“Hunting” Invasive Flora in the Middlesex Fells

Grade: Grade 9
Place of Focus: Middlesex Fells (Mustang Trail)
Participatory Science Protocol: iNaturalist and Anecdata
Partner(s): Friends of the Fells and Earthwise Aware (EwA)

Massachusetts Curriculum Framework for Science and Technology/Engineering Standards

- **HS-LS2-7.** Analyze direct and indirect effects of human activities on biodiversity and ecosystem health, specifically habitat fragmentation, introduction of non-native or invasive species, overharvesting, pollution, and climate change. Evaluate and refine a solution for reducing the impacts of human activities on biodiversity and ecosystem health.
- **HS-LS2-2.** Use mathematical representations to support explanations that biotic and abiotic factors affect biodiversity, including genetic diversity within a population and species diversity within an ecosystem.

Learning Objectives

By the end of the field lesson, students will:

1. Define invasive species
2. Explain how invasive species harm ecosystems
3. Identify examples of invasive flora in the Middlesex Fells and other parts of Medford
4. Describe traits/adaptations that have allowed certain invasive flora to thrive in the Middlesex Fells and other parts of Medford

Pre-Visit Learning

Prior to the site trip, students should understand:

- Invasive species are species that are not native to an ecosystem
- Humans introduce invasive species to new areas, either intentionally or unintentionally
- Invasive species harm ecosystems because they have no natural predators in their new environment; this allows them to reproduce rapidly and outcompete native species

Essential Questions

1. How do biotic and abiotic factors impact populations?
2. How have human activities impacted biodiversity and ecosystem health?

Guiding Questions

1. What types of invasive flora are present in the Middlesex Fells?
2. How prevalent are invasive flora in the Middlesex Fells?
3. What traits/adaptations allow certain invasive flora to thrive in the Middlesex Fells?

Field Visit Preparations

Time

- 1 class period (56 minutes)
  - 15 minutes entering the classroom, using the bathroom, reminding students about safety (see safety information below), applying sunscreen/bugspray, walking outside to the Mustang Loop in the Middlesex Fells
  - 25 minutes searching for invasive flora in the Fells; using iNaturalist app to document invasive species
  - 10 minutes reflection
  - 6 minutes to check for ticks, return to classroom, wrap up

Materials and Supplies

- Student cell phones - students will work in groups of 3; 1-2 student(s) in each group need a cell phone with access to apps
  - iNaturalist app (free)
  - Anecdata app (free)
- Clipboards (24)
- Pencils
- Student handouts
  - iNaturalist protocol sheet (x1 per group)
  - Anecdata protocol sheet (x1 per group)
  - EwA Invasive Flora Patrol Datasheet (x3 per group)
  - Paper Tally Sheet where students record species names and tallies (x1 per group)
  - The Trail Adopter's Guide to Invasive Plants (x1 per group)

Logistics

- Our site is the Mustang Loop in the Middlesex Fells. This loop is directly next to the high school, so we will walk.
- Students will leave backpacks and unnecessary personal belongings in the classroom, which will be locked.
- Students can use the bathroom in the first 10 minutes of the class period if needed, and then we will walk to the Mustang Loop as a class.
- Students can bring a water bottle, sunscreen, and bug spray outside if they would like to.
- During the site visit, students will stay on the Mustang loop trail (1 mile loop) within sight of the teacher.
- Students will work in groups of 3 and must stay with their group at all times. Every 5-10 minutes, the teacher will pause and gather students for a head count.

Scientific Protocol

- Students walk through the Mustang Trail and search for invasive species. Students should be able to identify invasive species based on the research they performed during the previous class period. One student in each group will also have The Trail Adopter's Guide to Invasive Plants (from Friends of the Fells) to help identify invasive species. Students can also use iNaturalist to confirm species identifications.
- When students find an invasive species, they will use the iNaturalist app (iNaturalist protocol sheet), the Anecdata app (Anecdata protocol sheet), and the EwA Invasive Flora Patrol Datasheet to record the invasive species. Students upload photos of each observation to both the iNaturalist app and the Anecdata app. Students should use the paper EwA Invasive Flora Patrol Datasheet to record between 1-3 of the invasive species they find (they should also upload these species to both apps).

