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Tree Monitoring & Early Pest Detection

Curriculum Overview

This bin/backpack contains materials and activities for you to do with your students to identify and monitor the trees in your school-yard/neighborhood. These activities connect to The Morton Arboretum's Woodland Ecosystem and Eco-Comparisons field trip programs. The activities can be done before or after your trip to extend your student's learning back into the classroom.

NGSS Connections:

Middle School	High School
MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.	HS-LS2-7: Design, evaluate and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

Activity Overview

Part 1: Tree Identification and Monitoring

1. In this lesson students will measure the trees in their school yard and collect data about each of the trees they sample. As part of their data collection students will identify the trees in their schoolyard and measure the d.b.h for each tree. It is recommended that students complete this task in groups. Depending on your schoolyard, it is also recommended to divide the school yard into plots so that each student group is responsible for a different set of trees to measure.
2. Activity Materials: Student Data Sheet (per group/pair), Clipboard (optional), measuring tape, writing utensil, *Tree Finder* by May Watts (information on common IL Trees and how to identify them), writing utensil, Map of School Yard or Printed Google Map of Area you are measuring your trees in, calculator.
3. Activity Procedure:
   a. Divide students into data collection groups and distribute materials. Each group needs a data sheet, clipboard (optional), tape measure, writing utensil, Tree Id book or other Tree Identification Resource (see materials for linked resources).
   b. Go outside to measure the trees in your community.
   c. *Recommended Tips for Management:*
      i. *Before letting students to measure trees on their own, model how students will complete their data sheet, by compiling data on 1 tree together.*
      ii. *Model how to use the Tree Finder Books (see attached supplement as well). Encourage students to draw the leaf shape and make other observations of the tree's features: bark texture, leaf texture, leaf arrangement etc.*
      iii. *Model how to measure the DBH (Diameter at Breast Height)- Using the tape measure, have students stand next to the tree and measure at the height of their armpit. Students should wrap the tape measure around the tree to get the tree's circumference in inches. Next students will need to calculate the diameter by dividing their measured circumference by Pi (3.14)*
      iv. *Model to student how you want them to describe their location or mark their location on the map of your school yard. (Since school yards vary by location, a map or chart on how you will want students to describe the location of the tree will need to be given to the students as well. As part of the analysis location of their plotted trees will become important information for them to collect.)*
      v. *Since the overall goal is to monitor the health of these trees overtime, you will want to make an initial assessment of whether or not the tree is healthy. Use the following key to help you determine the overall health of each tree. (chart also located in the supplemental resources)*
         1. Excellent (1)- Tree appears to be in reasonably good health. Less than 10% cumulative fine twig dieback, defoliation and or discoloration present.
         2. Good (2)- Major branch losses, fine twig dieback, and/or foliage discoloration present in 10-25% of the crown
         3. Fair (3)- Major Branch losses, fine twig dieback, and/or foliage discoloration present in 26-50% of the crown

4. Poor (4) -Major Branch losses, fine twig dieback, and/or foliage discoloration present in more than 50% of the crown
5. Dead (5) Tree is standing dead with no green leaves or buds (greater than 4.5 ft. tall

vi. Note: More information on these categories for tree health can be found within the 'Health Trees, Healthy Cities" App. The rating is modeled off of the U.S Forestry Department's Tree Health Scales.

vii. *Divide the School Yard and give each group of students an area to measure. (Note: Consider using Google Maps to create a grid of your school yard and assign each student group to a specific grid).*

Part 2: Tree Risk Assessment:

1. Now that you have identified the trees in your school yard, you will assess the potential risks that these trees may face against disease and non-native pests.
2. Review Threat ID pages. (Also Available: https://www.aphis.usda.gov/aphis/resources/pests-diseases/hungry-pests/the-threat) Have students work in groups review, research and identify information about each of these potential tree threats. Students can use the attached data sheet to compile this information, summarize the information on their own in another format.
3. Next, have students cross reference the trees on your site, with the information they researched on threats that apply. You are looking for overlap with the host species for the pests or diseases with the trees on your site. You will use this information to develop a threat analysis for the trees on your site. For example, if you do not have any Ash trees on your school site, than the emerald ash borer insect, would not be a potential threat, you would include or monitor for in coming years.
4. Have students work through the case studies (see below) to help them understand the impact these pests can have on the trees in a given area.
5. For each of the trees on your site, complete a Tree Monitoring Threat Analysis Page.

Part 3: Tree Stress Scenarios (Pest and Disease Case Studies)

1. The goal of this activity is for students to identify a common stress for a group of trees, determine what additional information may be needed to properly identify the stress and suggest a plan to protect the future of the tree or trees impacted.
2. Activity Materials: scenario cards, scenario notes sheet (1 per group or individual), appendixes and clue sets for each scenario, Additional resources page for next steps.
3. Activity Procedure:
   a. Divide students into 4 groups.
   b. Give each group a different tree stress scenario page.
   c. Allow students time to review their scenario, assess their needs for additional information and discuss as a group the discussion prompts for each scenario.
   d. Provide students with then next piece of information, or the requested appendixes.
   e. Allow students time to review the additional information, make a prediction or claim and provide supporting evidence.
   f. Provide students with the second piece of information, and allow them to verify or change their claim and add or remove their supporting evidence.
   g. Provide students with the final solution.
   h. Allow students time to formulate the next steps in to protect their tree(s). This may require access to the provided resource list, so that students can come up with feasible solutions for improving tree health in each of the given scenario's community.
   i. Discuss results as a group or whole class. Each group could present their scenario, result, and next steps for improving tree health.

Part 4: Data Sharing and On-going Monitoring

1. Once you have completed the Tree Monitoring Analysis Page for each tree in your plot. Students will share the information with the Healthy Trees, Healthy Cities Application.
2. The Nature Conservancy's Healthy Trees, Healthy Cities (HTHC) Tree Health initiative seeks to protect the health of our nation's trees, forests, and communities by creating a culture of stewardship that engages people in long-term stewardship and monitoring of the trees in their respective communities.
3. For more information about this resource visit: https://healthytreeshealthycitiesapp.org/index.cfm
4. Download the "Health Trees, healthy cities" Application on a smart phone or tablet.
5. Allow the app to use your current location. (You may need to turn location services on)
6. Create an account.
7. Choose "Add A Tree"
8. Record the information from your data sheet.
9. Click Save
10. Add a photo of the tree, if you are able to utilize the mobile device outside the classroom.
11. Share this information with your community or local forester. Look into how your municipality evaluates the trees in your city/town.
12. In subsequent years, compare the Tree Monitoring Threat Analysis pages for each tree, year after year.
13. Check for the arrival or evidence of pests or disease. Use Healthy Tree Healthy City to report evidence of pests or diseases.

Part 5: Building Awareness

1. Although (possibly) none of the trees in your site have evidence of a pest or disease- building awareness about these pests is a critical component of mitigating the impact that these pests/invasive can have on the environment.
2. Engage your students in the problem by creating awareness about these pests/diseases, in order to encourage early detection in your community.
3. Use the resources listed below, to have student's research information on the potential pests that could impact their community and create awareness tools. These awareness tools could be: videos, posters, ID brochures (for early detection). Etc.
    a. Junior Invasive Inspector Program: http://psaworks.sites.clemson.edu/JrInvasives/
        i. Curriculum: http://psaworks.sites.clemson.edu/JrInvasives/pdf/curriculum.pdf
    b. Hungry Pests: https://www.aphis.usda.gov/aphis/resources/pests-diseases/hungry-pests/meet-vin-vasive
        i. Hungry Pests Videos: https://www.aphis.usda.gov/aphis/resources/pests-diseases/hungry-pests/usda-efforts/hp-videos
        ii. Middle School Curriculum/Activities: https://www.aphis.usda.gov/hungrypests/partner-tools/HP_InvadeMS_Curriculum.pdf
        iii. Invasive Species Article (6-8): https://www.aphis.usda.gov/hungrypests/partner-tools/072117_APHIS_hungrypests_6-8ITA-508Compliant.pdf
        iv. Invasive Species Article (9-12) https://www.aphis.usda.gov/hungrypests/partner-tools/072117_APHIS_hungrypests_9-12ITA-508Compliant.pdf
        v. Pest ID Sheets:
            1. Asian longhorned beetle: https://www.aphis.usda.gov/aphis/resources/pests-diseases/hungry-pests/the-threat/asian-longhorned-beetle/asian-longhorned-beetle
            2. Emerald Ash Borer: https://www.aphis.usda.gov/aphis/resources/pests-diseases/hungry-pests/the-threat/emerald-ash-borer/emerald-ash-borer-beetle
            3. Gypsy Moth: https://www.aphis.usda.gov/aphis/resources/pests-diseases/hungry-pests/the-threat/asian-gypsy-moth/asian-gypsy-moth
            4. Spotted Lantern Fly: https://www.aphis.usda.gov/aphis/resources/pests-diseases/hungry-pests/slf/spotted-lanternfly

5. Sudden Oak Death: https://www.aphis.usda.gov/aphis/resources/pests-diseases/hungry-pests/the-threat/sudden-oak-death/hp-sudden-oak-death

vi. Pest Cards:
1. Asian longhorned beetle: https://www.aphis.usda.gov/hungrypests/partner-tools/HP-PestCards-ALB.pdf
2. Emerald Ash Borer: https://www.aphis.usda.gov/hungrypests/partner-tools/HP-PestCards-EAB.pdf
3. Gypsy Moth: https://www.aphis.usda.gov/hungrypests/partner-tools/HP-PestCards-GM.pdf
4. Sudden Oak Death: https://www.aphis.usda.gov/hungrypests/partner-tools/HP-PestCards-SOD.pdf

Why Monitor Tree Health?
Benefits of Trees Anticipation Guide

Anticipation Guide- The benefits of trees – (Or use Kahoot.it)

- Read each statement and decide if the statement is true or false.

Before	Statement	After
	Investing in trees pays off. Trees reduce building energy costs associated with heating and cooling.	
	The presence of trees and green space can reduce the symptoms of diabetes	
	The presence of trees/green space can help people have increased attention, memory and focus	
	Trees provide important economic value. This includes reducing noise pollution	
	Children benefit from the presence of trees which can increase the symptoms of ADHD	
	Trees and well-maintained landscaping make people feel safer.	
	Trees often evoke strong positive emotions and are anthropomorphized	
	Planting Trees can reduce storm water in urban environments	
	In one study, increase in street trees resulted in a reduction in prescribed antidepressants.	
	Trees can increase sales in a shopping area	

More information on the benefits of Trees (Literature Review): https://drive.google.com/file/d/12D73d-gAQmin7mwdcgbUjDTOoaxtJITJ/view

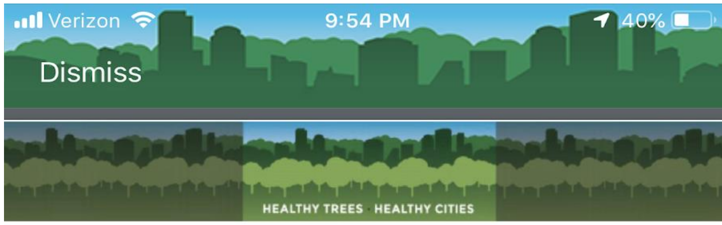
DATA SHEET

*As you explore your school yard, collect data on 4-5 trees in your plot. When choosing your trees try to choose trees with a DBH greater than 3 inches. This would mean the tree's circumference would be ~greater than 9 inches. Therefore you will want to take the DBH measurement first. Consider collecting the optional observations in order to get a "whole picture" of the trees in your school yard. You never know how your observations will help to answer questions or lead to interesting observations concerning the trees in your community.

