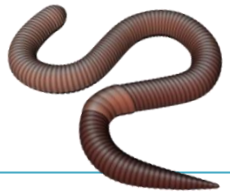
A FOCUS ON FOREST HEALTH: WISCONSIN WORM WATCH



Nutshell:
In this lesson, students will use language arts, science, and math skills to participate in a citizen science project and determine if invasive earthworms are present in a forest.

Background
Earthworms are newcomers to Wisconsin's forests. All native worms, if we had any, were killed during the last glacial period that ended 11,000 years ago. Humans have since introduced about 20 species of earthworms to Wisconsin from Europe and Asia by accident or for farming or fishing. All earthworms in Wisconsin are invasive species! Any native worms remaining after the glaciers have been outcompeted by invasive worms which spread much faster. Although worms can be good for your garden, they are bad for hardwood forests which evolved without earthworms disturbing the soil. See the attached "Earthworms and Earthworms-Invasive Species" handout for more detailed information.

Importance to Citizen Science:
The data collected through the Wisconsin Worm Watch survey is very valuable to Forest Health Specialists in the WDNR. Information provided in the surveys helps them understand the distribution of invasive earthworms across Wisconsin and their impact on local forests.

Objectives
Students will be able to….

- Participate in a citizen science research project
- Use scientific inquiry skills to conduct research on invasive earthworm populations in a forest
- Determine if earthworms are present in the forest
- Determine the diversity of earthworms in the forest by identifying the type (species) of earthworms present
- Collect, measure, and record the number of earthworms detected
- Submit data to Wisconsin Worm Watch. A research project hosted through the Wisconsin DNR

WI State, National CORE, and Next Generation Standards:
Next Generation Science: HS-LS2-3,6,7 and disciplinary core ideas HS-LS2.B,C; MS-LS4.4 and disciplinary core ideas MS-LS4.C; MS-LS2-1.3.4.5 and disciplinary core ideas MS-LS2-A, B, C; 5-LS2-1 and disciplinary core ideas 5-LS-2.B; 4-LS1-1; 3-LS4-3
Math Core: MP.4; 7.SP.1,2; S.IC; S.MD; S-ID.1;HSF-IF.C.7; 6.RP.A.3; 6.SP.B.5; 6.SP.4; HS-modeling; S-IC.3; S-IC.6
English/Language Arts Core: RST.6-8.3; RST.6-8.7; RST.9-10.3; RST.11-12.3; WHST.6-8.1; WSHT.6-8.2; WSHT6-8.9; WHST.9-12.7; WHST.9-12.9; WHST.11-12.8; RI.8.8; RI.5.7; RF.3.1; SL.3.4; SL.8.1; SL.8.4; SL.8.5; SL.11-12.5; W.3.2;W.9-10.7; and W.11-12.7

Lesson/Activity Time

- Pre-lesson: 30-45 minutes
- Prep time: 10 minutes
- Lab: 30-45 minutes

Materials List

- Mustard powder (available at grocery stores or online…or contact Bernadette Williams, WDNR to see if she has any available to send to you)
- Disposable plastic water jugs (1 gallon or larger)
- Earthworm Identification book or information found at: http://www.nrri.umn.edu/worms/identification/ecology_groups.html
- Forest Site

Teacher Preparation

- Read through the attached "Earthworms-Invasive Species" handout to become familiar with the concept of what an invasive species is, earthworm biology, and how earthworms affect forest health.
- If you complete the lab in the forest, mix the water and mustard ahead of time (but no more than 20 minutes before conducting the lab). Be sure to shake the container again in the forest to make sure the mustard and water are well mixed.

Pre-lesson

1. Discuss the concept of invasive species and earthworms as invasive species in the forest.
2. Allow students to develop questions that they would like to answer regarding earthworm biology, earthworm habitat, and their role in nutrient cycling, earthworms as an invasive species, and how they affect forest health.
3. Give students time to research background information about earthworm life cycles, earthworm anatomy, nutrient cycling, and earthworm distribution within the soil.
4. Using the information students learned about earthworms, take a trip to the forest site and allow student to use inquiry skills to determine where the worm sampling plots will be located.
5. Assign students to each plot (or plots) to ensure that sufficient data is collected for completion of the survey worksheets.

Forest Health: Wisconsin Worm Watch Procedure

1. Make sure students clearly understand the directions to conduct their investigations by using **either** the *Wisconsin Worm Watch Survey* **or** *Wisconsin Worm Watch Survey 1.*
2. Travel to the forest site.
3. Conduct Earthworm Investigations by completing **either** the *Wisconsin Worm Watch Survey* **or** *Wisconsin Worm Watch Survey 1.* ***All further procedural directions are listed within the survey you choose.***
4. Students should analyze their data and use critical thinking skills to answer the data analysis and conclusion section of *A Focus on Forest Heath: Earthworm Investigation* worksheet.
5. Send a copy of your survey results to Bernadette Williams, Invasive Plants and Earthworms Outreach Specialist, Wisconsin Department of Natural Resources. See the full address below.

