Unit 6.6, Lesson 7: Invasive Species

Lesson Plan

Teaching Time: 3 Class Periods (assuming 50 minute periods)

Instructional Setting:

- Classroom with a computer and projector

Lesson Question:

- What might be the effects of adding a new species to an ecosystem?

Gotta Have Checklist

- How changes to the biotic parts of the ecosystem affect things like the resources available, competition, predation and/or mutualism.
- How individuals are affected by a change to the biotic parts of the ecosystem.
- How populations are affected by a change to the biotic parts of the ecosystem.

Unit Summary Table (teacher version)

Lesson Key Concepts (DCI & CCC)	• Ecosystems can undergo big changes. • A change to a biotic part of the ecosystem could affect the entire ecosystem. • Small changes in one part of a system might cause large changes in another part. • Patterns can be used to identify cause and effect relationships.
Lesson Key Practices	• Articulate a statement that connects phenomena to scientific ideas.

Learning Performances

1. Students will analyze and interpret data that demonstrates how small changes in one part of an ecosystem can cause large changes in another part of the ecosystem.
2. Students will construct explanations supported by evidence for how populations within ecosystems respond to biotic disruptions.
3. Students will obtain and communicate information on the effects of different types of invasive species in Michigan's ecosystems.

NGSS Connections

Primary Subcomponents

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data ● Analyze and interpret data to provide evidence for phenomena. (MS-LS2-1) **Constructing Explanations** ● Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (MS-LS2-2)	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** ● Ecosystems are dynamic in nature, their characteristics can vary over time. Disruptions to any ~~physical or~~ biological components of an ecosystem can lead to shifts in populations. (MS-LS2-2)	**Stability and Change** ● Small changes in one part of a system might cause large changes in another part. (MS-LS2-4)

Lesson Introduction:

In the previous lesson, students considered the relationship between the physical components of an environment and its populations of organisms. They learned that a change in a physical component, such as an increase in snowfall, can help to determine the number of organisms in a population, such as the white-tailed deer of Michigan.

In this lesson, students explore the relationship between the biological components of the environment and populations. They see that a disruption, or change, in a biological component can lead to shifts in the numbers of organisms within an ecosystem. These biological disturbances can affect the amount of predation, competition and/or availability of resources for organisms, causing populations to either increase or decrease. Disturbances are not necessarily bad, for example historically in lodgepole pine forests in the Western US, periodic epidemics of mountain pine beetles kill old trees, opening up habitat for younger pine trees. These periodic epidemics are part of the natural ecosystem. Biological disturbances are also caused by humans. The most common example is the introduction of species to new ecosystems.

In this lesson, students examine the effects on populations in an ecosystem when an organism that does not normally live in that ecosystem is introduced. Species that have naturally evolved in an area are referred to as **native species**. Other species that migrate into, or are deliberately or accidentally introduced into an ecosystem by people, are called **non-native species**. Many nonnative species are beneficial to people, such as wheat, cattle, and chickens, which are major sources of food. However, when a nonnative species has few or no predators and/or competition for the things it needs, its population can increase. For example, a nonnative species with few predators may outcompete native species for available resources, causing the populations of native species to decrease. When a species causes economic or ecological harm it is called an **invasive species**. An invasive species can change specific physical or biological components of the ecosystem, such as when invasive animal species eats food that other organisms need or when invasive plants increase the shade experienced by other plants, making it harder for them to get needed light.

 Additional Resources to Support Teacher Background Knowledge

Science Words		
Previous Lessons	**This Lesson**	**Future Lessons**
Biological Competition Disturbances Ecosystem Interdependence Mutualism Physical Populations Population Growth Predation Predator Prey Resources	**Invasive species** **Native species** **Nonnative species**	

Advance Preparation

- Prepare copies of student resources as needed (see phase summaries).

Safety Considerations

- None

Mi-STAR Lesson Structure

Anchoring Experience

Phase Summary:

Students examine how a change to one biotic component of an ecosystem can have an effect on many other parts. Students view a video that illustrates how the reintroduction of wolves in a national park can cause a change in its rivers.