Notes to reference when conducting your observations

Plot # and Description	Tree Species	DBH	Tree Health Rating Descriptions :
• Mark on your School Yard Map or describe the location in the box below • For this section, be sure to observe the sunlight and exposure of this plot • Describe the location (or use a map) with the intended goal, that someone could find the exact tree you are observing. (Example: Use site descriptions to reference the tree: "SW corner of school near parking lot (gym)".	• Use Common Street Tree Reference/ID Sheets. • Use other Tree Finding Resources • Make observations on the leaves, bark, shape (leaf bud/fruit/flower- based on time of year)	• Diameter at Breast Height- (taken at approx. 4.5 feet above ground)Use Tape Measure to measure circumference and then calculate the DBH	Excellent (1)- Tree appears to be in reasonably good health. Less than 10% cumulative fine twig dieback, defoliation and or discoloration present.
			Good (2)- Major branch losses, fine twig dieback, and/or foliage discoloration present in 10-25% of the crown
			Fair (3)- Major Branch losses, fine twig dieback, and/or foliage discoloration present in 26-50% of the crown
			Poor (4) -Major Branch losses, fine twig dieback, and/or foliage discoloration present in more than 50% of the crown
			Dead (5) Tree is standing dead with no green leaves or buds (greater than 4.5 ft. tall

Tree Health Visuals and Details for Tree Health Ratings Examples



Crown Health: Vigor

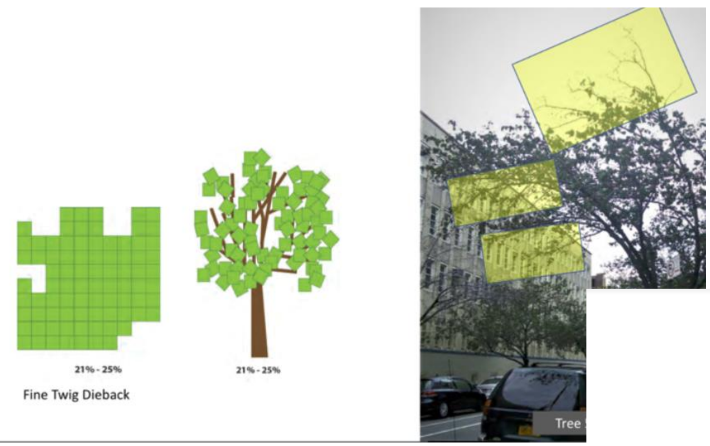
A holistic assessment of crown health based on several signs of stress (dieback, discoloration, defoliation)

Vigor Class	Description
1	Tree appears to be in reasonably good health; no major branch losses; **less than 10% cumulative** fine twig dieback, defoliation, and/or discoloration present
2	Major branch losses, fine twig dieback, and/or foliage discoloration present in **10-25% cumulative** of the crown
3	Major branch losses, fine twig dieback, and/or foliage discoloration present in **26-50% cumulative** of the crown
4	Major branch losses, fine twig dieback, and/or foliage discoloration present in **more than 50% cumulative** of the crown
5	Tree is **standing dead** with no green leaves or live buds; greater than 4.5 ft. tall

Photo by Julia Pike

Photo Example:
Vigor Class 2

(Due to some discoloration and fine twig dieback)



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Part I: Tree ID & Monitoring

Tree Identification/Monitoring Data Sheets

Group Members Names:

Plot # and Description	**Tree Species**	**Calculate the DBH**	**Tree Health Observations** :
1 Is the plot: Sunny? Shady? Partial Sun and Shade? (Circle one) Estimated distance to closest man-made structure (building, road, sidewalk etc): _______feet	Species: Leaf Drawing: Bark Description:	Circumference at Breast Height **:** ______inches *Calculate the Diameter- Formula is:* *Circumference* / π (3.14) **Diameter at Breast Height (DBH):** ________inches	Estimated distance to closest man-made structure (building, road, sidewalk etc): _______feet Tree Health: (Does the tree look healthy to you? Why or why not?)- Use the rating scale to help your analysis. Give one sentence explanation for your rating.

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The Scientific Benefit of Trees: A review

Water

Interception of stormwater
Planting trees can reduce stormwater in urban environments. The permeability of vegetated areas, including urban forested areas, allows more water to be intercepted, especially compared to concrete. (Bolund and Hunhammer 1999)

Interception of stormwater
Large trees are valuable to prevent runoff and to clean water, since they intercept and slow precipitation. The urban forest of Canberra, Australia, including both street trees and trees in parks, contributes to this ecosystem service of amelioration of water runoff, which is valued at $1,330,000 ($US) a year. (Brack 2002)

Mitigating stormwater
Although more research is needed in an urban setting, urban forests can be valuable assets for stormwater reduction. Trees can act as decentralized green infrastructure to control and reduce stormwater through interception, transpiration, and infiltration. (Berland et al. 2017)

Phytoremediation
Trees can be useful in phytoremediation because they can take up pollutants into their woody tissues. They may be useful in controlling heavy metals and other contaminants from sewage sludge. (French et al. 2006)

Interception of stormwater
A review of 14 studies across five continents showed that landscapes with trees are able to reduce rainwater runoff, improve the quality of the runoff water, and increase cooling by evapotranspiration from their leaves. (Livesley et al. 2016)

Interception of stormwater
When planted in bioswales, large trees with high stomatal conductance, allowing ample CO_2 and water vapor in and out of leaves, are valuable to reduce runoff and discharge of stormwater. Trees are an important component of green infrastructure design. (Scharenbroch et al. 2015)

Social/Cultural

Urban residents value trees
Urban residents valued trees because they provide shade, make people feel calmer, and reduce smog and dust. Any potential problems associated with trees, such as blocking storefronts or causing allergies, were not considered sufficient reasons to avoid planting trees in cities. (Lohr et al. 2004)

Trees and well-maintained landscaping make people feel safer

In Chicago, an increased density of trees and maintained grass in a neighborhood made residents feel safer. If the outside shared areas were well-maintained, it encouraged social ties within the community. (Kuo et al. 1998)

More trees means more social capital
An increase in tree canopy cover in a neighborhood has been documented to increase social capital for individuals and encourage neighborhood connections. (Holtan et al. 2014)

Trees are associated with increased social ecology
A review paper suggests that green areas, defined as those with well-maintained trees and grass, are linked to increased social ecology of an area. Greenness is associated with lower crime rates, more play activity with children, and a greater sense of safety as compared to barren areas. (Kuo 2003)

Trees are associated with increased social capital
In an observational study, trees encouraged residents in a public housing development in Chicago to use the common outdoor space, thus increasing social capital. Areas that had trees, as compared to areas devoid of trees, encouraged larger gatherings of people of a variety of ages. (Coley et al. 1997)

Trees often evoke strong positive emotions and are anthropomorphized
While the intensity and the emotions vary among individuals, people often have a strong connection for trees. Trees are often anthropomorphized, and they are used as religious symbols. (Dwyer et al. 1991)

Humans evolved from nature and have an innate need to be around nature
Our love of nature is inherent (biologically based), part of our evolutionary history, part of our “fitness” and our evolutionary advantage. It helps us achieve personal meaning and demonstrates that there is self-interest in conservation. (Kellert and Wilson 1995)

Humans are drawn to living things and processes
Humans evolved from nature, and so there is an innate need for humans to be around nature. (Wilson 1984)

Trees can be vital tools to increase community development and social ties
Involving the community in tree planting can be a great way to develop community capacity. Urban foresters and arborists are valuable to the health and happiness of a community. (Elmendorf 2008)

Photos of natural environments were preferred to photos of urban environments
Undergraduate females preferred looking at pictures from an arboretum, as compared to more urban scenes. They were also more likely to label the natural scenes as less complex. (Kaplan et al. 1972)

Physical Health

Hospital patients heal faster and better
Patients in hospital rooms that overlooked trees, as compared to a wall, had shorter stays and marginally reduced complications, needed fewer intense painkillers, and had fewer negative comments from hospital staff. (Ulrich 1984)

Trees affect asthma rates**
Increased density of street trees in an urban area has been associated with a lower prevalence of asthma among children, regardless of sociodemographic and other variables. (Lovasi et al. 2008)

**However, in a later study, Lovasi et al. (2013) incorporated all trees in an urban area, not just street trees, and found that Dominican or African American children who had higher levels of tree canopy cover at their prenatal address had greater sensitivity to tree pollen when they were older.

Decline in diastolic blood pressure
Study participants who sat in a room after completing a drive or a task and were able to look out over trees had a greater decline in diastolic blood pressure than participants who looked out on a view without trees. (Hartig et al. 2003)

Trees make people feel younger and healthier
In a study that controlled for a variety of demographic factors, scientists found that participants who lived on a block with 10 or more street trees felt, on average, as healthy as someone seven years younger or $10,000 a year richer and living in a wealthier neighborhood. Participants in areas with more trees also had reduced cardio-metabolic conditions. (Kardan et al. 2015)

Increase in physical activity, less likely to be overweight
Individuals who live in areas that are greener are much more likely to be physically active and 40 percent less likely to be overweight. (Ellaway et al. 2005) While this is not directly about trees, trees are often a large component of green space.

Trees clean the air
On a large scale, trees can improve the quality of the air by removing pollution, but it depends on numerous factors. In a study looking at 86 Canadian cities, in one year alone, trees removed 16,500 tonnes of air pollution. This removal of air pollution has the equivalent value of preserving 30 human lives and preventing 22,000 incidences of acute respiratory symptoms. It is important to note, however, that trees can impact how pollution is dispersed and effectively increase it on a localized scale through trapping pollution under the canopy or reducing wind speeds. (Nowak et al. 2018)

Children are less likely to be overweight
A study that controlled for a variety of demographic and socio-demographic variables found that children growing up in neighborhoods that are greener were less likely to increase their body mass index over two years, as compared to children who live in areas that are not as green. (Bell et al. 2008) Greenness was determined through satellite images and the Normalized Difference Vegetation Index (NDVI).

Alzheimer patients are less violent and have fewer falls
Care centers for Alzheimer's patients that had garden environments with trees had lower violence and fewer falls among their residents, as compared to care centers without gardens. (Mooney and Nicell 1992)

Mortality

Living near green spaces associated with reduced mortality
A long-term cohort study that adjusted for a variety of social and environmental factors, though not all confounding variables, found that living near green spaces was associated with reduced mortality, especially from respiratory disease. (Villeneuve et al. 2012) Greenness was determined through satellite images and the Normalized Difference Vegetation Index (NDVI).

Living near green spaces results in lower mortality in women
A cohort study that adjusted for factors including age, smoking, and socioeconomic status found that for women, living in areas with the densest vegetation, or "greenness," was associated with a lower rate of non-accident related mortality, such as lower rates of deaths related to respiratory disease, kidney disease, and cancer. (James et al. 2016) Greenness was determined through satellite images and the Normalized Difference Vegetation Index (NDVI).

Reduction in tree cover results in increased mortality
An observational study reported that counties with widespread ash tree dieback due to emerald ash borer infestation had an increase in deaths related to cardiovascular issues or respiratory illness. The authors included covariates in the model. The impact was greatest in wealthier counties, likely because these counties had more ash trees, that died from the infestation. (Donovan et al. 2013)

Mental Health

Reduction in negative thoughts and activities in the brain associated with mental illness
After participants walked through a green space that had scattered native shrubs and oaks, they had less perseveration, or tendency to dwell, on negative thoughts of self, and less activity in a part of the brain associated with mental illness. (Bratman et al. 2015)

Increase in attention, positive emotions, and reflection
Taking a walk in an arboretum, as compared to a setting in a downtown city environment with fewer trees, has been documented to increase the attention capacity, positive emotions, and capability for reflection in students. (Mayer et al. 2009)

Increased memory in depressed people
Walking in an arboretum, as compared to a downtown city environment, has been shown to increase the memory span and mood of individuals diagnosed with major depressive disorder. (Berman et al. 2012)

Green spaces reduce stress in participants
Stress was reduced in study participants if they spent more time in urban green spaces, regardless of sex, age, or socio-economic background. (Grahn and Stigsdotter 2003). While this is not directly about trees, trees are often a large component of green space.