Further Enrichment

- Send your students' citizen science results to the Wisconsin DNR.
  Contact: Bernadette Williams, Invasive Plants and Earthworms Outreach Specialist
  101 S. Webster St., PO Box 7921, Madison, WI 53707-7921
  Phone: 608-266-0624 or Bernadette.Williams@wisconsin.gov
- Allow students to compare the number of worms and worm species they found by creating a graph with class data.
- Create your district's own earthworm field guide. Identify and photograph each species of earthworm found in the sample plots, research and record information about each species, bind it together in a booklet.
- Compare class data in different parts of the forest. Were certain sections of the forest more heavily infested with earthworms? Create a color-coded map that shows earthworm distribution throughout the forest
- Create an educational presentation that informs other students or the general public about the invasive nature of earthworms, why they are an ecological, economic, and social threat to Wisconsin's forests, and how to help prevent the spread of earthworms in Wisconsin.
- Conduct research projects on other invasive species found in the forest which affect the health of the forest.

Resources

Great Lakes Worm Watch: http://www.nrri.umn.edu/worms/default.htm
Wisconsin DNR Invasive Plants & Earthworms Outreach Specialist:
Bernadette Williams: Bernadette.Williams@wisconsin.gov or Phone: 608-266-0624
Canada Worm Watch: https://www.naturewatch.ca/english/wormwatch/

Name: _____ Date: _____

A Focus on Forest Health: Wisconsin Worm Watch

Instructions:

1. Follow the instructions on **either** the *Wisconsin Worm Watch Survey* **or** *Wisconsin Worm Watch Survey 1* to conduct your research.
2. Be sure to complete each section of whichever survey you choose.
3. Analyze your data and use critical thinking skills to answer the conclusion section below.
4. Send a copy of your survey results to Bernadette Williams, Invasive Plants and Earthworms Outreach Specialist, Wisconsin Department of Natural Resources

Data Analysis and Conclusions:

1. Create a graph. Plot the total number of juvenile and adult epigeic, endogeic, and anecic earthworms found in your sample plots.

Use the graph you created and critical thinking skills to analyze the data and answer the following questions.

2. Which type of earthworms did you find the most of?...epigegic, endogeic, or anecic?
    a. Explain why you think this type of earthworm was found in the highest quantity.

    b. Based on this data, what conclusions can you draw about the soil conditions or amount of organic layer present in the forest?

3. Would you consider the total amount of earthworms found in your sample plots to be quantified at a low, medium, or high level?
    a. Why did you choose this infestation level? What did you compare it to?

Use the background information you know about earthworms, the data you collected, and good critical thinking skills to answer the following questions about the impact earthworms may be having on your forest site.

4. Think about the role the earthworms play in the energy flow or nutrient cycling of your forest's ecosystem. Diagram a food web or show the cycle in which nutrients may flow throughout the forest's ecosystem. Be sure to include the earthworm's role in your diagram! (Put your diagram on the back side of this paper.)

5. How does the invasive earthworm population affect the health of the forest?

    a. Describe your forest habitat. What types or species of trees and vegetation are present?

    b. Which species of trees or ground vegetation might be present on your forest if these invasive earthworms were not altering the cover type?

Earthworms

Background

Earthworms are newcomers to Wisconsin's forests. All native worms, if we had any, were killed during the last glacial period that ended 11,000 years ago. Humans have since introduced about 20 species of earthworms to Wisconsin from Europe and Asia by accident or for farming or fishing. All earthworms in Wisconsin are invasive species! Any native worms remaining after the glaciers have been outcompeted by invasives which spread much faster. Although worms can be good for your garden, they are bad for hardwood forests which evolved without earthworms disturbing the soil.

Description

Worm anatomy and a photo of an endogeic earthworm, the leaf worm.

Wisconsin has 3 types of worms:

- Surface dwelling (Epigeic) worms, such as composting worms, form no permanent burrows and live near the soil surface
- Topsoil dwelling (Endogeic) worms, such as the leaf worm, build horizontal burrows deeper in the soil.
- Soil dwelling (Anecic) worms, such as the Common Nightcrawler, build semi-permanent, vertical burrows that go down into the soil from the surface.

