

Worms in Alberta: Invasive Species and Ecosystem Interactions

TEACHERS GUIDE

In this series of lesson plans, Grade 7 students will learn about invasive species and ecosystem interactions by investigating earthworms in Alberta and contributing to a citizen science research project. These lessons align with the Alberta Grade 7 Science Program of Study, Unit A – Interactions and Ecosystems.

Overview of Lesson Activities

- Introduce earthworms as invasive species in Alberta
- Identify different ways of collecting information (e.g. earthworm collection, talking to experts, computer research, etc.)
- Collect, analyze, and evaluate data about earthworms
- Research the impact (both positive and negative) of earthworms on the environment and the impact of humans on earthworms

Duration

6 Lessons (approximately 8 class periods of 50 minutes)

[Lesson 1](#): Introduction

[Lesson 2](#): Earthworm Collection Preparation

[Lesson 3](#): Earthworm Collection

[Lesson 4](#): Earthworm Data Analysis

[Lesson 5](#): Earthworm Impacts

[Lesson 6](#): Should Earthworms be Banned in Alberta?



<http://www.photl.com/221692.html>

Background Information

Earthworms are not native to Alberta, or most of Canada, after being extirpated (local extinction) by the most recent ice age 10,000 years ago. As a result, Canada's forests have largely adapted to an environment without earthworms. The shaded areas in figure 1 represent where native North American species are located. The thick line indicates the Wisconsinan glacial margin.



Figure 1. Distribution of native North American earthworms

(Hendrix, P.F. & Bohlen, P.J. (2002). Exotic earthworm invasions in North America: Ecological and policy implication. *BioScience*, 52(9), 801-811.)

Earthworms were re-introduced to Canada through human activities as a result of colonization and the spread of agriculture. These earthworms continue to be introduced into Canada's forests by the activities of humans such as driving, in which earthworm cocoons are thought to hitch a ride in the mud attached to vehicles, or through angling, when anglers dump earthworms after they are done fishing. Recent evidence by Dr. Erin Cameron at the University of Alberta has shown that earthworm introduction is an ongoing process rather than a single event and so earthworm spread continues into remote areas of Alberta and Canada through human action.

Earthworms are broken into three broad categories. **Litter dwelling earthworms** have no permanent homes and only reside in the leaf litter layer of forests. These earthworms are commonly small and have a deep red pigment. **Soil dwelling earthworms** are quite small and are rarely seen above the surface unless during a heavy rainfall. They lack skin pigmentation and as a result they can appear greyish, yellow, pink or white in colour. Finally, **deep burrowing worms** live in permanent burrows in the soil. A pile of leaves and feces called 'middens' often covers the burrows. Deep burrowing worms are typically the largest of the earthworms and are deeply pigmented, often with a purplish colour.

Earthworms change Canada's forests by reducing the leaf-litter layer typically present on the forest floor. Soil dwelling and deep burrowing worms may actually eliminate the layer completely. The destruction of the leaf litter layer can result in forests becoming CO₂ emitters rather than carbon storage sites, the reduction of habitat for birds and insects, the introduction of plants deep into forests that would otherwise be found on the edges of forests, and the leaching of nitrogen into waterways.

For more background information:

- Cameron, E.K. (2010). Got bait? How we've spawned an underground invasion. *Conservation Magazine*, 14, 20-22. Retrieved from <http://magazine.ab-conservation.com/index.cfm/issue/springsummer-2010-volume-14/>
- [Great Lakes Worm Watch: Earthworm Ecological Groups](#)
- [OrganicGardening.com](#)
- [Worm Facts](#)
- [Contain those Crawlers \(Minnesota Department of Natural Resources\)](#)

Lesson 1: Introduction

Purpose

- Identify what students know about earthworms
- Introduce earthworms as an invasive species in Alberta
- Consider the question: 'Should earthworms be banned in Alberta?'

Overview

In this lesson, students will first be asked what they know about earthworms. Once they have considered this, students will be introduced to Dr. Erin Cameron's research project about earthworms, specifically introducing earthworms to the students as an invasive species in Alberta. Students will then be asked to consider the question: 'Should earthworms be banned in Alberta?' and identify what the kinds of information they need in order to answer this question.