Increased memory and attention

After walking in an arboretum or even looking at pictures of nature, study participants had increased memory and greater directed-attention. Being in the arboretum increased the participants' positive mood as compared to a walk in a downtown city environment with fewer trees. (Berman et al. 2008)

Ability to recover from stress more easily
Participants who viewed streets with more trees were able to recover from stress more easily. This study showed a linear positive association for participants regardless of age, baseline stress, or gender. (Jiang et al. 2014)

Increased attention and focus
Trees in an urban environment have been documented to increase an adult's ability to focus and pay attention. (Lin et al. 2014)

Nature-based learning can help classroom engagement
Elementary school classroom engagement was higher in lessons that occured in nature, as compared to those in a classroom. This was measured by several variables, including ratings determined by the teacher, counts of the number of times the class needed to be told to focus, independently reviewed photos of the lessons, and a composite index. (Kuo et al. 2018)

Increased test grades
Controlling for variables such as number of students, percent of students enrolled in free lunch programs, and teacher-student ratio, schools in the District of Columbia with more trees onsite had higher test grades in mathematics and reading. This research complemented work that found that outdoor "featureless landscapes," such as athletic fields or grass lawns without trees, can reduce students' test performance. (Kweon et al. 2017)

Teenagers exposed to greener environments self-reported better moods
When teenagers spent time outdoors in green environments, they self-reported lower rates of depression, anger, and fatigue. In general, time spent in higher concentrations of nature was related to the teenagers having better moods. This study was conducted using self-assessment surveys and GPS trackers over a four-day period. (Li et al. 2018)

Reduced symptoms of ADD/ADHD in children
Children with attention deficits (ADHD or ADD) had increased concentration after walking in a park. A walk in the park had an effect similar to taking attention deficit medication. (Taylor and Kuo 2009)

Reduced symptoms of ADD in children
Greener environments, such grassy areas or open spaces with big trees, have been linked to reduced symptoms of ADD in children. (Taylor et al. 2001)

Better attention and recovery from stress

Students who were able to look out a window onto trees and green spaces had higher attention levels and there was a trend that they were able to recover from stress quicker then students who did not have a view in their classroom. (Li and Sullivan 2016)

Increased discipline in young girls
Seven to 12-year-old inner-city girls who lived in apartments in Chicago that overlooked nature showed increased self-discipline (as measured by an index that combined concentration, impulse inhibition, and delayed gratification) than girls who lived in apartments that looked over a scene with less greenery. (Taylor et al. 2002)

Increased ability in paying attention
If a student's dormitory window overlooked views of natural settings, including trees and/or a lake, as compared to a more built setting, the student had increased directed attention. (Tennessen and Cimprich 1995)

Increase in street trees results in a reduction in prescribed antidepressants
In one study that attempted to control for confounding variables, residents living on a street with an increased density of trees were prescribed fewer antidepressant than individuals on streets with fewer trees. (Taylor et al. 2015)

Tree images make people happier
Looking at an image of a scene with trees made study participants happier and less angry and sad than looking at the same image with the trees removed. Not only were scenes with trees deemed more attractive, but trees evoked a positive emotional response. (Lohr and Pearson-Mims 2006)

Increased tree diversity, increased reflection
An increasing level of tree and shrub diversity in different urban green spaces was associated with increased psychological benefits of reflection and identity in 312 self-selecting participants. (Fuller et al. 2007)

Increase in life satisfaction, decrease in mental distress
Living near a green space has been documented to increase life satisfaction and decrease mental distress. (White et al. 2013)

Financial

Positive return on investment in tree planting and maintenance
For every dollar invested annually in tree planting and maintenance in five major cities, there was a return of $1.37 to $3.09, based on the benefit of trees (i.e. energy savings, atmospheric CO_2 reductions, stormwater runoff reductions, etc.). (McPherson et al. 2005)

Positive rate of return on tree maintenance
In California, street trees provide $1 billion in services annually, with a return of $5.82 for each $1 spent on tree management. (McPherson et al. 2016)

Trees are valuable structural assets

It is estimated that the compensatory value of the urban forest of the continental United States is more than \$2.4 trillion. The estimate is based on the benefits trees provide, such as energy savings, atmospheric CO_2 reductions, and stormwater runoff reductions. (Nowak et al. 2002)

Trees can save money on road maintenance
The shade of trees can protect roadways, therefore reducing the amount of asphalt sealers needed over a 30-year period and saving money. (McPherson and Muchnick 2005)

Well-maintained trees and landscaping increase office rents
Quality landscaping including trees can increase rental rates for offices, as long as the trees do not block the building from view. (Laverne and Winson-Geideman 2003)

Trees can increase sales in a shopping area
The presence of quality trees encourages shoppers to spend more time at a business district, and they will travel a greater distance to visit that center. Further, shopping areas with trees were more likely to be ranked as being more comfortable and having better upkeep, friendlier staff, and higher quality products. (Wolf 2005)

Trees can increase the sale price of a house
There is an association that homes will have a 3.5 to 4.5 percent greater selling price if there are trees on the property. (Anderson and Cordell 1988)

Street trees can help sell houses
Street trees are beneficial in selling homes. The presence of trees on the street not only increases a home's sales price but reduces its time on the market. (Donovan and Butry 2010)

Trees can increase the sale price of a house
Tree cover increases the sale price of a home. (Sander et al. 2010)

Proximity to a forest can increase the sale price of a house
Living closer to a larger forested area, or having a view onto a forest, increased a home's value in Finland. (Tyrväinen and Miettinen 2000)

Energy Bills

Reduced summer energy use
Houses shaded by trees on the south or west exposure have a reduced summertime energy use of over 5 percent. (Donovan and Butry 2009)

Reduced summer energy use
Dense shade around a home can reduce residential energy usage, depending on the season. (Pandit and Laband 2010)

Reduced energy use
Planting trees in urban areas can reduce energy use associated with heating and cooling. This reduction can be 25 percent in an urban landscape. (Akbari 2002)

Reduced energy use
Trees substantially reduce air conditioning and heating costs of residential and commercial buildings in Sacramento County, Calif. (Simpson 1998)

Reduce urban heat islands
Trees, combined with high-albedo surfaces, can help reduce urban heat islands in major cities. This can reduce electricity needed to cool buildings. (Akbari et al. 2001)

Ecosystem Services

Trees provide ecosystem benefits
This review paper illustrates that urban forests provide many ecosystem services, including increased physical health, psychological health, property values, community economic development, and tourism. (Nesbitt et al. 2017)

Trees provide ecosystem benefits
Nationwide, the 5.5 billion trees in our urban areas provide $18.3 billion worth of ecosystem benefits annually, through reducing building energy use, sequestering carbon, avoiding pollution emissions, and removing air pollution. (Nowak and Greenfield 2018)

Trees clean the air, regulate climate, reduce noise pollution, and add social value
Street trees, parks and lawns, and forested areas are beneficial as they can filter out pollution from the air, provide microclimate regulation, reduce noise pollution, and they provide social value. Parks, lawns, and forested areas can also provide the ecosystem service of rainwater drainage. (Bolund and Hunhammer 1999)

Green spaces increase ecosystem services
A literature review found numerous health benefits are associated with access to green space, due to the ecosystem services these areas provide. (Jenning and Gaither 2015)

Trees remove air pollution, creating huge economic value
Every year in the United States alone, urban trees are responsible for removing 711,000 metric tons of CO, NO_2, O_3, PM_{10}, and SO_2 from the air. This ecosystem service of removing air pollution is valued at over $3.8 billion. (Nowak et al. 2006)

Carbon storage
Urban forests are beneficial for storing carbon, which has an effect on carbon's contribution to climate change. (Nowak 1993)

Carbon storage
Based on data from 10 urban centers, urban trees annually sequester 22.8 million tons of carbon. The total carbon storage of urban trees in the continental United States is 700 million tons. (Nowak and Crane 2002)

Food security/Non-timber forest products
Urban Forests can help provide additional food security or non-timber forest products to a neighborhood. (McLain et al. 2012)

Food security/Non-timber forest products
Urban Forests can help provide additional food security or non-timber forest products to a neighborhood. (Poe et al. 2013)

Trees remove air pollution, huge economic value
In 2010, urban trees in the continental United States were responsible for removing over 17 million metric tons of air pollution, which had a health benefit valued at almost $7 billion. (Nowak et al. 2014)

Trees provide many indirect and direct benefits
This short review discusses the biophysical benefits trees provide, through the reduction of heating and cooling costs as well as management of stormwater. In addition, trees provide social benefits to neighborhoods such as improved health of constituents and reduced crime. (Donovan 2017)

Crime

The loss of street trees may increase crime rates
The loss of ash trees due to emerald ash borer in Cincinnati, Ohio, was positively associated with increases in crime. The authors suggest that invasive species that harm trees can have tremendous ecological and societal costs. They related their results to the theories of broken windows and routine activity. (Kondo et al. 2017)

Reduced crimes in a neighborhood
Controlling for other variables, mature street trees are related to reduced reports of crime in a neighborhood. On the other hand, trees that are smaller and closer to the house are related to increased crime reports. However, the authors caution that another explanation is possible: Neighborhoods with large trees may be more desirable areas where it would be more likely for a criminal to be spotted. (Donovan and Prestemon 2012)

Value of homes near parks relates to the crime rate in the park
Not all green spaces are desirable. In Baltimore, property values of homes close to parks are related to the amount of crime in an area. Higher levels of rape and robbery in a neighborhood reduce the value of a park to the community. (Troy and Grove 2008) This citation is important in relation to the others by Troy.

Well-maintained trees are related to lower crime rates**
Controlling for a variety of factors, including income, population density, and type of housing, there is a strong relationship between well-maintained trees and lower crime rates in Baltimore. This could be an example of "cues to care"—the idea that a well-tended landscape communicates it is valued. Visibly maintained areas may have greater social capital. (Troy et al. 2016)

**Higher crime areas typically have trees: There is a relationship between tree cover and crime rates in Baltimore, with more trees usually related to a reduced crime rate. In areas where there is a positive relationship between tree cover and crime rates, this is most likely due to those areas being unmanaged. (Troy et al. 2012)

Green view can lower aggression, violence, and mental fatigue
A study showed that women living in Chicago public housing reported less aggression and violence and lower mental fatigue, if their apartment overlooked a yard with grass and trees, as compared to a more barren landscape. (Kuo and Sullivan 2001a)

Vegetation reduces property crimes and violent crimes
Despite the fear that dense vegetation leads to greater crime rates, and controlling for other crime predictors, apartments in inner-city Chicago that had lower levels of vegetation had higher levels of property crimes and violent crimes. (Kuo and Sullivan 2001b)

Importance of Large Trees

Large trees are important
Using data from almost 50 forests from around the world, the authors found that the largest-diameter trees in the forests (1% of all trees) are responsible for half of the aboveground biomass. Since large-diameter trees represent most of the living mass in a forest, they are extremely important for carbon cycling and forest productivity. Forests should be managed to conserve large-diameter trees in order to maximize the ecosystem services forests can provide. (Lutz et al. 2018)

Large, old trees are critically important from an ecological and cultural perspective
In this review, the authors showcase the importance of old and large trees in the world, especially since these trees provide the most benefits. These benefits include managing important environmental cycles and processes as well as creating habitat for other species. Given the diversity of tree species, it is difficult to develop a universal definition for a large old tree, so there are limited management and conservation plans for these organisms. However, once large old trees are lost from the community, it is difficult--if not impossible--to replace their cultural and ecological function. (Lindenmayer and Laurance 2017)