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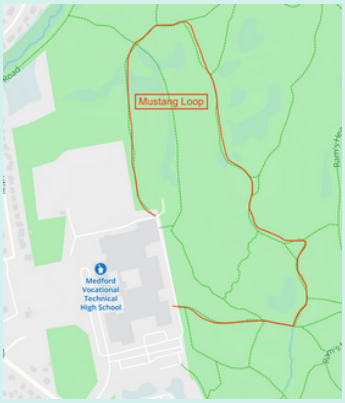
Scientific Protocol (cont.)

- *(cont. from previous)* Students do not need to use the paper EwA Invasive Flora Patrol Datasheet for all species. The paper datasheet is included to give students an idea as to how this data can be collected on paper in the absence of an app, but we will focus on collecting and analyzing data through the apps.
- In addition to the apps, students keep a paper record of the types of invasive plants they find (and the total number of each) (Tally Sheet).
- Group Roles (students work in groups of 3):
- Student A: Holds iNaturalist protocol sheet and uploads observations to iNaturalist
- Student B: Holds Anecdata protocol sheet and uploads observations to Anecdata; Holds EwA Invasive Flora Patrol Datasheet and chooses 1-3 findings to record on a data sheet
- Student C: Holds The Trail Adopter's Guide to Invasive Plants as a reference; Holds and records data on the Tally Sheet
- Teams earn 5 "points" for each invasive plant they capture. Students add up their total number of points at the end of the walk. The team with the most points wins a prize (choose from: stickers, small toys/fidgets, HW pass).

Field Visit Outline

Introduction

- Mustang Trail in the Middlesex Fells (1 mile loop) (see image)



(Map created on MapMyRun)

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Introduction (cont.)

Safety:

- Wear sneakers that can get dirty
- Do not touch plants/animals
- Do not disturb wildlife
- Hydrate before and after
- Check for ticks after exiting the Middlesex Fells
- Protect from the sun with hats, sunscreen, and physical barriers
- Students will work in groups of 3 and must stay with their group at all times

On-Site Expectations:

- Students will use the iNaturalist app, the Anecdata app, and the EwA Invasive Patrol Datasheet to record invasive flora they encounter.
- Students should use both apps to document any/all invasive species they find, uploading the species to our class project pages.
- Students should use the paper EwA Invasive Patrol Datasheet to record between 1-3 of the invasive species they find (they should also upload these species to both apps). Students do not need to use the paper EwA datasheet for all species. The paper datasheet is included to give students an idea as to how this data can be collected on paper in the absence of an app, but we will focus on collecting and analyzing data through the apps.

Learning Tasks

The entire activity requires 7 class periods; on-site visit occurs on day 4.

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Learning Tasks (cont.)

Day 1: Before the site visit (1 class period) (56 minutes): Introducing Invasive Species

- 5 minutes: Do Now
  - 2 minutes: Students pick up a "Do Now" slip and answer the "Do Now" question: What does "invasive" mean?
  - 3 minutes: Teacher asks 2-3 students to share their answers with the class.
- 10 minutes: Direct Instruction
  - Teacher introduces "invasive species" by playing the following video: TedEd Invasive Species
  - Teacher asks the class:
    - What is an invasive species?
    - Why do invasive species thrive in their new ecosystems?
    - Who moves invasive species into their new ecosystems? Is this always done intentionally?
- 25 minutes: Independent Research
  - Students independently research one invasive species online, using this handout as a guide Invasive Species Research.
- 10 minutes: Partner Sharing
  - Students share their research with a partner. Each partner gets 5 minutes to share.
- 6 minutes: Wrap Up
  - Teacher asks 1-3 student(s) to share a surprising/interesting fact about their invasive species with the whole class
  - Teacher previews the next three class periods:
    - Tomorrow, we will learn about ways that we can contribute to scientific research (participatory science).
    - The day after tomorrow, we will research invasive species found in Medford.
    - The following day, we will go outside to the Middlesex Fells to search for invasive species ourselves.

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Learning Tasks (cont.)

