be seen flitting across lawns at dusk during mid-summer as they deposit eggs at the base of the turfgrass leaves. Once the larvae hatch, they feed at the base of the plant.
- **Bluegrass billbug** larvae feed on turfgrass plants at the crown and soil interface. The adult weevils lay eggs at the base of the turfgrass plant. Hatched larvae then feed on turfgrass plants often at areas along a sidewalk or driveway, where soil temperatures are warmer. **Symptoms of damage appear as brown dead patches or smaller spots of turf.**

BEST MANAGEMENT PRACTICES

Regardless of the pest, there are tactics to reduce the population of insect pests to an acceptable threshold to reduce subsequent feeding damage.

- **Season-long scouting** for pests and correct identification of a problem insect is critical to support proper control recommendations. Consult Extension specialists to aide in diagnosis.
- **Reduce excess thatch** in lawns to reduce areas where insects can be protected or overwinter.
- General removal of turfgrass debris in the spring will help to re-invigorate the turfgrass stand.

- **Select improved turfgrass cultivars and consistently overseed** turfgrass lawns in high-priority areas. Improved cultivars have been developed to support turfgrass health and can reduce damage from feeding insects.
- **Selecting turfgrasses that are endophyte-enhanced** will also deter/repel surface feeding insects.
- **Keep the turfgrass healthy through proper fertilization and irrigation**. Healthy roots enable the turfgrass to withstand stress and insect feeding pressure.

Biological Control Options:

Biological control agents can mitigate or reduce populations of insect pests. All biological control agents require a host to survive. Biological product options include:

- Grub gone (*Bt galleriae*), a strain of Bt that has had success as a grub control product.
- Met52 (*Metarhizium anisopliae*) is found naturally in soils; it infects and kills insects, targeting ticks, thrips, weevils, mites and whiteflies.

Consult with Extension specialists for biological control options available at schools. The UConn fact sheet Biological Pest Control Products, found at s.uconn.edu/biologicalproducts, provides a list of biocontrol for turfgrass insect pests. Where allowed (high school/municipal properties), chemical products may be considered to control insect pests. Follow label directions when using all chemical treatments.

Correct identification is needed in order to provide effective control. The UConn Plant Diagnostic Lab (plant.lab.uconn.edu) or the CAES Diagnostic Lab are valuable resources for assistance with pest identification.

TURFGRASS DISEASES

Several pathogens can cause serious damage to turfgrasses. **A lawn that is maintained to support its optimal health should be able to withstand minor seasonal disease activity.** When environmental conditions favor turfgrass growth and the turfgrass is healthy, there is little opportunity for fungal diseases to pose an issue. However, when environmental conditions favor growth of a pathogen and the turfgrass is not healthy, then there is opportunity for disease.

Most diseases impact stressed turfgrasses (e.g., inadequate or excessive fertility, pH imbalance, drought, extensively trafficked, scalped, etc.). Overseeding new cultivars with improved genetic tolerance to a pathogen or are bred to improve turfgrass vigor can reduce disease incidence.

Maintaining turfgrass health with proper management (fertilizer, irrigation, cultivation) **practices will keep the lawn healthy and limit disease incidence**. Mower blades should always be sharp to reduce wounding during each mowing event. If the lawn is irrigated, watering should occur early in the morning, so that turfgrass leaf surfaces dry quickly.

Many diseases require prolonged wet leaf surfaces to allow germination and movement of the fungus into the turfgrass plant. Reducing excessive thatch at the turfgrass/soil interface can limit overwintering and the survival of fungal structures (mycelium and spores) during unfavorable environmental conditions.

Figure 36. Snow mold damage. Photo by John Inguagiato, University of Connecticut.

Some turfgrass diseases actively attack turfgrass in cold weather (snow molds, *Figure 36*) or during extreme hot humid weather (brown patch, pythium, summer patch). Other diseases can be active in the temperate spring or fall conditions (dollar spot, red thread). "Signs" of infection are the actual fungal pathogen causing disease, while a "symptom" is a plant response caused by an active fungal infection. Symptoms can be leaf spots, dead or wilting turf often displayed in a pattern. Symptoms may be apparent in shorter cut turf, and less apparent in turf maintained at higher height of cut.

Consistent scouting for disease should occur throughout the growing season. It is critical to confirm the identity of the pathogen to determine any necessary adjustment to a cultural practice or to identify the correct chemical treatment. **An incorrect identification may contribute to an inappropriate treatment that will not improve the health of the turfgrass.** Confirmation of disease requires examination by a turfgrass pathologist. The turfgrass pathologist can recommend the appropriate control measure once the disease organism is correctly identified.

The UConn Turfgrass Pathology lab (cahnr.uconn.edu/turflab) can **confirm turfgrass disease pests and recommend alterations in management programs that will reduce disease severity**. To be properly examined, a turfgrass sample must include both the dead/dying turf as well as nearby healthy turf.

NUISANCE PESTS

Schools grounds managers often have to address damage to landscape plants attributed to nuisance pests, such as deer, geese, groundhogs, moles, and voles. Other mammals (e.g., beavers, skunks) can cause problems on school properties, depending on the environmental conditions of the location. Contact CT DEEP Wildlife Division for assistance with best management practices when considering management options for these pests. The safety of the students and staff must be prioritized.

DEER

White-tailed deer (*Odocoileus virginianus*) are primarily browsers. As herbivores, they feed on woody shrubs, trees, and herbaceous flowering plants (forbs). **When deer find a location where food is readily accessible, they will continually frequent that area.** Deer may become "trained" to visit a site; they will return to locations where they know they have found food. When a preferred food source, such as acorns, corn, or hay, is abundant, they will eagerly devour it, but when favored vegetation is unavailable, **deer will eat almost anything to survive**. In harsh conditions, when drought or starvation are a possibility, deer will strip bark off small trees and branches. Deer also injure and disfigure young trees by rubbing their antlers against the bark.

The most effective method to discourage deer browse from causing disfiguring damage in the landscape is to **plant trees, shrubs, and perennials that deer prefer not to eat**. While no plant is completely deer proof (*Figure 37*) (young deer do not know which plants are palatable until they are sampled), there are many that they dislike or avoid.

Deer tend to avoid plants:

- with strong scents and bitter, acrid flavors;
- with thorns or prickles on leaves or stems;
- that have hairy or fuzzy foliage;
- that are poisonous or have thick, latex-like sap.

Figure 37. Deer will even browse plants they do not prefer to eat, such as Yucca filamentosa, when food supplies are scarce.

Best Management Practices

Strategies to use in combination to reduce browse damage and to protect plant material on school properties include:

- **Incorporate deer-resistant plants** into the landscape (*refer to Table 5, Appendix*).
- **Divide the school landscape into deer feeding preference zones, prioritized by attractiveness to deer and damage potential.** Plant the most browse-resistant plants along the far edge of the property where deer frequent. Plants that are the most susceptible to browse damage should be used infrequently and interspersed with deer resistant plants or grown within a fenced or protected area, such as a school courtyard.
- **Shield young trees and those with thin bark** with protective devices to discourage feeding and deer rub.
- **Use tree protectors, plastic tree wrap, burlap, netting,** or fishing line to restrict access to young or specimen plants.
- **Use fencing** to restrict deer access when possible. Fences must be at least 7-8' high, with no more than 6" x 6" gaps, and must extend to the ground.
- **Incorporate the use of CT DEEP approved EPA minimum risk repellents**. All products used to discourage feeding must be referenced in the district's IPM plan if placed in a school landscape.
- **Use motion-activated lights, sprinklers, or noisemakers**, where appropriate, to startle deer and cause them to flee.

Read more at UConn IPM Deer Management.

GEESE

Canada geese (*Branta canadensis*) are a common concern for many school athletic fields and lawns in Connecticut. **School athletic fields and lawns meet geese's major habitat requirements.** Geese prefer to feed on Kentucky bluegrass and perennial ryegrass, important turfgrasses for athletic field use here in the northeast. They prefer open turfgrass areas for landing and grazing, located near a body of water.