Large trees are an important type of urban habitat
Large trees in urban areas are important habitat for birds. The greater number of large trees in a park (as measured by diameter), the larger the increase of bird diversity. This was especially true for woodland-dependent bird species. This paper also includes an overview of urban tree protection policies worldwide. (Stagoll et al. 2012)

Large trees are an important type of urban habitat
One group of researchers looked at the importance of large trees and how their value compares when these trees are replaced by several small- and medium-sized trees, as is often done during development projects. In urban parks, a few large trees provided more habitat for birds when compared to many small- or medium-sized trees. In fact, almost 30% of bird species observed in this study were only found on large trees. (Le Roux et al. 2015)

Large trees fix a tremendous amount of carbon
A global analysis of more than 670,000 individual trees from more than400 species demonstrated that tree mass increases with tree size. This means that large trees store and sequester carbon at an unprecedented rate, much greater than smaller and younger trees. In fact, in the best-case scenario, a big tree could fix the same amount of carbon that is found in a medium-sized tree each year. (Stephenson et al. 2014)

Large old trees contribute significantly to ecosystems
Given that they are single organisms, large old trees provide a disproportionate impact on biodiversity and ecological processes, from providing habitat to participating in important ecological cycles. In order to make sure terrestrial ecosystems continue to retain the benefit these trees provide, old trees need to be protected. There needs to be a reduction in old-tree mortality as well as a greater number of younger trees achieving old age. (Lindenmayer 2017)

Large old trees need our help
Despite their global importance as keystone structures for ecosystem integrity and biodiversity, large old trees are threatened disproportionality in ecosystems worldwide. (Lindenmayer et al. 2012)

Negative Associations Regarding Trees

Detriments from street trees
Street trees can be considered undesirable due to the potential for damage of municipal property, leaf litter, problems associated with visibility and security. (Lohr et al. 2004)

Fear of concealment
Trees and shrubs can offer places of concealment, which can make college students feel unsafe at night on college campuses. (Nasar& Fisher 1993)

Costs vs. benefits of trees
Communities in Florida were concerned about urban trees due to the potential of hurricane damage from the trees; falling branches and damage to property; the mess trees can create with falling leaves; and pollen and tree sap on cars. Despite this, these same communities favored an increase in urban tree planting, as trees increased shade, character, and the beauty of a community, as well as increasing property values to the area. (Wyman et al. 2012)

Storm damage costs
It can be expensive to clean up after urban trees after a storm. (Staudhammer et al. 2009)

Ecosystem disservices
Urban forests can produce many ecosystem disservices, which can be categorized as financial costs, social nuisances (including vectors for pests or disease), and environmental conditions (such as altered nutrient cycles). (Escobedo et al. 2011)

Disadvantages of trees
Trees can cause ecosystem disservices. Roots can break up concrete. Tree branches increase cover, which

may increase crime. Branches can cause unnecessary shading or maintenance issues. Fallen leaves can decrease the ability of vehicles to break at appropriate speeds. (Lyytimäki and Sipilä 2009)

Limitations of These Studies

Unequal distribution of trees
Trees are more likely to be found on public rights of ways in wealthy areas than in poorer areas. (Landry and Chakraborty 2009)

Income and tree distribution
While trees and nature clearly are beneficial for humans, there are many variables that could be confounded. For example, in one study that analyzed seven major cities, the authors found a strong relationship between urban tree cover and income: the lower the income, the fewer the trees. (Schwarz et al. 2015)

Tree research correlative
Some studies may not consider important variables in understanding the importance of trees. While there is strong evidence that nature benefits humans, it is important to note that much of the research that has been conducted is correlative. (Keniger et al. 2013)

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Compiled by Jessica Turner-Skoff, PhD; Last edit 07/31/2018

Part 2: Tree Risk Assessment

Tree Monitoring Threat Analysis

*Use the data sheet from your tree identification/monitoring activity
*Complete a threat analysis for each of the trees in your plot. If you # your trees, include a map, to ensure that future monitors can track the data over time.

Name of Person(s) Completing the Analysis: ____

Date of Observations: (Month/Year) ____

Tree # (information on multiple trees is collected)	Tree location (description OR GPS location)
Tree Species:	Tree Observations:
Diameter at Breast Height (DBH):	Tree Health Rating: (Ranging between 1-5 where 1=good, 5=dead)
Potential Pest or Disease threats to monitor for (based on species)	Potential future signs or symptoms, based on future potential threats:

Please visit https://www.aphis.esda.gov/aphis/resources/pests-diseases/hungry-pests/the-threat for "Tree Threat ID Sheets" on

- Asian longhorned beetle
- Emerald Ash Borer
- European Gypsy Moth
- Asian Gypsy Moth
- Spotted Lantern Fly
- Sudden Oak Death

Part 3: Tree Stress Scenarios

Activity Overview

Background: A number of stresses impact the growth and health of trees. However, trees are also resilient and have adapted throughout history to a number of environmental stressors, diseases, changes in climate, and pests. As humans and trees live together, and trees serve as a vital part of our urban and rural landscapes, it is important to identify and monitor the stresses and impacts imposed on trees, especially since many of these stresses that threaten tree health have been introduced by humans.

Materials: scenario cards, scenario notes sheet (1 per group or individual), appendixes and clue sets for each scenario, Additional resources page for next steps.

Goal: Students will be able to identify a common stress for a group of trees, determine what additional information may be needed to properly identify the stress and suggest a plan to protect the future of the tree or trees impacted.

Procedure:

1. Divide students into 4 groups.
2. Give each group a different tree stress scenario page.
3. Allow students time to review their scenario, assess their needs for additional information and discuss as a group the discussion prompts for each scenario.
4. Provide students with then next piece of information, or the requested appendixes.
5. Allow students time to review the additional information, make a prediction or claim and provide supporting evidence.
6. Provide students with the second piece of information, and allow them to verify or change their claim and add or remove their supporting evidence.
7. Provide students with the final solution.
8. Allow students time to formulate the next steps in to protect their tree(s). This may require access to the provided resource list, so that students can come up with feasible solutions for improving tree health in each of the given scenario's community.
9. Discuss results as a group or whole class. Each group could present their scenario, result, and next steps for improving tree health.

Tree Stress Scenario #1 SOLUTION:

Asian longhorned beetle

Tree Stress Scenario #2 SOLUTION:

Tar Spot

Tree Stress Scenario #3 SOLUTION:

Emerald Ash Borer

Tree Stress Scenario #4 SOLUTION:

Oak Wilt

Additional Web Resources for Pest and Disease Packets/Research

Pests (Insects) Fact Sheet(s) and Resources:

- Emerald Ash Borer
  - http://www.mortonarb.org/trees-plants/tree-and-plant-advice/help-pests/coping-emerald-ash-borer
  - APHIS/USDA Resource
- European Gypsy Moth
  - http://www.mortonarb.org/trees-plants/tree-and-plant-advice/help-pests/gypsy-moth
  - http://www.dontmovefirewood.org/pest_pathogen/european-gypsy-moth-html/
- Asian longhorned beetle
  - http://www.mortonarb.org/trees-plants/tree-and-plant-advice/help-pests/asian-longhorn-beetle
  - APHIS/USDA Resource
- Gold-Spotted Oak Borer
  - http://ucanr.edu/sites/gsobinfo/about_goldspotted_oak_borer_930/
  - https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprd3833276.pdf
  - http://www.dontmovefirewood.org/pest_pathogen/goldspotted-oak-borer-html/

Diseases Fact Sheet(s) and Resources:

- Bur Oak Blight
  - https://www.na.fs.fed.us/pubs/palerts/bur_oak_blight/bob_print.pdf
- Tar Spot
  - http://www.mortonarb.org/trees-plants/tree-and-plant-advice/help-diseases/tar-spot-maple-rhytisma-spp
- Oak Wilt
  - http://www.mortonarb.org/trees-plants/tree-and-plant-advice/help-diseases/oak-wilt
- Cedar-Rust
  - http://www.mortonarb.org/trees-plants/tree-and-plant-advice/help-diseases/cedar-apple-rust
- Apple Scab
  - http://www.mortonarb.org/trees-plants/tree-and-plant-advice/help-diseases/apple-scab
- Anthracnose
  - http://www.mortonarb.org/trees-plants/tree-and-plant-advice/help-diseases/anthracnose-shade-trees
- Verticillium Wilt
  - http://www.mortonarb.org/trees-plants/tree-and-plant-advice/help-diseases/verticillium-wilt

Other Resources (by species or governing agency)

- Hungry Pests:
- Oak Problems:
- Don’t Move Firewood.

Scenario #1 Card

Part 1: Review the Scenario

- Read through the scenario
- Review and decide on what additional information is needed to help solve the problem.

Scenario: Spotted on the Schoolyard

5th grade students at Lincoln Elementary notice some changes to the trees on their playground. The playground contains 16 trees total, 4 different species with 4 trees of each species. When they were in 4th grade, they had to adopt different trees as part of a science project, and so they remember making observations on different tree throughout the course of the year. They remember 2 of the trees that were adopted having more leaves in the top half of the tree.

- *Look at the list of appendixes, which do you think would be useful to consult?*
- *What observations do you think the 5th grade students should record during recess?*
- *What information do they need to collect on all of the trees?*
- *What information do they need to collect on some of the trees?*

Appendixes:

- *List of trees planted and their location (from the school's landscape design).*
- *List of venders and landscape garden centers in which the trees were purchased.*
- *The "adopt a tree observations" from the last 2 years.*

Part 2: Additional Clues

- Review the additional appendixes you requested- How does this information help?
- Look at the leaf photo, bark and other observations made this year from the 5th graders. Based on these observations, what do you think could be impacting these trees?

Part 3: First Prediction:

- Make a prediction: What do you think is causing a change to the foliage of the tree?
- Record the evidence you have to support this claim.

Part 4: Additional information:

- Review the final set of information and make a claim about what is impacting the trees on the schoolyard.
- Record the evidence you have to support this claim.

Part 5: Review the Solution.

- Review the additional evidence that definitely solves this scenario.
- Was your prediction correct? If you prediction was incorrect, what evidence did you miss?

Part 6: Wrap Up- Next Steps

- What can be done to improve the help of these trees?
- What next steps should the school/students consider?
- How can the community help to support the health of these trees moving forward?

Scenario #1 Worksheet

Part 1: Review the Scenario

1. Think about: What additional information do you need?

Part 2: Additional Clues:

1. What does this additional information tell you? What do you observe?

Part 3: Make your first prediction:

1. Do you think it is likely that a pest, disease or other environmental factor could be impacting the tree?

2. Prediction/Claim:

3. Evidence that supports your claim:

Part 4: Additional Information:

1. Does any of this additional information add more support/evidence for your claim? Does it change your prediction?

Part 5: The Solution

1. Was your prediction/claim correct? If your prediction/claim was incorrect, what evidence did you miss?

Part 6: Next Steps:

1. Research solutions to this pest/disease. What can be done to improve the health of the tree?

2. What advice would you give to the school in regards to this tree(s)?

Part 3: Tree Stress Scenarios

Scenario #1: Spotted on the Schoolyard

Additional Information (Part 4): The principal at Lincon, heard about the 5th grade student's concerns, and looks outside to examine the affected trees. He notices the "holes" as well, but additionally, finds some sawdust like material in the branch joints. Additionally, since he is almost 6 feet tall, he is able to measure some of the hole on the branches that the student's first observed. He placed a dime next to the hole for reference.

Part 3: Tree Stress Scenarios

Scenario #1: Spotted on the Schoolyard

Additional Information (Part 2): Leaf and Bark Images- from the trees on the Lincoln Elementary Playground/Schoolyard that are losing leaves at the top of the tree. Upon closer examination, the students also notice some "holes" in the branches of the tree.