Resources Needed for this Instructional Phase:

- L07 Anchor Video 1

Student Steps:

1. Individually, students respond to the following question: Can a wolf change a river?

2. Students share their ideas with a partner. Pairs share their ideas with the class.

3. Students watch L07 Anchor Video 1**.**

   Teacher Note: This is **not** an example of invasive species. Wolves are a native species within Yellowstone Park, but by the 1930's humans had killed all the wolves. The killing of all the wolves is often considered a human caused disturbance. Reintroducing the wolves was also a human caused biological disturbance, it was a change to the biotic ecosystem that happened as a discrete event.

4. Students share their observations with a group and then groups share their common observations with the class.

5. Individually, students record their answers to the lesson question:
   - What might be the effects of adding a new species to an ecosystem?

Uncover Your Ideas

Phase Summary:

Students create graphs in order to analyze plant species data for a wetland ecosystem. The data shows the effect of purple loosestrife on the number of other plant species found in a wetland area. Students identify the overall pattern in the data by drawing a line through their graphed data points.

Resources Needed for this Instructional Phase:

- Per Class
  - 6.6_L07_Slides_InvasivePlants
- Per Pair
  - Graph paper
  - 6.6_L07_Uncover_Student_Data
- Teacher Resources
  - 6.6_UnitSummaryTable_TeacherVersion

Student Steps:

1. Students observe the two images of the ecosystem shown on slide 1 of 6.6_L07_Slides_InvasivePlants. They are provided the following scenario:

   The plants with the purple flowers shown in the second image are called purple loosestrife. Some people are concerned that the purple loosestrife is taking over the ecosystem and harming plants that normally grow there, causing them to disappear. A local politician argues that the purple loosestrife is not a problem and is not affecting other plant species. Rather, the purple loosestrife is taller and bigger than other plant species. All the other plants are still there, just harder to see.

2. Students work in groups and develop a list of evidence that would explain how the purple loosestrife is problematic to the ecosystem. Groups share their ideas with the class.

3. Pairs of students are provided a piece of graph paper and the student resource 6.6_L07_Uncover_Student_Data. Students create a graph of the data provided on the resource.

   Teacher Note: If students are not familiar with a scatterplot, they may need some assistance determining which variables should be represented on each axis. For the data

provided, students should label the x-axis as the percent of study area with purple loosestrife and the y-axis as the total number of plant species present. The data table provided on the student resource comes from a study of the impacts of purple loosestrife carried out in 2006. Following is the table as well as a graph of the data that was developed from the study.

Percent of Study Area with Purple Loosestrife	Number of Plant Species Present
17	42
18	32
22	20
45	20
65	8
85	5
92	6

Data estimated from Figure 5(a) in Schooler et al. 2006.

Teacher Note: As instructed on the student resource, after students complete their graphs they draw a single, straight line through the middle of the data points. This line should estimate the overall pattern and may differ slightly among students. Following is an example graph showing an example line.

