2018

AP CollegeBoard

AP Environmental Science

Sample Student Responses and Scoring Commentary

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Free Response Question 3

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AP® ENVIRONMENTAL SCIENCE
2018 SCORING GUIDELINES

Question 3

An Arctic food web includes the following organisms.

(a) Refer to the diagram above to complete the following table.

(3 points; 1 point for correct identification of each organism in the table)

	Organism from Arctic food web
(i) **Identify** a primary producer	Diatom (phytoplankton)
(ii) **Identify** a primary consumer	Krill (zooplankton)
(iii) **Identify** a secondary consumer	Cod or seal

(b) Other than showing which organisms are consumed by others, **describe** what is indicated by the direction of the arrows in the diagram.

(1 point for correct description of what is indicated by the direction of the arrows)

- Shows the flow of energy among trophic levels
- Shows the flow of matter through trophic levels

As the amount of sea ice has decreased, larger expanses of the Arctic Ocean are now completely free of sea ice for several weeks each summer. Ringed seals, the preferred prey of polar bears, come to holes in the sea ice to breathe.

(c) **Describe** how the change in sea ice habitat is affecting polar bears' ability to hunt and feed.

(1 point for correct description of how the change in sea ice habitat affects ability to hunt and feed)

- Decreasing area of hunting ground (area of ice used for hauling out/fewer seal breathing holes/seals are a less available food source because of more open water) makes it more difficult for polar bears to get food
- Increasing area/distance between hunting ground means the polar bears have to exert more energy to swim to find food/physical exhaustion from swimming results in less energy available for hunting
- Increasing physiological stress (dehydration, exhaustion, cub mortality, etc.) because polar bears are not physiologically adapted to warmer temperatures
- Increasing the time between successful kills results in bears spending more time waiting/hunting for prey

Question 3 (continued)

(d) **Explain** how melting sea ice leads to a feedback loop that increases Arctic warming.

(2 points; 1 point for correct explanation of the connection between melting ice and the increased absorption of sun's energy and 1 point for correct explanation that increased absorption of sun's energy leads to increased melting of ice. For the second point the student must complete the positive feedback loop.)

- Melting of sea ice leads to a decrease in albedo, or reflectivity, leads to water surfaces absorbing more of the sun's energy.

AND

- Increasing absorption of sun's energy warms the water surface further, which leads to further ice melt (completes positive feedback loop).

(e) Many species, including some whales and birds, will travel thousands of kilometers during annual migrations.

(i) **Provide** one reason a species may migrate a long distance.

(1 point for a correct reason why a species may migrate a long distance)

- Limited food/water supply leads to migration to locations with more food/water supply
- Food supply migrates and species follow prey
- More hospitable climate during certain seasons
- Availability of mates/breeding/birthing occurs in different location
- Protection of offspring from predators

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Question 3 (continued)

(ii) The North Atlantic right whale migrates between subtropical and polar waters annually. Nearly 50 percent of right whale deaths are due to human activities. **Describe** one commercial activity, other than whaling, that may result in the death of right whales.

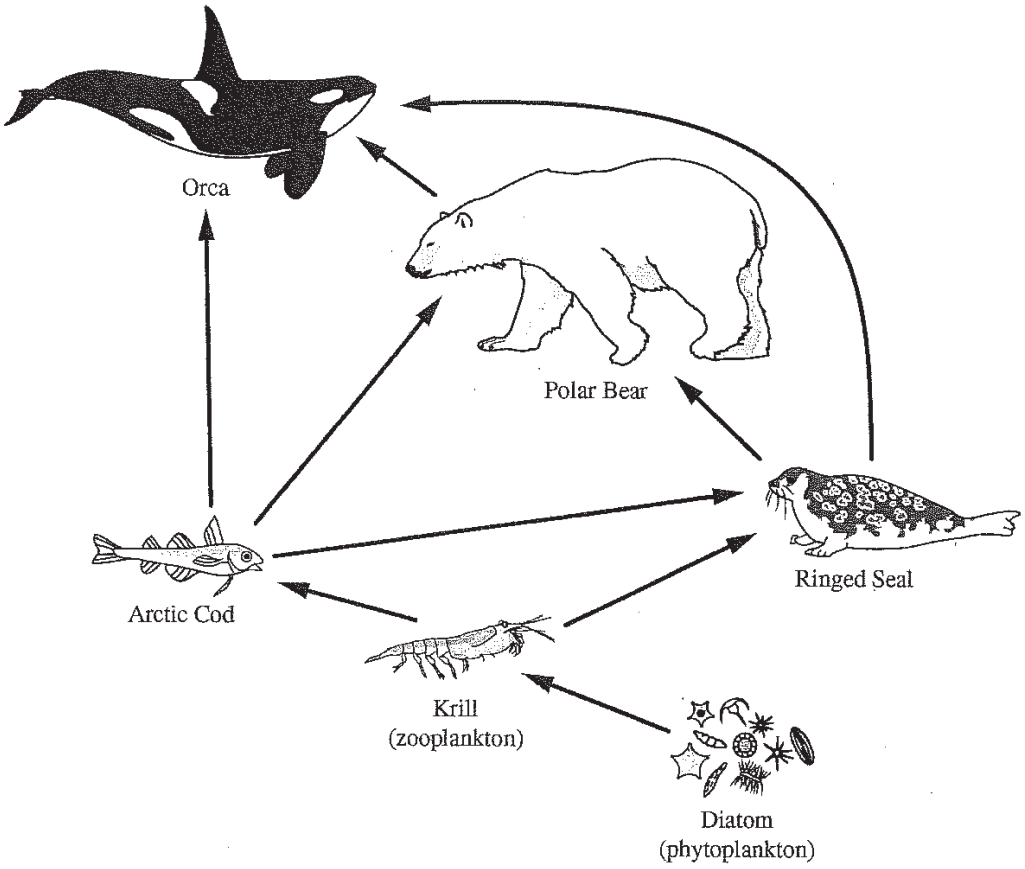
(1 point for correct description of one commercial activity, other than whaling)