Signs and Symptoms

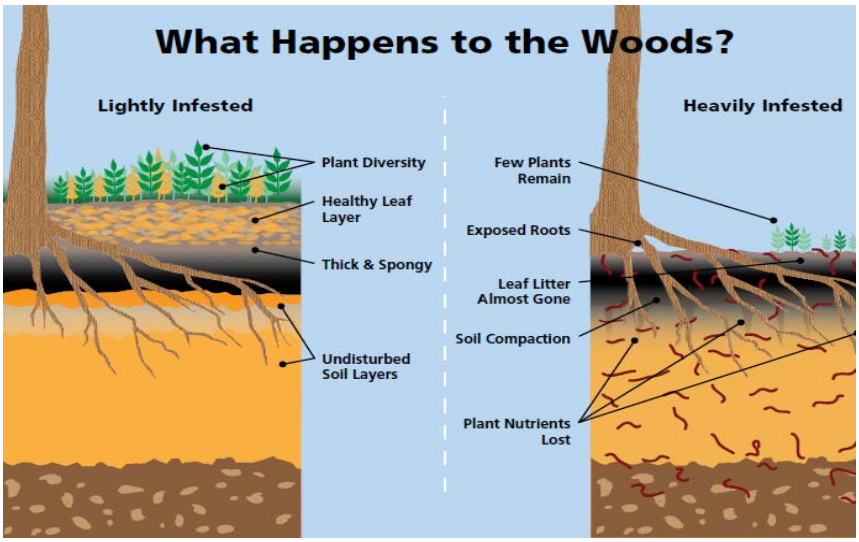
- Earthworms
- Middens - piles of cast material (earthworm poop) around the openings to their burrows
- Burrows with partially eaten leaves or stems sticking out
- Forest with bare soil – no or little leaf litter on the forest floor
- Invasive plants – Invasive plants take advantage of earthworm disturbed soil

Earthworm middens with the stems of eaten leaves sticking out and piles of castings around the burrows. Notice the lack of leaf litter surrounding the middens.

Habitat and Current Distribution

Invasive earthworms are found in hardwood forests all around the state but earthworm free areas still exist. Surveys are being conducted to determine the species of worms present in Wisconsin and the distribution of each species.

Impact and Management



Earthworms are a major threat to Wisconsin's forests.

- Ecological – When earthworms burrow and mix leaf litter and the soil, it is a major disturbance for Wisconsin forests. Healthy forests that evolved without earthworms depend upon fungi and invertebrates to slowly break down organic matter and gradually release nutrients back to the plants. Earthworms disrupt this normal breakdown of leaves. This is important because the leaf litter in a forest is comparable to the skin on an animal. The leaf litter retains moisture, protects the organs (roots), breathes, prevents erosion, deters pathogens (non-native plants), and promotes seed germination. Worms puncture the "skin" by eating leaf litter rapidly which exposes the soil, making it available to invasive plants, compaction, and run-off of rainwater, which would normally keep the soil moist. The disturbance also reduces the diversity of plants, insects and other species.
- Economic – Healthy forests are critical to Wisconsin's economy. Forests with earthworms have few regenerating seedlings and often instead have invasive plants. This means that if a group of trees dies or is cut, there are no trees to replace them. Healthy stands have abundant seedlings and few costs, while sites with earthworms cost much more because foresters or landowners must pay to treat the invasive plants and establish seedlings.
- Social/recreational – Earthworms can be a benefit to humans when kept contained in composting piles, agriculture fields and gardens. But the same benefits they provide in human controlled landscapes have major costs in natural ecosystems. Keeping worms out of our forests will help keep them healthy for all of us to enjoy.

While we don't have a way of ridding the forests of worms once they are established, we can keep them from spreading to forests that are not yet invaded. You can help prevent invasive worms from spreading in Wisconsin by:

- Invasive worms enter the forest primarily through horticulture, agriculture, and recreation.
    - If you fish DO NOT dump your worms in the water, on the ground, or in the woods. Dispose of live worms in the trash.
    - If you plant trees and shrubs on your property examine the root balls for worms and destroy any you find.
- Wash your shoes and tire treads when you leave a site with earthworms so you do not spread them to the next forest you visit.

For more information

- http://dnr.wi.gov/topic/Invasives/
- http://www.nrri.umn.edu/worms/default.htm

Created by Mike Hillstrom, WDNR Forest Health Specialist

Invasive Species: Will the introduction of a nonnative species cause, or is be likely to cause, economic or environmental harm or harm to human health?

It's important to understand the relationship earthworms have with the soil and that this relationship is not always beneficial, even though this can be a difficult topic. Given that common understanding has been that worms are beneficial for growing plants.

In the glaciated regions of North America our understanding of the presence of earthworms is established through the glacial and post-glacial geological and ecological records. Those records establish that the regeneration of our native plant species developed in the absence of earthworms. Furthermore we know that all of our most pervasive and ubiquitous earthworms are native to Europe. This helps us to establish the basis for our understanding that when the first explorers arrived in these formerly glaciated regions, they also brought along earthworms that many people today assume were already here. Additionally, when you examine the record of the native forests and vegetation of Wisconsin prior to the arrival of European settlers and the cutover that scoured the land of our native hardwoods, you're struck by the amount of diversity and density of those forests and vegetation. The westward expansion and the continued arrival of new settlers to these lands transformed them from native forests to prairies to wide rolling expanses of agricultural lands and dairy farms, which have altered the appearance of the landscape, and provided mechanism for a wide variety of non-native species to spread across the landscape.

