NUTSHELL

In this lesson, students participate in a group discussion that defines urban forest management and how different situations require different management. Students then learn about the impact of biodiversity on an urban forest by mapping and analyzing data from a sample of an urban forest. Students learn about potential management problems caused by invasive species and plot where non-native species come from on a world map. Finally, students make suggestions about how to manage an urban forest based on what they learned about different species and potential impacts of climate change on Wisconsin's urban forests.

ENDURING UNDERSTANDINGS

- Trees from all over the world with the ability to tolerate climate, soils, and maintenance regimes are being planted in Wisconsin's urban forests. (Subconcept 5)
- Urban forest management is the use of planning and science-based techniques (e.g., planting, mulching, pruning, removal, monitoring, evaluation) to meet desired outcomes. (Subconcept 10)
- Urban forests are managed for both individual trees and as groups of trees for the impact they have on the community. (Subconcept 12)
- Invasive plant and animal species, pests, diseases, and damaging weather events can create problems in urban forests; management attempts to control these. (Subconcept 16)
- Biodiversity, in terms of canopy cover, diameter and species distribution, richness, evenness, and genetic diversity, can help decrease the impact of invasive species, pests, diseases, and damaging weather events. (Subconcept 20)

ESSENTIAL QUESTIONS

- What is urban forest management?
- What is biodiversity?
- What are the benefits of biodiversity in an urban forest?
- What is the difference among native, non-native, and invasive species?
- Why do urban forest managers sometimes choose to plant non-native species in Wisconsin's forests?

OBJECTIVES

Upon completion of this lesson, students will be able to:

- Define urban forest management.
- Explain that urban forests are managed for individual trees and groups of trees.
- Define biodiversity.
- Describe the benefits of biodiversity.
- Compare and contrast invasive species, non-native species, and native species.
- Explain that trees from all over the world that can adapt to Wisconsin conditions are being planted in urban forests.

SUBJECT AREAS

ELA, Mathematics, Social Studies, Science

LESSON/ACTIVITY TIME

Total Lesson Time: 125 minutes
Time Breakdown:

- Introduction — 15 minutes
- Activity 1 — **ANALYZING BIODIVERSITY** — 30-120 minutes (climate update)
- Activity 2 — **NATIVE, NON-NATIVE AND INVASIVE SPECIES** — 35 minutes (climate update)
- Conclusion — 30 minutes

MATERIALS:

FOR STUDENTS - 1 set of ANY of the following three Student Resource Sheets (Print whichever set you are utilizing for each student)

- **Student Resource Sheets 1-4, Field Enhancement Option** (requires going outdoors to survey trees in your community)
  https://docs.google.com/presentation/d/1otn__p4rFdls7_BklEfYxjsI6Gy3RO5YxqBODqNNxkc/edit?usp=sharing
- **Student Resource Sheets 1-10 , WI Community Tree Map Option** (classroom activity; requires each group of students to have ability to access the online DNR Wisconsin Community Tree Map) If you select this option, students need only the data collection map and table sheets assigned to their group 1-2, 3-4, 5-6, OR 7-8 you need to print sheets 9 & 10 for ALL students.
  https://docs.google.com/presentation/d/1ASf_4udhgpIAsdw4att33uI6mERP976SqHsRERZRjCU/edit?usp=sharing
- **Student Resource Sheets 1-4 , Worksheet Option** (traditional classroom activity)
  https://docs.google.com/presentation/d/1ZeUp1WNzkEFGJJCauO73AnWzrna5ZNa6cK7-v6W95r0/edit?usp=sharing

FOR THE TEACHER:

FOR ACTIVITY 1:

- **Educator Resources_Lesson 3 Activity 1_ Field Enhancement Option** (requires going outdoors to survey trees in your community)
  https://docs.google.com/presentation/d/1Tqk3o8SDfWB6aqvkEOHG1SvSBMAn-LgrSZpj8d9eQqE/edit?usp=sharing
- **Educator Resources_Lesson 3 Activity 1_ WI Community Tree Map Option** (classroom activity; requires each group of students to have ability to access the online DNR Wisconsin Community Tree Map)
  https://docs.google.com/presentation/d/184ENBQFbufUJcsGJeFXmFvdDimmMtwejHX112jvO4lc/edit?usp=sharing
- **Educator Resources _Lesson 3 Activity 1_ Worksheet Option** (traditional classroom activity)
  https://docs.google.com/presentation/d/1kdveJerdGEWli3n3Vh6fvVl0sR8sSauzDRjqaThi1H4/edit?usp=sharing

FOR ACTIVITY 2:

- **Educator Resources_Lesson 3 Activity 2_Slideshow**
  https://docs.google.com/presentation/d/1je4SQKReJ9poiwxUI5mKREVjl5SbcxVdrALg1K7u20s/edit?usp=sharing
- **Class Resources Lesson 3 Activity 2, Species Cards**
  https://drive.google.com/file/d/1BLrLEb42L08g3rnLNXro24fysVUihYQp/view?usp=sharing

VOCABULARY

Arboriculture: The planting, care, and scientific cultivation of trees on an individual plant basis.
Biodiversity: The variety and complexity of all life on earth.
Non-native Species: A species from a specific geographic region that has been introduced into an area outside of that region.
Invasive Species: A species that enters an area and causes harm by outcompeting species that are already there.
Native Species: A species that exists within its natural range.
Urban Forest Management: The use of planning and science-based techniques (e.g., planting, mulching, pruning, removal, monitoring, evaluation) to meet desired outcomes.