(iii) **Describe** one strategy that could reasonably be implemented to decrease right whale deaths caused by the commercial activity you described in part (ii).

(1 point for correct strategy linked to activity in (ii))

Description of commercial activity	Description of one strategy
• Fishing nets entangle whales as by-catch. • Fishing gear can accidently trap.	• Require change of fishing method (location, timing, or materials) that traps whales to reduce the number of whales trapped in nets/gear • Fines for discarded fishing gear (long-line gear, ropes for hauling pots up, etc.) so less gear is discarded reducing the number of whales trapped in gear
• Ships and whales use the same channels, which can increase number of ship strikes.	• Improved navigational technology to spot whales that are close to ships in order to avoid collisions • Increased education of ship captains and crews about whale habitat/migration routes/feeding behaviors in order to reduce ship collisions with whales • Expansion of low-speed navigational zones around ports to reduce ship collisions with whales
• Noise pollution from seismic surveys/sonar/engine noise can disrupt a whale's internal navigational system.	• Reduction of seismic survey activity/sonar use in coastal areas to reduce exposure to noise pollution • Installation of quieter motors to reduce or eliminate noise pollution

3. An Arctic food web includes the following organisms.



Note: Figures not drawn to scale.

(a) Refer to the food web above to complete the following table.

	Organism from Arctic food web
(i) **Identify** a primary producer	Diatom
(ii) **Identify** a primary consumer	Krill
(iii) **Identify** a secondary consumer	Arctic Cod

(b) Other than showing which organisms are consumed by other organisms, **describe** what is indicated by the direction of the arrows in the diagram.

As the amount of sea ice has decreased, larger expanses of the Arctic Ocean are now completely free of sea ice for several weeks each summer. Ringed seals, the preferred prey of polar bears, come to holes in the sea ice to breathe.

(c) **Describe** how the change in sea ice habitat is affecting polar bears' ability to hunt and feed.

(d) **Explain** how melting sea ice leads to a feedback loop that increases Arctic warming.

(e) Many species, including some whales and birds, will travel thousands of kilometers during annual migrations.

(i) **Provide** one reason a species may migrate a long distance.

(ii) The North Atlantic right whale migrates between subtropical and polar waters annually. Nearly 50 percent of right whale deaths are due to human activities. **Describe** one commercial activity, other than whaling, that may result in the death of right whales.

(iii) **Describe** one strategy that could reasonably be implemented to decrease right whale deaths caused by the commercial activity you described in part (ii).

(a) (i) Diatom

(ii) Krill

(iii) Arctic Cod

(b) The ~~[illegible]~~ arrows in the diagram represent the flow of energy in an ecosystem

(c) Due to decreasing sea ice, the polar bears are losing contact with one of their primary prey. Since ringed seals have to breathe from the surface, they go to holes in the ice to breathe. With shrinking ice, the seals can breach the surface virtually anywhere which means the polar bears on the ice cannot attack them. The polar bears also have a much smaller area to hunt in which means less seals are around them to catch.

(d) Melting sea ice means less ice is reflecting the Sun's rays which leads to the warming of the water which goes back to melting more sea ice to form a positive feedback loop.

(e)(i) One reason a species may migrate a long distance is to go where food is more plentiful in order to raise offspring.