Earthworms – Invasive Species

Objective:

Students will learn what invasive species are, how they got here and why they are problematic, and how to prevent their spread by using earthworms as the primary example.

Background

A **native species** is a plant or animal that occurs naturally in a certain area. Because it evolved in that area over time, it typically co-evolved with other species that served to keep its population in check through predation, competition, or disease.

Invasive species (non-native species) are species that have been introduced or moved by human activities to an area where they do not naturally occur. A non-native species is not necessarily harmful and in fact, some non-native species are beneficial (e.g., honeybees). However, when a non-native species overruns or outcompetes a native species in natural communities or ecosystems it can cause ecological, environmental and economic harm and is frequently labeled as an **invasive species**.

When **invasive species** enter new locations and do not have any natural controls that would serve to limit their spread and population they typically spread at a high rate outcompeting the native species. Because of the lack of natural predators, high reproduction rates and the ability to adapt and tolerate a vast array of conditions it enables them to take over in non-native areas.

Invasive species are not just a problem in Wisconsin but they are a problem worldwide as they degrade and change habitats, crowd out native species, and prevent our native forests from regenerating. Once established invasive species are nearly impossible to remove and controlling and limiting their spread is time consuming and expensive.

Invasive species are not a new phenomenon, with globalization and increased world-wide travel and shipments of goods new introductions are occurring continuously. Scientists estimate that in the United States alone we have over **7000 established invasive species** ranging from plants, mammals, birds, amphibians, reptiles, fish, arthropods, and mollusks.

There are many ways in which **invasive species** end up in new locations and commonly it's because we intentionally introduce them or we accidentally introduce them thinking they are good for the environment not realizing the damage they may ultimately cause. For example earthworms, we've all been told that earthworms

are good for the soil and help things grow. Though in Wisconsin our native earthworms were destroyed during the last ice age, roughly 10 thousand years ago when the glaciers retreated our native plant species grew and evolved without the presence of earthworms in the soil.

The question than is how did they get here? We introduced them of course! Here's the tricky part - we introduced ourselves as well. Just like new introductions of plants and insects that occur constantly at our boarders, we were the first "invasive species" to make our way into North America and because of our ability to travel and move long distances and adapt to new environments we grew and spread except that we also brought along more non-native species with us because as we made our home in the new world we wanted to have things that reminded us of home.

So how does this explain earthworms? Before settlers arrived in Wisconsin it was a vast wilderness of dark dense forests which would have been for the most part undisturbed, uncharted territory aside from Native American's whose home it was. With the arrival of European settlers also came the arrival of non-native plants and the soil that held them, which created a mechanism for introduction. Earthworms live and reproduce in soil, and while they didn't realize it, soils contain earthworm cocoons (eggs).

When European settlers expanded their range across North America they took advantage of the resources which, in Wisconsin, was the vast forested lands which provided timber for building and shelter as well as fuel and heat. It wasn't long before the expansion and cut-over of Wisconsin's forests was rapidly progressing, and the soil disturbance of logging practices and settlement of towns and homesteads changed the soil and native **ecosystems**.

While the presence of earthworms in our forests may not seem like much to be concerned about, we need to remember that, just like a healthy diet and proper nutrition is key to our growth and development, the soil on the forest floor is just as important to the health of our trees and how they grow. Earthworms affect how the soil works, and so it is important to know how that interaction takes place, and what it does.

Earthworms are **nature's recyclers** and they are incredibly efficient at the job they do – sometimes too good! While they are extremely beneficial and good at consuming kitchen scrapes and **fertilizing** our gardens, this same benefit has the exact opposite effect on our forests.

Imagine yourself walking through the woods on a crisp autumn day the leaves are vibrant in color and many have fallen from the trees and they're covering the forest floor in an array of beautiful colors. Imagine that carpet of leaves almost as a protective skin blanketing the forest floor and protecting it from the cold winter months that lie ahead. That protective layer over the forest floor is essential to the regeneration and growth of our native trees. The problem is that there is something eating them, and that "something" is earthworms.

If an earthworm could speak it would tell you that its favorite foods are freshly fallen leaves, and in particular, the leaf of a Sugar Maple (Acer saccharum – the Wisconsin state tree!). When earthworms consume fallen leaves, they interrupt an essential cycle that occurs between the soil and the micro-nursery created by the fallen leaves. For example if you were to pick up a pile of fallen leaves after they've built up you may notice something that looks a little like white mold, but what you're really seeing is **mycelium** which is a naturally occurring **fungus** that has an integral and **mutualistic relationship** with the regeneration of most of our native species. When earthworms consume the fallen leaves, they disrupt the relation between the soil and the **fungal layer** that is not only protecting the soil but also feeding and encouraging the process of regeneration on the forest floor. A forest with earthworms is a forest that experiencing a change in how things grow and what will grow.

