Why Does The Green Crab Love Climate Change?

	Time	Grade Level	Content Area (s)
	90 minutes	MS	LS, ESS

Overview

Students engage in science and engineering practices and use patterns as a thinking tool to make sense of the phenomenon of the (dramatic) growth in the population of green crabs and their migration to new areas.

Lesson-level Performance Expectation (Lesson Objective):

Obtain and use information to develop a model that helps explain what could be **causing a shift within populations of the coastal ecosystem.**

Lesson Summary

1. The lesson will start with students generating ideas, recording them, and sharing them to answer the question "Why would a crab be wanted?"
2. Students watch the film Our Beautiful Planet The Future of Shellfish. They document and share with a partner any questions they have about the information from the film.
3. Working in small groups, students gather and document information using the Range Map of European Green Crab to help them figure out more about the green crabs. With this information, students develop their initial presentation.
4. Student groups research additional documents to revise their presentations and create a model that explains why the green crab population has grown and spread.
5. Students think more deeply to recognize which living things do well in warmer water and which living things might not survive in an area without enough oxygen to support all of the organisms living there.
6. Students are presented with competing claims supported by the same evidence, providing an opportunity to engage the class in a discussion about the nature of science.

Materials

Per student or pair of students

- Our Beautiful Planet The Future of Shellfish
- Chart paper or large whiteboard
- Markers
- Carcinus maenas (green crab) range map
- Downeast Institute Research—Green Crab (article)
- European Green Crab in Puget Sound (article)
- ANS Task Force: European Green Crab (article)
- The Quiet Invasion: A Guide to the Invasive species of the Galveston Bay Area (article)
- Green Crabs Invading Maine Mudflats (video)

NSTA Collection of Resources for Today's Daily Do

NSTA has created a Why does the green crab love climate change? collection of resources to support teachers and families using this task. If you're an NSTA member, you can add this collection to your library.

nsta National Science Teaching Association

SCIENCE AND ENGINEERING PRACTICES	DISCIPLINARY CORE IDEAS	CROSSCUTTING CONCEPTS
Developing and Using Models Develop or modify a model - based on evidence - to match what happens if a variable or component of a system is changed. **Obtaining, Evaluating, and Communicating Information** Integrate qualitative and/or quantitative scientific and/or technical information in written text with that contained in media and visual displays to clarify claims in findings.	**LS2: Ecosystems: Interactions, Energy, and Dynamics** **LS2.C: Ecosystem Dynamics, Functioning, and Resilience.** Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. **ESS3: Earth and Human Activity** **ESS3.D: Global Climate Change.** Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decision and activities.	**Cause and Effect** Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. **Systems and System Models** Systems may interact with other systems; they may have sub-systems and be part of larger complex systems.

This lesson could be one in a series of lessons building toward:

MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

[Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]

MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

[Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures; atmospheric levels of gases, such as carbon dioxide and methane; and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]

Safety

NSTA encourages K–12 teachers and school leaders to promote and support the use of science activities in science instruction and work to avoid and reduce injury. Additionally, NSTA recommends teachers and school leaders visit the NSTA Safety Resource page for up-to-date information on safety issues and guidelines.

S = Students T = Teachers

Phenomenon

The green crab population is increasing rapidly and spreading to new locations.

Experiencing the Phenomenon

Students get direct experience with a phenomenon that is relevant to them. Students generate question(s) that are used to drive the lesson.

1. Begin by showing students the crab "wanted poster" pictured below.
2. Tell students you saw this poster on a trip to the east coast of the United States, then ask, "Why would a crab be wanted?"
3. In the alone zone, have students think about what this picture might mean and record their ideas in their science notebook.
4. Have students share their ideas as a whole group and record their ideas on the board.

   S Think about what this picture might mean and record their ideas in their science notebook.

   T Additional teacher guidance...

   - Ideas here will vary based on prior learning and geographic region, as students who live in coastal regions might have more lived experience with these organisms.
   - However, most students will likely come up with one of two answers: Crabs are "wanted" because people desire to eat them, or crabs are "wanted" because they pinch people and need to be removed from beaches.