Part 3: Tree Stress Scenarios

Scenario #1: Spotted on the Schoolyard

2 Years Ago :Adopt a Tree" Observations

Tree Journal

Tree #1

Tree Location: Large tree in the northwest corner of the school.

Date of Observation: October 1st

Diameter of Tree: .48M DBH

Tree Species: American Elm

Other Tree Observations: Lots of leaves, they have started to change color, there is a large bump on the trunk.

Tree #2

Tree Location: Large tree in the northwest corner, closet to the basketball court.

Date of Observation: October 1st

Diameter of Tree: .39M DBH

Tree Species: Sugar Maple

Other Tree Observations: Tree looks healthy, has lots of leaves, no bare spots. Leaves have started to change color

Tree Journal

Tree #3

Tree Location: West side of the school clos-est to the front of the building

Date of Observation: October 1st

Diameter of Tree: .9M DBH

Tree Species: White oak

Other Tree Observations: Lots of leaves, and acorns. Some leaves have started to change color

Tree #4

Tree Location: East side of school , closest to the building and the playground.

Date of Observation: October 1st

Diameter of Tree: .4M DBH

Tree Species: Sugar Maple

Other Tree Observations: Leaves on all the branches. Trunk is rough, not smooth. Leaves have started to change color

Part 3: Tree Stress Scenarios

Scenario #1: Spotted on the Schoolyard

Last Year's :Adopt a Tree" Observations

Tree Journal

Tree #1

Tree Location: Large tree in the northwest corner of the school.

Date of Observation: September 30th

Diameter of Tree: .5M DBH

Tree Species: American Elm

Other Tree Observations: Lots of leaves, they have not started to change color, there is a large knot on the trunk.

Tree #2

Tree Location: Large tree in the northwest corner, closet to the basketball court.

Date of Observation: September 30th

Diameter of Tree: .4M DBH

Tree Species: Sugar Maple

Other Tree Observations: Has lots of leaves and does not have any bare branches. Leaves do not have spots. Some branches have holes

Tree Journal

Tree #3

Tree Location: West side of the school closest to the front of the building

Date of Observation: September 30th

Diameter of Tree: 1M DBH

Tree Species: White oak

Other Tree Observations: Lots of leaves, and visible acorns. Some leaves have brown spots, but most are all green

Tree #4

Tree Location: East side of school , closest to the building and the playground.

Date of Observation: September 30th

Diameter of Tree: .5M DBH

Tree Species: Sugar Maple

Other Tree Observations: Some of the leaves on the branches near the top of the tree are missing. Some branches have holes.

The Morton Arboretum | THE CHAMPION of TREES

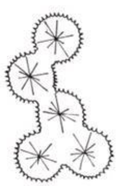
Scenario #1: Spotted on the Schoolyard

Ulmus Americana (American Elm)

Thuja occidentalis (Arborvitae)

Quercus alba (White Oak)

Acer saccharum (Sugar Maple)

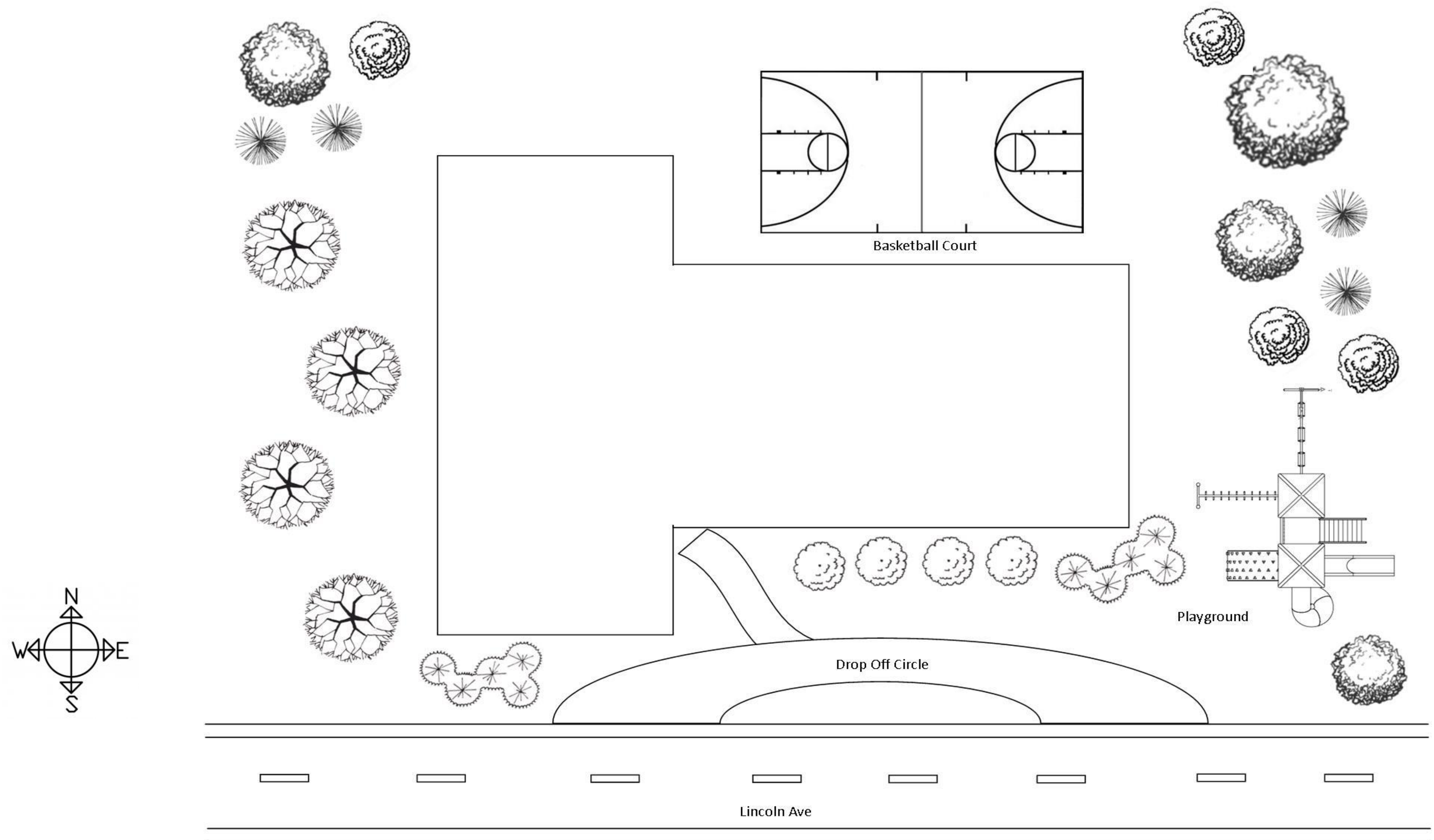


Juniperus horizontalis ‘hegedus’ (Juniper shrub)

Buxus ‘green velvet’ (Boxwood shrub)

Part 3: Tree Stress Scenarios

Scenario #1: Spotted on the Schoolyard



Part 1: Review the Scenario

- Read through the scenario
- Review and decide on what additional information is needed to help solve the problem.

Scenario 2: Frisbee Frustration

The Park District has noticed that several trees at one of the town's Frisbee golf course have spots on their leaves. The spots are black and vary in size and frequency on the leaves. The spots on the leaves became present during the early part of the summer. The park has over 10 different species of trees, some planted within the landscape others part of the park's natural area. They have noticed the spots on a total of 15 trees.

- *Look at the list of appendixes, which do you think would be useful to consult?*
- *What observations do you think the park manager should record?*
- *What information do they need to collect on all of the trees?*
- *What information do they need to collect on some of the trees?*

Appendixes:

- *List of trees planted and their location (from the park's landscape design).*
- *List of venders and landscape garden centers in which the trees were purchased.*

Part 2: Additional Clues

- Review the additional appendixes you requested- How does this information help?
- Look at the leaf photo, bark and other observations made from the park manager. Based on these observations, what do you think could be impacting these trees?

Part 3: First Prediction:

- Make a prediction: What do you think is causing a change to the foliage of the tree?
- Record the evidence you have to support this claim.

Part 4: Additional information:

- Review the final set of information and make a claim about what is impacting the trees at the frisbee course/park.
- Record the evidence you have to support this claim.

Part 5: Review the Solution.

- Review the additional evidence that definitely solves this scenario.
- Was your prediction correct? If you prediction was incorrect, what evidence did you miss?

Part 6: Wrap Up- Next Steps

- What can be done to improve the help of these trees?
- What next steps should the park manager consider?
- How can the community help to support the health of these trees moving forward?

Scenario #2 Worksheet

Part 1: Review the Scenario

2. Think about: What additional information do you need?

Part 2: Additional Clues:

2. What does this additional information tell you? What do you observe?

Part 3: Make your first prediction:

4. Do you think it is likely that a pest, disease or other environmental factor could be impacting the tree?

5. Prediction/Claim:

6. Evidence that supports your claim:

Part 4: Additional Information:

2. Does any of this additional information add more support/evidence for your claim? Does it change your prediction?

Part 5: The Solution

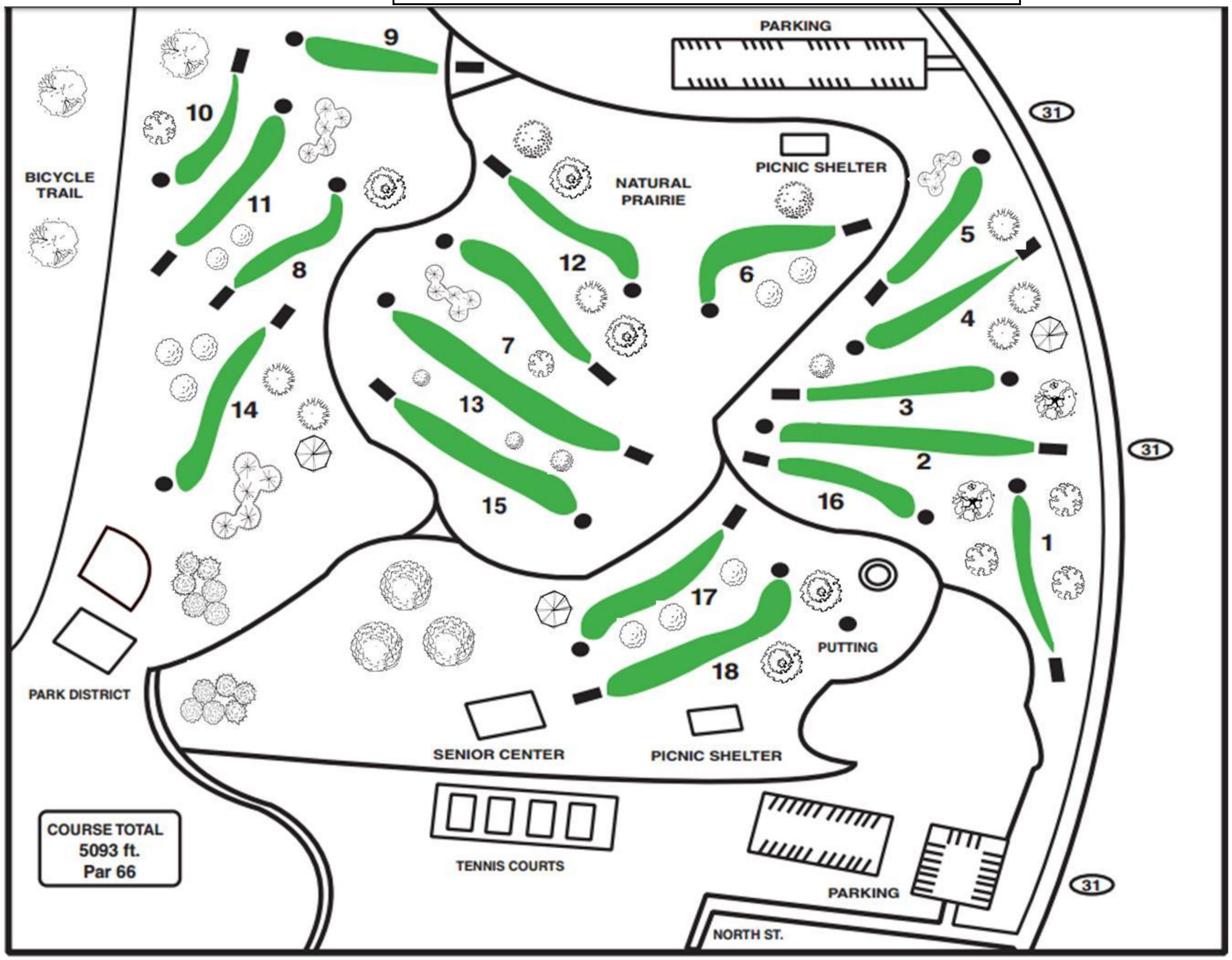
2. Was your prediction/claim correct? If your prediction/claim was incorrect, what evidence did you miss?