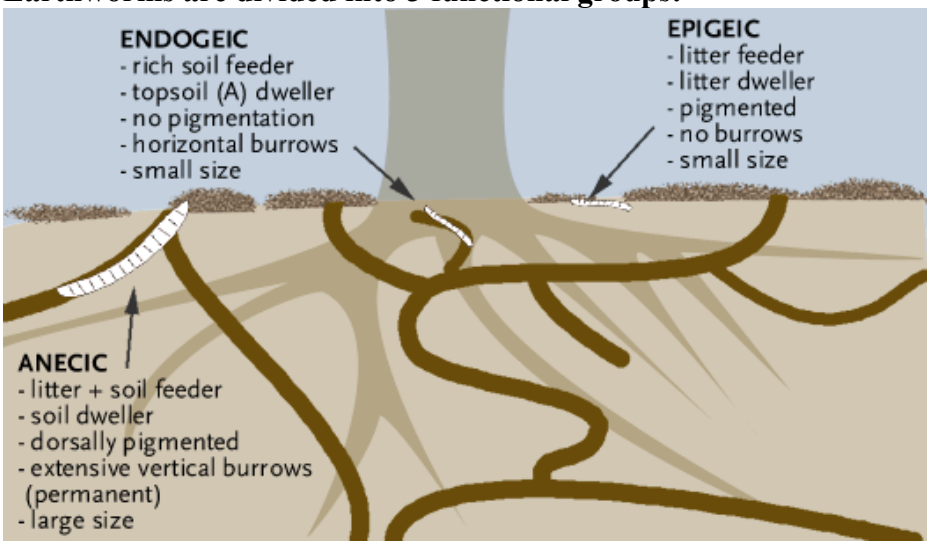
What can we do? In Wisconsin we still have areas of the state that are earthworm free as well as areas that have **minimal** spread and **abundance** of earthworms. If we can document these areas early on before infestations occur, and educate and change the **perception** of what earthworms do and why they are harmful to the health of

our forest, we have a good chance of **minimizing** their spread. Additionally, minimizing the spread of earthworms helps to reduce the spread of a host of other invasive species i.e., garlic mustard, honeysuckle, buckthorn. This is because earthworms change the soil and the nursery effect that leaves have for growing trees, which leaves those "new ecosystems" open to some of the best opportunists out there – other invasive species, which are usually faster growing, more aggressive, and less palatable to native foragers, diseases and insects., Generally, when you have one invasive species you'll have another, and earthworms are no exception!

What you need to know

- All earthworms in Wisconsin are non-native invasive species.
- Earthworms affect and alter the health of our forests.
- You can help document the presence of earthworms in Wisconsin

Earthworms are divided into 3 functional groups:



Three major ecological groups of earthworm have been identified based on the feeding and burrowing behaviors of the different species.

Vocabulary:

Native species	Nature's recyclers	Mutualistic relationship
Invasive species	Fertilizing	Minimal
Biodiversity	Fungus	Abundance
Regeneration	Fungal layer	Minimizing
Ecosystems	Mycelium	Perception

Wisconsin Worm Watch Survey

Date of Survey ___/___/_____

School: _____

Land Type: Public Private Commercial Tribal

Location: _____

Are there any distinctive landmarks? _____
_____
_____

Weather Conditions: Sunny Cloudy Rainy Slightly Overcast

Air Temperature: ____° Soil Temperature ____°

Is there a duff layer (leaf litter)? Yes No Measure depth? _____

Mustard Extraction Instructions:

1. Select site
2. Clear any ground covering and lay down frame
3. Mix a 1/3 cup of mustard powder in 1 gallon of water & shake well
4. Pour over area and count & sort worms that emerge for 5 minutes
5. Make sure all the worms are gathered then pour the other half over and wait an additional 5 minutes
6. After gathering all supplies keep the worms and move on to a new location 10 to 20 feet away and repeat.

Submit findings to: **Bernie Williams** **bernadette.williams@wisconsin.gov**

101 S. Webster St., P.O. Box 7921, Madison, WI 53707-7921

608-266-0624

Remember to take pictures and record survey information on the back of this form.

Plot # ______		
Type	Juvenile	Adult
Epigeic		
Endogeic		
Anecic		

Plot # ______		
Type	Juvenile	Adult
Epigeic		
Endogeic		
Anecic		

Plot # ______		
Type	Juvenile	Adult
Epigeic		
Endogeic		
Anecic		

Plot # ______		
Type	Juvenile	Adult
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Plot # ______		
Type	Juvenile	Adult
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Plot # ______		
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Anecic		

Plot # ______		
Type	Juvenile	Adult
Epigeic		
Endogeic		
Anecic		

Plot # ______		
Type	Juvenile	Adult
Epigeic		
Endogeic		
Anecic		

Wisconsin Worm Watch Survey 1

WHEN?