While not all school properties contain a water source, many are situated within a mile of other locations, such as golf courses, town parks, or corporate office parks. These venues often provide the water sources that geese need to survive. Geese must remain close to a water source during molting season (a four-to-five-week period in summer when the birds are flightless), while they shed and re-grow their outer wing feathers. Other times of the year, geese often frequent open areas up to a mile from a water source.

Some of the major problems that can be attributed to large geese populations on school grounds include:

- Geese activity interferes with pesticide-free management of turfgrasses. Geese are **destructive to athletic fields and general turfgrass areas on school properties**. Feeding by geese contributes to thin, bare stands of turfgrass and soil, which can lead to weed invasion and soil erosion.
    - While feeding on turfgrasses, geese pull the plants directly out of the ground, disrupting the uniformity of the playing surface and contributing to the overall decline of the turfgrass athletic fields or lawn areas. This often results in poor traction/footing for the athlete, **acting counter to school grounds managers' primary responsibility of providing a safe playing surface**.
    - They also are disruptive to necessary overseeding practices and subsequent turfgrass establishment. Overseeding is a necessary and critical maintenance practice used on schoolgrounds that cannot use pesticides to ensure dense, uniform, and weed-free playing surfaces. **Where geese frequent, grounds managers will be challenged to provide safe athletic fields and lawn areas.**
- Besides overgrazing turfgrass areas, large numbers of waterfowl **create unsanitary conditions** for student athletes, who slip on geese feces deposited on the turfgrass areas (*Figure 38*). A build-up of geese feces can present a **health risk for students** who play, walk, or eat near locations where geese frequent. Feces also

can be tracked into school buildings on the soles of student shoes. Feces can adhere to mowing equipment and be tracked throughout multiple fields, creating a problem that is difficult to clean. Geese feces may contain **numerous bacterial agents** that contribute to an overabundance of nitrogen, which triggers algal blooms and degrades water quality of nearby waterways.

- Geese not only **aesthetically destroy lawns and landscape areas, they also increase maintenance costs** associated with cleanup of geese feces.
- Geese can cause **noise issues** that are disruptive to a sound learning environment and pose traffic hazards. They also can be aggressive as they congregate in large groups.

For turfgrass areas that have been heavily populated with geese, **cultural practices are critically important to repair damage and allow recovery of the turfgrass areas**. Constant overseeding, proper mowing, fertilization, irrigation, and cultivation practices should be prioritized to encourage recovery and the subsequent health of the turfgrass surface that supports student activity and player safety.

Best Management Practices

Most non-lethal methods to reduce geese populations achieve only temporary effectiveness. Non-lethal methods for goose management include modifying either goose behavior or the habitat that is attractive to geese. **Habitat modification is necessary for non-lethal, long-term results** (Smith, Craven, and Curtis, 1999). For best results, use multiple, coordinated techniques that are appropriate for the school environment at the most effective time.

To develop a successful goose management program, consider the following strategies:

- **Identify the characteristics** of the site inhabited by geese that are most attractive to the geese (e.g., security, food, nesting sites, water).
- **Identify the time of year** when populations of geese are problematic. Consider control options available based on regulatory or logistical restrictions, the effectiveness and acceptability of

Figure 38. Large numbers of waterfowl create unsanitary conditions for the student athletes.

population control techniques, and administrative/community support. Consider the costs and appropriate budget.

- **Prohibit or discourage the feeding of geese and display signage that deters feeding**. Comprehensive policies regarding feeding should be displayed in a prominent location. The DEEP Wildlife Division has developed a "Do Not Feed Waterfowl" pamphlet (portal.ct.gov) that outlines the detrimental effects of feeding resident Canada geese and other waterfowl. For more information or to request a sign, call the Wildlife Division (860-418-5960).
- **Visual deterrents, barriers, and exclusion are recommended components of a geese repellent plan.**
  - **A school environment has distinctive considerations that may prevent the use of or disallow deterrents.** Deterrents and barriers may not be appropriate for a school environment, given student safety and liability concerns.
  - **In areas where the safety of students is not the primary concern** (e.g., municipal parks and open space locations, or state lands), physical deterrents may be considered, which prevent geese from flying into an area. Deterrents and barriers must be used in

combination with other tactics for effective results.
    - **Coyote decoys** have been reported (anecdotally) to be effective, especially when they are moved at least twice a week around the site.
    - **Exclusion** is an effective tactic along water bodies when geese are flightless during the summer molting period. At this time of year, geese are repelled by any barrier over one foot high (e.g., string or wire fencing with dangling ribbons).
- **Habitat modification may reduce the number of birds attracted to the location**. The practicality of various habitat modification methods will vary depending on the site. Changes may depend on whether there is a water body on the school campus or whether geese are consistently landing on open turfgrass lawn areas or school athletic fields from a neighboring location.
    - **Choose the method(s) of habitat modification that will reduce the identified "attractive" characteristics**. Techniques that do not address biological or behavioral changes to goose activity will likely not solve the long-term problem.
    - **Altering the design of the landscape can reduce its attractiveness as a landing or feeding area.** Geese are uncomfortable landing or feeding in areas with poor visibility of potential predators. Where possible, alter components of the landscape that geese prefer and strategically design landscapes near athletic fields to discourage landing. Shrubs and small trees interspersed throughout a feeding area or planted along a water body's edge reduce the amount of space that geese have to land and take off. In non-athletic field areas, allowing turfgrasses to remain unmown also may deter geese populations.
    - **Hazing, or scaring geese from an area**, is one technique to consider to move geese away from an area where grazing is unwanted. This practice typically offers temporary success as geese become accustomed to the disturbances. Noises that deter geese movement may be impractical in a school environment.
    - **Commercial dog services** can also be contracted to provide daily visits to disrupt geese behavior cycles. After some time of the daily visits, the geese relocate to avoid the dogs. While dog services may be cost-prohibitive, the extra labor required to clean geese feces from school campuses, walkways, lawns, and sports turf may make the cost of the service a practical consideration.
- **Chemical repellents are regulated as pesticides and may not be permitted under Connecticut's pesticide regulations**. While repellents can be effective, they are expensive and require constant re-application. They may be practical for a small lawn area, bordering a lake or pond, but are not well-suited for large expanses of athletic fields.

For more information about geese and control options, refer to CT DEEP.

GROUNDHOGS

Groundhogs (*Marmota monax*) (*Figure 39*), also known as woodchucks, are often seen along woodland edges and open fields and are a common nuisance in residential and school landscapes. **Damage to landscape plantings and edible gardens may be caused by groundhogs burrowing** (*Figure 40*)**, feeding, and gnawing or clawing on trees.**

In the landscaped garden, groundhogs feed on many common plants, including herbs, grasses, vegetables, newly planted shrubs or young trees, and the succulent new growth of herbaceous plants (*Figure 41*). **They are frequently disruptive to newly planted landscapes,** targeting freshly planted material, especially nutrient-rich perennials and annuals.

Groundhogs are powerful diggers: they burrow in lawns, gardens, or along stone walls and develop

large, complex, underground dens, typically with a main entrance and one or more escape routes. The entry to their burrow is often established under sheds or other structures, which may undermine foundations. The burrow holes and the mounds of earth produced by their digging may present hazards when located where students or others walk on lawns or access athletic field areas. When they abandon their burrows, skunks, possums, and raccoons may inhabit them. With few predators, there is little to keep their populations under control.

Best Management Practices

Physical Exclusion

- **Where possible, use wire fencing to exclude groundhogs from new plantings.** Edges must be buried 1-2' deep in the soil to thwart burrowing. groundhogs can climb fences, so fences should be at least 3-6' high, with the top 12" loose and bent outward at a 90° angle (*Figure 42*).
- Burrowing under sheds or other structures may be prevented by **installing galvanized wire mesh along the perimeter of the structure** or the visible opening. Bury the mesh at least 1.5' to 2' underground.
- **Constructing a visibility barrier** may prevent groundhogs from identifying the area as a foraging site. For small school vegetable or raised bed gardens, pop-up row covers or a 3' black plastic wall may deter feeding.
- Electric fencing may be an option, but may not be economically feasible or safe in areas where students frequent.

