**Earthworm Invaders**

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Target Grade: Middle School Science (6-8)

Topic: Invasive Species

Time: 2-3 class periods (50-60 minutes each)

**Lesson Overview:**

This lesson is integrated into a 6th grade PBL project about biodiversity and the invasive worm ideas came from the Smithsonian Science Education Academy for Teachers Biodiversity Session that I attended in 2012. Students have learned about the different energy roles in food webs and why biodiversity is vital to the survival of an ecosystem. This lesson focuses on the role of earthworms in the food web and how invasive earthworms are having a devastating effect on some forest ecosystems in the United States. They will learn more about earthworm species, why they can be considered invasive, and do a lab to collect earthworms around the school.

**Sources Consulted:**

[Smithsonian: Ecosystems on the Edge-Earthworm Invaders](http://insider.si.edu/2013/07/ecosystems-on-the-edge-earthworm-invaders/) / [Ecosystems on the Edge](http://ecosystemsontheedge.org/earthworm-invaders/) (alternate site)

[Great Lakes Worm Watch](http://greatlakeswormwatch.org/)

Expert Contact @ Smithsonian: Melissa McCormick [Contact Site](https://link.springer.com/article/10.1007%2Fs10530-011-9959-0#citeas)

“**Ecosystem effects of non-native earthworms in Mid-Atlantic deciduous forests”** Szlavecz, K., McCormick, M., Xia, L. et al. Biol Invasions (2011) 13: 1165. <https://doi.org/10.1007/s10530-011-9959-0>

**Learning Objectives:**

After the lesson, students will be able to…

1. Describe how invasive earthworms impact the ecosystems and food webs in which they live
2. Design an experiment to investigate the health of a local forest based on the number and types of worms found during the earthworm collection lab
3. Compare and contrast worm collection data from both the forest ecosystem and an agricultural setting and discuss the pros and cons of worm populations/communities in these areas

**Michigan Science Standards Addressed:**

**SEP: Science and Engineering Practices**

* Planning and Carrying Out Investigations
* Analyzing and Interpreting Data

**DCI: Disciplinary Core Ideas**

* MS-LS2-1 Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
* MS-LS2-3 Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.
* MS-LS2-4 Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

**CCC: Cross Cutting Concepts**

* Cause and Effect
* Stability and Change

**List of Materials:**

* Computer access to links or printed articles.
* Worm Extraction Solution: ⅓ c ground mustard per gallon of water (milk jugs work well)
* Worm Lab: 4 meter sticks and collection cup per group, worm identification chart, worm collection data table, optional: student lab handout

**Room Arrangement or Special Needs**

Students are grouped together for the activities and lab (3-4 students max).

**Outdoors: *Area to collect worms for lab***: Forest to see if earthworm invaders are present in the forests (finding worms here is NOT good). A yard or football field will work and will yield more worms (note-worms are HEALTHY in an agricultural or garden setting, so worms here are good)

* + Forest Ecosystem: Students will see if there are any invasive earthworms in the forests. They will document the type of forest, amount of leaf litter, and if possible, test the soil for pH, etc. The Great Lakes area does not yet have the same invasive worm problem as eastern forests. The videos from Smithsonian will highlight the vast impact the worms have had on forests there. If students do not find any worms in the forest in the Great Lakes Region, that’s good!
  + Agricultural Setting: With permission, use a well groomed football field, grassy area or garden. Students will most likely find a LOT of worms here and it is good to test the soil here if possible too! Students can compare this data with the forest data and can research why worms are a value to these types of locations.

**New Vocabulary**

Invasive Species: A non-native species in an ecosystem that may cause harm to the economy, the environment or human health.

Community: A group of different species living and interacting in the same area

Population: A group of the same species living and interacting in the same area

Species: A group of similar individuals that are able to breed with one another and produce fertile offspring

Epigeic: Worms that live in leaf litter on the forest floor and do NOT burrow. They are usually darker in color and found only at the surface. [Great Lakes Worm Watch](http://nrri.d.umn.edu/worms/identification/ecology_groups.html)

Endogeic: Worms that make shallow burrows, are smaller and usually have light or no pigmentation. [Great Lakes Worm Watch](http://nrri.d.umn.edu/worms/identification/ecology_groups.html)

Anecic: Largest worms, live in vertical burrows and have dorsal pigmentation. [Great Lakes Worm Watch](http://nrri.d.umn.edu/worms/identification/ecology_groups.html)

**5E Model Lesson Plan**

***Engage - Guiding Question: Are Worms Friend or Foe?***

Students should already know that earthworms play a very important role as decomposers in food webs. Ask students if they think worms are always a benefit to ecosystems. Ask them if they can think of a situation where worms are harmful to ecosystems. The teacher may or may not reveal at this point that most earthworms in the Great Lakes area are non-native species. Our job will be to determine if earthworms in Mid-Michigan should be considered invasive or not.