Program of Studies Outcomes

Outcomes for Science, Technology and Society (STS) and Knowledge

1. Investigate and describe relationships between humans and their environments, and identify related issues and scientific questions
 - describe examples of interaction and interdependency within an ecosystem
4. Describe the relationships among knowledge, decisions and actions in maintaining life-supporting environments
 - describe and interpret examples of scientific investigations that serve to inform environmental decision making

Attitude Outcomes

Interest in Science

- Show interest in science-related questions and issues

Materials

- [Pictures](#) of earthworms or actual earthworms
- [KWL chart](#) (individual)
- KWL chart (class – use poster paper or use an online tool such as Google Docs)
- Access to internet and projector
- Video - Talking with the Expert: Dr. Erin Cameron [video](#)

Lesson Activities

1. Introduction (5 min)

Begin by showing students a picture of an earthworm (or if you are able, bring in some earthworms for students to look at) and ask them if they know what they are. If students respond with 'worm', ask them if they know about any specific kinds of worms (e.g. tapeworms, earthworms, roundworms, hookworms, inchworms, etc.) and what kind of worm this might be.

2. KWL Chart – Earthworms (20 min)

Once you or the students have identified this as an earthworm, have students use the KWL charts to individually write down as many things as they can about earthworms under the **K** column (if they are not sure about something, they can place a star beside it). Do the first one with the students to demonstrate how the KWL chart works (see below). Have students share their answers as a class and record their responses on the class KWL chart (if possible, set up as a Google Doc for the all the class to see). If questions about earthworms arise during this discussion they can be added to the **W** column. Additionally, students will be guided to add more to the **W** column in the next lesson.

Examples

The following chart indicates possible student responses for the **K** column. Question prompts are provided for you to help solicit responses from students. The last column includes additional resources and information identifying where related content is addressed in the following lessons.

Possible Student Responses	Question Prompts	Lesson Links and Additional Resources
Live mostly in or on top of soil (can be found under rocks and trees, near water)	Where do earthworms live? Have you seen them in places other than the ground?	In lesson 3 students will learn about the 3 classifications of earthworms and their habitat.
Eat dirt, manure, smaller things (bacteria, fungi), dead animal or plant material	What do earthworms eat?	In Lesson 5 students will read information about how earthworms obtain their nutrients.
Shaped like a tube, have segments, reddish-brown in colour	What do earthworms look like? Do they all look the same?	In Lesson 3 students will learn about the three main types of earthworms and learn that they vary in size and color. Additional information regarding earthworm classification can be found on the project website .
Bait for fishing	What human activity uses earthworms?	In Lesson 5 students will explore the effects using earthworms for bait can have on the environment.
Birds eat them	What things eat earthworms?	Earthworms are also eaten by fish, moles, and turtles among other things. Students will explore this relationship in Lesson 5
Good for soil*	Why do you want earthworms in your garden?	Earthworms help to aerate the soil and cycle nutrients. However, they can be harmful to some ecosystems. [See lesson 5]

In the chart below we have listed possible student responses that may contain misconceptions or scientifically incorrect ideas. If students state these during the KWL, prompt them to clarify their idea by asking, “How do you know this?” During the discussion you might also ask students how confident they are in their current ideas about earthworms and let them know that they will have the opportunity to revisit the KWL chart during the following lessons and revise their ideas as they learn new things about earthworms. You might also have students star statements where the class discussion raises disagreement or uncertainty.

For the teacher’s information, the chart below includes a description of the correct scientific idea, lesson links, and additional resources. Since the point of this part of the activity is for students to freely share their ideas and prior knowledge it is best to address the specific misconceptions that arise in the following lessons where appropriate. For misconceptions that are not directly addressed in the following lessons we have provided additional resources that can be used to address the topics. It is important to be aware that since these are common misconceptions and the science is not always straightforward to explain, the Internet is also full of misinformation regarding these topics. As these ideas are addressed during the following lessons, have students write in the correction in the **L** column for things they have learned.