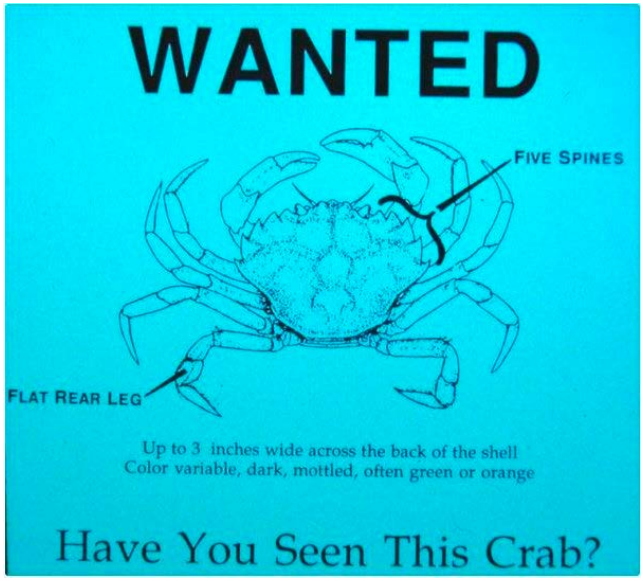
Using Artifacts and/or Discussions to Formatively Assess Student Learning

Many opportunities exist within the lesson to formatively assess student learning. One example is described below.

Artifact/Discussion: Small group "must-have" list

Look and listen fors:

- ocean temperature is rising
- green crabs tolerate warmer ocean temperatures
- green crabs have no natural predators in [United States] coastal ecosystems
- green crabs eat everything
- populations of other ocean animals decreasing [eaten by green crabs or moving to new locations]
- loss of income for communities [green crab eat clams; warmer waters driving out lobsters]



Wanted poster

Students as Scientists

Students engage in science and engineering practices to develop and/or use science ideas needed to explain how or why the phenomenon occurs.

5. Ask students, "Do we have enough information to determine what exactly this poster means?" Students should reach the conclusion that more information is needed.

   T Additional teacher guidance...

   - As students share, use talk moves to encourage others to add to what someone is saying or share similar ideas.

   Talk moves could include these:

   - Could you explain why you think that?
   - Does anyone have a similar idea?
   - What other ideas do you have about this poster?

6. Next, tell students you will show them a short film clip.

7. Ask students to turn to a partner and share the questions that arose for them while watching the clip.

   S Document any questions they have about the information shared.

   T Play the Our Beautiful Planet The Future of Shellfish film from 1:09 to 2:12 and have them document any questions they have about the information shared.

8. Next, have each student share a question (or a partner's question) with the class.

   T Common questions could include these:

   - How do crabs live on the land? (We thought they lived in the water.)
   - Why are they collecting the crabs?
   - Are the crabs stranded up there?
   - Are the crabs climate change winners or losers?
   - Are the crabs on the beach because of climate change? Is the water too warm for them?
   - What is climate change?
   - The ocean is really big, so how does a change in temperature affect everything living in the ocean?

9. Draw students' attention back to the poster and ask them if they can now explain why a crab would be wanted.

10. Prompt students to consider what information or data they might need about the crab to figure out what the sign means.

11. Have students form small groups and brainstorm a list of things they might need to know about the green crab.

    S Work in small groups to brainstorm a list of things they might need to know about the green crab.

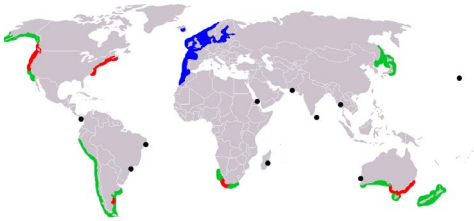
    T Students should confirm that they still don't have enough information.

    Students' lists could include the following:

    - Where does the green crab live (where is its natural habitat)?
    - What does it eat?
    - How did it get on the rocks, or do green crabs live on the rocks?
    - Does anything eat green crabs?
    - Do people catch and eat the green crab?

12. Have students work in small groups and write down any information they can identify from the map that might help them figure out more about the green crab.

    S Work in small groups and write down any information they can identify from the map that might help them figure out more about the green crab.



Rough map of the distribution of C. maenas: Blue areas are the native range; red areas are the introduced or invasive range; black dots represent single sightings that did not lead to invasion; and green areas are the potential range of the species.

SOURCE: STEMONITIS—ENGLISH-LANGUAGE WIKIPEDIA; BASED ON BLANK WORLD MAP AND DATA FROM CSIRO., CC BY-SA 2.5

T To help students figure out more about the green crab, show them the *Range Map of European Green Crab* below

13. **Walk around the room to answer any clarifying questions students may have about the map.**

T You can use this activity to formatively assess students' understanding of the words *native*, *invasive*, and *species*.

If students ask about the meaning of these words, use talk moves with the small groups to surface prior learning. Talk moves include these:

- What do you think the word means based on what we have been talking about?
- What do you remember about ecosystems in previous grades? Did you ever talk about (bees, Asian carp, butterflies)? What do you remember?