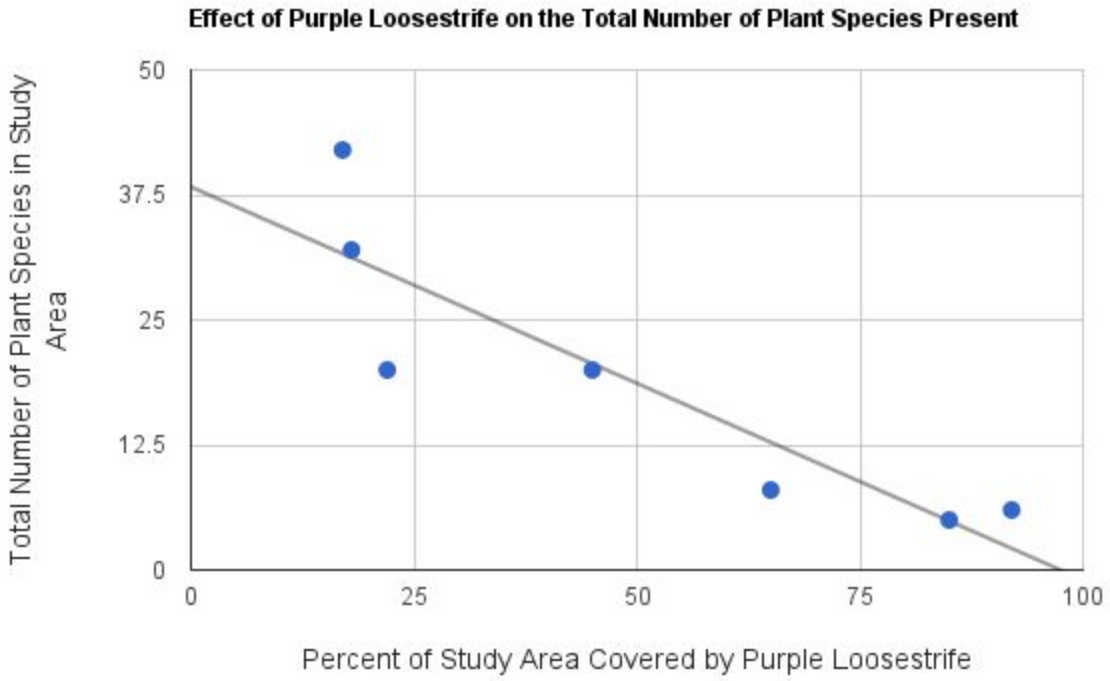

Figure derived from data estimated from Schooler et al. 2006.

4. In small groups, students reason by analyzing their graphs and discussing the overall pattern between percent cover of purple loosestrife and the number of other plant species that can be found in the wetland ecosystem and discuss questions in the table below.

Example Guiding Questions	Example Student Answers
What evidence did you gather about the relationship between the percent cover of purple loosestrife and the number of other plant species present in the wetland ecosystem? Make sure to support your explanation with the data you gathered and graphs you made.	*Based on the graphs that we made as the percent of a study area covered by purple loosestrife increase the total number of plant species decreased.*
Provide a statement in which you support or refute the politician's claim "that purple loosestrife is not a problem because it	*The purple loosestrife is in fact a problem because the data we gathered shows that as the percent of the study area covered*

does not actually reduce the number of species present.“ Support your statement with your analysis of the data.	*by purple loosestrife increased the total number of species found in the study area decreased.*

5. In small groups, students use their observations to derive an initial argument about how the politician's claim is supported by the evidence on the graph and record their initial reasoning in the 6.6_L07_Uncover_Student_Data resource.

6. Students refer to row A. "What activity did we do?" and row B. "What evidence did we gather?" on the 6.6_UnitSummaryTable_Student Version. Note that students will enter information into the Unit Summary Table after the Uncover, Share, and Connect phases of lessons 2-8.

   Teacher Note: To save time, these two rows can be partially or completely filled in by the teacher prior to teaching the unit, or can be filled in by the students. Example entries can be found in the 6.6_UnitSummaryTable_TeacherVersion (note these entries are not necessarily in student language).

Share Your Ideas

Phase Summary:

Students interpret the graphs and trend lines they developed in the previous phase. They explain that as the area covered by purple loosestrife in the ecosystem increases, the number of native species decreases. Students are introduced to the science words: native species, nonnative species, and invasive species.

Resources Needed for this Instructional Phase:

- Per Class
  - 6.6_L07_Slides_InvasivePlants
- Teacher Resources
  - 6.6_UnitSummaryTable_TeacherVersion

Student Steps:

1. Student groups share their initial arguments for how the politician's claim is supported by the evidence on the graph in the Uncover phase by posting their whiteboards or verbally

sharing their explanations. As student groups are sharing their explanations, focus the students to look for similarities and differences by using these questions.

- What similarities do you see in the explanations?
- What difference do you see in the explanations?