BACKGROUND

Trees from all over the world are being planted in Wisconsin's urban forests. Trees can survive in places outside their natural range as long as those places have similar soil and climate. That means that trees from Europe and Asia are able to survive here if all other basic needs are met.

This offers many opportunities for people who manage urban forests. Urban trees sometimes face harsh growing conditions, lack of growing space, and poor soils. By using trees from other parts of the world that can tolerate the conditions present, the diversity of species that can be planted is greatly expanded. This can have positive benefits because of the increase in biodiversity. However, planting these species can create some challenges too.

NATIVE/NON-NATIVE/INVASIVE SPECIES

There are important definitions to know to understand this subject. They are native species, non-native species, and invasive species. A native species is a species that lives within its normal range. A **non-native** species is any species living outside its normal range. It could be from another continent or another part of North America. By strict definition, an **invasive species** is an non-native species that successfully outcompetes native plants. This definition is sometimes modified to include plants that are native and competitive. For the purposes of this lesson, we will stick to the idea that invasive species are non-native. It is important to note, however, that even though invasive species are non-native, non-native species are not always invasive. It is also important to remember that "species'' refers to plants, animals, and insects.

As mentioned earlier, using non-native species can help urban forest managers by giving them more options of species. These added species may be valuable resources because they may be better able to deal with the management challenges in urban forests. Problems can arise, however, when the non-native species is invasive.

These invasive species can outcompete other species in wooded parks and river ways in cities and towns. They can reduce the ability of native plants to survive and make the area less diverse. Non-native invasive species also come in the form of damaging insects and disease. They can have large negative impacts on urban forests. In addition to the impact invasive species can have in an urban forest, they can also impact rural forests. Many problem species in rural forests were introduced to the area through their use in urban forests.

URBAN FOREST MANAGEMENT

Urban forest management is the use of planning and science-based techniques to meet desired outcomes. In that basic definition, it is very similar to traditional forest management. The big difference comes when we consider the techniques urban forest managers use to do their jobs and the qualities of the resource they are managing. With fewer trees per acre in an urban forest, the job of pruning, mulching, monitoring, removing, and evaluating individual trees is much more feasible. The number of owners, and therefore management objectives, is much higher in an urban forest.

Although individual tree management (also known as arboriculture) is a big contrast to traditional forestry, it is important to remember that urban forestry deals with trees both individually, such as in a yard, as well as in groups, such as a series of street trees or trees in a park. Different techniques are used in different situations.

The problems that trees in urban areas face can include air pollution, soil compaction, lack of space, and vandalism; these don't happen regularly in rural forests. The problems that do impact rural forests such as insects, disease, weather-related damage, and invasive species, also affect urban forests.

BIODIVERSITY

One way for urban foresters to help address these potential threats is to increase biodiversity. **Biodiversity** is the variety and complexity of life on earth. It is measured in different ways. The broad categories of biodiversity often used are ecosystem diversity (how many different ecosystems there are), species diversity (how many species there are), and genetic diversity (how many different variations in genes there are in a population). Urban forests have additional important measures of diversity. The diversity of canopy cover (percentage of cover and type), diameter and species distribution (the size of the trees and where they are), and richness and evenness (how many species and their proportion).

With increased biodiversity, the impact of a pest or disease that targets a single species decreases. A wind or ice storm that can easily break large, weak-wooded trees will not have such a major impact if different trees of different ages are present. Young trees may be more susceptible to a drought, but older trees can survive it. A specific genetic strain of a species may tolerate a disease when another can't. Having biodiversity on many levels can increase the overall health of an urban forest.

PROCEDURE

INTRODUCTION -

NOTE: If students have not completed Lesson 1, define and explain what an urban forest is prior to beginning this lesson.