Day 2: Before the site visit (1 class period) (56 minutes): Introducing Participatory Science + Download Participatory Science Apps

- 30 minutes: Direct Instruction
  - 5 minutes:
    - Teacher introduces the term "participatory science" as an approach where members of the public contribute to larger scientific research.
    - Teacher tells students that participatory science used to be called "citizen science," but the name has since been changed in order increase inclusivity; the previously used vocabulary, "citizen science," had, potentially, exclusionary implications.
    - Teacher explains that in the episode we will watch, this type of science is referred to as "citizen science," but that it is now referred to as "participatory science," and this is the term we will use in class.
  - 20 minutes:
    - Teacher plays the first 20 minutes of Episode 1: Even Big Data Starts Small.
    - In notebooks, students take notes on examples of participatory science and its impacts while watching.
  - 5 minutes:
    - Teacher asks 3-4 students to share out examples of participatory science and its impacts from the video.
- 20 minutes:
  - Teacher tells students that we will be engaging in citizen science in two days; Students will have to download two apps (iNaturalist and Anecdata), which they will use to record observations of invasive species in the Middlesex Fells.
  - Teacher introduces iNaturalist using this video: iNaturalist Video Introduction.

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Learning Tasks (cont.)

        - Students download iNaturalist app, create an account, and join our class project page.
    - Teacher introduces Anecdata and Earthwise Aware (EwA) by showing these slides: Anecdata slides with directions.
        - Students download Anecdata app, create an account, and join our class project page.
- 6 minutes:
    - Teacher previews the plan for tomorrow and the following day:
        - Tomorrow, we will spend time in class researching invasive species that are present in the Middlesex Fells.
        - The following day, we will go outside to document those species in the iNaturalist and Anecdata apps.

Day 3: Before the site visit (1 class period) (56 minutes): Group Roles + Research on Invasive Species in the Middlesex Fells

- 6 minutes: Do Now
    - 3 minutes: Turn and Talk:

1. What is participatory science?
2. What are the benefits of participatory science?

- 3 minutes: Teacher asks 1-2 student(s) to share out their answers with the class.
- 20 minutes: Learning to Use the Apps
    - Teacher reminds students that they should have downloaded two apps (iNaturalist and Anecdata) yesterday.
    - Teacher tells students that tomorrow, we will be using these apps to engage in participatory science by searching for and documenting invasive flora in the Middlesex Fells.
    - Together, inside the classroom, teacher and students record a sample observation in each app and using the EwA Invasive Flora Patrol Datasheet; teacher tells students NOT to upload the sample observation to the apps, as it will skew the real data.

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Learning Tasks (cont.)

- 10 minutes: Group Roles
  - Teacher informs students that tomorrow, they will work in groups of 3 to use these apps to record invasive species in the Middlesex Fells.
    - Students will earn 5 points for each invasive plant they upload, and at the end of class, the team with the most points will win a prize.
  - Students select their groups and decide on who will perform each role:
    - Student A: Holds iNaturalist protocol sheet and uploads observations to iNaturalist
    - Student B: Holds Anecdata protocol sheet and uploads observations to Anecdata; Holds EwA Invasive Flora Patrol Datasheet and chooses 1-3 findings to record on a data sheet
    - Student C: Holds The Trail Adopter's Guide to Invasive Plants as a reference; Holds and records data on the Tally Sheet
- 20 minutes: Researching Invasive Species in the Middlesex Fells
  - Students use the following links to research examples of invasive species in the Middlesex Fells; teacher tells students that they will be on the lookout for these species tomorrow.
    - EwA Guide to Common Invasive Species in Middlesex County
    - The Trail Adopter's Guide to Invasive Plants
- 10 minutes: Recap and preparation for tomorrow
  - Teacher reminds students about safety for tomorrow and that we will meet in the classroom at the beginning of class.

Day 4: On-site visit (1 class period):

- 15 minutes:
  - Students enter the classroom and use the bathroom (if needed).
  - Students will be working in groups of 3. Each individual student gets a clipboard.

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Learning Tasks (cont.)

        - One group member gets the iNaturalist protocol; one group member gets Anecdata protocol and three EwA Invasive Flora Patrol Datasheets; one group member gets The Trail Adopter's Guide to Invasive Plants and the Tally Sheet.
    - Teacher reminds students about safety (see above).
    - Teacher takes a headcount.
    - Students and teacher walk outside to the courtyard and apply sunscreen and bugspray.
    - Students and teacher check for cars and walk together across the parking lot to the Mustang Loop entrance.
- 25 minutes:
    - Teacher leads students on a walk through the Mustang Loop (1 mile) in the Middlesex Fells.
    - As a group, we will stop periodically to give students time to search for invasive flora.
    - If students see invasive flora, one partner will upload a photo to iNaturalist; one partner will upload a photo to Anecdata, and one partner will document the species name (and tally) on their tally sheet.
- 10 minutes:
    - Reflection (see below)
- 6 minutes:
    - Check for ticks
    - Return to classroom