Possible Student Misconceptions	Scientific Idea	Lesson Links and Additional Resources
Cut in half they will survive	Earthworms have a head and a tail. If you cut them in half, sometimes one end will survive and regenerate some of the missing segments. Although some types of worms can regenerate new worms from both the head and the tail end (depending upon where the cut occurs), this is extremely unlikely in the earthworm species that students will encounter.	The following sources provide additional information regarding earthworm regeneration and pose the theoretical possibility that regeneration could result in two worms. <ul style="list-style-type: none"> - Earthworm Regeneration
Come to the surface when it rains so they don’t drown*	Worms can live in water for a few days as long as the water has enough dissolved oxygen. The current theory is that they come to the surface because it is easier to move over land with the increased humidity.	Resources: <ul style="list-style-type: none"> - Scientific American article
Earthworms are the same everywhere*	There are over 3000 species of earthworms around the world	Resources: <ul style="list-style-type: none"> • Earthworm diversity

3. Talking with the Expert: Dr. Erin Cameron (20 min)

Now that students know a little bit more about earthworms, tell them they will be watching a video featuring someone who studies earthworms, Dr. Erin Cameron. Hand out the “Talking with an Expert” video guide. As students are watching the video have them write answers to the questions on the guide. Consider stopping the video as the different topics are discussed. Discuss the answers with the class in order to clarify concepts and terminology presented in the video.

After viewing the video and completing the video guide have students fill in anything new they have learned about earthworms under the **L** in their KWL chart. Share some thoughts as a class.

Example

Students should have the following key points added to the L column:

- Earthworms in Alberta are an invasive species (i.e. no native species in Alberta)
- Native earthworms were eliminated from most of Canada by glaciers during the last ice age.

4. Closure (5 min)

Tell students that over the next few days they will be trying to answer the following question: Should earthworms be banned in Alberta? Ask students to spend the remainder of class talking to a partner or two about what kinds of evidence they would need to collect in order to answer this question (this will get the students thinking about tomorrow’s lesson).

Additional Resources

NSTA - The Wonder of Worms (common misconceptions)

<http://www.nsta.org/elementaryschool/connections/201302SmithWormMisconceptionsTable.pdf>

Lesson 2: Earthworm Collection Preparation

Purpose

- Consider the question: 'Should earthworms be banned in Alberta?'
- Identify different ways to collect information to answer the question
- Prepare for earthworm collection

Overview

Students will be asked to consider the question: 'Should earthworms be banned in Alberta?' They will then identify the kinds of information they need in order to answer this question. Finally, students will prepare to see if there are any earthworms in their schoolyard as one way of collecting data (or other site as deemed appropriate by the teacher).

Program of Studies Outcomes

Outcomes for Science, Technology and Society (STS) and Knowledge

1. Investigate and describe relationships between humans and their environments, and identify related issues and scientific questions

- describe examples of interaction and interdependency within an ecosystem
- identify examples of human impacts on ecosystems, and investigate and analyze the link between these impacts and the human wants and needs that give rise to them
- analyze personal and public decisions that involve consideration of environmental impacts, and identify needs for scientific knowledge that can inform those decisions

Skills Outcomes

Initiating and Planning

- identify science-related issues
- identify questions to investigate arising from practical problems and issues

Materials

- [Article](#) – Earthworms in Alberta (1 or 2 copies per group – in colour if possible)
- [KWL chart](#) (individual)
- KWL chart (class – set up as a google doc)
- Access to internet and projector
- [Videos](#)
 - [Site Preparation](#)
 - [Flip and Strip](#)
 - [Hand Sampling](#)
 - [Midden Count](#)
 - [Mustard Extraction](#)

Lesson Activities

1. Introduction (10 min)

Assign students to groups of 3 or 4 (they will work on the rest of the lessons in this group) and ask each student to share one thing they learned about worms in the previous days class with their group. As a class read the article 'Earthworms in Alberta'

which summarizes the spread of worms in North America and introduces students to the three types of earthworms they might see while collecting earthworms.