1. Ask students what they would have to know and do if they were planning a party for a few people. Write their suggestions in a list on the board. *(How many people are coming? Who is coming? When and where can they have the party? What activities are they going to do at the party? Will they have any help with the party? How much will it cost? Where will the money come from?)*
2. Using the questions below, list on the board what needs to be considered if you are managing trees in a yard.
    - How many trees do you have?
    - What kinds are they?
    - How much money do you have to take care of them?
    - How many people do you have available to help take care of them?
    - Where are existing trees and where can more be planted?
3. Explain that planning a party has things in common with planning for trees in a yard. As a class, draw lines connecting the things on the party planning list to the things on the yard tree planning list that are similar and discuss. *(Connections could be made from all the things on the yard tree planning list to similar things on the party planning list.)*
4. Read and discuss the definition of urban forest management. *(Urban forest management is the use of planning and science-based techniques [e.g., planting, mulching, pruning, removal, monitoring, evaluation] to meet desired outcomes.)* Explain that trees in an urban forest are sometimes managed individually, such as in a yard, and sometimes managed as groups, such as in a park.
5. Tell the students that now, instead of planning a party for a few people, they are planning a party for 100 people. Would you need to answer the same questions as before?(*Yes.)* Will the way you handle the party be the same? *(No. You will need a larger space, more money, different activities, etc.)*

   Tell students that managing entire urban forests is different than managing trees in a yard. Although you still need to know the same information, what you do with it will change with the different answers. Discuss what might be different about managing a large park with lots of trees compared to managing a few trees along the street. *(There are more trees in the park, it will cost more to maintain more trees, fewer kinds of trees are able to grow along the street, it is probably all right if a tree in a park has messy fruit but not all right on a street, there are more places to plant trees in a park.)*

ACTIVITY 1–ANALYZING BIODIVERSITY

Ask the class to tell you what they think of when they hear the word diversity. *(Diversity of cultures, thoughts, religion, etc.)* Ask them if they have heard of "biodiversity." Define **biodiversity**. *(The variety and complexity of all life on earth.)* Explain that there are different ways of thinking about how diverse a forest is. One way biodiversity is measured is by identifying how many different species there are. You can also consider the ages of trees. *(More ages are more diverse.)* Where trees grow is another way they are diverse. *(If all the trees in an urban forest are in people's yards, it isn't as diverse as if there were also trees in parks, along streets, along rivers, etc.)* Tell students they are going to look at how much biodiversity there is in an urban forest.

FIELD ENHANCEMENT OPTION - This option requires taking your students outdoors to create their own Tree Data Collection Map. It takes a lot more time but provides students with valuable field experience.

1. Prior to taking students out to participate in data collection for the **Field Enhancement Option**
    - Determine which two blocks you and your students are going to map
    - Enter the 3 street names that border the blocks onto **Educator Resource 1 FEO, Tree Data Collection Map Key**
    - Identify the species of trees that can be found on the two blocks
        - If you are not familiar with tree species, use the WISCONSIN URBAN TREE KEY from the Wisconsin DNR (*https://dnr.wisconsin.gov/education/treeID*)
        - If you think this will be a struggle for your students, instead of determining individual tree species, you can use a different symbol to represent different trees and skip the tree identification
    - Determine abbreviations to use for each tree species identified (or what symbols represent which trees if you are not identifying tree species)
        - RM = Red Maple; WO = White Oak; GA -= Green Ash; WP = White Pine
        - Record this information on the **Educator Resource 1 FEO, Tree Data Collection Map Key**
    - Determine how you are going to measure the diameter of each tree
        - Use DBH tapes *(Check out LEAF's 7-8 Lesson Guide Kit https://dnr.wisconsin.gov/education/treeID - free for WI educators)*
            - *Refer to this video for a tutorial on using a DBH tape (start at 2:31) https://www.youtube.com/watch?v=AaBWERR-_YM*
        - Use a sewing tape measure / flexible tape measure *(measure the circumference of the tree and divide by 3.14 (π))*
            - *use the same method of measurement as used with the DBH tape)*
2. Hand out **Student Resource 1 FEO, Tree Data Collection Map - Field Enhancement Option** to each student. Explain to students that urban foresters collect and use data about their urban forest to decide how to manage it. *(Remind students of this point made in the Introduction.)* The data may include the number of trees, location, species, size, health, and other information. Sometimes this information is put onto a map and urban foresters use computers to locate and keep track of information. Explain to students that they will be making a map and using symbols on **Student Resource 1 FEO, Tree Data Collection Map - Field Enhancement Option** to collect data from two blocks in their school neighborhood. Use the **Educator Resource 1 FEO Tree Data Collection Map Key** to help students record Street Names and Species abbreviations on their **Student Resource 1 FEO sheet.** Explain how you want them to measure the diameter of the tree (at breast height), the tools they'll use and the symbols they'll record.
3. Take students outside and work block by block to document the trees on the street. Have students work with a partner. Do your best to record all trees that line the street and are not on private property (are on the boulevard). Instruct students to make a best estimate for trees that are visible in yards without trespassing. Don't have every student measure every tree, divide up trees among the different pairs of students and have them share data when you return to the classroom.
4. Once you have finished mapping trees, return to the classroom and have students share their data with each other. Project **Educator Resource 2 FEO Tree Data Collection Sharing** . You can make copies of the tree icons to place on the diagram (or use smartboard markers to fill trees in on the map). All students should try to record all trees on their maps.