Reflections

10 minutes

- We will circle up in the courtyard before re-entering the high school.
- Students groups will share out their total points earned – we will determine who "caught" the most invasive species.
- Teacher asks students the following reflection questions (teacher can adjust the reflection questions based on the course of the class conversation):
  - What surprised you?
  - Did you expect to find this many invasive plants in our 1 mile loop? Did you expect to find more? Fewer?
  - Which type of invasive plant was most common for your group? For the whole class?
  - Were there any invasive species from our research that we didn't find? Why do you think this is the case?
  - Why do you think the plants we observed are able to survive in the Fells? What traits do they have that help them survive here? What conditions in the Fells allow them to survive here?
- Remind students that we will return to the classroom to gather belongings, and that they will then proceed to their next class after the bell rings.

Post-Visit Learning

Day 5: After Site Visit (1 Class Period) (56 minutes): Data Analysis and Reflection

- Each student complete their own copy of the following worksheet: Data Analysis and Reflection Handout
  - Students can work together in their groups of 3 to discuss ideas.

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Post-Visit Learning

- Analysis questions include:
  - Go to our class project page on iNaturalist. Which types of invasive flora did we find as a class? Include all species.
  - Which species was most common? Least common?
  - Go to the iNaturalist EwA Invasive Monitoring project page. Use the map to zoom in on the Mustang Trail in the Middlesex Fells.
  - Which types of invasive flora have other people found on/near the Mustang Loop? Identify at least 3 species that overlap with our class data and at least 3 species that we did not find as a class.
  - Now go to the EwA Fells Habitat Fragmentation Map. On the right, under "Fragmentation Surveys," scroll down and select "Introduced Species." Then, zoom in on the Mustang Trail in the Middlesex Fells.
  - What similarities do you notice with the iNaturalist data?
  - What differences do you notice with the iNaturalist data?
  - Why do you think there are differences between the two data sets?
  - Using both data sets (iNaturalist EwA Invasive Monitoring and EwA Fells Habitat Fragmentation Map), zoom out on each map so that you are looking at all of the Middlesex Fells.
  - Identify at least 3 additional invasive species that are found in other parts of the Middlesex Fells.
  - Based on these data sets, why do you think participatory science is useful? (Why is it useful to have many people contribute to data collection?)
  - Most of the invasive species observed are plants. Give two possible reasons for this.
  - Do you think that there are more invasive plants in the Fells that are not documented in these data sets? If so, where are they?
  - What is one limitation of these data sets? Where does most of the data come from?
  - What surprised you about the data?

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Post-Visit Learning

Days 6-7: After Site Visit (2 Class Period) (112 minutes): Making “Wanted” Posters

- Students work in groups of 3 to make a “Wanted” Poster for one invasive species found in the Middlesex Fells, using this handout and rubric as a guideline: Invasive Species "Wanted" Poster

Full Unit Outline

We use the biology phenomenon-driven storylines curriculum (Biology Phenomenon-Driven Storylines) This activity will fit into the beginning of the homeostasis unit, which focuses on ecosystem homeostasis and human impacts on biodiversity and the environment. The unit starts with an introductory video showing that a marine ecosystem off of Shemya Island in the Pacific had seen a loss of sea otters and had also seen a decline in kelp forests. Students analyze a food chain for this ecosystem (kelp → urchins → otters) and draw the conclusion that the loss of sea otters leads to an increase in urchins and a decline in kelp. Students are introduced to the term "trophic cascade” to describe this phenomenon (HHMI Some Animals Are More Equal than Others)

From there, students plot population data showing changes in population sizes in four species (kelp, urchins, otters, orcas) near Shemya Island over time. The data shows that as the otter population decreases, urchin population increases, and kelp population decreases. Students are introduced to the concept of carrying capacity and asked to consider examples of biotic and abiotic factors that impact the population size of each species.

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Full Unit Outline

Interestingly, students notice that the orca population remains relatively constant over time. Students later discover that human hunting of whales after World War II had forced Orcas to shift from eating whales to hunting otters (HHMI Some Animals Are More Equal than Others). This leads to a discussion of how humans can impact food webs and entire ecosystems.