2. Should Earthworms be Banned in Alberta? (15 min)

In their groups, have students think about what they would need to know in order to answer the question ‘Should earthworms be banned in Alberta?’ On their KWL charts, under the **W** column, have students write down questions they would need answered in order to decide if earthworms should be banned in Alberta.

As a class, have students share their responses. In the chart below are some suggested prompts that can be used to guide students to some of the key ideas that should be included. As you are doing this, have the class consider how they might try and find out that information (putting that in brackets beside each question). Below are some key things that the students should have as you will be doing these in subsequent lessons.

W What do you want to know?	Prompts
Do earthworms cause any damage? (Internet search, talk to an expert)	Why might someone want to ban earthworms? [Help students reframe their answers into questions]
What are the benefits of earthworms? (Internet search, talk to an expert) Who uses earthworms? (Internet search or try and collect earthworms)	Is there any reason people might not want earthworms to be banned? [Help students reframe their answers into questions]
Where are earthworms located? (internet search, try and collect earthworms)	Are earthworms an issue everywhere in Alberta? [Help students reframe their answers into questions]
How did earthworms get to new locations? (Internet search or analysis of where earthworms are found)	Have earthworms always been found in Alberta? [Help students reframe their answers into questions]

3. Earthworm Collection Preparation (10 min)

Ask students if they can remember what Dr. Cameron’s research was about and share some answers. Next, tell them they are going to be collecting earthworm data to help them learn more about earthworms and contribute to the citizen science project described by Dr. Cameron. Citizen science is research that is undertaken by nonprofessional scientists or ordinary citizens.

Show students the video – Site Preparation. After the video is complete, discuss the questions for consideration with the class. These particular questions focus on

Foundation 3: Skills, in the Alberta Science 7-8-9 Program of Studies. Specifically, these questions begin to address using tools and apparatus effectively and accurately for collecting data, and estimating measurements.

Site Preparation - Questions for Consideration

1. Why do you think it is important to sample more than one plot?
To get an average number of worms in the whole sample area. The plot size is small and the earthworms may not be equally distributed in the larger area that we are sampling.
2. Why does Dr. Cameron measure the leaf litter in all four corners of the plot?
Again, to get an average for the plot. The leaves and other material may be piled up in one corner so if we only sampled in one corner our estimate may be too high or too low for the whole plot.

4. Earthworm Collection Methods (15+ min)

There are multiple methods for earthworm collection. A brief summary of the four method types are described below (for additional information, [click here](#)). The mustard extraction method is the most effective method for collecting all types of earthworms and the one that we suggest you use. However, the other methods can also be used to provide additional data. Once you have decided which method(s) you will be using to collect earthworms with the class, show students the corresponding video(s). After the video(s), discuss with the class the key points and questions for consideration.

Mustard Extraction: collecting earthworms that come to the surface after pouring mustard water into the sample area; the mustard water acts as an irritant so earthworms move to the surface.

Key Points

- most effective way of sampling for earthworms
- mustard is an irritant to worms which is why they crawl to the surface
- requires more preparation ahead of time
- best for collecting all types of earthworms

Questions for Consideration

1. Why would we only count the earthworms that emerge from within our sample area and not outside of it?
We might use the sample plot to extrapolate to a larger area. The ones outside the sample area may be sampled by someone else.
2. Why do you think it is important to wait 5 minutes each time we pour the mustard water?
5 minutes allows the earthworms time to crawl to the surface. If we do not wait enough time then we may not be collecting all of the earthworms in that area.

Flip and Strip: flipping rocks, leaves, and logs, stripping off bark and just generally hunting around for earthworms.

Key Points

- simple form of sampling
- need some way of identifying the sample area
- not as accurate as other methods as the sample area is larger and there is a greater possibility of not collecting all of the earthworms
- best for collecting litter dwelling and soil dwelling earthworms (you might sometimes find deep burrowing earthworms)

Questions for Consideration

1. What are the advantages of sampling for earthworms using the flip and strip method?

It is very simple and no special tools or materials are required.

2. How is the sample area in the flip and strip method different from the sample area in other earthworm collection methods (or in how the site preparation video displayed)?

The other sample areas (and the one shown in the site preparation video) is specifically 25cm x 25cm, while in this method you need to identify a larger area which is not as specific.