5. Instruct students to start analyzing their data by entering the types of trees and diameters of trees into the tables on **Student Resource 2 FEO, Tree Data Collection Tables.** Use **Educator Resource 3FEO and 4FEO** as needed to help students. *Remind students that % of total trees = number of trees for that species (or diameter) ÷ total number of trees for all species (or all diameters) x 100.*
6. Pass out **Student Resource 3 FEO, Tree Data Discussion Questions** to every student. Have students use their data tables to answer the discussion questions. You can choose to have students work independently, with a partner, or in small groups to answer the discussion questions. Once students are done working, discuss the answers as a class.
    - *1. Depends on local data*
    - *2. Depends on local data*
    - *3. Depends on local data*
    - *4. Depends on local data*
    - *5. It would wipe out all/most of those trees. The more trees of that species in the two blocks, the greater the impact it would have.*
    - *6. It is better to have a variety of species. Some are more resistant to pests, some do better in dry conditions, others do better in wet conditions, etc.*
    - *7. Depends on local data*
    - *8. Depends on local data*
    - *9. Something happened that the trees were all planted at the same time. It could be that the area had been harvested, that there had been storm damage that knocked a lot of trees down, or that there were issues (pests, drought, flooding) that killed many trees at the same time.*
    - *10. It is not good to have all large (old) trees. It makes the urban forest more susceptible to damage from storms/wind and damage from pests. Even if the trees die naturally, it would take a long time for new trees to grow that large. Similarly, if an urban forest has all small trees, they are more susceptible to drought where old trees could withstand that.*
    - *11. It is best to have trees of a variety of sizes so even if there are storms, pests, drought, it is not likely that all trees will be damaged or killed. It also takes more time to care for and manage young trees - it could be expensive (and exhausting) to maintain an urban forest made up of all young trees.*

Climate Update - Climate Sequestration

7. Discuss the role trees play in **sequestering** carbon dioxide as a class. *(Trees take in CO_2 from the atmosphere, during the process of photosynthesis, CO_2 and H_2O combine to make sugar - $C_6H_{12}O_6$ and O_2. After photosynthesis, carbon remains stored as a sugar in the tree until it is eaten by another organism, dies and decays, or is burned. Even if the tree is cut down and its wood is used to build something, the CO_2 is still being stored in it. Because of their capacity to store carbon, trees can play an important role in climate mitigation and solutions.)*
8. Make sure each student has a copy of **Student Resource 4 FEO, Carbon Sequestration**. Select one of the larger trees that you measured and have students use MyTree to determine how much Carbon is sequestered by that tree. *(This is the same procedure as LEAF Urban Guide 5-8 Lesson 1-Urban Tree Benefits if you have already completed that with your students.)* You/Students will need to recall and estimate (or go back and collect the following additional information - address -street name and block should be close enough, tree condition and sun exposure). If you have not completed Lesson 1, you may want to go through this process with your students. Instructions are included on **Student Resource 4 FEO.**

- Go to the MyTree itreetools website and click on get started: https://mytree.itreetools.org/#/
- Enter the street (or street address)
- Click on "Next, describe your tree"
- Enter Tree species
- Enter condition of tree
- Enter trunk size in diameter
- Enter sun exposure (it is likely full sun)
- Select "Skip" for the question about being within 60 feet of a building.
- Click on "Add more trees or get results"
- When you get to the *"Your list of trees"* page, click on the calculator icon for tree you entered (or the calculator for all trees). Look at Carbon Sequestered and CO_2 equivalent for both "now" and "20 years" and discuss impact. Click on the "Equivalents" tab for 20 years and see how many miles of driving were offset by this tree (MyTree shows the offset miles worth of CO_2 emitted from the average gas-powered passenger vehicle).

9. Have students complete **Student Resource 4 FEO** with their partner/group. Discuss as a class when everyone finishes.
   - *1. Carbon sequestration is the capture and storage of carbon dioxide from the atmosphere into biotic (e.g.,trees) or abiotic (e.g., coal) pools of carbon.*
   - *2. Depends on your local tree measurements*
   - *3. Urban trees are carbon sinks. If urban trees are cared for and allowed to grow, they will continue to store carbon. If trees that are damaged or nearing the end of their lifecycle are harvested and used in forest products, they will continue to store carbon. This reduces the level of CO_2 in the atmosphere and can reduce climate change impacts.*
   - *4. Shade, reduced heating/cooling costs, absorb water to reduce run-off/assist with flood control, hold soil in place/reduce erosion, habitat for animals, contribute to "green" setting which is good for mental health and physical health, reduce pollution*

WISCONSIN COMMUNITY TREE MAP OPTION - This option is for locations where it is not possible or it is difficult to complete the data collection map near the school (or if there is inclement weather). This option utilizes the Wisconsin Community Tree Map. The Wisconsin Community Tree Map is a tool created by the DNR that allows users to see what trees are growing in their community and the benefits that those trees offer. You will be walked step-by-step through how to use the Wisconsin Community Tree Map for the purposes of this lesson. Wisconsin Community Tree Map also provides additional options for students to participate in collecting data and logging trees. If you would like to learn more about Wisconsin Community Tree Map, please consider LEAF's online course "Using the WI Community Tree Map as an Educational Tool: Tree Inventories and School Site Assessment" https://cnroutreached.asapconnected.com/#CourseID=198815 .