14. **Have each group share one piece of information they gleaned from the map that they think will help them figure out more about the green crab.**

S Share one piece of information they gleaned from the map that they think will help them figure out more about the green crab.

T Shared information should include the following:

- The green crab is native to a small part of the world, along the west coast of Europe.
- The green crab can now be found in five other locations: the east and west coasts of the United States, the southern coast of Australia, the east coast of South America, and the west coast of Africa.
- The green crab could spread to other parts of those countries and other parts of the world.
- There are a few places where the green crab has been spotted, but we think they don't really live there.
- We think in the areas where the map is red, the green crabs are causing a problem, and that is why the creators used red.
- We think the map uses red because the green crab is an invasive species, and we learned invasive species can be bad because they can eat all the food in an area or occupy all the places to live.

15. **Have students revisit the poster from the introduction, and say, "Now that we have more information about the green crab, what inferences can we make about the poster?"**

16. **Give students a few minutes in their groups to gather their ideas, then have them share with the class.**

17. **Tell students you are unsure about the crabs in the clip, but agree that the posters are a way to help scientists and other concerned citizens keep the green crab population from spreading.**

S Work in small groups to gather their ideas, then share them with the whole class.

T Additional teacher guidence...

- Most students will now think the poster is a warning, and if you see the crabs, you need to tell someone so they can do something to keep them out of the area/rid them from the area.
- Students may wonder if that is what they observed the people doing in the film clip: collecting crabs to get rid of them.

18. **Give students some thinking time, then have students share their ideas.**

19. **Have students revisit the class list of questions to decide which one they need to answer next.**

20. **Through discussion, help guide students to the questions related to the crabs' environment.**

21. **Once they identify this is what they need to know next, tell students each group will be responsible for researching a different topic and reporting their findings to the class.**

22. **Tell students to record important information on their groups' whiteboards or posters.**

S Students will...

- Take some thinking time, then share their ideas.
- Revisit the class list of questions to decide which one they need to answer next.

T Additional teacher guidance...

- If students don't ask why we want to keep the green crabs from spreading, prompt them by

asking, "Why would we care if a small number of the green crab population is spreading?"

- Ideas will vary, but focus students' attention on any ideas shared about how the green crab might interact with the environment.
- Agree that the next step is to figure out how it interacts with other organisms in the environment.

Assign each group to research the following topics:

- Environmental conditions. Describe the habitat of the green crab. What is the climate like where green crab populations are found?
- Food choice. What do green crabs eat? What eats green crabs?
- Population. How often do green crabs reproduce? How many eggs do they lay?
- Other interactions. How do green crabs affect other living things in the ecosystem? Do they occupy the space where other organisms should be living? Which organisms?

23. Pair small groups to share the information they found before they present it to the whole class.

24. Allow students to revise their whiteboard/poster presentation based on peer feedback before sharing their findings with the class.

S Work in small groups to share the information they found before they present it to the whole class.

Using peer feedback,

- Revise their whiteboard/poster presentation.
- Share revised presentations with the class.

T After each group shares, ask them to place their whiteboard/poster where all students can easily access them.

The following resources provide information about green crab habitat, food chain/web, and life cycle:

- Downeast Institute Research—Green Crab (college-level reading, but includes video support)
- European Green Crab in Puget Sound (long article; consider assigning sections to different groups)
- ANS Task Force: European Green Crab
- The Quiet Invasion: A Guide to the Invasive Species of the Galveston Bay Area

Note: Many of the resources include information on all of the bulleted topics above. Depending on time and students' ability levels, you may choose to task each group to seek information on only one topic within their assigned resource, or to find information on as many of the topics as they can.

These key takeaways should emerge from students' presentations:

- Green crabs like warmer water (64–79 °F).
- They can lay up to 185,000 eggs at a time.
- Green crabs eat bivalves and other shellfish, eelgrass, and just about everything else they can, including one another.
- They do not have any natural predators in the United States, but some fish and some birds will eat them.
- They are moving into new locations because the temperature of the ocean is getting warmer in these areas.
- Green crabs are hurting the shellfish industry.

Finally, play the video Green Crabs Invading Maine Mudflats to ensure all students have the same information.

25. Have students work in small groups to create a "must-have" list of components (living and nonliving) and interactions among components that are necessary to include in a model.

26. Bring the students back together to create a class consensus model.

27. Invite each group to share one component on their "must-have" list.

28. Ask the class if they agree (thumbs up) or disagree (thumbs down) whether each component should be included in the model.

