

**Lesson 1:**

**How are organisms responsing to rapid ecosystem change?**

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| **Unit: Adaptation and Evolution: Phenotypic/Genotypic Response to Climate Change in Lady Beetles** | **Essential Question: How are organisms responding to rapid ecosystem change?** |  **Duration:** 3 one-hour periods (4 if Handout #1.4 is done as classwork) |
| **Performance Expectation(s):** HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. |
| **Learning Targets (Students will be able to…):** * Distinguish between genotypic and phenotypic variation
* Explain the concept of phenotypic plasticity
* Demonstrate understanding that climate change involves not only global warming, but also increased weather extremes and seasonal shifts.
* “Identify particular species that may be better suited to survive extreme climate change events.”\*
* “Propose why organisms that display greater phenotypic plasticity would be better suited to survive climate change events.” \*
* Explain how certain kinds of insects survive the winter.

\*<https://www.cpet.ufl.edu/resources/curricula/created-by-fellows/evolution/>, Lesson 1 |
| **Student Evidence:** * Completed activity handouts (1.1 - 1.4)
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| **Materials (access worksheets at project website, https://evolution.berkeley.edu/evolibrary/teach/lessons/beetle-project-overview.php):*** Student Handout #1: The Effect of Climate Change on Living Organisms (*HO 1.1)*
* Student Handout #2: Whiplash Weather and Phenotypic Plasticity Reading Guide *(HO 1.2)*
* Student Handout #3: Winners and Losers of Climate Change *(HO 1.3)*

*→* Beginning learning level version→ Intermediate learning level version→ Advanced learning level version* “Winners and Losers” activity cards (*pages 13-16,* [*linked here*](https://www.cpet.ufl.edu/wp-content/uploads/2014/12/Chpt1_Drosophila2017.pdf), https://www.cpet.ufl.edu/wp-content/uploads/2014/12/Chpt1\_Drosophila2017.pdf*; recommend one set for every 2-4 students, double-sided and color printed, lamination suggested)*
* Student Handout #4: How Do Insects Survive The Winter? *(HO 1.4)*
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| **5E LESSON SEQUENCE** |
| **Engage (Day 1): What are some ways that organisms respond to temperature change?** |
| To introduce and provide context about phenotypic plasticity as a foundational concept, some possible ideas include:* Show the [short film, “Liz Hadly Tracks the Impact of Climate Change in Yellowstone”](https://www.hhmi.org/biointeractive/liz-hadly-tracks-the-impact-of-climate-change-in-yellowstone), https://www.hhmi.org/biointeractive/liz-hadly-tracks-the-impact-of-climate-change-in-yellowstone (7.5 min.)
* Put an insect in a refrigerator, submerge in ice, and/or in a freezer; ask students, what do you predict will happen and why?
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| **Explore (Day 1): What is phenotypic plasticity?** |
| ***For all student levels*:*** Pass out Student Handout #HO1.1, “The Effect of Climate Change on Living Organisms”to students.
* Facilitate an initial student discussion of the focus questions shown on the handout. At this point, accept all reasonable answers:

→ *How do organisms respond to environmental change?**→ Does response always involve genetic differences that could be acted on by natural selection, or is there a non-genetic phenomenon at work? If so, what do we call that phenomenon?**→ What is phenotypic plasticity?** Students engage with the phenomenon of phenotypic plasticity as directed on the student handout, by watching two films and reading one article about phenotypic plasticity and recording information as instructed.
* Facilitate a follow-on student discussion to assess students’ understanding of phenotypic plasticity when students have finished their engagement. *Use a technique such as pair-share, whiteboard sharing, or other dialogue-generating formative assessment method.*

***Alternate option for more advanced students*:*** Instruct students to read the online article, [“Nature or nurture: evolution and phenotypic plasticity”](https://evolution.berkeley.edu/evolibrary/article/side_0_0/natureornurture_01), https://evolution.berkeley.edu/evolibrary/article/side\_0\_0/natureornurture\_01.
* Instruct students to do some independent research to identify at least one example of phenotypic plasticity that is not discussed in the online article. Students should be prepared to present their example and explain why it represents phenotypic plasticity in their own words.
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| **Explore (Day 2): What is the nature of climate change - is it only warming?** |
| * Re-show the [short film, “Liz Hadly Tracks the Impact of Climate Change in Yellowstone”](https://www.hhmi.org/biointeractive/liz-hadly-tracks-the-impact-of-climate-change-in-yellowstone) https://evolution.berkeley.edu/evolibrary/article/side\_0\_0/natureornurture\_01 (7.5 min.)
* Facilitate a class discussion about the following questions. Encourage students to use examples from both the short film and their previous knowledge or personal experience.
1. Does climate change affect life?
2. What is the nature of climate change - is it only warming?
3. How are organisms responding?
4. Are there “winners” and “losers” in the response to climate change?
* Provide students with access to one or both of the following two articles, plus Student Handout #HO1.2: “Whiplash Weather and Phenotypic Plasticity Reading Guide”. Students will read articles and record their learning on the worksheet.
* ***Recommended for all students****:* [*More evidence that global warming is intensifying extreme weather*, John Abraham, The Guardian, July 2015](https://www.theguardian.com/environment/climate-consensus-97-per-cent/2015/jul/01/more-evidence-that-global-warming-is-intensifying-extreme-weather), https://www.theguardian.com/environment/climate-consensus-97-per-cent/2015/jul/01/more-evidence-that-global-warming-is-intensifying-extreme-weather
* ***Additional reading, recommended for more advanced students:***[*Evolutionary Response to Rapid Climate Change*, Bradshaw & Holzapfel, Science 2006](https://bradshaw-holzapfel-lab.uoregon.edu/PDF/B%26H06sci.pdf), https://bradshaw-holzapfel-lab.uoregon.edu/PDF/B&H06sci.pdf
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| **Explain/Elaborate (Day 3): Are there “winners” and “losers” in response to climate change?** |
| *Activity summary: Student groups receive a set of “Climate Affected Species” cards and participate in an activity to predict which species populations are likely to increase (“winner”) or decrease (“loser”) in response to the current climate change trajectory.** Facilitate a review and discussion of yesterday’s articles.
* Pass out “Winners and Losers” Student Handout, selecting beginning, intermediate, or advanced Learning Level. *(See “Materials” list above for links.)*
* Divide students into groups of 2-4; pass out a set of “Winners and Losers” activity cards. *(See “Materials” list above for links.)*
* Facilitate completion of the “Winners and Losers” activity; eliminate map analysis activity.
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| *Note, 6/2019: After teaching the* [*“Winners and Losers”*](https://www.cpet.ufl.edu/wp-content/uploads/2014/12/Chpt1_Drosophila2017.pdf) *activity to 32 9th grade Biology Honors students,*  |
| **Evaluate (Day 3):** |
| * Students submit completed “Winners and Losers” worksheet; teacher may assess as desired.
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| * Students complete [HO1.4, “How Do Insects Survive the Winter?”](https://docs.google.com/document/d/1p7rGpKmSH7vOA8bvUEFnIzOtR9cO2xte0EVPXaDVfZc/edit?usp=sharing)
* Teacher evaluates understanding, using formative assessment technique of choice (small group discusion, pair-share, whiteboards, Kahoot, whole-class discussion, etc.)
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