1. Divide the class into groups of 2-3 students. Assign each group one of the following middle schools located in Wisconsin. Give students the corresponding **Student Resource 1-2, 3-4, 5-6, OR 7-8 WCTM, Tree Data Collection Map.** Please make sure NOT to copy these resources back to back as students will need to look at the odd-numbered resource while completing the even-numbered resource.
   - Appleton Area School District: **Wilson Middle School, 225 N Badger Ave, Appleton, WI, 54915**
   - Racine (City): **Mitchell Middle School, 2701 Drexel Ave, Racine, WI 53403**
   - Eau Claire Area School District: **South Middle School, 2115 Mitscher Ave, Eau Claire, WI 54701**

- La Crosse School District: **Longfellow Middle School, 1900 Denton St, La Crosse, WI 54601**

2. Show students how to access the data they will use from the Wisconsin Community Tree Map.
   - Go to the Wisconsin Community Tree Map website: https://pg-cloud.com/Wisconsin/
   - Read the information about the Wisconsin Community Tree Map on the left of the screen and then close it by clicking on the small green arrow at the bottom, middle of the screen.
   - In the LEGEND, have students scroll to find the Organization for their map and click on it. They should make sure the "Toggle All" box is checked.
     - Appleton Area School District
     - Racine (City)
     - Eau Claire (City)
     - La Crosse (City)
   - On the far left of the map, have students click on the icon that looks like a globe and enter the address of the middle school they have been assigned and hit return. They do NOT need to type in the name of the middle school or zip code.
     - Wilson Middle School: **225 N Badger Ave, Appleton, WI**
     - Mitchell Middle School: **2701 Drexel Ave, Racine, WI**
     - South Middle School: **2115 Mitscher Ave, Eau Claire, WI**
     - Longfellow Middle School: **1900 Denton St, La Crosse, WI**
   - When they reach the location of their school, it will likely be too zoomed in for them to see the streets they will be using to collect data. Have them click the – icon one time (located above the globe icon on the left) to zoom the map out. Tell them to look for the street names they are using. If they see them, they should adjust the map on their screen so they can see the entire blocks they are working with. To do this they click on the map, hold, and drag it in the direction they would like it to go.
   - Once the map is positioned well, students should click on the "Show All Trees" box in the Legend at the right. They will see the word "Loading" and then see a bunch of circles added to their map. Tell students that each circle represents a tree that data was collected for. Explain that for this exercise you are only looking at trees that are along the street (data isn't recorded for the trees in backyards as they are on private property). Students should only look at trees that are ON the blocks they are assigned and NOT across the street. (This means that students will only look at 1 side of each street EXCEPT for the street that runs through the middle of their block.)
   - Tell students to pick a tree to start with and click on it. A white box will appear with information about the tree. For this exercise, they will only need to record the name of the tree (using the abbreviation on their Tree Data Collection Map sheet) and the diameter of the tree (in inches). They should record their data by drawing a circle (or tree top shape) on their paper in the location of the tree and recording the diameter and tree abbreviation (i.e. 6 RM). They will then click on the next tree, and record that information. They should continue this process until they have collected the data from all the trees on their map.
3. Instruct students to start analyzing their data by entering the types of trees and diameters of trees into the tables on **Student Resource 2, 4, 6, or 8 WCTM, Tree Data Collection Tables.** Use **Educator Resource 3FEO and 4FEO** as needed to help students. *Remind students that % of total trees = number of trees for that species (or diameter) ÷ total number of trees for all species (or all diameters) x 100.*
4. Pass out **Student Resource 9 FEO, Tree Data Discussion Questions** to every student. Have students use their data tables to answer the discussion questions. You can choose to have

students work independently, with a partner, or in small groups to answer the discussion questions. Once students are done working, discuss the answers as a class.