Trapping

- **Cage trapping is effective for removing and/or controlling groundhogs populations**. While regulations vary in each state, live trapping and relocating is legal in the state of Connecticut. *Note*: It is legal, but not recommended, to relocate groundhogs to state lands and forests. Many animals spread disease; the relocating of any animal may simply transfer the problem to other locations. CT DEEP offers more information.

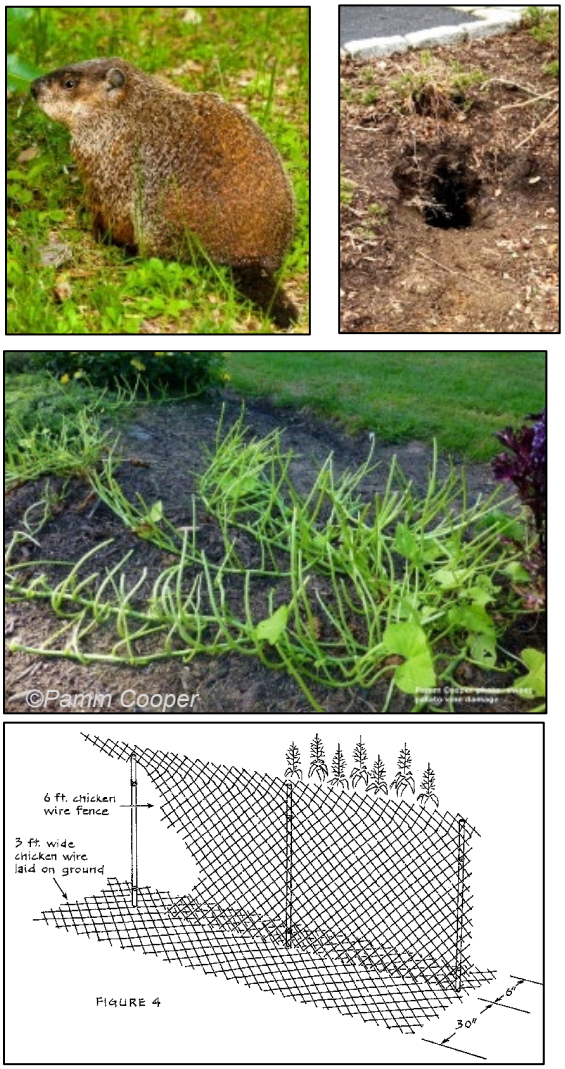

Figure 39. A groundhog (top left). Photo source: Flickr. Figure 40. Groundhog burrow entrance (top right). Photo Source: Westchester Wildlife. Figure 41. Groundhog damage on sweet potato vine (above middle). Photo by Pamm Cooper. Figure 42. Fencing with the top 12" loose and bent outward at a 90° angle to prevent groundhogs from climbing the fence. Source: massaudubon.org

- **Traps should be sized appropriately** and set near the burrow entrance, with barriers on both sides to direct the groundhog into the trap. Using bait in traps is recommended.
- **Check traps multiple times a day**. Since groundhogs are active during the day, traps should be closed at night and reset at dawn to prevent catching non-target nocturnal animals, such as skunks and raccoons.

25(b) Minimum Risk Deterrents

- Minimum risk products on the approved DEEP list and labeled to repel groundhogs are permitted for use on school properties. A licensed pesticide applicator is required.
    - Product ingredients may include either plant extracts (peppermint, clove, or wintergreen oil) or the urine of groundhog predators, such as coyotes.
    - Minimum risk products require repeated spray applications: rain events may mitigate their effectiveness and new plant growth is unprotected without repeated application.
    - Be aware that 25(b) minimum risk products may not be registered and approved by the EPA, so efficacy may not be substantiated.
    - Refer to the State of Connecticut's DEEP List of Pesticides Exempt from Federal Registration (available at: portal.ct.gov/DEEP/pesticides).

Depending on the scope of the problem, **hiring a licensed Nuisance Wildlife Control Operator (NWCO) may be required.** Refer to CT DEEP's Factsheet for more details.

MOLES

Moles are usually of little concern in managed landscapes. They are typically only noticed when their activity causes damage to turfgrasses or landscape plants. Mole damage in landscape beds or lawn areas is the result of tunneling in search of worms, insects (grubs) and other invertebrates (*Figure 43*). Burrowing can dislodge plants and dry out their roots.

Mole activity may generate greater concern on school properties, particularly in areas used for recreational play, which must be managed as pesticide-free. **When mole activity impacts the health of landscape plants, makes lawn maintenance practices difficult, or impacts player safety,** their presence in the municipal or school landscape may not be tolerable.

Best Management Practices

School grounds managers face a significant challenge to reduce mole populations above tolerable thresholds on pesticide-free school properties. **Scouting is critical to keep damage to a minimum.** Control efforts should begin as soon as active holes, mounds, or surface runways are evident. Without the use of chemical control options, **a combination of techniques may be required.**

Consider the safety of students when using any management control option. Traps or other control devices may not be feasible options on school grounds or athletic fields. The placement of traps must be chosen carefully, as they must never pose a hazard to students.

In areas where moles have been known to inhabit, continual scouting to monitor for re-infestation is needed. Desired control levels and intended maintenances practices should be documented in the school's IPM plan.

- **Trapping is the most reliable method of mole control, but must be used away from areas where students frequent.** It is most effective during spring and fall when mole activity is at its

Figure 43. Mole damage on school athletic fields (left) and active mole holes (below).

peak, although moles can be trapped any time of year. Trap manufacturers provide detailed instructions, which should be followed carefully. As a mole can easily sense foreign objects in its burrow, traps must be situated around or above the tunnel, or the mole will plug off that portion of the tunnel and dig around or under the object.

- **Vertical underground barriers** can provide temporary relief in small landscape plantings, but in large, open areas they are impractical. They are constructed from galvanized hardware cloth, aluminum sheathing or wire mesh planted 18-24" deep.
- On school properties, **minimum risk bait and fumigant** products on the approved DEEP list and labeled for moles are permitted for use on school properties. With any pesticide product, the target pest should be controlled without harm to other mammals that may directly consume or come in contact with the product.
- For more information, refer to Mole Management in CT School Landscapes (ipm.cahnr.uconn.edu).

TICKS

Correct identification of the species is critical in order to determine what, if any, action is needed to manage ticks. Black legged/deer ticks (*Ixodes scapularis*) can transmit tick-borne diseases such as Lyme, Babesiosis, Anaplasmosis, and Powassan virus, threatening the health of students and school staff. **Lone star ticks** *(Amblyomma americanum*) are becoming more prevalent in CT and can also transmit disease (e.g., Ehrlichiosis, Tularemia). They travel through mown grass and can be found in lawns, as well as woodlands, grassy fields, and roadsides.

Best Management Practices

The best way to prevent tick populations where children are present is to modify the habitat to prevent their travel and survival close to school buildings and play areas.