Part 6: Next Steps:

3. Research solutions to this pest/disease. What can be done to improve the health of the tree?

4. What advice would you give to the park manager in regards to this tree(s)?

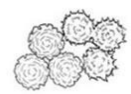
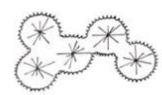
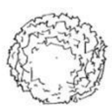
Bogey Frisbee Golf Course



Bogey Frisbee Golf Course

Landscape Design and Tree Selection/Survey

*This outlines the existing and added trees that have been incorporated into the new Frisbee Golf Course.

Landscape Drawing	Tree Species	Landscape Drawing	Tree Species
	Quercus Alba (White Oak)		Acer platanoides (Norway Maple)
	Fraxinus pennsylvanica		Rhus typhina (Staghorn Sumac)
	Larix decidua (European Larch)		Thuja occidentalis (Arborvitae)
	Acer saccharum (Sugar Maple)		Liquidambar styraciflua (Sweet Gum)
	Ostrya virginiana (Ironwood)		Ulmus Americana (American Elm)

2017 List of Vendors
(Golf Course Maintenance and Design)
Bogey Golf Course

Vendor	Item	Cost
ABC Landscape	*Thuja occidentalis* (arborvitae) (2), *Larix decidua* (European Larch) (2), *Liquidambar styraciflua* (Sweet Gum) (2)	6 @ $ 89.99
Dynamic Discs	Disc Basket (replacement)	5 @ $149.99
Tree-scape	*Acer plantanoides* (Norway Maple) (2), *Acer saccharum* (Sugar Maple) (2), *Rhus typhina* (Staghorn Sumac) (2)	6 @ $179.99
Sand Gravel Incorporated	8 yards of sand	$44.99/per yard
Golf Supply Unlimited	Tee Markers (36)	$39.99 (per unit)
Signs-4-You	Custom Sizes to mark off new portions of the course (4 total)	$249.99
Green-N-Healthy Lawns	Lawn Treatments (3 times per year)	$599.95
For-Evergreen Tree Supply	*Ulmus Americana* (American Elm) (4), *Fraxinus pennsylvanica* (2), *Ostrya virginiana* (Ironwood) (2), *Quercus Alba* (White Oak) (3)	4 @$199.95, 4 @ $219.99, 3 @$179.99

Part 3: Tree Stress Scenarios

Scenario #2: Frisbee Frustration

Additional Information (Part 4): Leaf Images from several of the Norway maple (<u>*Acer platanoides*</u>) and Sugar maple (*Acer saccharum*). Additionally the park manager noticed that over the last year, they have had more rainfall in early spring than previous years.





Additional Information (Part 2): Leaf and Bark Images- from the types of trees on at the Bogey Frisbee Golf Course that have spots.

Part 1: Review the Scenario
- Read through the scenario
- Review and decide on what additional information is needed to help solve the problem.

Scenario 3: Fire Station Sprouts

The fireman in Centerville have noticed that some of the trees surrounding the fire station, have less leaves within the top ½ of the tree and have branches or outgrowths visible from the trunk of the tree. The fire station has over 10 trees planted in the parkway and 5 small trees planted near the building. The trees affected are located in the parkway that runs adjacent to the sidewalk and road.
- *Look at the list of appendixes, which do you think would be useful to consult?*
- *What observations do you think the fire men should record?*
- *What information do they need to collect on all of the trees?*
- *What information do they need to collect on some of the trees?*

Appendixes:
- *List of trees planted and their location (from the city's landscape design of the fire station).*
- *List of venders and landscape garden centers in which the trees were purchased.*

Part 2: Additional Clues
- Review the additional appendixes you requested- How does this information help?
- Look at the leaf photo, bark and other observations made from the firemen. Based on these observations, what do you think could be impacting these trees?

Part 3: First Prediction:
- Make a prediction: What do you think is causing a change to the foliage of the tree?
- Record the evidence you have to support this claim.

Part 4: Additional information:
- Review the final set of information and make a claim about what is impacting the trees at the fire station.
- Record the evidence you have to support this claim.

Part 5: Review the Solution.
- Review the additional evidence that definitely solves this scenario.
- Was your prediction correct? If you prediction was incorrect, what evidence did you miss?

Part 6: Wrap Up- Next Steps
- What can be done to improve the help of these trees?
- What next steps should the park manager consider?
- How can the community help to support the health of these trees moving forward?

Scenario #3 Worksheet

Part 1: Review the Scenario

3. Think about: What additional information do you need?

Part 2: Additional Clues:

3. What does this additional information tell you? What do you observe?

Part 3: Make your first prediction:

7. Do you think it is likely that a pest, disease or other environmental factor could be impacting the tree?

8. Prediction/Claim:

9. Evidence that supports your claim:

Part 4: Additional Information:

3. Does any of this additional information add more support/evidence for your claim? Does it change your prediction?

Part 5: The Solution

3. Was your prediction/claim correct? If your prediction/claim was incorrect, what evidence did you miss?

Part 6: Next Steps:

5. Research solutions to this pest/disease. What can be done to improve the health of the tree?

6. What advice would you give to the firemen in regards to this tree(s)?

Additional Information (Part 4): The fire chief pulled out some photos from last year that they took during an annual inspection of the property, realizing that they may be helpful in determining how the trees have changed over the last year. Additionally, while they were outside cleaning some of their equipment in the fire station's front lawn, they found a twig beneath the tree affected trees and noticed the unique markings just below the branch bark.

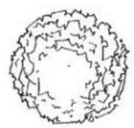
Last year during the annual inspection

This year during the annual inspection

Twig found near infected trees

Map Key and Vender List

Centerville Fire Station



Fraxinus americana (White Ash)

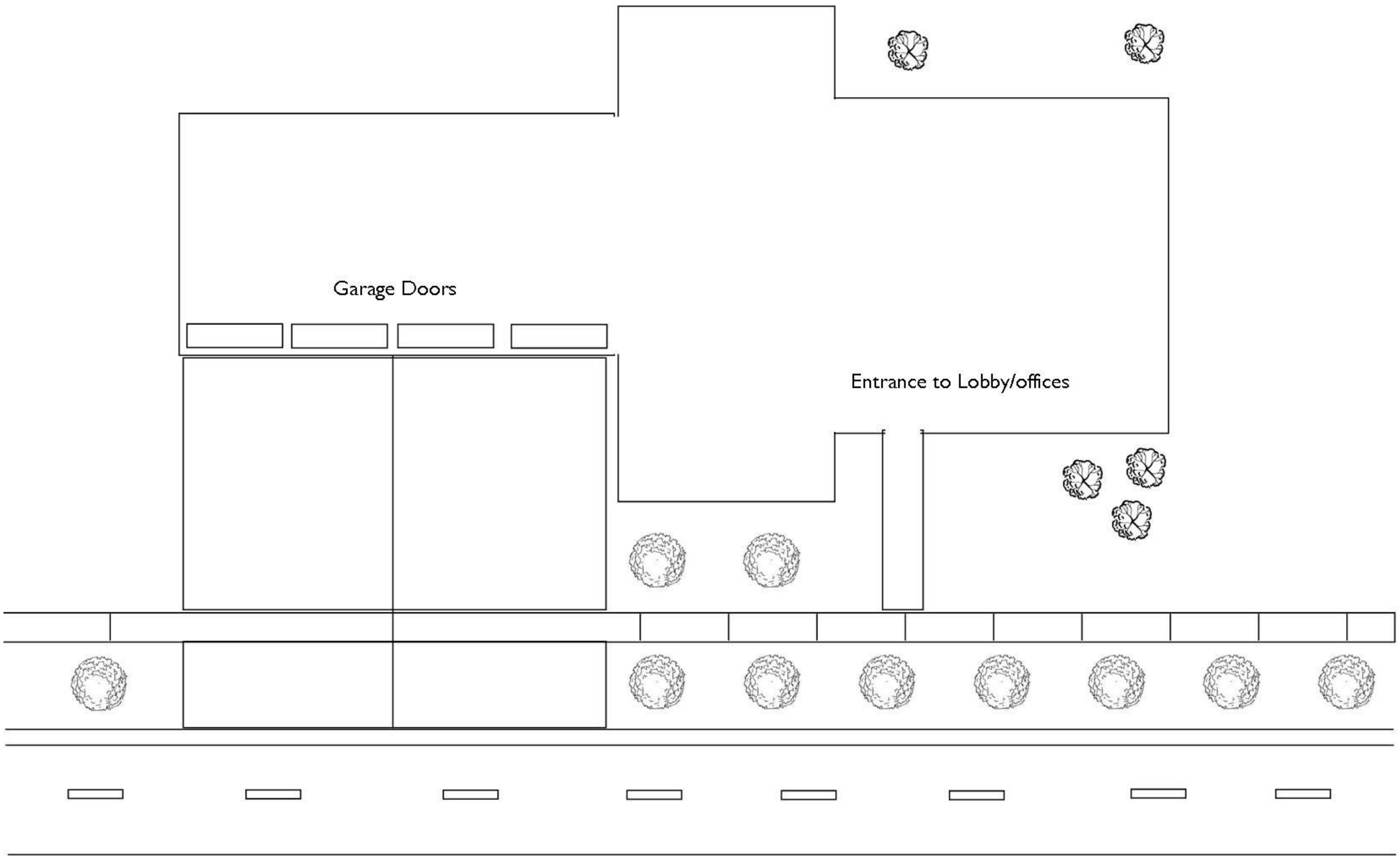
(10) Purchased at ABC Landscape

Cornus florida (Flowering Dogwood)

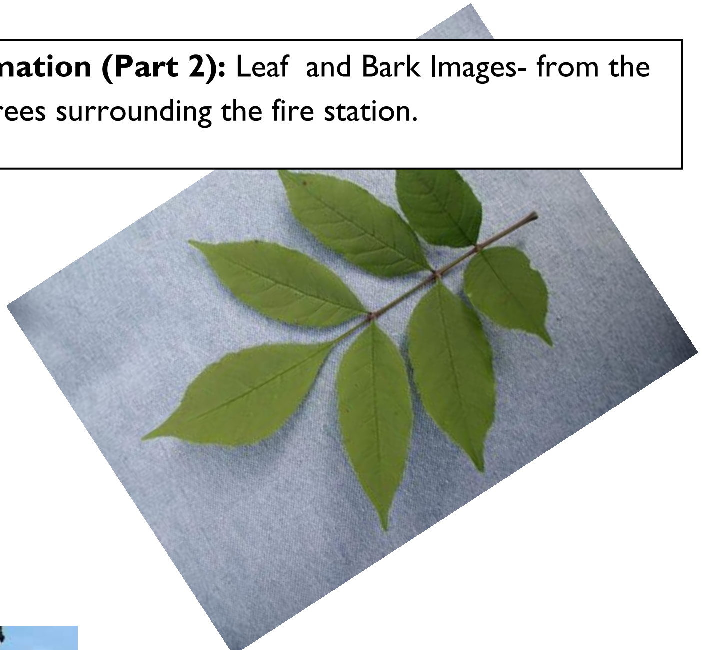
(5) Purchased at ABC Landscape)

Centerville Fire Station

6,000 square feet



Additional Information (Part 2): Leaf and Bark Images- from the trees surrounding the fire station.