***Explore - Activities***

1. Know/Need to Know: Ask students to document everything they think they know about worms so far. Ask them to also document what they want to know about worms. This can be in a T-table, a big class paper with sticky notes, or for fun, an online sticky board at <http://scrumblr.ca/>
2. Attention Grabber-Worm Facts: These can be displayed in a handout or on slides...
   1. 99% of worms are NOT native and many are considered invasive
   2. Worms can migrate up to 30 ft a year
   3. Worms can live up to 10 years
   4. There are 2700 species of worms worldwide
   5. Worms breathe through their skin
   6. Worms come in MANY colors
   7. In 24 hours, a single worm can produce their own weight in “casts” (aka worm poo)
   8. Some species of worms can JUMP up to a foot off the ground.
3. **Reading Option 1**: [Article: The Early Worm Gets the Bird](http://www.conservationmagazine.org/2011/12/early-worm-gets-the-bird-2/): This is a short, easy to read article that is easily paired with a reading for information strategy. It will start to shed light on earthworms as invasive species. It may get students thinking of ways to prevent further spread of earthworm invaders. Teachers could consider doing a Q&A worksheet and/or reading for comprehension strategy as a graded assignment. This article will help students to understand that…
   1. Earthworms are not native and if they ever existed in North America, it was prior to the last Ice Age
   2. Non native earthworms are spread mainly by anglers letting bait go free
   3. Evidence exists that earthworms could be considered invasive due to the effect they are having on ground dwelling birds
   4. Once earthworms are in an ecosystem, it is difficult to stop their spread.
4. **Reading Option 2:** [Web Article: Forest Ecology and Worms](http://nrri.d.umn.edu/worms/forest/index.html) This website is linked to the Great Lakes Worm watch website. This is great to use if your students have web access. There are lots of great images to help students see how worms can negatively affect a forest ecosystem, mainly by decreasing leaf litter. It also addresses that while worms can be great for gardens and agriculture, they can upset the forest ecology. For older students, you may want to consider the next page, which shows a detailed model of [Forest Ecology.](http://nrri.d.umn.edu/worms/forest/ecosystems.html)
5. **Video Option:** [Ecosystems on the Edge](http://ecosystemsontheedge.org/earthworm-invaders/)Students can see actual research being done at a research center. Scientists are closely monitoring the effect invasive worms are having on the forests on the east coast. Check in after the video to see if students can tell you why they consider worms invasive and not “non-native” in that area.
6. **Pre-Lab Learning:** Students will need to learn more about the types of worms they may encounter during the lab. The website [Great Lakes Worm Watch](http://nrri.d.umn.edu/worms/identification/ecology_groups.html) will go over the terms epigeic, endogeic and anecic worms, in addition to species of worms that are found in our area. While students will mainly be concerned with counting worms during lab, it is important to at least know the three main types. Students should know that in a garden/athletic field setting, no epigeic worms will be found because there is no leaf litter!

***Explain - Lab Data and Evidence***

1. Students will create a hypothesis and discuss where they think more worms will be found, in the forest or in the agricultural setting (for our kids, it was the football field). Teachers may want to design their own handout for this activity or use this one [Worm Lab Handout](https://docs.google.com/document/d/1EdkWhBiJ_bzL-tV09ug8jnSE9TpIGR2HhpI4uYjdzPc/edit?usp=sharing)
2. Students will then design a data collection document to conduct the worm lab. See [Worm Lab Handout](https://docs.google.com/document/d/1EdkWhBiJ_bzL-tV09ug8jnSE9TpIGR2HhpI4uYjdzPc/edit?usp=sharing)
3. Lab/Collection Day: If you are able, have half the class collect data in the forest setting and the other half in the agricultural setting. See [Worm Lab Handout](https://docs.google.com/document/d/1EdkWhBiJ_bzL-tV09ug8jnSE9TpIGR2HhpI4uYjdzPc/edit?usp=sharing) for lab setup and materials. Students will collect their data and report out the next day.