Hand Sample: using a small spade or shovel and digging the soil out of a sample area (approximately 15cm deep); then searching through the removed soil for earthworms.

Key Points

- simple form of sampling (although digging can be difficult depending on the soil)
- need to get deep into the soil for a better sample
- best for collecting litter dwelling and soil dwelling earthworms (the deep burrowing earthworms can sense the vibrations of the digging)

Questions for Consideration

1. What are the advantages of hand sampling for earthworms?

It is simple and only minimal tools are required. The sample plot area is small and you are able to sift through all of the soil in that plot.

2. Why do you think it is important to dig at least 15cm in the ground to obtain your sample?

In order to collect as much of the area where the earthworms may be present.

Midden Count: identifying middens (piles of earthworm feces); each midden holds one earthworm.

Key Points

- not difficult, although you need to be able to identify a midden
- each midden has a burrow hole in the middle
- only one earthworm lives in each burrow hole
- best for collecting deep burrowing earthworms (they are the only kind that lives in the burrows)

Questions for Consideration

1. What are the advantages of sampling for earthworms using middens?
It is very simple and no special tools or materials are required.
2. Why might we not get an accurate number of earthworms in our sample area if we are only counting middens?
We are assuming that each midden has an earthworm living in it, which could cause us to overestimate the number of earthworms. There is only one species of earthworm that creates middens, therefore we may be underestimating the number of earthworms in total.

5. Closure

Remind students that they will be outside during the next class to collect earthworm data and they should dress appropriately for the weather (e.g. if it is supposed to rain they should be wearing waterproof shoes and they may want to bring a change of clothes in case they get wet). If students will be using the app, ask them to download the worm tracker app (which can be downloaded for free [here](#)) to their mobile device (currently only available for iPad or iPhone).

Lesson 3: Earthworm Collection

Purpose

- Identify different types (adults and juveniles) and species of earthworms
- Collect data using one or more earthworm collection methods

Overview

Students will be introduced to different species of earthworms. They will then collect earthworm data using one or more earthworm collection methods.

Program of Studies Outcomes

Outcomes for Science, Technology and Society (STS) and Knowledge

3. Monitor a local environment, and assess the impacts of environmental factors on growth, health and reproduction of organisms in that environment
 - investigate a variety of habitats, and describe and interpret distribution patterns of living things found in those habitats
4. Describe the relationships among knowledge, decisions and actions in maintaining life-supporting environments
 - describe and interpret examples of scientific investigations that serve to inform environmental decision making
 - analyze a local environmental issue or problem based on evidence from a variety of sources, and identify possible actions and consequences

Skill Outcomes

Initiating and Planning

- select appropriate methods and tools for collecting data and information

Performing and Recording

- use tools and apparatus effectively and accurately for collecting data

Analyzing and Interpreting

- classify organisms found in a study plot

Communication and Teamwork

- communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means

Attitude Outcomes

Collaboration

- Work collaboratively in carrying out investigations and in generating and evaluating ideas

Safety

- Show concern for safety in planning, carrying out and reviewing activities

Materials

- [Powerpoint presentation](#) – Identifying Earthworms
- [Alberta Worm Invasion – Worm Tracker App](#) or [Earthworm Data Sheet](#) (one per group) and computers that students can use to manually enter the data at <http://worms.educ.ualberta.ca/app/>
- [User guide for the Worm Tracker App](#)
- Earthworm Collection Kit (one per group)
 - Quadrat (for instructions on how to create this, click [here](#))

- Magnifying glasses
- Ruler
- 3 plastic cups filled halfway with water and sealed with a lid
- Mustard water – one 2L jug per sample site (*if using the mustard extraction method*)
- Spade or shovel (*if using the hand sample method*)
- Gloves (*optional*)
- *Tarps or garbage bags for collection materials*

Mustard Water Preparation (per jug)

Mix 20grams of ground mustard powder with 2L of water in a jug. Shake well. Prepare the morning of or the night before. If you prepare the mixture too early the mustard may harden to the bottom of the jug.