- Scout for ticks all season long.
- Reduce shady and damp areas that many ticks prefer.
- **Remove habitat that attract or shelter tick hosts, such as deer or mice.**
    - Eliminate woodpiles, stonewalls or other structures that may shelter mice.
    - Replace plants that deer prefer to browse with deer resistant plants (*refer to Table 5*, *Appendix*).
    - Where feasible, in areas with high deer populations, consider a deer fence to keep deer away and reduce tick populations.
- **Practice good sanitation to remove leaf litter**, including clearing leaf litter from field edges near wooded or unmanaged areas.
    - **Ensure that collected, piled leaves are well away from student activity.** Research from the New Jersey Department of Health found that blacklegged tick nymph populations tripled when leaves where raked or blown along forest margins, compared to areas where leaves were not disturbed or collected by human intervention (Lampman, 2020).
- **Keep children out of tall grass areas**, which may harbor a higher number of ticks. Restrict movement into these areas with signage or barriers if needed.
- Consider installing a 3' wide gravel buffer zone between wooded areas and fields.
- **Use CT DEEP approved minimum risk products** to reduce tick populations. If an IPM policy is in place for the school district, all products must be referenced in the district's IPM plan, as well as applied by a licensed pesticide applicator.
- **Encourage parents to consider the use of tick repellent products** and to dress their children in lighter colored socks and pants to make checking for ticks easier.

For more information, refer to Understanding and Managing Ticks from Cornell University Extension (nysipm.cornell.edu) and Tick Management Handbook from CT Agricultural Experiment Station (CAES) (ct.gov/caes).

MOSQUITOES

Mosquitoes can act as vectors for many viral diseases, such as Eastern Equine Encephalitis (EEE), Zika, and West Nile, posing a health threat to students and the school community. They typically rest in vegetation or shady locations during the day and lay eggs in puddles of standing water.

Best Management Practices

To eliminate mosquito populations from the school property, employ a combination of appropriate management tactics.

- **Monitor to detect mosquito populations** all season long, especially if there is historical precedent for EEE or West Nile.
- **Modify the school environment to eliminate habitat that supports mosquito breeding and adult resting sites.**
  - **Ensure that all places where water might be caught and held are drained at least weekly**, including water catchment basins, storm drains, low areas, equipment storage yards, athletic and playground equipment.
  - **Remove debris** from rain gutters and piles of dead leaf material from under plants.
  - **Cut back or remove dense brush** and other vegetation from around buildings.
  - **Mow grassy areas** frequented by the school community and restrain children from entering tall grass areas.
  - **Improve air circulation** around school buildings, where possible, to discourage mosquito occurrence. Promote natural breezes; prune plants that are too close to school buildings.
  - **Ensure that windows and doors are well sealed** to block mosquitoes from entering the building.
  - Where possible, improve cross ventilation; the breeze will reduce mosquito activity.
- Where populations are greatest, and **when diseases such as EEE are a concern, limit athletic practices and general activities in late afternoon until dusk.**
  - **Follow the district's IPM plan guidelines** for notification to students, staff, and parents of any health concerns related to ticks and mosquitoes.
  - **Use CT DEEP approved minimum risk products** to manage mosquito populations. If an IPM policy is in place for the school district, all products used must be referenced in the district's IPM plan. Ensure that the applicator is appropriately licensed to treat mosquitoes on school properties. Hire a licensed, professional applicator equipped to apply the appropriate treatment if necessary.
  - **Where EEE/West Nile/Zika have been identified and the level of activity warrants treatment, conventional pesticides should be used.** For public schools, the Superintendent of Schools is authorized to make the determination to treat. For private schools, the local health department would need to make the determination for emergency treatment.

More information is available at CT DEEP or IPM for Pennsylvania Schools and Childcares.

JUMPING WORMS

While most earthworms are not native to the U.S., many earthworm species provide benefits to urban soils by helping to improve soil porosity, drainage, and aeration. However, **concern has grown over the last decade over several worm species**, predominantly of the *Amynthas* species, that are reported to cause damage to the soils of landscapes, lawns, and forests. These species, known as jumping worms (the common name for several similar-looking species), may significantly change the texture and composition of surface soils.

Jumping worms eat the organic matter from the soil surface and dramatically accelerate the normal process of decay and nutrient release back into the soil. Whereas European earthworms distribute their high nutrient-value castings (feces) throughout the soil, **jumping worms deposit castings on the soil surface**, where the nutrients are unavailable to plants. **The castings are similar to the appearance and feel of coffee grounds** (*Figure 44*).

The combination of their castings and aggressive churning of the soil forms a coarse, granular soil structure with large air pockets, which can impact the ability of plants to produce and anchor roots, absorb water, and extract nutrients. When introduced to a property, they can destroy healthy woodland edges, turfgrass areas, and landscape beds, resulting in nutrient leaching, root desiccation, soil erosion, destruction of the soil microbial food web, and plant death. Though primarily a concern in landscaped areas, **there is a concern for unstable footing when**

Figure 44. Castings (left). Figure 45. Jumping worm with cream colored clitellum (right).

populations have extended into recreational turfgrass areas where children play.

Jumping worms are increasingly found in urban, managed, and natural landscapes. The invasive species live in the topmost layer of the soil, in debris and leaf litter. They thrive in forests, home yards, parks, compost piles, and roadsides. The common jumping worm species in Connecticut are **annual** species. **They can be easily recognized from July to September. Jumping worms can be identified by several key features:**

- **Snake-like thrashing or "jumping" movement** when disturbed.
- **High density of visible, very active adult worms near the soil surface** from late June to mid-October.
- **Smooth, metallic sheen; glossy dark gray-brown; uniformly colored**. 1.5-8" long. Sleek, dry, smooth and firm body, less slimy to the touch than other earthworms (e.g., nightcrawlers).
- **Cloudy-white to gray clitellum** (band) encircles the body; smooth, not raised, and located nearer to the front portion of the body (*Figure 45*).

Best Management Practices

Precautions to limit the unintentional introduction and movement of jumping worms and cocoons from one area of a property to another are critical. Prevention tactics are currently the most realistic and viable options to manage the spread of these invasive worm populations:

- **Use only reputably-sourced soil**, as well as heat-treated compost and mulch. High temperatures (>105°) can kill worms and cocoons.
- **Plant bare-root trees or inspect the rootball**, soil and mulch of all plants before planting.
- **Clean tools, equipment, or shoes** after laboring in landscaped areas.

Research is ongoing. However, to date, there are no documented effective treatments to control or eradicate existing jumping worm populations.

Learn more at: UConn Jumping Worm Fact Sheet (ipm.cahnr.uconn.edu).

BEES AND WASPS

While bees and wasps are extremely important to preserving a healthy environment, their activity can be a concern in locations where people with allergies to bee stings may be present. Bees are essential plant pollinators, and many native bee species are facing the threat of extinction. Wasps are insect predators and play an important role in controlling other insect pests. Most bee and wasp species are solitary and generally do not sting, as they lack the nest-guarding instinct of the social bees or wasps.

As increased attention about the need for pollinator survival has been reported, grounds managers and many in the school community are interested in encouraging pollinator activity by integrating native plant species that attract pollinators into the landscape. At the same time, the presence of bees and wasps may be a cause for student safety concerns in the school environment. Bee or wasp stings may be life-threatening for those who have allergic reactions.

While neither wasps nor bees necessarily pose a threat to humans, they usually are not welcome in close proximity to children in a school environment. Social bees and wasps are more likely to sting, but only when threatened as they defend their nests.

Large nests located near school entryways or recreational areas pose the greatest concern and would most likely warrant action by school grounds managers.

Best Management Practices

Identification of the species is critical in order to determine what, if any, action is needed to control bees or wasps on the school property. **Control strategies differ depending on the species and location of activity**.

MONITORING, INSPECTION, AND PREVENTION

- **Scout regularly for bee and wasp nests.** Frequently utilized turfgrass areas and landscape plantings surrounding school buildings, as well as property edges, should be regularly inspected.
  - Nests may be built in the ground, under building overhangs, in wall voids, in trees, under logs or rock piles, and other protected sites.
  - Nests that are attached to school buildings may qualify for a pesticide treatment exemption.
- **Reduce bees and wasps' access to nesting sites, food**, and water near areas where children frequent, including entrances and play areas. Practice routine and thorough sanitation.
  - **Prioritize a daily cleanup of all food residues** and sticky drinks from outside eating areas. Outside lunch areas and bleacher areas should be cleaned of food scraps and trash should be removed.
  - **Keep trash containers sealed or covered**. Remove trash daily from all receptacles and clean dumpsters frequently.
  - **Minimize water sources that may attract bees and wasps** in all outdoor student areas.
    - Repair leaky outdoor faucets.
    - Direct air conditioner drainage to areas where wastewater will not pool.
    - Improve drainage and level areas where water creates puddles after rain events.
  - **Prevent bees and wasps from entering buildings or classrooms**. Caulk holes and cracks in buildings. Repair screens and ensure that they are properly set in windows.