S Share one component on their "must-have" list.

T Additional teacher guidance...

- Consider asking students how components they disagree with should be represented on

the model (for example, placing a question mark next to the component, or drawing the component using dashed lines).

- Continue in this way until all components, and then interactions, have been shared and represented on the class model.
- Consider using shapes (squares, circles, etc.) and arrows to represent components and interactions to add to the consensus model quickly, which will allow you to keep pace with the groups' sharings.
- An example of a class consensus model is shown above.
- The particular shapes/colors are not significant (but could be, depending on how your class chooses to represent their ideas).

29. **Ask students to recall what the green areas indicate. Why do you think green crabs are such a problem now? What has changed?**

    S Recall and share what the green areas indicate by answering the following questions:

    - Why do you think green crabs are such a problem now?
    - What has changed?

30. **Ask students to use the class consensus model to explain why scientists are predicting the green crab will invade these locations (the green areas) next.**

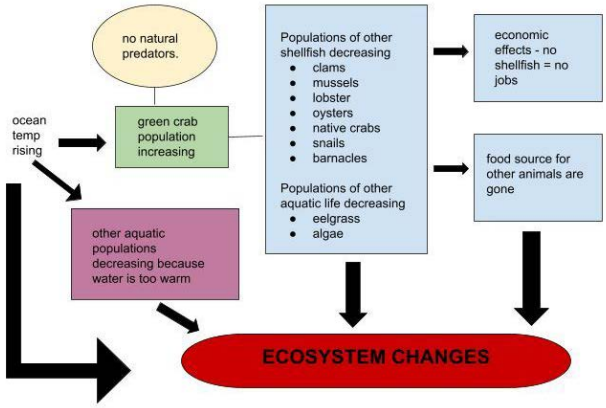
    S Use the class consensus model to explain why scientists are predicting the green crab will invade these locations (green areas) next.

    T If students don't mention the rise in ocean temperature, tell them, "We know the green crabs have been in the United States for a long time (since the 1880s)."

31. **Ask students to turn to a partner to share their thinking before asking them to share their ideas with the class.**

    S Turn to a partner to share their thinking, then share their ideas with the class.

    T Students will likely share the green crab population has increased because the ocean temperature has increased.



Example of class consensus model

32. **Ask students why scientists are predicting the green crab will move to the areas marked in green on the map.**

    S Share their ideas about green crab migration with the class.

    T Students might share that either the green crabs are moving to these locations because the water temperatures are warmer there than they used to be, or they have to move to find more food (and other resources) because their population is growing.

33. **Ask students which is the cause and which is the effect.**

34. **Ask how they could use the class consensus model to support their thinking.**

35. **Ask students if they would like to add to or revise the class consensus model before moving on to the next part of the lesson.**

Reflecting on the Phenomena

What have we figured out? What new questions do we have? Where do we go next?

36. **Return to some of the questions from the beginning of the lesson.**

    "Why does the green crab love climate change?"

37. **Ask questions posed in The Future of Shellfish film clip.**

    "Are there climate change winners and climate change losers?"

38. **Ask students to consider what they have figured out about the green crab and to develop a claim that answers this question:**

    "Are green crabs climate change losers or winners?" (The green crab is a climate change winner.)

    S Use the evidence they have gathered throughout the lesson to expand on their answer to this question:

    - "Why does the green crab love climate change?"

    T Additional teacher guidance...

    - Students should use the evidence they have gathered throughout the lesson to support their claim.
    - They should connect their evidence to their claim using scientific reasoning.

    An example of students connecting their evidence to their claim using scientific reasoning is the following:

    - The green crab is a climate change winner.
    - We also know that they do not have any natural predators that live in the warmer water, either. This is another reason why their population is increasing.
    - Since the ocean water is continuing to get warmer, I think the warmer water will continue to spread, increasing the water temperature in other places.
    - Since the water temperature will increase in more places, this will give the green crab more places to live.

39. **Ask students to think about climate change winners and losers.**

40. **Remind students that we have figured out the green crab is a climate change winner.**

41. **Ask, "Are there other climate change winners?"**

42. **Ask, "What organisms are climate change losers?"**

43. **Have students return to their small groups and use the class consensus model to support their thinking about climate change winners and losers.**

44. **Have each group share their ideas and encourage them to support their ideas with evidence from the model and/or scientific reasoning.**

    S Students will...

    - Return to their small groups and use the class consensus model to support their thinking about climate change winners and losers.
    - Share their ideas and support their ideas with evidence from the model and/or scientific reasoning.