- *1. Depends on community tree map data*
- *2. Depends on community tree map data*
- *3. Depends on community tree map data*
- *4. Depends on community tree map data*
- *5. It would wipe out all/most of those trees. The more trees of that species in the two blocks, the greater the impact it would have.*
- *6. It is better to have a variety of species. Some are more resistant to pests, some do better in dry conditions, others do better in wet conditions, etc.*
- *7. Depends on community tree map data*
- *8. Depends on community tree map data*
- *9. Something happened that the trees were all planted at the same time. It could be that the area had been harvested, that there had been storm damage that knocked a lot of trees down, or that there were issues (pests, drought, flooding) that killed many trees at the same time.*
- *10. It is not good to have all large (old) trees. It makes the urban forest more susceptible to damage from storms/wind and damage from pests. Even if the trees die naturally, it would take a long time for new trees to grow that large. Similarly, if an urban forest has all small trees, they are more susceptible to drought where old trees could withstand that.*
- *11. It is best to have trees of a variety of sizes so even if there are storms, pests, drought, it is not likely that all trees will be damaged or killed. It also takes more time to care for and manage young trees - it could be expensive (and exhausting) to maintain an urban forest made up of all young trees.*

Climate Update - Climate Sequestration

5. Discuss the role trees play in **sequestering** carbon dioxide as a class. *(Trees take in CO_2 from the atmosphere, during the process of photosynthesis, CO_2 and H_2O combine to make sugar - $C_6H_{12}O_6$ and O_2. After photosynthesis, carbon remains stored as a sugar in the tree until it is eaten by another organism, dies and decays, or is burned. Even if the tree is cut down and its wood is used to build something, the CO_2 is still being stored in it. Because of their capacity to store carbon, trees can play an important role in climate mitigation and solutions.)*
6. Make sure each student has a copy of **Student Resource 10 WCTM, Carbon Sequestration**. Select one of the larger trees that you measured and have students look up the data about Carbon sequestration and storage for the tree. Instructions are included on **Student Resource 10 WCTM.**
    - Select one of the larger trees from your map
    - Go to that tree on the Wisconsin Community Tree Map
        - Click on the tree; when the white box appears, click on "ECO-BENEFITS"
        - Click on "CARBON ANNUAL" and record the monetary benefit and CO_2 Sequestered annually
        - Click on "CARBON LIFETIME" and record the monetary benefit and CO_2 stored and Carbon stored
7. Have students complete **Student Resource 10 WCTM** with their partner/group. Discuss as a class when everyone finishes.
    - *1. Carbon sequestration is the capture and storage of carbon dioxide from the atmosphere into biotic (e.g.,trees) or abiotic (e.g., coal) pools of carbon.*

- *2. Depends on your local tree measurements*
- *3. Urban trees are carbon sinks. If urban trees are cared for and allowed to grow, they will continue to store carbon. If trees that are damaged or nearing the end of their lifecycle are harvested and used in forest products, they will continue to store carbon. This reduces the level of CO_2 in the atmosphere can reduce climate change impacts.*
- *4. Shade, reduced heating/cooling costs, absorb water to reduce run-off/assist with flood control, hold soil in place/reduce erosion, habitat for animals, contribute to "green" setting which is good for mental health and physical health, reduce pollution*

WORKSHEET OPTION - This option is for locations where it is not possible or is difficult to complete the data collection map near the school (or if there is inclement weather) AND when there is not time to complete the Wisconsin Community Tree Map Version. This version is the original version from the Urban Guide with a similar Climate add-on.

1. Hand out **Student Resource 1 WS, Tree Data Collection Map** to each student. Explain to students that urban foresters collect and use data about their urban forest to decide how to manage it. *(Remind students of this point made in the Introduction.)* The data may include the number of trees, location, species, size, health, and other information. Sometimes this information is put onto a map and urban foresters use computers to locate and keep track of information. Explain to students that they will be using the map and symbols on **Student Resource 1, WS Tree Data Collection Map** to collect the data needed to fill out the table on **Student Resource 2 WS, Tree Data Collection Tables**. Let students begin filling out the worksheet. Review the process of determining percentages if needed and have students write the formula they will be using on their sheets. *(Percent of total for each species = Number of trees for each species ÷ Total number of trees for all species. Multiply by 100.)*
2. After students have completed entering their data on the worksheet, hand out **Student Resource 3 WS, Tree Data Discussion Questions** to each student and have them answer the discussion questions. You can choose to have students work independently, with a partner, or in small groups to answer the discussion questions. Once students are done working, discuss the answers as a class.
    - *1. 32*
    - *2. 9*
    - *3. Yes, there are nine different species in the small 2-block area*
    - *4. Green ash is the most common species*
    - *5. If an insect killed all the green ash trees, there would be a block that had no trees since the only trees on Wisconsin Street are green ash trees. This would have a significant impact on that block as there would be no urban trees at all left reducing urban tree benefits and would require more money to replant an entire block than just one or two trees.*
    - *6. It is better to have a variety of species. Some are more resistant to pests, some do better in dry conditions, others do better in wet conditions, etc.*
    - *7. More of the trees on the block are small than large.*
    - *8. There is not as much age diversity as there is species diversity. Most trees are in the 10-14 inch range.*
    - *9. Something happened that the trees were all planted at the same time. It could be that the area had been harvested, that there had been storm damage that knocked a lot of trees down, or that there were issues (pests, drought, flooding) that killed many trees at the same time.*