Lesson Activities

1. Introduction (10 minutes)

Remind students that one way to help us make decisions (for example, with our focus question ‘should earthworms be banned in Alberta?’) is to collect some data or evidence. The data that students will be collecting is a count of how many and what kinds of earthworms there are in a chosen site (this may be a site chosen on school grounds or you may choose to go off school grounds with the appropriate permission). Go through with the students the PowerPoint presentation – Identifying Earthworms. They should be able to identify juvenile, litter dwelling, soil dwelling and deep burrowing earthworms.

2. Earthworm Collection (40+ min)

Adjust the instructions as necessary depending on the method(s) you choose to use and the number of classes you have to dedicate to this activity. Provide each group with an Earthworm Collection Kit. Have your groups collect earthworm data in 3 different areas (ideally, students would be able to collect data in multiple habitats – example, schoolyard, wooded area, and near a roadside). Students will use the cups to collect their earthworms temporarily while they are sampling the site. Once they have completed their sampling. Have them return the earthworms.

3. Closure (5 min)

Once the activity is complete, make sure that students have returned their earthworms, dumped the water in the plastic cups, and put all materials back in the kit. If there is extra mustard water it will keep for a few days but will then need to be flushed down the sink with water.

*If students recorded the data on the paper data sheets, provide them time to manually enter the data on computers once back in the classroom.

Lesson 4: Earthworm Data Analysis

Purpose

- Analyze data collected from earthworm collection

Overview

Students will begin to analyze the data they have collected and compare it to other data that has been collected across Alberta. They will then have a chance to develop ideas about the data that has been collected.

Program of Studies Outcomes

Outcomes for Science, Technology and Society (STS) and Knowledge

- Investigate and describe relationships between humans and their environments, and identify related issues and scientific questions
 - describe examples of interaction and interdependency within an ecosystem
 - identify examples of human impacts on ecosystems, and investigate and analyze the link between these impacts and the human wants and needs that give rise to them
 - analyze personal and public decisions that involve consideration of environmental impacts, and identify needs for scientific knowledge that can inform those decisions
- Monitor a local environment, and assess the impacts of environmental factors on growth, health and reproduction of organisms in that environment
 - investigate a variety of habitats, and describe and interpret distribution patterns of living things found in those habitats
- Describe the relationships among knowledge, decisions and actions in maintaining life-supporting environments
 - identify intended and unintended consequences of human activities within local and global environments
 - analyze a local environmental issue or problem based on evidence from a variety of sources, and identify possible actions and consequences

Skills Outcomes

Initiating and Planning

- state a prediction and a hypothesis based on background information or an observed pattern of events

Performing and Recording

- estimate measurements

Analyzing and Interpreting

- compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs and line graphs

Attitude Outcomes

Scientific Inquiry

- Seek and apply evidence when evaluating alternative approaches to investigations, problems and issues

Collaboration

- Work collaboratively in carrying out investigations and in generating and evaluating ideas

Materials

- Computers, iPads, or smartphones with Google Earth installed on each
- [Analysis of Earthworm Data Handout](#)

Lesson Activities

1. Introduction (10+ min)

If students used a paper copy of the Earthworm Data Sheet, they will need to input the data into the [web-based application](#). Inputting their data may take time; therefore you may need more than one day for this lesson. Once data has been uploaded either through the Worm Tracker app or the web-based application, students can download the most recent [map data file](#) for Google Earth.

Google Earth

The following tutorial will assist you in downloading Google Earth: [Setting up Google Earth for Exploring Your Data](#).

Once you have downloaded Google Earth, watch the following tutorial: [Viewing your Data in Google Earth](#).

Both videos are also available on [Alberta Worm Invasion: Worm Tracker website](#).

2. Data Analysis (30+ min)

Demonstrate for the students how Google Earth works (if you need instructions on how to do this, see the links above). Have students download the map data from the following [link](#) (if this does not work you can download the .kml file from the Worm Tracker website [here](#)). Once the students have opened the map data in Google Earth, have them work with their group to answer the questions on the worksheet – Analysis of Earthworm Data.

3. Conclusion (10 min)

Go through the worksheet with the students (alternatively, you may choose to use this worksheet as a form of assessment).