I plan to add my capstone lesson here, as invasive species provide another example as to how humans can impact a food web and an ecosystem. Since my capstone lesson takes place in the Middlesex Fells, students will be asked to apply their understanding of marine food webs to the terrestrial food webs in the Fells. Students may be able to connect certain invasive species to the loss of native species and, potentially, to a trophic cascade. Invasive species also provide another example of humans impacting the environment.

After this, the unit continues with more examples of how humans impact the environment. Students learn about the carbon cycle and the greenhouse effect. We discuss how humans have increased greenhouse gas emissions, particularly since the industrial revolution. Students analyze carbon dioxide and temperature data from NASA in order to make the connection between increased carbon dioxide and global warming. Students also analyze human population growth data (American Museum of Natural History) to see the connection between increased human need for resources and increased industrialization.

The unit goes on to have students perform a water testing lab, where they test the CO_2 levels and the pH of various samples of tap water. Based on the data they collect, they should find a connection between high CO_2 and low pH. As a class, we discuss the reaction between CO_2 and water to form carbonic acid. Students are introduced to the idea of ocean acidification, and we discuss how it's harmful to marine life. We connect ocean acidification to increased industrialization and use of fossil fuels.

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Full Unit Outline

To model the impact of ocean acidification on marine life, we place an egg (which has a calcium carbonate shell, just like a sea urchin) in neutral water and slightly acidic water; students see that the acidic water degrades the egg's shell quickly.

Citations

- MA Curriculum Frameworks: https://www.doe.mass.edu/frameworks/scitech/2016-04.pdf
- Friends of the Middlesex Fells Reservation: https://www.friendsofthefells.org/
- The Trail Adopter's Guide to Invasive Plants: The Fells Reservation (Friends of the Middlesex Fells Reservation): https://friendsofthefells.org/wp-content/uploads/2015/06/Guide-to-Invasive-Plants.pdf
- Earthwise Aware (EwA) Invasive Flora Patrol: https://www.earthwiseaware.org/citizen-science/4/
- Earthwise Aware (EwA) Monitoring Invasive Flora: https://docs.google.com/presentation/d/e/2PACX-1vT8pnZX1oojDjjzhZIMU-kwcBf8z6RBQWwAvxeBBjLx1M0YZ8hpoBlsGPgWOKaiWFUeF83fOhwI2wuz/pub?start=false&loop=false&delayms=3000&slide=id.g76f0113010_0_741
- EwA Invasive Flora Patrol Datasheet: https://www.anecdata.org/projects/view/ewa-invasive-monitoring/pages/162
- iNaturalist: https://www.inaturalist.org/
- "How to Make an Observation" (iNaturalist): https://help.inaturalist.org/en/support/solutions/articles/151000192921-how-to-make-an-observation
- "Observe Nature with iNaturalist: (YouTube): https://www.youtube.com/watch?v=Mb_i-WoUKt0

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Citations

- MapMyRun https://www.mapmyrun.com/dashboard
- Jennifer Klos (TedEd) “The Threat of Invasive Species” (YouTube): https://www.youtube.com/watch?v=spTWwqVP_2s
- The Crowd and the Cloud: https://crowdandcloud.org/watch-the-episodes/episode-one
- EwA Guide to Common Invasive Species in Middlesex County (MA, US) (iNaturalist): https://www.inaturalist.org/guides/8561
- EwA Invasive Monitoring (iNaturalist): https://www.inaturalist.org/projects/ewa-invasive-monitoring
- EwA Fells Habitat Fragmentation Map (ArcGIS): https://www.arcgis.com/apps/webappviewer/index.html?id=eac30514ad6c4a8f83b152fdde20dcc8
- Dr. Jason Crean, Biology Phenomenon-Drive Storylines: https://www.allspeciesconsulting.com/storylines
- HHMI, Some Animals Are More Equal than Others: https://www.biointeractive.org/classroom-resources/some-animals-are-more-equal-others-keystone-species-and-trophic-cascades
- Carbon Dioxide (NASA): https://climate.nasa.gov/vital-signs/carbon-dioxide/?intent=121
- Human Population Through Time (American Museum of Natural History): https://www.youtube.com/watch?v=vJ5p3pZlBi4