Figure 46. Adult yellowjacket. Photo by M. Bertone, NC State Extension.

  - **Mow clover flowers regularly in recreational turfgrass areas** to remove the bees' foraging interest and limit opportunities for bee stings while children play.

METHODS OF CONTROL

- **If a nest is detected and may be a potential hazard to the health of students and staff, restrict access to the area. Post signage and use all available methods of communication to instruct children not to disturb nests and use caution.**
- Physical removal of nests can be difficult, but is possible with proper safety measures. Protective clothing must be worn. If detected, removal of nests in the evening is recommended, once the insects typically have returned to the nests.
- If the nest is reachable, it can be removed by enclosing it in a strong plastic bag, then severing the base of the nest to remove it.
- The hiring of a professional pest control service may be required if removal by staff is not feasible.
- CT DEEP can be consulted for assistance to determine if an emergency exemption may be warranted. If pesticide use is considered necessary at a public school, the Superintendent of Schools is authorized to approve an emergency treatment. For private schools, the local health department would need to make the determination for emergency treatment. If an exemption is approved, a licensed, professional

applicator should be hired to provide the appropriate treatment.

- Trapping is effective to attract foraging wasps, particularly yellowjackets (*Figure 46*). Place traps out of children's reach.

Refer to schoolipm.tamu.edu for more information.

EVALUATION

Turf and landscape areas should be regularly inspected. The effectiveness of the IPM program should be annually assessed based on timely evaluation of treatments, scouting records, staff observations, budget records, and administrative/ parent feedback.

The UConn Extension Turf and Landscape Assessment Forms (found at ipm.cahnr.uconn.edu/school-ipm) can be valuable record-keeping tools. Changes or alterations to maintenance programs can be tracked and offer evidence of sound agronomic decisions.

Forms for soil tests and protocol for sampling can be obtained through the local Cooperative Extension office. For instructions, visit soiltest.uconn.edu or call the UConn Soil testing lab at (860) 486-4274 or the UConn Home and Garden Education Center toll-free at (877) 486-6271.

WHERE CAN SCHOOL GROUNDS MANAGERS FIND RESOURCES FOR NON-CHEMICAL MAINTENANCE OPTIONS?

UConn's School IPM website provides a wealth of information for school grounds managers on how to maintain school grounds without the use of pesticides (ipm.cahnr.uconn.edu):

- **Best Management Practices** for Pesticide-Free, Cool-Season Athletic Fields (Second Edition)
- **Native Plant** & Sustainable Landscaping Guide (s.uconn.edu/UConnNativePlantGuide)
- A School Grounds Manager's Primer on Connecticut's School Grounds **Pesticide Regulations**
- Connecticut **Native Plant Availability** List
- **Recommended Sustainable Plant List** for Schools - Parents & Garden Clubs
- **Biological Pest Control** For Connecticut School Grounds
- **Biological Pest Control Products** Available for Connecticut School Grounds
- Identification of Problem **Weeds** in School **Turf** Areas
- Identification of Problem **Weeds** in School **Landscapes**
- **Meadows**: An Alternative Management Strategy for School Landscapes
- Using **Weather Station** Data on Connecticut School Grounds and Athletic Fields
- **Pruning** Recommendations and Guidelines
- Strategies to Minimize **Deer** Damage on School Grounds
- **Mole** Management in CT School Landscapes

Other Helpful Links:

- UConn Turfgrass Science: turf.uconn.edu
- Minimum Risk Products Permitted for Use at Schools (CT DEEP list – generate and download a roster): portal.ct.gov/DEEP/pesticides or elicense.ct.gov. (Click on "Generate Rosters" then click on "Pesticide Management Program" – select the roster you want then scroll to bottom of page and click continue)

- CT Department of Energy and Environmental Protection: ct.gov/deep/ipm or DEEP's Pesticide Management Program
- EPA Exempt Pesticides: epa.gov/minimum-risk-pesticides
- Connecticut Invasive Plant Working Group: cipwg.uconn.edu
- Sports Field Management Association: sportsfieldmanagement.org
- New England Sports Turf Managers Association: nestma.org

GLOSSARY

Abiotic: Not associated with or derived from living organisms (e.g., sunlight, temperature, precipitation, mowers, pesticides, weedwhackers, wind patterns).
Biochemical pesticide: A naturally occurring substance/pesticide that controls pests by nontoxic means.
Biotic: relating to living organisms; as a factor in an ecosystem, produced by actions of living organisms.
Cultural practices: Management techniques that manipulate a landscape's growth, planting, and cultivation to reduce pest damage and pest numbers.
Fallow: To plow, harrow, and break up land, without sowing it for a season, in order to reduce weed populations and conserve soil moisture.
Habitat corridor: A corridor of wildlife habitat, generally native vegetation, which joins two or more larger parcels or tracts of similar wildlife habitat. Corridors are critical for the maintenance of ecological processes including allowing for the movement of animals and the continuation of viable populations.
Herbivorous: an animal that eats only plants.
Lawn care pesticide: Defined in the law as any pesticide that is labeled for use on lawns, gardens or ornamental sites and areas (including trees).
Microbial pesticide: A pesticide that consists of a living microorganism as the active ingredient.
Nurse crop: A nurse crop is typically a non-competitive, clump-forming grass, incorporated as part of the meadow that helps to reduce weed invasion and reduces soil erosion.
Riparian: Relating to or living or located on the bank of a natural watercourse (such as a river) or sometimes of a lake or a tidewater.
Riparian Buffer: The aquatic ecosystem and the portions of the adjacent terrestrial ecosystem that directly affect or are affected by the aquatic environment. This includes streams, rivers, lakes, bays and their adjacent side channels, floodplain, and wetlands (U.S. Dept. of Agriculture). Natural riparian buffers are composed of grasses, trees, or both types of vegetation. Also known as forest buffers.
Soil Bulk Density: An indicator of soil compaction that is calculated as the dry weight of soil divided by its volume, including the volume of soil particles and of pores among soil particles. Expressed in g/cm^3.
Soil Structure: The arrangement of soil particles (sand, silt, clay, and organic matter) bound together into small clumps, called "peds." The size and shape of the spaces, or pores, between the peds, through which air, water, and organisms move, are another important component of soil structure.
Till: To loosen or break up soil; cultivate to prepare for the planting of crops or other plants.