2. In a whole group consensus discussion, students craft a class-wide argument to how the politician's claim is supported by evidence on the graph based on the similarities that the students noticed. Also have them note the points on which they do not agree. Simultaneously, using meaningful similarities in the student arguments, the teacher and class begin to identify and record relationships among key concepts for an initial Gotta Have Checklist.

   Teacher Note: To assist you in identifying these relationships you may refer to the GHC for this lesson, or you may simply give your students the GHC.

3. As students bring up the concepts of native species, nonnative species, and invasive species, lead them to define these science words using questions similar to the following:

Example Guiding Questions	Example Student Answers
What would you call a species that has naturally evolved in an area?	*Native species*
What would you call a species that migrates into, or is deliberately or accidentally introduced into an ecosystem?	*Nonnative species*
What would you call a non-native species that causes ecological or economic harm?	*Invasive species*

Teacher Note: It is important to highlight to students the difference between a reduction in population size and the disappearance of native species from an ecosystem. At large scales (continents), native species are unlikely to disappear, as they are not frequently driven to extinction across their entire range by invasive species (though examples of extinctions do exist.) However, at smaller scales, native populations may disappear from some areas, or populations are reduced such that the number of species remains the same, but many of the native species persist as greatly reduced populations.

More information on purple loosestrife in Michigan can be found on the following website: L07 Share Resource 1

4. Students check their argument against the list of science words below. If necessary, students are introduced to any unused science words; first by prompting students with questions that lead them to the terms similar to the following, and then by providing the definitions. Use the definitions and additional information on slides 2-7 of the resource 6.6_L07_Slides_InvasivePlants to revise their explanations. Slides 2-5 provides students with following Science Word definitions:

   Native species: species that have naturally evolved in an area.
   Nonnative species: other species that migrate into, or are deliberately or accidentally introduced into an ecosystem.
   Invasive species: species that cause ecological or economic harm.

   In whole group, students formalize their explanation from the consensus discussion using the science words above.

   Teacher note: The goal for the previous two steps is to prepare students to use correct and appropriate terminology when explaining **this lesson's key concepts** and relationships. If needed, use other resources (readings, websites, textbook sections, grade appropriate science articles) along with note-taking organizers or student guides to help students connect their thinking to the accepted body of science knowledge and terminology.

5. The class discusses why purple loosestrife is an invasive species:

Example Guiding Question	Example Student Answer
Why might purple loosestrife tend to become the most common species in areas where it has been introduced? Make sure to use the science words of native, non-native and invasive species in our answer.	*Purple loosestrife is an effective competitor for resources compared to other plant species. In addition, there are no native species that feed on purple loosestrife.*

5. Students individually construct an explanation to the lesson question in row C. "My answer to the lesson question(s):" on the 6.6_UnitSummaryTable_Student Version. Students use the Science Words list and GHC developed in previous steps to check their explanation. The main purpose of the Unit Summary Table is to support students in addressing lesson question(s) by organizing the question(s), details of the investigation conducted, and the evidence gathered, all in one place.

   Teacher Note: Example entries can be found in the 6.6_UnitSummaryTable_TeacherVersion (note these entries are not necessarily in student language). Students should use the

science words of native, non-native and invasive species in the answer to the lesson question in the Unit Summary Table.

Connect Your Ideas (Connection to the Unit Challenge)

Phase Summary:

Students work in their Unit Challenge ecosystem teams to gather information on an invasive species that has the potential to impact their ecosystem. Students learn about the invasive species by reading an informational fact sheet that describes how the species lives and the resources it needs. Students use the information to predict how the invasive species could impact organisms that are native to the ecosystem.