Lesson 5: Earthworm Impacts

Purpose

- Research the impact of earthworms on the environment and the impact of humans on earthworms

Overview

Students will research information about the impact of earthworms on the environment or the impact of humans on earthworms and become an 'expert' in one of these areas. They will then conduct a jigsaw activity to share this information with others.

Program of Studies Outcomes

Outcomes for Science, Technology and Society (STS) and Knowledge

1. Investigate and describe relationships between humans and their environments, and identify related issues and scientific questions

- describe examples of interaction and interdependency within an ecosystem
- identify examples of human impacts on ecosystems, and investigate and analyze the link between these impacts and the human wants and needs that give rise to them
- analyze personal and public decisions that involve consideration of environmental impacts, and identify needs for scientific knowledge that can inform those decisions

4. Describe the relationships among knowledge, decisions and actions in maintaining life-supporting environments

- identify intended and unintended consequences of human activities within local and global environments
- analyze a local environmental issue or problem based on evidence from a variety of sources, and identify possible actions and consequences

Skills Outcomes

Performing and Recording

- research information relevant to a given problem or issue

Communication and Teamwork

- communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means

Attitude Outcomes

Collaboration

- Work collaboratively in carrying out investigations and in generating and evaluating ideas

Materials

- [KWL chart](#) (individual and class)
- [Impacts of Earthworms Handout](#) (can be modified if not all articles are used)
- [Impacts articles](#)
 - Impacts of Earthworms in Gardens
 - Impacts of Earthworms on Other Species
 - Impacts of Earthworms on Vegetation
 - Impacts of Earthworms on Leaf Litter
 - Impacts of Earthworms on the Nutrient Cycle (optional)
 - Impacts of Earthworms and Composting

- Impacts of Humans on Earthworm migration
- Impacts of Fishing on Earthworm migration

Lesson Activities

1. Introduction (5 min)

Remind students that one of the purposes of the earthworm collection activity was to collect some data to help answer the question, 'should earthworms be banned in Alberta?'. Using the class KWL chart, briefly highlight some of the key points from the data analysis and have students fill in this information on their KWL charts under **L**.

2. Impacts Jigsaw (35 min)

On the KWL chart, revisit with students some of the other ways to collect information, specifically doing some computer research/talking to experts. Give each student a copy of the Impacts of Earthworms Handout.

- a) In order to learn about the environmental impacts that earthworms have and the impacts that humans have on earthworm migration, assign each 'expert' group one of the impact articles (you may have to assign the same article to more than one group or give more than one article to a group depending on how many groups you have).
- b) Have each group read their article(s) and summarize the positive and negative impacts on the handout. Computers should be available for students in case they would like to do some more research regarding their assigned topic. Students will become the 'experts' for the impact they are assigned so all students in the group will need to be able to briefly summarize the impact for their peers in the next part of the activity. **(20 min)**
- c) Regroup the students so that there is at least one 'expert' from each impact in the new groups. Have each 'expert' provide a brief summary of the impact; explaining any positive or negative impacts on other species, populations or ecosystems. The students should fill in the chart on the handout for each impact based upon the 'expert' presentation. **(15 min)**

3. Conclusion (10 min)

Once they have completed the jigsaw, have the original 'expert' groups come back together and summarize what they have learned about each of the impacts (some groups may have gathered more or less information so this is a chance to hear what was said in each group). Ask students to consider if they think anything should be done to control earthworms in Alberta for the next lesson (e.g. should they be banned or controlled in some other way).

Lesson 6: Should Earthworms be Banned in Alberta?

Purpose

- Evaluate whether earthworms should be banned in Alberta
- Present findings from research and decision

Overview

In this lesson, you will review with students what they have learned so far about earthworms and discuss why making decisions about whether earthworms should be controlled in Alberta is not a one sided issue. Students will then evaluate the information they have gathered and make a decision on whether they think earthworms should be controlled in Alberta. They will present their decision and evidence to the class.