BIBLIOGRAPHY

1. Baker, A., C. Redmond, S. Malcolm, and D. Potter. 2020. Suitability of native milkweed (*Asclepias*) species versus cultivars for supporting monarch butterflies and bees in urban gardens. *PeerJ*. 25 September 2020. peerj.com/articles/9823
2. Bartholomew, C., B. Campbell, V. Wallace. 2015. Factors Affecting School Grounds and Athletic Field Quality after Pesticide Bans: The Case of Connecticut. *HortScience.* 50(1):99-103.
3. Bauer S., 2017. Managing Sports Turf Using Wetting Agents: A Case for Full Field Applications. sportsfieldmanagementonline.com/2017/12/19/managing-sports-turf-using-wetting-agents
4. Benedict M. A. and E. T. McMahon. 2002. Green Infrastructure: Smart Conservation for the 21st Century. Renew Res J 20(3):12–17.
5. Brittingham, M. C. 2006. Woodchucks. Penn State Extension. extension.psu.edu/woodchucks
6. Cantaluppi, C. and G. Rubio. 2016. Ice Melters and Their Effects on Plants. North Carolina Cooperative Extension. granville.ces.ncsu.edu/2016/01/ice-melters-and-their-effects-on-plants-2/
7. Connecticut Department of Energy and Environmental Protection. 2015. Woodchuck. State of Connecticut. portal.ct.gov/DEEP/Wildlife/Fact-Sheets/Woodchuck
8. Connecticut Department of Energy and Environmental Protection. 2014. K-8, EPA-Registered, Lawn Care Pesticide Ban Municipal Listening Sessions Summary. Feb. 4, 2014.
9. Connecticut General Assembly. 2009. An Act Concerning Pesticide Applications at Child Day Care Centers and Schools. cga.ct.gov/asp/cgabillstatus/cgabillstatus.asp?selBillType=Public+Act&which_year=2009&bill_num=56
10. Connecticut General Assembly. 2015. Pesticide applications at schools: Definitions. cga.ct.gov/current/pub/chap_170.htm#sec_10-231a
11. Charbonneau, P. and T. Hsiang. 2015. *Integrated Pest Management for Turf*. Ontario, Canada: Ministry for Agriculture, Food, and Rural Affairs. omafra.gov.on.ca/english/crops/pub845/pub845.pdf
12. Colding, J. and C. Folke. Ecosystems. 2009. 12: 191. https://doi.org/10.1007/s10021-008-9217-1
13. Credit Valley Conservation. 2017. Native Plants for Pollinators. cvc.ca/wp-content/uploads
14. CT DEEP. 2019. Problems with Canada Geese. CT.gov - Connecticut's Official State Website. portal.ct.gov/DEEP/Wildlife/Nuisance-Wildlife/Problems-with-Canada-Geese
15. Dobson, A. 2020. Jumping Worm Update. *Connecticut Gardener*. conngardener.com/jumping-worm-update
16. Dobson, A. and B. Blossey. 2015. Earthworm invasion, white-tailed deer and seedling establishment in deciduous forests of north-eastern North America. J Ecol 103(1):153–164
17. Dyment, J. and A. C. Bell. 2007. Active by Design: Promoting Physical Activity through School Ground Greening. *Children's Geographies*. 5:4, 463-477, DOI: 10.1080/14733280701631965
18. Eaton. A. 2018. Dealing with Woodchuck Damage. University of New Hampshire Cooperative Extension. extension.unh.edu
19. Ferree, R. 2016. Recycled leaves make inexpensive mulch. University of Illinois Extension. aces.illinois.edu
20. Fisher, M. and D. Miller. Schools Integrated Pest Management (IPM) For Wasps and Bees. Virginia Tech. sites.ext.vt.edu/schoolipm/ipmtechniques/documents/wasps.pdf
21. Grant, J. 2011. The Child Safe Playing Fields Act: NY's Ban on Pesticide Use on School and Day Care Center Grounds. *Cornell University Turfgrass Times.* 22(1):1, 3-4.
22. Guillard, K., 2002. Lawn Care During Drought Conditions. University of Connecticut. ctiwr.uconn.edu/DroughtArticles
23. Guillard, K.; D. Moore, M. Oliver, S. Vose. 2018. Turfgrass cultural practices that maximize soil carbon sequestration. 2017 Annual Turfgrass Research Report [Connecticut]. p. 62-64. turfgrass.cahnr.uconn.edu/2020/01/24/2017-annual-research-report
24. Hayes, R. F. Pollinator Friendly Gardening: Gardening for Bees, Butterflies, and Other Pollinators. Minneapolis, Minnesota, Voyageur Press, 2016.
25. Henderson, J., V. Wallace, and J. Campbell. 2013. Best Management Practices for Pesticide-Free, Cool-Season Athletic Fields. Storrs, CT: University of Connecticut Extension. s.uconn.edu/uconnathleticfieldbmp
26. Horton, J. 2014. Fall is a beautiful season, but leaf me alone! Alabama Turf Times. Fall. p. 14-19. issuu.com/leadingedgepubs
27. Hurley, J. 2012. Fast Facts about Mosquito Prevention and Control around Schools. Texas A & M Agrilife Extension. schoolipm.tamu.edu/2012/08/23/fast-facts-about-mosquito-prevention-and-control-around-schools/
28. Kerwin K. and B. Maslo. 2020. Ecology and Management of the Groundhog (Marmota monax). New Jersey Agricultural Experiment Station. Departments of Ecology, Evolution, and Natural Resources and Wildlife Ecology. njaes.rutgers.edu

29. Lampman, J. 2020. The leaves are falling, manage wisely for ticks. *New York State IPM Program Blog*. blogs.cornell.edu
30. Larson, J., A. Dale, D. Held, B. McGraw, D. Richmond, K. Wickings, and R. Williamson. 2017. Optimizing pest management practices to conserve pollinators in turf landscapes: Current practices and future research needs. *Journal of Integrated Pest Management*. January. 8(1): p. 18 [1-10]. academic.oup.com/jipm/article-pdf/8/1/18/18245669/pmx012.pdf
31. Lubell-Brand, J.D. 2019. Suitability of Cultivated Forms of Native Shrubs to Support Pollinators. UConn. Storrs, Connecticut.
32. Lal, R. and B. Augustin, eds. 2011. Carbon Sequestration in Urban Ecosystems. New York, New York: Springer. xi, 385 pp.
33. Kao-Kniffin, J. 2017. School Weed Management Brochure. hort.cornell.edu/kao-kniffin/lab/pubs
34. Mader, E., M. Shepherd, M. Vaughan, S. Black, and G. LeBuhn. 2011. Attracting Native Pollinators: Protecting North America's Bees and Butterflies. Storey Publ.
35. Maryland State Department of Education. 2012. A Practical Guide to Planning, Constructing, and Using School Courtyards.
36. Baltimore, MD. montgomeryschoolsmd.org/uploadedFiles/curriculum/outdoored/outreach
37. Matsuoka, R.H. 2010. Student Performance and High School Landscapes. *Landscape and Urban Planning*, 97, pp. 273-282.
38. Merchant, M. (Texas AgriLife), D. Pollet (LSU), S. Daar, T. Drlik, H. Olkowski, and W. Olkowski. Compiled from publications. 2019. School Integrated Pest Management: IPM Action Plan for Yellowjackets. Texas A & M Agrilife Extension. schoolipm.tamu.edu/forms/pest-management-plans/ipm-action-plan-for-yellowjackets/
39. Miller, D. M. 2004. A Training Program for Cooperative Extension Agents: Implementation of Integrated Pest Management (IPM) in Virginia Public Schools. *Journal of Extension*. 42 (5). Article 5FEA3. joe.org/joe/2004october/a3.php
40. Murray, K. 2015. School Pest Solutions: Wasps, Hornets and Bees. Maine Department of Agriculture, Conservation and Forestry. www1.maine.gov/dacf/php/integrated_pest_management/school/pest-solutions/documents
41. National Road Map for Integrated Pest Management. 2018. ars.usda.gov
42. Nikolai, T., P. Rieke, and N. McVay. 1997. Leaf Mulch Forum "Research and Real-World Techniques." Crop and Soil Sciences Department. Michigan State University. archive.lib.msu.edu/tic/mitgc/article/199866b.pdf
43. Patton, D. 2018. Mulch Mowing Fall Leaves. Kansas State Extension. johnson.k-state.edu/lawn-garden
44. Ridge, G. and K. Stoner. Ground Nesting Bees. Connecticut Agricultural Experiment Station. portal.ct.gov/-/media/CAES
45. Schrum, H. 2018. Wildflower meadows for the busy superintendent (because aren't they all?). Golfdom. 74(8):p. 12-17.
46. Soil Science Society of America. soils.org/about-soils/basics. Online.
47. Smith, A. E., S. R. Craven, and P. D. Curtis. 1999. Managing Canada geese in urban environments. Jack Berryman Institute Publication 16, and Cornell University Cooperative Extension, Ithaca, N.Y. ecommons.cornell.edu
48. Stapleton, J. and R. Molinar. 2018. Pest Notes: Soil Solarization for Gardens & Landscapes Management. UC Statewide IPM Program, Kearney Agricultural Center. San Diego County, CA. ipm.ucanr.edu/PMG/PESTNOTES/pn74145.html
49. Stoner, K. 2018. Protecting Pollinators from Pesticides. Connecticut Agricultural Experiment Station. Power point presentation. business.ct.gov/-/media/CAES/DOCUMENTS/Publications/pollinators/Conference_2018
50. Tallamy, D. 2009. Bringing Nature Home: How You Can Sustain Wildlife with Native Plants. Portland, Ore.: Timber Press.
51. Trappe, J. 2018. Should I mulch or bag my leaves? University of Minnesota Extension. extension.umn.edu
52. Tu, M., C, Hurd, and J. M. Randall. 2001. Weed Control Methods Handbook: Tools & Techniques for Use in Natural Areas. The Nature Conservancy. invasive.org/gist/products/handbook/methods-handbook.pdf
53. UConn Home and Garden Education Center. 2016. Woodchuck Damage and Control. UConn Extension. homegarden.cahnr.uconn.edu
54. UConn Home & Garden Education Center. 2018. Shrubs: Pruning Early Flowering Varieties. homegarden.cahnr.uconn.edu
55. University of California - Davis. 2008. Designing Wildlife Corridors: Wildlife Need More Complex Travel Plans. *ScienceDaily*. Retrieved January 25, 2019 from sciencedaily.com/releases/2008/10/081020135221.htm
56. United States Environmental Protection Agency. Bees and Wasps and Schools. epa.gov/ipm/bees-and-wasps-and-schools
57. United States Environmental Protection Agency. 2017. Green Infrastructure in Parks: A Guide to Collaboration, Funding, and Community Engagement. 24 pp. [Washington, D.C.]: United States Environmental Protection Agency.
58. Wallace, V., C. Bartholomew and B. L. Campbell. 2016. Turf Manager Response to Changing Pesticide Regulations. *HortScience*. 51 (4):p. 394–397. journals.ashs.org/hortsci/view/journals/hortsci/51/4/article-p394.xml
59. Wallace, V., J. Henderson, and W. Dest. 2012. Athletic Field Assessment Form. University of Connecticut, Storrs, Connecticut. 3 pp. Available at: ipm.cahnr.uconn.edu
60. Wallace, V., D. Ellis, A. Siegel-Miles. 2017. Revised Landscape Assessment Form. University of Connecticut, Storrs, Connecticut. 3 pp. Available at: ipm.cahnr.uconn.edu/school-ipm
61. Wallace, V. and A. Siegel-Miles. 2020. Integrating Assessments into a Municipal/School Grounds Management Program. Sports Field Management. December 4, 2020. sportsfieldmanagementonline.com
62. Wallace, V. and A. Siegel-Miles. 2022. Invasive Jumping Worms. UConn Extension. 2 pp. s.uconn.edu/UConnJumpingWorm