- *10. It is not good to have all large (old) trees. It makes the urban forest more susceptible to damage from storms/wind and damage from pests. Even if the trees die naturally, it would take a long time for new trees to grow that large. Similarly, if an urban forest has all small trees, they are more susceptible to drought where old trees could withstand that.*
- *11. It is best to have trees of a variety of sizes so even if there are storms, pests, drought, it is not likely that all trees will be damaged or killed. It also takes more time to care for and manage young trees - it could be expensive (and exhausting) to maintain an urban forest made up of all young trees.*

Climate Update - Climate Sequestration

3. Discuss the role trees play in **sequestering** carbon dioxide as a class. *(Trees take in CO_2 from the atmosphere, during the process of photosynthesis, CO_2 and H_2O combine to make sugar - $C_6H_{12}O_6$ and O_2. After photosynthesis, carbon remains stored as a sugar in the tree until it is eaten by another organism, dies and decays, or is burned. Even if the tree is cut down and its wood is used to build something, the CO_2 is still being stored in it. Because of their capacity to store carbon, trees can play an important role in climate mitigation and solutions.)*
4. Make sure each student has a copy of **Student Resource 4 WS, Carbon Sequestration**. Select one of the larger trees that you measured and have students use MyTree to determine how much Carbon is sequestered by that tree. *(This is the same procedure as LEAF Urban Guide 5-8 Lesson 1-Urban Tree Benefits if you have already completed that with your students.)* You/Students will need to recall and estimate (or go back and collect the following additional information - address -street name and block should be close enough, tree condition and sun exposure). If you have not completed Lesson 1, you may want to go through this process with your students. Instructions are included on **Student Resource 4 WS.**
   - Go to the MyTree itreetools website and click on get started: https://mytree.itreetools.org/#/
   - Enter a fake address for your tree (you can use your home address)
   - Enter American elm for the tree species
   - Type in good for tree condition
   - Type in 36 for trunk size
   - Select Full for Sun Exposure
   - Click on "Add more trees or get results"
   - When you get to the "Your list of trees" page, click on the calculator icon for tree you entered (or the calculator for all trees).
   - Click on "Skip" for "Is it within 60 feet of a building"
   - Click on "Add more trees or get results"
   - When you get to the *"Your list of trees"* page, click on the calculator icon for tree you entered (or the calculator for all trees). Look at Carbon Sequestered and CO_2 equivalent for both "now" and "20 years" and discuss impact. Click on the "Equivalents" tab for 20 years and see how many miles of driving were offset by this tree (MyTree shows the offset miles worth of CO_2 emitted from the average gas-powered passenger vehicle).
5. Have students complete **Student Resource 4 WS** with their partner/group. Discuss as a class when everyone finishes.
   - *1. Carbon sequestration is the capture and storage of carbon dioxide from the atmosphere into biotic (e.g.,trees) or abiotic (e.g., coal) pools of carbon.*
   - *2. Depends on your local tree measurements*
   - *3. Urban trees are carbon sinks. If urban trees are cared for and allowed to grow, they will continue to store carbon. If trees that are damaged or nearing the end of their*

lifecycle are harvested and used in forest products, they will continue to store carbon. This reduces the level of CO_2 in the atmosphere and can reduce climate change impacts.

- *4. Shade, reduced heating/cooling costs, absorb water to reduce run-off/assist with flood control, hold soil in place/reduce erosion, habitat for animals, contribute to "green" setting which is good for mental health and physical health, reduce pollution*

ACTIVITY 2–NATIVE, NON-NATIVE AND INVASIVE SPECIES

1. Share the following definitions with students. **Native Species** – A species that exists within its natural range; **Non-Native Species** – A species from a specific geographic region that has been introduced into an area outside of that region; **Invasive Species** – A species that enters an area and causes harm by outcompeting species that are already there. Once students have a grasp of these terms, proceed to the next step. Slides with definitions and images can be found in **Educator Resources_Lesson 3 Activity 2 Slideshow**.
2. Hand out cards made from **Class Resources Lesson 3 Activity 2, Species Cards**, one to each student or pair of students. Each card has a non-native tree, shrub, or pest name and a description on it. Some of the species listed on these cards can be problems in an urban forest, some are not.
3. Tell students that they need to decide if the species described on their card is invasive or noninvasive. The descriptions on the cards will give them the information they need to do this. Discuss the words and phrases from the descriptions that will indicate invasive species. *(Aggressive, outcompetes, spreads rapidly, grows quickly, etc.)* They should check either "invasive" or "noninvasive" on their cards.
4. Once students have read their card and checked the appropriate word, start a brief class discussion about why invasive species are significant. *(Invasive species are successful at competing with native plants. They reduce the numbers of native plants or eliminate them entirely. This disrupts the ecosystem. For instance, if invasive honeysuckle grows so densely in a forested area of a park that it shades out all the other plants, it reduces the food available for the animals that eat those plants. Without food, the animals can't survive and go elsewhere. In an urban forest, animals may not have another place to go because that area may have been the only one with those plants.)* Have some students with the invasive species cards share the name of their species. Ask students if they have seen or heard about any of these invasive species. Discuss what they have heard.
5. Project the **World Map (Slide 4,Educator Resources_Lesson 3 Activity 2 Slideshow).** Ask students to come up, one at a time, and mark on the map with an "X" where their species originated. Use different colors for invasive and noninvasive. They should each tell the class where the species came from and if it is invasive. After all the species have been marked on the map, start a discussion about what the species that can grow in Wisconsin have in common. *(They are all from the northern hemisphere. They all grow in similar climates.)* Be sure to make the point that not all of the non-native species are invasive. NOTE: You may wish to use a large map of the world instead of a projection of the map. If so, use colored sticky notes to mark the countries the species originate in.