Program of Studies Outcomes

Outcomes for Science, Technology and Society (STS) and Knowledge

1. Investigate and describe relationships between humans and their environments, and identify related issues and scientific questions
 - describe examples of interaction and interdependency within an ecosystem
 - identify examples of human impacts on ecosystems, and investigate and analyze the link between these impacts and the human wants and needs that give rise to them
 - analyze personal and public decisions that involve consideration of environmental impacts, and identify needs for scientific knowledge that can inform those decisions
4. Describe the relationships among knowledge, decisions and actions in maintaining life-supporting environments
 - identify intended and unintended consequences of human activities within local and global environments
 - describe and interpret examples of scientific investigations that serve to inform environmental decision making
 - analyze a local environmental issue or problem based on evidence from a variety of sources, and identify possible actions and consequences

Skills Outcomes

Performing and Recording

- research information relevant to a given problem or issue
- select and integrate information from various print and electronic sources or from several parts of the same source

Analyzing and Interpreting

- identify strengths and weaknesses of different methods of collecting and displaying data

Communication and Teamwork

- communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means
- defend a given position on an issue, based on their findings

Attitude Outcomes

Interest in Science

- Show interest in science-related questions and issues, and pursue personal interests and career possibilities within science-related fields

Mutual Respect

- Appreciate that scientific understanding evolves from the interaction of ideas involving

people with different views and backgrounds

Scientific Inquiry

- Seek and apply evidence when evaluating alternative approaches to investigations, problems and issues

Collaboration

- Work collaboratively in carrying out investigations and in generating and evaluating ideas

Materials

- [KWL charts](#) (individual and class)
- Computers, mobile devices
- Poster materials
- [Alberta Earthworm Invasion Project Rubric](#)

Lesson Activities

1. Introduction (5 min)

Have students take out their KWL charts (and project the class KWL chart) and their Impacts of Earthworms Handouts. Briefly discuss with students what they have learned in the previous lessons about the impacts of earthworms on other species, populations, and ecosystems and the impacts that humans have on the migration of earthworms. Remind students of the overarching question for the unit: Should earthworms be banned in Alberta? Tell them that in this lesson they will take on the role of a different member of the community (e.g. fisherman, forester). From the perspective of that member of the community they will be asked to come to a decision about whether or not earthworms should be controlled in Alberta and if so, how? Controlling earthworms could include a complete or partial ban on the sale of earthworms, efforts to eliminate earthworms already present in Alberta, and/or educational campaigns to change people's behavior.

2. Should Earthworms be Banned in Alberta? (2 classes)

For this activity, you should decide on the different roles that you will assign students. Possible roles include: fisherman, forester, gardener, nature club member, environmentalist. The different roles will have different primary concerns. Possible areas of concern for each role are listed below.

- Fisherman – will likely be concerned with any decision that would affect their ability to use worms as bait.
- Forester – will likely be concerned with how the spread of earthworms will impact tree species in forests.
- Gardener – will likely be concerned with any decision that would limit earthworms in gardens or purchased for compost bins.
- Nature club member – will likely be concerned with how the spread of earthworms will impact wildlife species.
- Environmentalist – will likely be concerned with how the spread of earthworms will impact native species and changes to carbon and nitrogen cycling.

Assign students to groups and assign each group to take on one of the roles. In their groups, students should decide what actions should be taken regarding earthworms in Alberta from the perspective of the role they are assigned. They should support their decision based on evidence from the data that has been collected on earthworms and what they have learned through the impacts activity. Students should discuss the impacts of their decision on earthworms, humans, other species, and the environment.

Once they have made their decision, students will either create a poster or make a multimedia presentation to present their decision and the evidence to support their decision. Encourage students to search out additional information (e.g. from the Internet) if needed to support their decision.

3. Conclusion: Town Hall Meeting (1 class)

Have students present their poster or multimedia presentation to the class. As each group presents, encourage other students to ask questions of the groups about their decisions. For example, are their impacts of the decision that the group hasn't considered? After all of the groups have presented, have each student decide what approach they think is best and write a reflection describing their decision and their reasons for it.

4. Assessment

The rubric listed in the materials list can be used to assess the group projects or modified (by removing the "presentation" criteria) to be used as an individual assessment for the final student reflections.