63. Wallace, V. and A. Siegel-Miles. 2022. Management of Moles in CT School Landscapes. UConn Extension. 4 pp. ipm.cahnr.uconn.edu
64. Wallace, V. and A. Siegel-Miles. 2022. Strategies to Minimize Deer Damage in School Landscapes. UConn Extension. 6 pp. ipm.cahnr.uconn.edu
65. White, A. 2016. From Nursery to Nature: Evaluating Native Herbaceous Flowering Plants Versus Native Cultivars for Pollinator Habitat Restoration. Graduate College Dissertations and Theses. 626. scholarworks.uvm.edu/graddis/626
66. Wickings, K., J. Bonhotal, M. Schwarz, J. Lampman. 2015. The Effects of Mulching Leaves in Place on Tick Populations in Lawns and Parks. New York State IPM Program. ecommons.cornell.edu/handle/1813/44244
67. Zimmerman, C. 2010. Urban and Suburban Meadows: Bringing Meadowscaping to Big and Small Spaces. Silver Spring, Maryland: Matrix Media Press.
68. Zuberer, David A. Texas A & M University, organiclifestyles.tamu.edu/soil/microbeindex.html.

For any questions about products that are allowed for use on school properties or anything else related to Connecticut's School Grounds Pesticide Law, contact:
CT DEEP Pesticide Management Program, (860) 424-3369; DEEP.pesticideprogram@ct.gov.

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APPENDIX – PLANT LISTS

TABLE 1. GENERA THAT PROVIDE THE GREATEST SUPPORT TO NATIVE BUTTERFLY AND MOTH CATERPILLARS

Source: Tallamy, 2009, and Zimmerman, 2010. Check individual state lists to identify native species of these genera (e.g. *Populus tremuloides*, quaking aspen, is native, while *Populus alba*, white poplar, is invasive).

TREES & SHRUBS		PERENNIALS	
Common Name (Botanical Name)	**Butterfly/Moth Species Supported**	**Common Name (Botanical Name)**	**Butterfly/Moth Species Supported**
Oak (*Quercus*)	534	Goldenrod (*Solidago*)	115
Black Cherry (*Prunus*)	456	Aster (*Symphyotrichum*)	112
Willow (*Salix*)	455	Sunflower (*Helianthus*)	73
Birch (*Betula*)	413	Joe Pye Weed (*Eutrochium*)	42
Poplar (*Populus*)	368	Blue Grass (*Poa*)	42
Crabapple (*Malus*)	311	Sedge (*Carex*)	36
Blueberry (*Vaccinium*)	288	Lupine (*Lupinus*)	33
Maple (*Acer*)	285	Rye, Blue Wild (*Elymus*)	31
Elm (*Ulmus*)	213	Violet (*Viola*)	30
Pine (*Pinus*)	203	Wild geranium (*Geranium*)	24

TABLE 2. PLANTS THAT SUPPORT BIOLOGICAL GARDEN HEALTH (ATTRACT BENEFICIAL INSECT AND INSECT PREDATORS/PARASITOIDS)

Source: Biological Pest Control for CT School Grounds, UConn Extension (ipm.cahnr.uconn.edu)

ANNUALS		PERENNIALS	
Common Name	**Botanical Name**	**Common Name**	**Botanical Name**
Sweet alyssum	*Lobularia maritima*	Common yarrow	*Achillea millefolium*
Cosmos	*Cosmos bipinnatus*	Wild bergamot	*Monarda fistulosa*
Marigold (yellow)	*Tagetes* spp.	New England aster	*Symphyotrichum novae-angliae*
Calendula	*Calendula officinalis*	Goldenrods	*Solidago* spp.
Sunflower	*Helianthus annuus*	Joe-pye weed	*Eutrochium* spp.
Zinnia	*Zinnia elegans*	Foxglove beardtongue	*Penstemon digitalis*
Dill	*Anethum graveolens*	Culver's root	*Veronicastrum virginicum*
Fennel	*Foeniculum vulgare*	Helen's flower	*Helenium autumnale*
Cilantro	*Coriandrum sativum*	Anise hyssop	*Agastache foeniculum*
Mint	*Mentha* spp.	Butterfly weed	*Asclepias tuberosa*

From left to right: anise hyssop (Agastache foeniculum), goldenrod (Solidago spp.), wild bergamot (Monarda fistulosa), and Culver's root (Veronicastrum virginicum).