    T Additional teacher guidance...

    - At this point, students will probably recognize that the shellfish green crabs eat are climate change losers.
    - Encourage them to think deeper to recognize what other living things (not represented on the model) might also be "losers."

    At this point, students will probably recognize that the shellfish green crabs eat are climate change losers.

    Encourage them to think deeper to recognize what other living things (not represented on the model) might also be "losers."

    Students might offer some of the following ideas:

    - Tons of green crabs on the beach might affect tourism; people and towns could lose money.
    - Organisms that rely on beaches for resources might be affected.
    - Warm water holds less oxygen than cold water: Therefore, there might not be enough oxygen in an area to support all of the organisms who live there.

Now that students have identified some climate change losers...

45. Ask, "Do you think there are other climate change winners?"

46. Tell students that scientists are working on determining if there are other climate change winners, and may have found one.

47. Tell them you are going to show the film The Future of Shellfish introduced at the beginning of the lesson, then play the film.

48. Ask them to note climate change winners and losers shared in the film.

    S Take notes focused on climate change winners and losers shared in the film

    T Students may predict that organisms that do well in warmer water, like the green crab, would also be climate change winners.

49. Engage students in a whole-group discussion about new noticings or wonderings about the information presented in *The Future of Shellfish*

    S Students will...

    - Use the evidence for conflicting claims (arguments) to discuss the nature of science.
    - Identify competing evidence-supported arguments.

    T Additional teacher guidance...

    - Students should notice that conflicting claims about how warmer water affects lobster larvae and juvenile lobsters were shared, and that both of these claims are supported by evidence.
    - Competing evidence-supported arguments often exist, especially when concepts/ideas are new.
    - Explain that this is how science ideas get figured out and how new discoveries are made.

50. Ask students if they have ideas about the lobster larvae.

51. Have each student individually make and record their prediction about whether lobster (larvae) will be climate change winners or losers.

52. Remind them to support their prediction with scientific reasoning.

53. Ask students to share their predictions with a partner or small group; give students time to add to or revise their prediction based on peer feedback.

    S Students will...

    - Make and record their prediction about whether lobster (larvae) will be climate change winners or losers.
    - Support their prediction with scientific reasoning.
    - Share their predictions with a partner or small group.

    T Additional teacher guidance...

    - Some students may want to share their predictions with the class.
    - After these students have shared, suggest that the class check on this topic periodically to see if any new evidence has been added to support or refute their predictions.

About the *Our Beautiful Planet* Film Series

This lesson is based on information provided in *Our Beautiful Planet The Future of Shellfish*. *Our Beautiful Planet* is a fascinating new series highlighting the work that climate scientists around the country are doing to solve some of the world's most pressing issues. These dedicated scientists are seeking to better understand and plan for the realities of our changing climate. Using cutting edge technology and innovative problem solving, their answers are sometimes found in rather surprising and unexpected places. Our series brings the viewer along for the ride to some of the most important field work being done today, taking the science out of the classroom and into the world. These compelling stories will not only teach our viewers crucial scientific principles, but will also inspire them to use science to examine the issues their own communities face in this changing world and climate. Through these films, we hope scientists and citizens alike can come together to safeguard our environment and to protect our beautiful planet. Productions by Kikim Media. Support provided by Kennebunkport Climate Initiative.

KIKIM MEDIA

KENNEBUNKPORT
CLIMATE INITIATIVE

Meet the Scientist from *Our Beautiful Planet*

Markus Frederich

Frederich is a professor of marine sciences at the University of New England. He received his master's degree in biology from the Technical University of Darmstadt, Germany, where he investigated anatomical abnormalities in ants that got exposed to the Chernobyl nuclear disaster. He received his PhD degree from the University of Bremen, Germany, for his work at the Alfred Wegener Institute of Polar and Marine Research in Bremerhaven, Germany. Here he investigated stress physiology mechanisms in Antarctic crustaceans. For this project, he also worked at the Station Biologique de Roscoff in France, and at the Instituto de la Patagonia, Universidad de Magallanes, in Punta Arenas, Chile. Frederich did his postdoctoral work at Harvard Medical School in Boston, Massachusetts, where he investigated energy metabolism of mammalian hearts using NMR spectroscopy. In 2003, he joined the faculty of the University of New England, where he established his lab investigating energy metabolism and stress physiology in marine invertebrates. He also spent several summers at the Mount Desert Island Biological Laboratory in Bar Harbor, Maine.

Learn More

www.kikim.com • www.kportclimate.org