Date of Survey:

Start Time: **End Time:**

WHO?

Surveyor(s) Name(s):

Name of school, organization, or affiliation or lead surveyor or contact:

WHERE?

Site Ownership Type/Name: (i.e. Northern Highland American Legion State Forest, Beaver Creek State Natural Area (SNA)).

County:

Township:

GPS or Map point:

Landmark :(is there a distinct land feature you can describe that would assist in locating this survey site for future visits)?

WHAT? (and HOW!)

Weather Conditions (circle those that apply):

Clear/Sunny Slightly Overcast Cloudy Cloudy/Light Rain Clouds & Rain

Temperature: (be sure to indicate if it is ^{o}C or ^{o}F)

Habitat Type: circle and indicate the habitat type you are surveying and record any unique features you notice that may not be listed. You may survey in an area that may contain two habitat types, if that's the case circle all that apply. If the habitat type changes within a transect note the change on the plots that this occurs.

UPLAND (dry to moist)

Forest and Woodland (shrubs may be present, but trees make up main canopy component)
Deciduous trees
Coniferous trees
Mix deciduous/conifer

Shrub/Savanna (trees may be present but area is mostly open with shrubs)
Deciduous shrubs or trees
Coniferous shrubs or trees
Mix deciduous/conifer

Agriculture & Grassland
Ag Field or Pasture
Hedgerow
Old fields/ fallow land
Dry prairie, grassland, or barrens

LOWLAND
(wet to periodically wet)

Open Water & Wetland
Marsh
Lake, Pond, Reservoir
River or stream

Agriculture & Grassland
Ag Field or Pasture
Hedgerow
Old /fallow fields
Wet meadow /Prairie
Open Sedge bog

Shrub/Savanna
Deciduous shrubs or trees
Coniferous shrubs or trees
Mix deciduous/conifer

Forest and Woodland
Deciduous trees
Coniferous trees
Mix deciduous/conifer

URBAN
(towns/cities/farmsteads)

Urban Areas
Residential areas
Neighborhoods
Open areas/parks/town greens/golf course
Recreational trails
School Forests/County lands/preserves
Roadways/corridors
Forest/Woodland edges
Commercial/Industrial lands

Rural Areas
Roadways/easements
House/Homestead/Farm
Fields/lawns/agriculture
Parks/Hiking trails
Recreational areas
Commercial/Industrial lands

Surrounding Land Use (Circle all that apply):

Urban area Suburban area Rural area Lake area Streams/Rivers
Other (please describe)

Disturbance in survey area (Circle all that apply for the area you are surveying):

*If you are surveying on State Forests or SNA's past disturbance history should be historically recorded if surveyor is unsure at the time of sampling)
Unknown
Undisturbed Forest
Previous logging
Current logging
Recreational use (please indicate motorized or non-motorized)
Fishing (please indicate proximity to water bodies) _____
Other (please describe) _____

Size of survey area (Circle the best match for the area in which you are surveying):

* If you are surveying on State Forests or SNA's with transects in place the size data will have been already documented.
0-2 acres 2-5 acres 5-20 acres 20-40 acres 40-100 acres 100+ acres

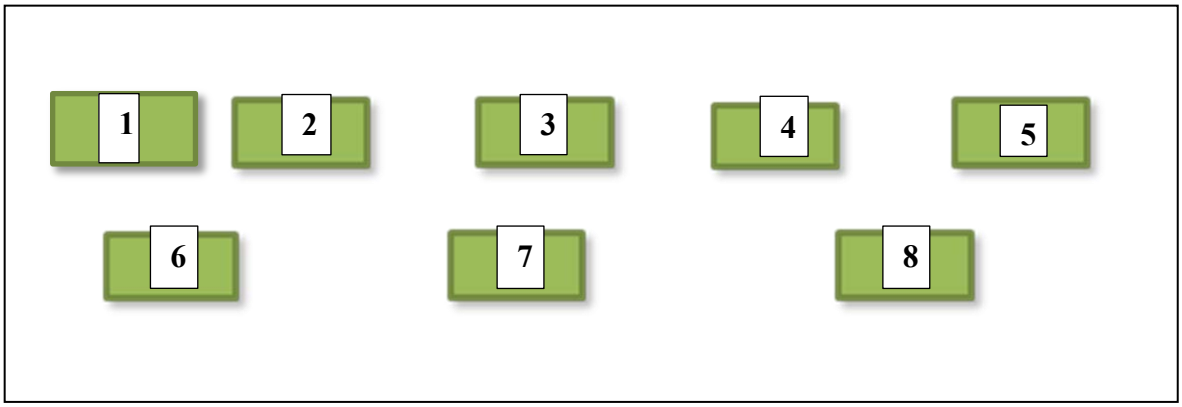
Survey Protocol – Document the number of **ADULT** and **JUVENILE** earthworms within each of the quadrat squares and transect areas you are surveying.