TABLE 3. TREES THAT PRODUCE MINIMAL LITTER

Source: The Best Plants for 30 Tough Sites, University of Minnesota Extension (extension.umn.edu)

Latin Name	Common Name	Height	Comments
Abies spp.	fir	40-60'	Korean, Canaan, balsam, Fraser, white.
Acer negundo	boxelder	40-60'	'Baron' is recommended; use only male forms.
Carpinus caroliniana	blue beech	20-30'	Good native small tree.
Fraxinus americana	white ash	50+'	'Northern Blaze' is recommended; use only male forms.
Fraxinus pennsylvanica	green ash	40-60'	Select seedless forms: 'Marshall Seedless', 'Bergeson', Kindred', 'Wahpeton.'
Gleditsia tria. inermis	honeylocust	30-60'	Minimal raking; select a thornless/fruitless form.
Larix laricina	tamarack	40-70'	Deciduous conifer; yellow fall color.
Malus hybrids	crabapple	15-25'	Select persistent fruit or fruitless (e.g., 'Spring Snow') forms.
Ostrya virginiana	ironwood	25-40'	Good native small tree.
Picea spp.	spruce	25-50+'	Black, white, Norway, Serbian.
Pinus spp.	pine	25-50+'	White, Austrian, Scots, Norway, Swiss stone, mugo.
Populus deltoides 'Siouxland'	cottonless cottonwood	80-100'	South Dakota selection; adapted to poor soil, grows quickly.
Populus hybrids	seedless poplar	40-60'	Good selections are: 'Prairie Sky,' 'Robusta,' 'Tower,' 'Highland'
Populus x *acuminata*	lanceleaf cottonwood	40-60'	Hardy; upright seedless pyrimidal tree.
Prunus hybrids	cherry	15-25'	Select fruitless varieties.
Prunus x *nigrella* 'Muckle'	muckle plum	10-15'	Sterile hybrid, thus no fruit; red buds and showy pink flowers; red fall color.
Syringa reticulata	Japanese tree lilac	15-25'	Attractive bark, flowers and form.
Thuja occidentalis	arborvitae	25-50'	Wide variety of forms and height from cultivars.
Tilia cordata	littleleaf linden	25-50'	Conical form, fragrant flowers

TABLE 4. SALT TOLERANT PLANTS

Source: Salt Injury on School Grounds, UConn Extension (ipm.cahnr.uconn.edu)

TREES AND SHRUBS:	PERENNIALS AND ORNAMENTAL GRASSES:
Bayberry (*Morella pensylvanica*)	Blanket flower (*Gaillardia pulchella*)
Bearberry (*Arctostaphylos uva-ursi*)	*Bluestem, big (Andropogon gerardii)*
Blueberry, highbush (*Vaccinium corymbosum*)	Bluestem, little (*Schizachyrium scoparium*)
Chokeberry (*Aronia* spp.)	Butterfly weed (*Asclepias tuberosa*)
Cypress, Japanese false (*Chamaecyparis* spp.)	Candytuft (*Iberis sempervirens*)
Eastern red-cedar (*Juniperus virginiana*)	Columbine (*Aquilegia* spp.)
Groundsel Bush (*Baccharis halimifolia*)	Hens and Chicks (*Sempervivum tectorum*)
Holly, American (*Ilex opaca*)	Joe Pye weed (*Eutrochium purpureum*)
Honey-locust (*Gleditsia triacanthos*)	Muhly grass (*Muhlenbergia capillaris*)
Oak, white (*Quercus alba*)	New England Aster (*Symphyotrichum novae-angliae*)
Oak, willow (*Quercus phellos*)	Northern Sea-Oats (*Chasmanthium latifolium*)
Serviceberry (*Amelanchier* spp.)	Pinks, cheddar (*Dianthus* spp.)
Sourwood (*Oxydendrum arboreum*)	Seaside Goldenrod (*Solidago sempervirens*)
Southern Magnolia (*Magnolia grandiflora*)	Sea holly (*Eryngium x oliverianum*)
Sumac, fragrant (*Rhus aromatica* 'Gro-Low')	Star of Persia (*Allium christophii*)
Summersweet (*Clethra alnifolia*)	Stonecrop (*Sedum* 'Autumn Joy')
Sweetfern (*Comptonia peregrina*)	Switchgrass (*Panicum virgatum*)
Winterberry (*Ilex verticillata*)	Yarrow (*Achillea millefolium* 'Sunny Seduction')

TABLE 5. DEER RESISTANT PLANTS

Source: Minimize Deer Damage, UConn Extension (ipm.cahnr.uconn.edu)

Deer Avoid Plants:

- with thorns or prickles on leaves or stems;
- with strong scents and bitter flavors (ex. herbs);
- that are poisonous or have thick sap;
- that have hairy or fuzzy leaves.

Ornamental grasses and ferns are nearly all highly resistant to deer damage.

TREES AND SHRUBS:	PERENNIALS:
Bayberry (*Morella pensylvanica*)	Adam's needle (*Yucca filamentosa*)
Boxwood (*Buxus sempervirens*)	Anise hyssop (*Agastache foeniculum)*
Chokeberry, red (*Aronia arbutifolia*)	Aster, New England (*Symphyotrichum novae-angliae*)
Eastern red-cedar (*Juniperus virginiana*)	Bleeding heart, fringed (*Dicentra eximia*)
Maple, sugar (*Acer saccharum*)	Catmint (*Nepeta* sp.)
Pieris, Japanese (*Pieris japonica*)	Coneflower, pale purple (*Echinacea pallida)*
Pine, eastern white (*Pinus strobus*)	Ginger, wild (*Asarum canadense*)
Serviceberry, Downy (*Amelanchier arborea*)	Indigo, false (*Baptisia australis*)
Sumac, fragrant (*Rhus aromatica*)	Milkweed, butterfly (*Asclepias tuberosa*)
Summersweet (*Clethra alnifolia*)	Sage, ornamental (*Salvia* x *sylvestris*)
Sweetbells (*Eubotrys racemosa*)	Sage, Russian (*Perovskia atriplicifolia*)
Sweetfern (*Comptonia peregrina*)	White snake-root (*Ageratina altissima*)
Sweetgale (*Myrica gale*)	Yarrow (*Achillea millefolium*)

TABLE 6. TREE AND SHRUB PRUNING TIMING

Source: Pruning Recommendations and Guidelines, UConn Extension (ipm.cahnr.uconn.edu)

Trees and Shrubs to Prune in Late Winter-Early Spring

These species should be pruned in late winter or early spring before growth begins. Most of these woodies bloom during fall and summer, on new wood (growth from the current season).

Buddleia davidii, butterfly-bush	*Hamamelis virginiana*, witch-hazel	*Potentilla fruticosa*, shrubby cinquefoil
Callicarpa spp., beautyberry	*Hydrangea arborescens,* smooth hydrangea	*Rhus spp*., sumac
Clethra alnifolia, summersweet	*Hydrangea paniculata*, panicle hydrangea	*Spiraea* spp., late blooming varieties
Cornus racemosa, gray dogwood	*Ilex verticillata*, winterberry	*Tilia* spp., linden
Cornus sericea, red-osier dogwood	*Morella pensylvanica,* bayberry	*Vaccinium corymbosum*, blueberry
Cotinus coggygria, smokebush	*Oxydendrum arboreum*, sourwood	

Trees and Shrubs to Prune in Summer - After Flowering

Trees and shrubs that bloom in early spring, on old wood (growth from the previous season), must be pruned after flowering to avoid removing the current season's flower buds.

Amelanchier spp., serviceberry	*Fothergilla gardenii*, fothergilla	*Prunus × cistena*, purpleleaf sandcherry
Aronia spp., chokeberry	*Hydrangea macrophylla,* bigleaf hydrangea	*Pieris japonica*, Japanese pieris
Calycanthus spp., sweetshrub	*Hydrangea quercifolia*, oakleaf hydrangea	*Rosa* spp., climbing roses
Cercis canadensis, redbud	*Kolkwitzia* spp., beautybush	*Rhododendron* spp., Azalea
Chaenomeles speciosa, flowering quince	Magnolia spp., magnolia	*Syringa vulgaris*, lilac
Crataegus spp., hawthorn	*Malus* spp., crabapple	*Spiraea* spp., early blooming varieties
Deutzia gracilis, deutzia	*Prunus virginiana*, chokecherry	*Viburnum* spp., viburnum
Forsythia spp., forsythia	*Prunus* spp., flowering cherry	*Weigela* spp., weigela