***Elaborate - Student Share Out***

1. The teacher will need to make all student data available to all the groups. Data sheets can be printed or shared online. It is very important for groups to have access to all data so that they can analyze the worm counts at each site and make a conclusion.
2. Student groups will complete the analysis of data on the [Worm Lab Handout](https://docs.google.com/document/d/1EdkWhBiJ_bzL-tV09ug8jnSE9TpIGR2HhpI4uYjdzPc/edit?usp=sharing).
3. Groups may meet and share in a group “Think-Pair-Share” activity. These discussions and activities should help to prepare students to make an individual written conclusion about their findings.

***Evaluate - Apply Knowledge***

1. Remind students of the driving question ***Are Worms Friend or Foe?*** And remind them of the definition of invasive species. Introduce the assessment! Students will be graded on this lesson with a written essay question to answer the driving question in an argumentative format.
2. Using the prior experiences in class (articles, video and discussions) as well as lab data, determine whether or not the worms in our area, while NON native, should be classified as an invasive species.
   1. Pre-writing activity: Students may need time in class to reflect on activities, gather and analyze more data or search the web for more information. You may also need to go over the pieces of an argumentative essay.
   2. Teachers should create an appropriate grading rubric to score each student on the following criteria:
      1. Ability to use examples, sources and lab data to support their conclusion that worms are to be considered invasive or simply non-native (grading content and knowledge)
      2. Ability to write an argument in an organized fashion (grading writing skills)

**Student Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Earthworm Invaders Lab**

1. Create your hypothesis. Where do you think you’ll find more worms, and why? Remember to make your hypothesis an EDUCATED guess. Consider all you have learned so far about worms. We will collect in the school forest and the football field on the same day.

|  |
| --- |
| Write your hypothesis as an “If...then” statement… |

1. On a separate page, design a data collection sheet for the worm collection lab. You will collect the following information and must include it on your data sheet: # and type of worm found (epigeic, endogeic, anecic), weather for collection day, ecosystem/area observations, soil information (color, texture, moisture level, pH, etc)
2. Lab Setup and Collection
   1. Student groups should be split between a forest ecosystem and agricultural setting on the same day, if possible (we used the school forest and football field).
   2. Student groups will get 4 meter sticks to setup a 1 square meter collection zone. Worms will ONLY be collected from this area.
   3. Worm extraction solution (1 gallon of water + ⅓ c ground mustard) and one gallon of fresh water will be used. Students will slowly pour solution in an “S” pattern, waiting momentarily for worms to come up before pouring more. Freshwater will be used to rinse away solution and to push solution deeper into anecic burrows.
   4. Student observers will put worms in a collection cup where they will be sorted, counted and released before returning to the classroom.
   5. Observations of the site will be made and documented on the lab handout. For students in the woods, it is very important to note the amount and type of litter on the forest floor before it is removed to search for worms!
3. Data Share Out
   1. Students will share/post their data collection sheets either online or the teacher can copy/print the data sheets for each group.
   2. Using the data, groups will analyze the findings at each site and make a conclusion about the worms in our area.
4. Analyze Data

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| --- | --- | --- |
| Data Analysis | Forest Site | Agricultural Site |
| Combine all data from all groups: | Epigeic:  Endogeic:  Anecic:  Total: | Epigeic:  Endogeic:  Anecic:  Total: |
| Create an average TOTAL (all worm types) based on data from all groups at each site | Add up all the worms in the forest site and divide by the number of groups: \_\_\_\_\_\_\_ | Add up all the worms in the agricultural site and divide by the number of groups: \_\_\_\_\_\_\_ |

1. Compare the average number of worms at each site. Which had more? Why do you think there were more worms there?
2. Compare and contrast the leaf litter at each site. Why is leaf litter important for studying earthworms’ impact on an ecosystem?
3. Compare the soil chemistry (if available) at each site, especially pH. If possible, research which pH worms prefer. Was there a difference in soil at each site? How could this affect the worm population at each site?
4. Research, use data, and complete the table Below: What are the pros and cons of worms in each ecosystem?

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| --- | --- |
| Worms in the Forest Ecosystem | |
| Pros-Benefits of having worms in the forest | Cons-Negative effects of having worms in the forest |
|  |  |

|  |  |
| --- | --- |
| Worms in the Agricultural Ecosystem | |
| Pros-Benefits of having worms in the agricultural setting | Cons-Negative effects of having worms in the agricultural setting |
|  |  |

**Individual Assessment:** Based on your research, class activities and this lab and all the data you’ve analyzed, you will be asked to write an essay as to whether or not the non-native earthworms in our area should be classified as “invasive” or “non-native”. Your teacher will tell you when this assessment will take place and you may be asked to complete some pre-writing activities before you write your essay.