RUNNING YOUR TRANSECT TO SURVEY

When you decide where you will be surveying it's important to record and document the area and understand that a transect may follow a direct path or it may be randomly placed Ideally you will want to perform 8 quadrat plots within your survey transect though unless they are already in place and flagged you may choose to pace them off in a straight line dropping them 15 to 30 feet apart or you may choose to randomly place them within an area you anticipate will yield the best results. Though when doing this it's important to remember to still number each survey plot and draw a diagram in the box the below how you placed your transect.

At the start or end of each survey please draw/map out the placement of your transect and placement of quadrat plots.

***EXAMPLE**



PLACE YOUR QUADRAT FRAME

Using your quadrat frame place it on the first plot you'll be surveying and answer the following questions (below) which are outlined on your level 1 and 2 surveying form. Each quadrat plot survey you perform will be different and the variations are important to note as part of the data collection.

*Note: If you are not using the standard 2x3frame please indicate the size or estimate of each survey plot below under sample plot size.

Earthworm Sampling plot size: (Indicate size of plot)**: 2x3**____ **2x2**____ **Other**_____* If you are using quadrat frame supplied by Wisconsin Worm Watch the size is 2x3

Soil features: Tell us what you see!
Looking at the ground cover what do you see? What percentage of bare or exposed soil do you see? (Circle the best estimate for your survey site)

0-5% 5-25% 25-50% 50-75% other (explain) _____

Leaf Litter (Duff Layer): Is there a noticeable, intact layer?

YES NO

What is the average thickness of the leaf litter?
Circle the estimate that applies below – or using a yard/meter stick measure the depth/thickness within your quadrat and record the measurement.

0-2cm 2-4cm 4-6cm 6-10cm 10+cm
or provide measured depth_____ **centimeters or inches**

After you have measured the depth/thickness of the leaf litter – tell us about it.

Is it mainly freshly fallen leaf litter? YES NO

Is it a mix of freshly fallen leaves as well as older decomposed leaves? YES NO

Do the leaves look like they have white fungus fanning (mycelium) on them? YES NO

Are there any distinguishable species of tree leaves/needles or surrounding tree species you can identify?
(Circle as many as you can identify)

Sugar maple
Red maple
Red pine
White oak
Cherry
Red oak
Aspen
White Birch
Basswood
Ironwood
Green Ash
Black Ash
White Ash
White pine
Yellow birch
Hemlock
Balsam fir
Jack pine
Spruce
Other _____

What if none of the above applies?
If none of the above criteria apply to your survey plot – tell us what you see:
_____
_____
_____

Do you have any of the following? Please answer whether or not you observe these species in the area you are surveying with YES or NO

Penn Sedge (Looks like grass and has 3 edges when rolled between your fingers)
Hemp Nettle
Reed canary grass
Tree seedlings
Canada thistle
Other
*Explain as much about the plot as you can.

_____
_____
_____
_____
_____

Soil observations: once you have measured the leaf litter and made your observations remove the leaf litter that is within your survey plot to expose the bare soil. If you do not have leaf litter and your ground cover is mainly comprised of Penn sedge or other vegetation remove as much as possible to expose the soil. * If your survey plot has tree seedlings remove the leaf litter around them – do not pull the tree seedlings out.

What is the Soil Texture? (Circle the soil type that best describes your area or tell us about its
*Note: soil types can be verified through location.

Sandy	Loamy sand	Loam or sandy loam	Silt Loam
Sandy clay loam – clay loam		Silt clay loam – silt	Sandy clay-clay
Silt –clay	Wet – muddy	Hard – compacted soil	dark organic soil

What type of sampling method(s) are you using?

Liquid mustard extraction Flip/strip soil removal Midden Counts

Basic Earthworm Sampling estimating density of Adult and Juvenile present through Liquid Mustard Extraction:
Allow yourself at least 5 to 10 minutes per plot and add your dry mustard to water at each plot because the chemical reaction which causes the irritation only lasts about 20 minutes. Evenly pour one half to one third of your mustard water on your survey plot and repeat again after the mixture has completely saturated the soil and you have removed all the earthworms that rose to the surface. Dividing your solution in two to three pours will allow you to extract the highest number of earthworms from each plot because many earthworms are deeper dwelling and require more time to rise to the surface as the mustard solution seeps through.

Functional Group Earthworm Sampling
Earthworms are divided into 3 groups given their habitat within the soil:

Surface dwelling (EPIGEIC) worms, like the Red worm (*Eisenia fetida*) which form no permanent burrows and live near the soil surface

Topsoil dwelling (ENDOGIC) worms, like the Gray worm (*Aporrectodea rosea*), which build horizontal burrows deeper in the soil.