Resources Needed for this Instructional Phase:

- Per Group
  - 6.6_UnitChallenge_Student_InvasiveSpeciesFactSheets
  - 6.6_UnitChallenge_Student_InvasiveSpeciesPredictionChart
- Teacher Resources
  - 6.6_UnitSummaryTable_TeacherVersion

Student Steps:

1. Students meet with their Unit Challenge ecosystem teams. Each team is provided with the appropriate fact sheet that describes an invasive species that can be found in its ecosystem. Fact sheets are provided in the resource: 6.6_UnitChallenge_Student_InvasiveSpeciesFactSheets

2. Students obtain information from their fact sheets. They identify the following:
   - The common and scientific name of the invasive species;
   - Where the species originates;
   - Where it can be found;
   - Why it is (or could be) successful at invading Michigan ecosystems;
   - What effect it may have on native species (e.g. *Hemlock wooly adelgid kills Hemlock trees.)*

   Teacher Note: Each fact sheet contains optional questions at the bottom. These questions are designed to let students learn some “fun facts” about each invasive.

3. Each student in a team uses information from their fact sheet to predict the immediate and long term impacts of the invasive species on their assigned organism as well as the whole ecosystem. Students record their predictions.

   Teacher Note: At this time, some students may think that their organism is unaffected by the invasive species. As students discuss the invasive species with their ecosystem teams they begin to identify potential impacts. Students who think there is no impact should record why they think their organism would be unaffected.

4. As a team, students compare individual predictions as to how the introduction of an invasive species might affect their organisms.

5. Teams use the chart 6.6_UnitChallenge_Student_InvasiveSpeciesPredictionChart to record their ideas.

6. Teams share with the class their predictions for the effects of the invasive on their ecosystem.

7. Students complete row D "Connecting my ideas to the Unit Challenge", on the 6.6_UnitSummaryTable_Student Version. Students modify their scientific explanations to address the lesson question(s) in the context of the Unit Challenge, based on the Connecting Your Ideas investigation and using the lesson "Gotta Have Checklist" and key concepts as a reference.

   Teacher Note: Example entries can be found in the 6.6_UnitSummaryTable_TeacherVersion (note these entries are not necessarily in student language).

Check Your Progress

Phase Summary:

Students are provided with data of how an invasive species is affecting a hypothetical ecosystem. They analyze the data and determine if the invasive species has had an effect on native species. They use patterns in the provided data to support or refute a scientist's claim using evidence. Finally, students will revisit the lesson question and reflect on how their understanding of the lesson question has changed.

Resources Needed for this Instructional Phase:

- Per Student
  - 6.6_L07_Check_Student_EA_StudentCopy
- Teacher Resources
  - 6.6_L07_Check_Teacher_EA_Student Exemplar
  - 6.6_L07_Check_Teacher_EA_Instructions&Rubric

Student Steps:

1. Students individually analyze data to determine the impact of the Snark, a hypothetical invasive species. Each student is provided a copy of 6.6_L07_Check_Student_EA_StudentCopy. This resource sheet contains a graph that shows the relationship between the Snark population and the number of native species in the area.

   Teacher Note: Read the directions and scenario to students. The intent of the EA is to assess students' ability to interpret graphs rather than assessing reading comprehension.

2. Students use the graph to answer the questions provided on the resource sheet. Answers to questions can be found on the following teacher resource: 6.6_L07_Check_Teacher_EA_Student Exemplar

3. Instructions for assessing the performance on the student resource sheet, through the use of a rubric, can be found at: 6.6_L07_Check_Teacher_EA_Instructions&Rubric

4. Individually, students record and/or refine their answers to the lesson questions a second time using the "Gotta Have Checklist" and an evidence-based explanation:
   - What might be the effects of adding a new species to an ecosystem?

5. Students refer back to the initial answers that they recorded in the Anchoring Experience phase and respond to a prompt similar to the following:
   - Explain how the activities in this lesson confirmed, challenged, or otherwise changed your original ideas about the lesson question.

Sources

1. Schooler, S. S., P. E. McEvoy, and E. M. Coombs. 2006. Negative per capita effects of purple loosestrife and reed canary grass on plant diversity of wetland communities. Diversity and Distributions 12:351-363

2. Pimentel, D., Zuniga, R., & Morrison, D. (2005). Update on the environmental and economic costs associated with alien-invasive species in the United States. Ecological economics, 52(3), 273-288.