Part 1: Review the Scenario
- Read through the scenario
- Review and decide on what additional information is needed to help solve the problem.

Scenario 4: Soccer Field Fiasco

Several parents and coaches have noticed a change to the trees surrounding the community's soccer and softball fields. Each of the fields are separated by small patches of woodland and tree plantings. Several of the trees within these bordering plots have discoloration and browning on several of the leaves. Several of the leaves appear to be ½ brown or burnt looking.

- *Look at the list of appendixes, which do you think would be useful to consult?*
- *What observations do you think the parents and coaches should record?*
- *What information do they need to collect on all of the trees?*
- *What information do they need to collect on some of the trees?*

Appendixes:

- *Map of the park with some trees identified (from the city's landscape design of the park and fields).*
- *List of teams and people who use the field.*

Part 2: Additional Clues
- Review the additional appendixes you requested- How does this information help?
- Look at the leaf photo, bark and other observations made from the parents and coaches. Based on these observations, what do you think could be impacting these trees?

Part 3: First Prediction:
- Make a prediction: What do you think is causing a change to the foliage of the tree?
- Record the evidence you have to support this claim.

Part 4: Additional information:
- Review the final set of information and make a claim about what is impacting the trees at the fire station.
- Record the evidence you have to support this claim.

Part 5: Review the Solution.
- Review the additional evidence that definitely solves this scenario.
- Was your prediction correct? If you prediction was incorrect, what evidence did you miss?

Part 6: Wrap Up- Next Steps
- What can be done to improve the help of these trees?
- What next steps should the park manager consider?
- How can the community help to support the health of these trees moving forward?

Scenario #3 Worksheet

Part 1: Review the Scenario

1. Think about: What additional information do you need?

Part 2: Additional Clues:

1. What does this additional information tell you? What do you observe?

Part 3: Make your first prediction:

1. Do you think it is likely that a pest, disease or other environmental factor could be impacting the tree?

2. Prediction/Claim:

3. Evidence that supports your claim:

Part 4: Additional Information:

1. Does any of this additional information add more support/evidence for your claim? Does it change your prediction?

Part 5: The Solution

1. Was your prediction/claim correct? If your prediction/claim was incorrect, what evidence did you miss?

Part 6: Next Steps:

1. Research solutions to this pest/disease. What can be done to improve the health of the tree?

2. What advice would you give to the community members in regards to this tree(s)?

Additional Information (Part 4): By mid-summer, a few parents have observed that several of the affected trees, have started to lose their leaves. Additionally, they notice some streaking on the interior of the branches when broken (see image below).

Additional Information (Part 2): Leaf and Bark Images- from the trees affected at the community park

List of Teams using the Community Soccer and Softball Fields

Current Soccer Teams

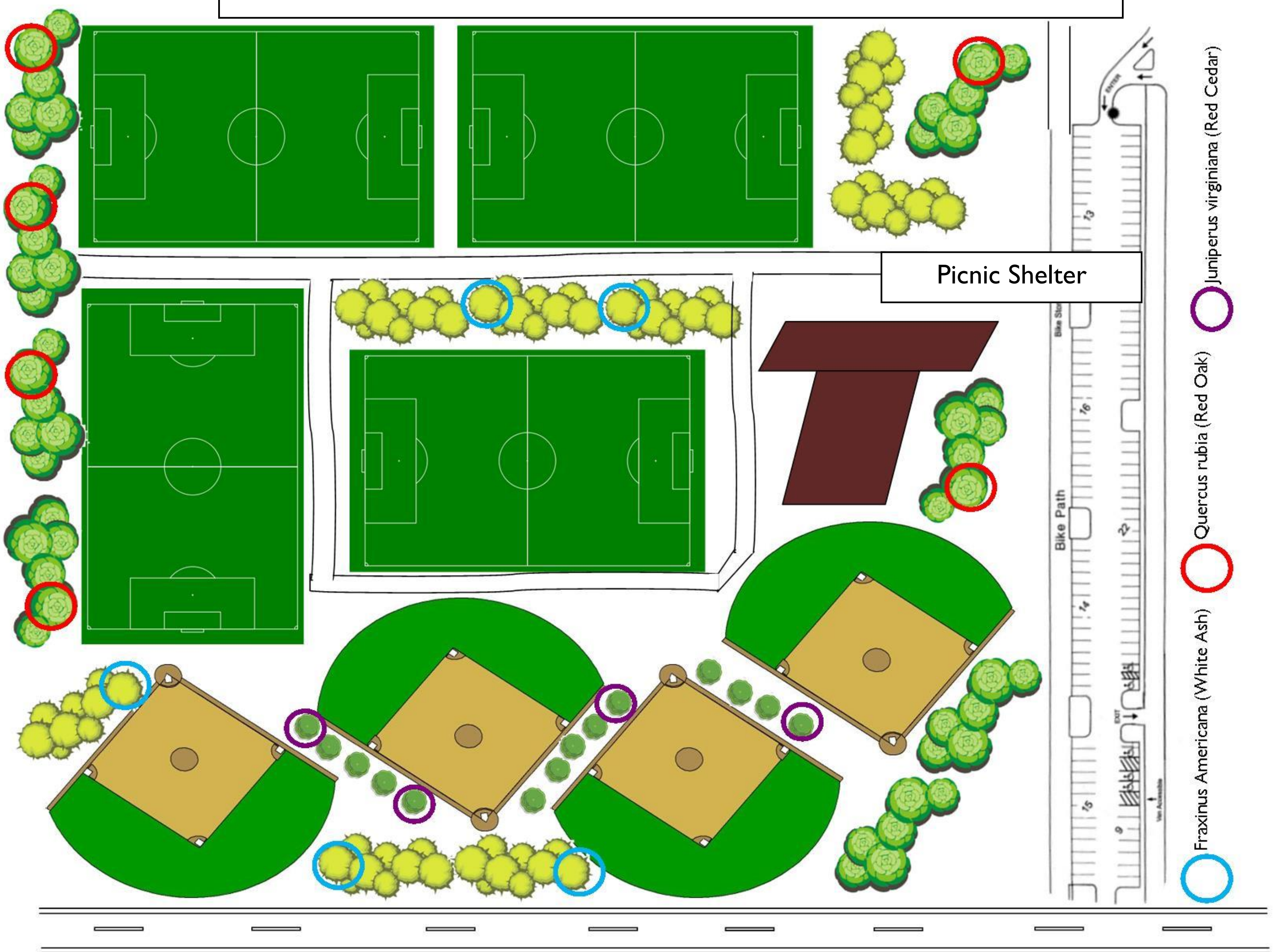
Team	Season	Day of Week/Time	Field Used
Jaguars	Fall, Spring	MWF 4:00-5:30PM	Field 1
Trojans	Fall, Spring	TTH 4:00-5:30 PM	Field 1
Tigers	Fall, Spring	MWF 4:00-5:30 PM	Field 2
Strikers	Fall ONLY	TTH 4:00-5:30 PM	Field 1
Magic	Fall, Spring	TTH 4:00-5:30 PM	Field 2
Celtics	SPRING ONLY	MWF 4:00-5:30 PM	Field 3

Current Softball Teams

Team	Season	Day of Week/Time	Field Used
Rangers	Spring, Summer	MWF 4:00-5:30PM	Field 1
Dodgers	Spring, Summer	TTH 4:00-5:30 PM	Field 1
All-Stars	Spring, Summer	MWF 4:00-5:30 PM	Field 2
Bulls	Spring, Summer	TTH 4:00-5:30 PM	Field 2
Bears	SUMMER ONLY	TTH 4:00-5:30 PM	Field 3
Cubs	Spring, Summer	MWF 4:00-5:30 PM	Field 3

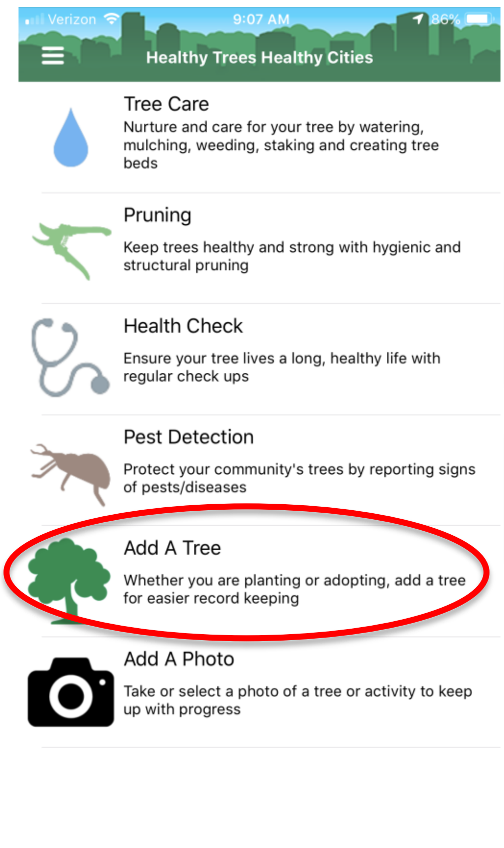
Scenario #4: Soccer Field Fiasco

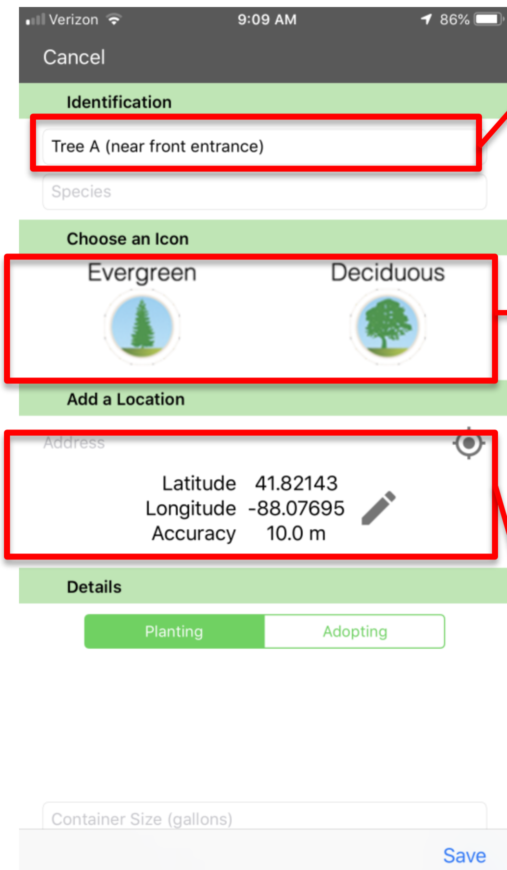
Community Soccer and Softball Fields
(Some trees and species have been identified)



How to Use the Healthy Trees Health Cities Application

1. Download the Application on internet enabled tablets or devices.
2. Open the Healthy Trees Healthy Cities Application
3. Create an account (with one email address, you can have multiple devices logged into an account)
4. Once you are ready to add your trees or record your data, begin by opening the application logged into your created account.
5. Use the screen shots below to walk you through the process of adding your trees and inputting health information.