Climate Update

6. Ask students if they think climate change will make Wisconsin's Urban Forests more susceptible or less susceptible to invasive species. Ask them to explain their reasoning.
7. Explain to students that the Wisconsin Initiative on Climate Change Impacts-Forestry Working group is concerned that climate change might give invasive species an advantage over natives. Invasive plants often have strategies that allow them to colonize areas that have been disturbed.

If urban forests are disrupted by climate change, this may give invasives more opportunity to spread.

CONCLUSION

1. Remind the class what urban forest management is. *(The use of planning and science-based techniques [e.g., planting, mulching, pruning, removal, monitoring, evaluation] to meet desired outcomes.)*
2. Have students write two paragraphs about the following prompt:
   According to evidence examined by the Wisconsin Initiative on Climate Change Impacts, Wisconsin is getting warmer (the last two decades are the warmest ever recorded in Wisconsin) and wetter (the last one decade is the wettest ever recorded in Wisconsin) and experiencing more extreme rain events and flooding. Pretend you are an Urban Forest Manager who is responsible for a forest that looks similar to the one you collected data on in Activity 1. Write a 2-paragraph plan that includes:
   - Paragraph 1: The species you would plant or help grow in the urban forest and what might you have to do to help these species be successful in Wisconsin's changing climate. Be sure to include what you understand about the importance of biodiversity in this paragraph.
   - Paragraph 2: The species you would want to hinder or keep from growing in the urban forest and what you might have to do to keep these species from spreading too much in Wisconsin's changing climate.

ADDITIONAL RESOURCES

LEAF

The lessons listed below, for the LEAF Wisconsin K-12 Forestry Education Lesson Guide, contain possible enhancements, extensions, or replacements for Urban Forest Lesson Guide: 5-8 Lesson 3.

- **UNIT 5-6 LESSON 6: WHAT IS MANAGEMENT?**
  Students discover what's happened in Wisconsin's history that led us to modern forestry and about management techniques by creating a timeline and reading a "choose your own adventure" story. Use the entire 5-6 Lesson 6 as a follow-up to Urban Forest Lesson Guide: 5-8 Lesson 3. The lesson will help students understand what the history, techniques, and results of rural forest management are.
  https://www3.uwsp.edu/cnr-ap/leaf/SiteAssets/Pages/5-6-Wisconsin-Forestry-Lesson-Guide/5-6L6.pdf
- **UNIT 7-8 LESSON 2: BIODIVERSITY AND THE FOREST CONNECTION**
  Students analyze three ecosystems to determine their interconnections and create a Venn diagram. They also discuss the value of Wisconsin's forests in terms of biodiversity. Use 7-8 Lesson 2 Activity 1, Activity 2, and Conclusion to extend Urban Forest Lesson Guide: 5-8 Lesson 3 Activity 1. The lesson examines biodiversity by comparing the interconnections between ecosystems. Add the urban forest to the list of ecosystems included in 7-8 Lesson 2 Activity 1.
  https://www3.uwsp.edu/cnr-ap/leaf/SiteAssets/Pages/7-8-Wisconsin-Forestry-Lesson-Guide/U78_L2.pdf
- **UNIT 7-8 LESSON 3: HOW FORESTS ARE MANAGED**
  Students explore forest management plans, multiple use, and sustainability through a simulation, video, and game. After completing Urban Forest Lesson Guide: 5-8 Lesson 3, use 7-8 Lesson 3 Introduction, Activity 1, Activity 3, and Conclusion to help students understand how management is used in rural forests.
  https://www3.uwsp.edu/cnr-ap/leaf/SiteAssets/Pages/7-8-Wisconsin-Forestry-Lesson-Guide/U78_L3.pdf

Other Resources

- WICCI Forestry Working Group: Progress and Emerging Opportunities (2021)
  https://uwmadison.app.box.com/s/q3us9y06n53vh4d22gepjk1nfr3myjob