Soil dwelling (ANECIC) worms, like the Common Nightcrawler (*Lumbricus terrestris*); build semi-permanent, vertical burrows that go down into the soil from the surface

Frequently found species of earthworms in Northern Wisconsin:
Lumbricus terrestris, Lumbricus rubellus, Lumbricus juveniles, Eiseniella tetraedra, Eisenia fetida, Dendrobaena octaedra, Aporrectodea rosea, Aporrectodea tuberculata, Aporrectodea juveniles, Octolasion cyaneum, Octolasion juveniles, Eiseniella tetraedra

Example
The difference between an Adult and a Juvenile earthworm is the presence or absence of the Clitellum (saddle/band) a third of the way down the earthworms' body. An adult will have an apparent clitellum whereas on a juvenile it will be absent.

Level 1 surveying is a simple way to gather and estimate the density and prevalence of earthworms within a given area. Simple identification determining whether there are more adults or juveniles is requested.

LEVEL 1 Surveying (Please draw/map out your transect path and quadrat placement).

Start time: _____________
SURVEY PLOT Number: ____
Transect # (if applicable): ____
Soil % Exposure: ____
Leaf litter Depth: ____
Fungus/mushroom on leave litter or nearby: ______________________________________
Tree Seedlings Present: ____
Penn Sedge or other vegetation: ____
Number of Adult: ____
Number of Juvenile: ____
Notes:____
End time: _____________

Start time: _____________
SURVEY PLOT Number: ____
Transect # (if applicable): ____
Soil % Exposure: ____
Leaf litter Depth: ____
Fungus/mushroom on leaf litter or nearby: ______________________________________
Tree Seedlings Present: ____
Penn Sedge or other vegetation: ____
Number of Adult: ____
Number of Juvenile: ____
Notes:____
End time: _____________

Start time: _____________
SURVEY PLOT Number: ____
Transect # (if applicable): ____
Soil % Exposure: ____
Leaf litter Depth: ____
Fungus/mushroom on leaf litter or nearby: ______________________________________
Tree Seedlings Present: ____
Penn Sedge or other vegetation: ____
Number of Adult: ____
Number of Juvenile: ____
Notes:____
End time: _____________

Start time: _____________
SURVEY PLOT Number: ____
Transect # (if applicable): ____
Soil % Exposure: ____
Leaf litter Depth: ____
Fungus/mushroom on leaf litter or nearby: ______________________________________
Tree Seedlings Present: ____
Penn Sedge or other vegetation: ____
Number of Adult: ____
Number of Juvenile: ____
Notes:____
____
End time: _____________

Start time: _____________
SURVEY PLOT Number: ____
Transect # (if applicable): ____
Soil % Exposure: ____
Leaf litter Depth: ____
Fungus/mushroom on leaf litter or nearby: _____________________________________
Tree Seedlings Present: ____
Penn Sedge or other vegetation: ____
Number of Adult: ____
Number of Juvenile: ____
Notes:____
End time: _____________

Start time: _____________
SURVEY PLOT Number: ____
Transect # (if applicable): ____
Soil % Exposure: ____
Leaf litter Depth: ____
Fungus/mushroom on leaf litter or nearby: _____________________________________
Tree Seedlings Present: ____
Penn Sedge or other vegetation: ____
Number of Adult: ____
Number of Juvenile: ____
Notes:____
End time: _____________

Start time: _____________
SURVEY PLOT Number: ____
Transect # (if applicable): ____
Soil % Exposure: ____
Leaf litter Depth: ____
Fungus/mushroom on leaf litter or nearby: _____________________________________
Tree Seedlings Present: ____
Penn Sedge or other vegetation: ____
Number of Adult: ____
Number of Juvenile: ____
Notes:____
End time: _____________

Start time: _____________
SURVEY PLOT Number: ____
Transect # (if applicable): ____
Soil % Exposure: ____
Leaf litter Depth: ____
Fungus/mushroom on leaf litter or nearby: _____________________________________
Tree Seedlings Present: ____
Penn Sedge or other vegetation: ____
Number of Adult: ____
Number of Juvenile: ____
Notes:____
End time: _____________

Other observations / Additional Notes
(This information can be added before, during and after surveys are performed as you will undoubtedly notice new things during the course of the transect)

Dominant tree species in the area where you are surveying:

Native plants within the area you're surveying:

Non-native invasive plants:

Fungus/mushrooms:

Large and small mammals:

Salamanders/Frogs/Toads:

Other:_____
_____
_____
_____
_____

Please submit your completed survey forms to:

Bernie Williams
WDNR – Forest Health FR-4
101 S. Webster St.
P.O. Box 7921
Madison, WI 53707-7921

bernadette.williams@wisconsin.gov
608-266-0624