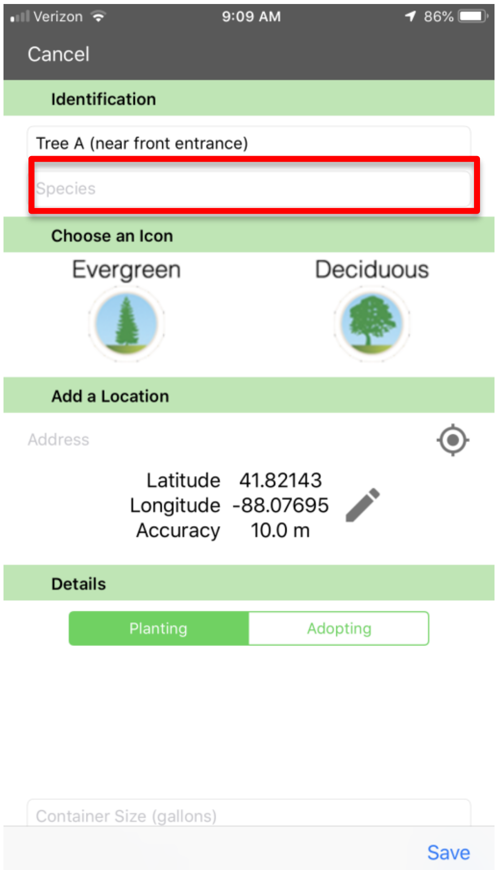


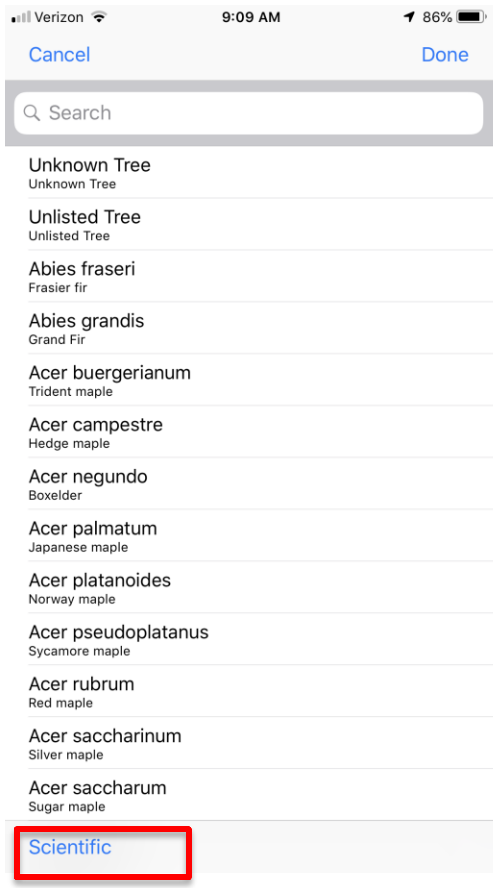


Enter Tree Label (Consider including location description, if it is brief.)

Look at the leaves, are they needle or broad shaped? If it is winter, are they bare or green? (Hint: Deciduous lose leaves in winter.)

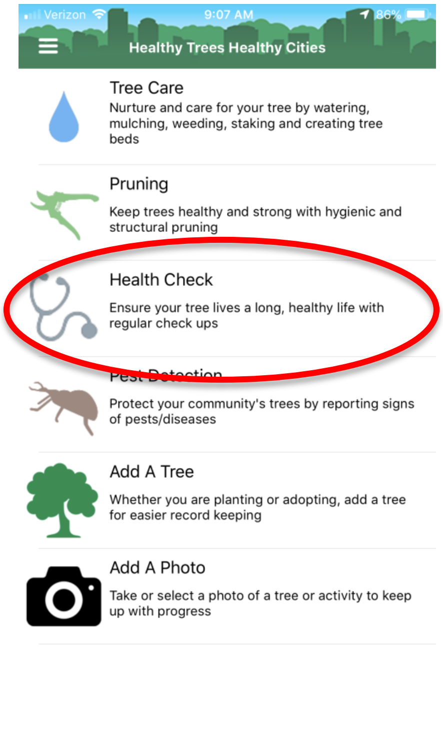
This is the GPS location, as enabled by the device. If you are not next to the tree, you can log the same location for all of your trees.

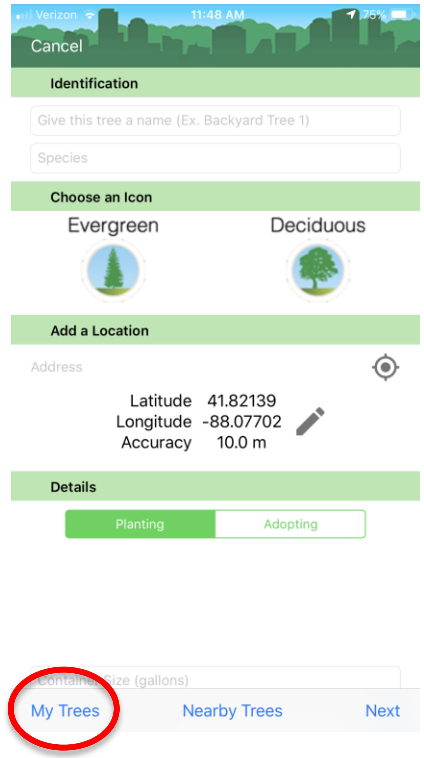


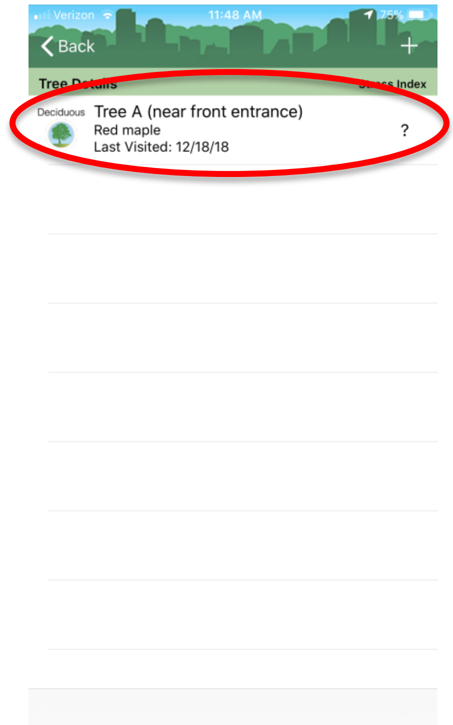


Use Tree Identification Resource to help you identify the trees on your site. You can search by either scientific (Latin name) or common name. The example included in these screen shots is for Acer Rubrum (Red Maple).

Identifying the tree correctly is important. However, please note: pests and diseases usually impact the entire "family" of trees, so exact species or variety is less important, as long as the family is identified correctly. (For example: "Acer" is the family name for Maples.)



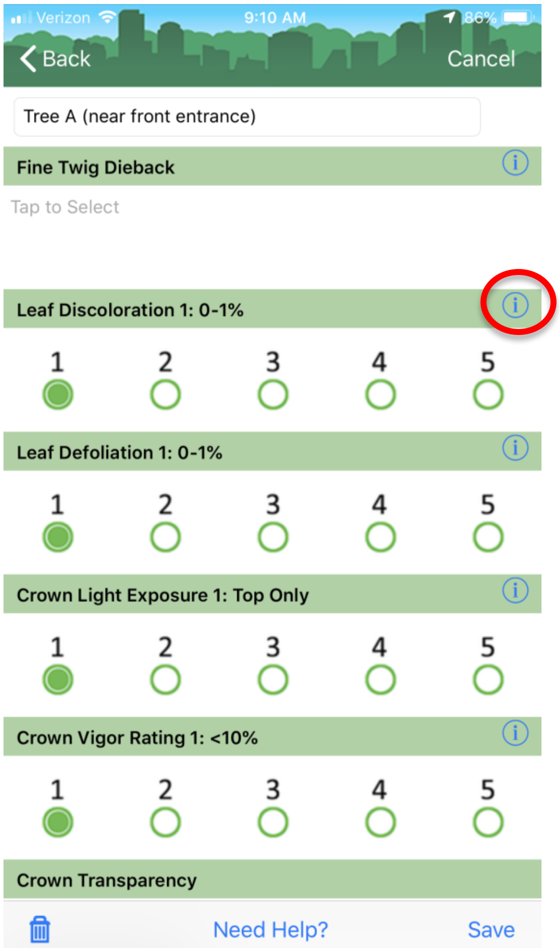


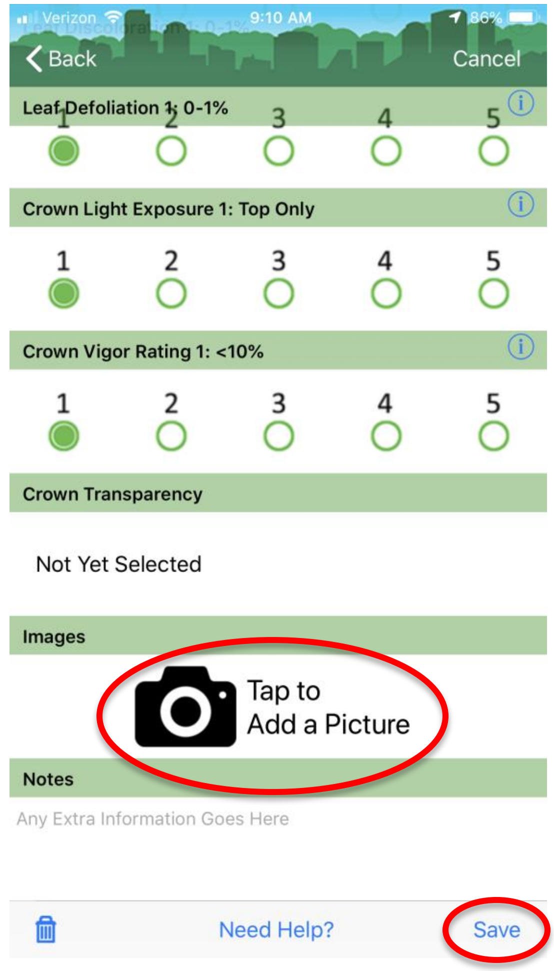


Once all of the trees in your inventory have been added, and you are ready to monitor or add tree health data, go back to the Main Menu.

Choose Health Check and then select "My Trees" from the bottom of the screen.

Choose a tree in which you recorded a health score.





Enter any health information you have recorded about the tree. Any information you can provide is helpful, even if you are not completing a rating for every category. Remember the scale is 1 (Healthy) to 5 (dead).

For additional information, images and definitions of each of the categories, click the blue info circle in the upper right of each section/category.

Once you have recorded the rating, add a picture if you are able.

Click "Save" when you are done.

Thank you for recording information about the trees in your community!

PART 5: Building Awareness:

To access the Hungry Pests Curriculum, visit the following web addresses:

- Hungry Pests 6-12 : https://www.aphis.usda.gov/hungrypests/partner-tools/HP_InvadeMS_Curriculum.pdf
- Kindergarten – 5th grade informational article for Hungry Pests: https://www.aphis.usda.gov/hungrypests/partner-tools/072117_APHIS_hungrypests_K-5ITA-508Compliant.pdf
- 6th – 8th grade informational article for Hungry Pests: https://www.aphis.usda.gov/hungrypests/partner-tools/072117_APHIS_hungrypests_6-8ITA-508Compliant.pdf
- 9th – 12th grade informational article for Hungry Pests: https://www.aphis.usda.gov/hungrypests/partner-tools/072117_APHIS_hungrypests_9-12ITA-508Compliant.pdf
- Vin Vasive Mask: https://www.aphis.usda.gov/hungrypests/partner-tools/VinVasiveMask.pdf
- Jr. Invasive Program Powerpoint: http://psaworks.sites.clemson.edu/JrInvasives/pdf/curriculum.pdf