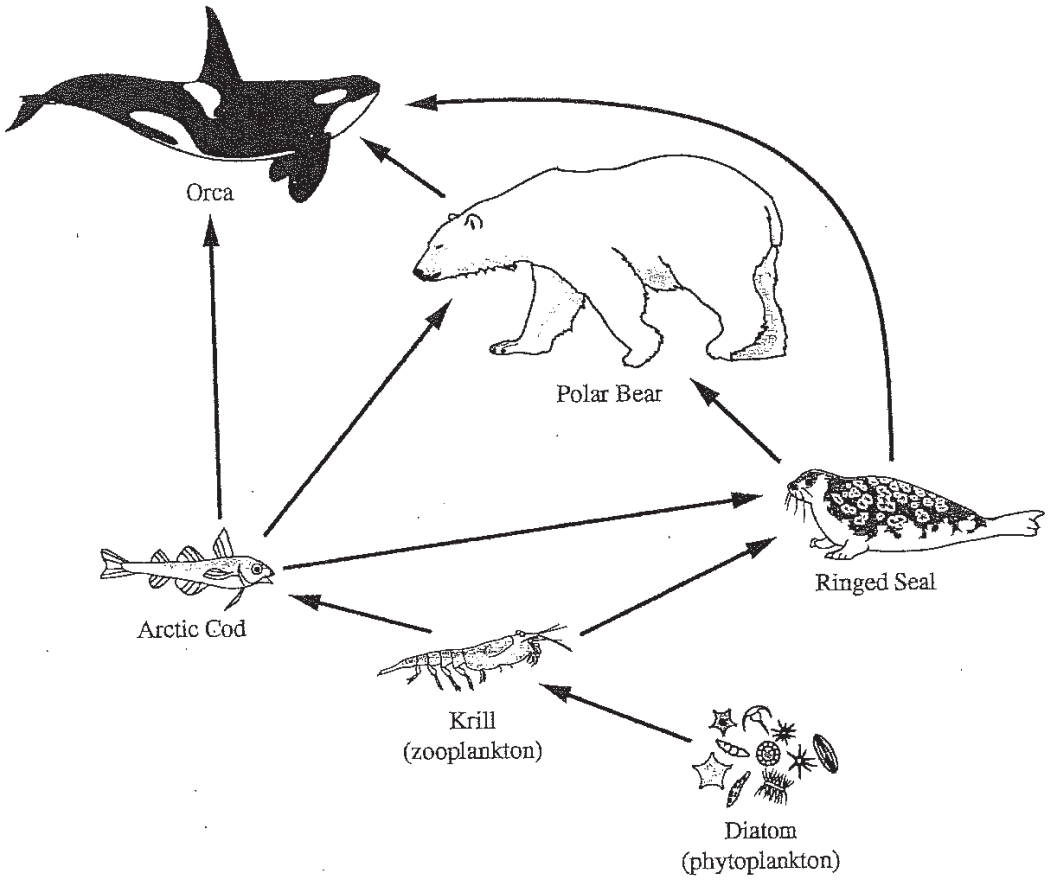
(ii) One commercial activity other than whaling that could kill right whales is shipping. Cargo ships carry a substantial amount of goods and if a whale breaches the surface in front of a ship, there is not anything

ADDITIONAL PAGE FOR ANSWERING QUESTION 3

to do to stop the ship from hitting it.

(iii) A way to decrease the amount of deaths caused by this activity is to require those in opperation of large commercial ships to have an awareness of right whale migratory patterns to have an idea of when and where to look out for whales. This would prevent deaths because ~~dh~~ during migration season, boats could avoid certain areas of be more careful while travelling through them.

3. An Arctic food web includes the following organisms.



Note: Figures not drawn to scale.

(a) Refer to the food web above to complete the following table.

	Organism from Arctic food web
(i) **Identify** a primary producer	Diatom
(ii) **Identify** a primary consumer	Krill
(iii) **Identify** a secondary consumer	Arctic cod

(b) Other than showing which organisms are consumed by other organisms, **describe** what is indicated by the direction of the arrows in the diagram.

As the amount of sea ice has decreased, larger expanses of the Arctic Ocean are now completely free of sea ice for several weeks each summer. Ringed seals, the preferred prey of polar bears, come to holes in the sea ice to breathe.

(c) **Describe** how the change in sea ice habitat is affecting polar bears' ability to hunt and feed.

(d) **Explain** how melting sea ice leads to a feedback loop that increases Arctic warming.

(e) Many species, including some whales and birds, will travel thousands of kilometers during annual migrations.

(i) **Provide** one reason a species may migrate a long distance.

(ii) The North Atlantic right whale migrates between subtropical and polar waters annually. Nearly 50 percent of right whale deaths are due to human activities. **Describe** one commercial activity, other than whaling, that may result in the death of right whales.

(iii) **Describe** one strategy that could reasonably be implemented to decrease right whale deaths caused by the commercial activity you described in part (ii).

3. a) i) Diatom (phytoplankton) is a primary producer

3 a) ii) Krill is a primary consumer

3. a) iii) Arctic cod is a secondary consumer

3. b) The movement of energy through the ecosystem is also shown by the arrows.

3. c) The polar bears used to know the precise location of where the ringed seals would be, as they would only come to the holes in the ice to breathe. But since all the ice has been significantly reduced, the seals can come up to breathe anywhere, making it hard for polar bears to identify the location of the seals, and making it harder for them to get food.

3. d). Water vapor is a greenhouse gas, meaning it traps outgoing infrared radiation and causes the temperature of the earth to rise. In a positive feedback loop, the temperature of the earth increases, causing ice to melt and water vapor to increase in the atmosphere, and causing the temperature of

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the Arctic in this instance to increase even more, and the cycle continues.

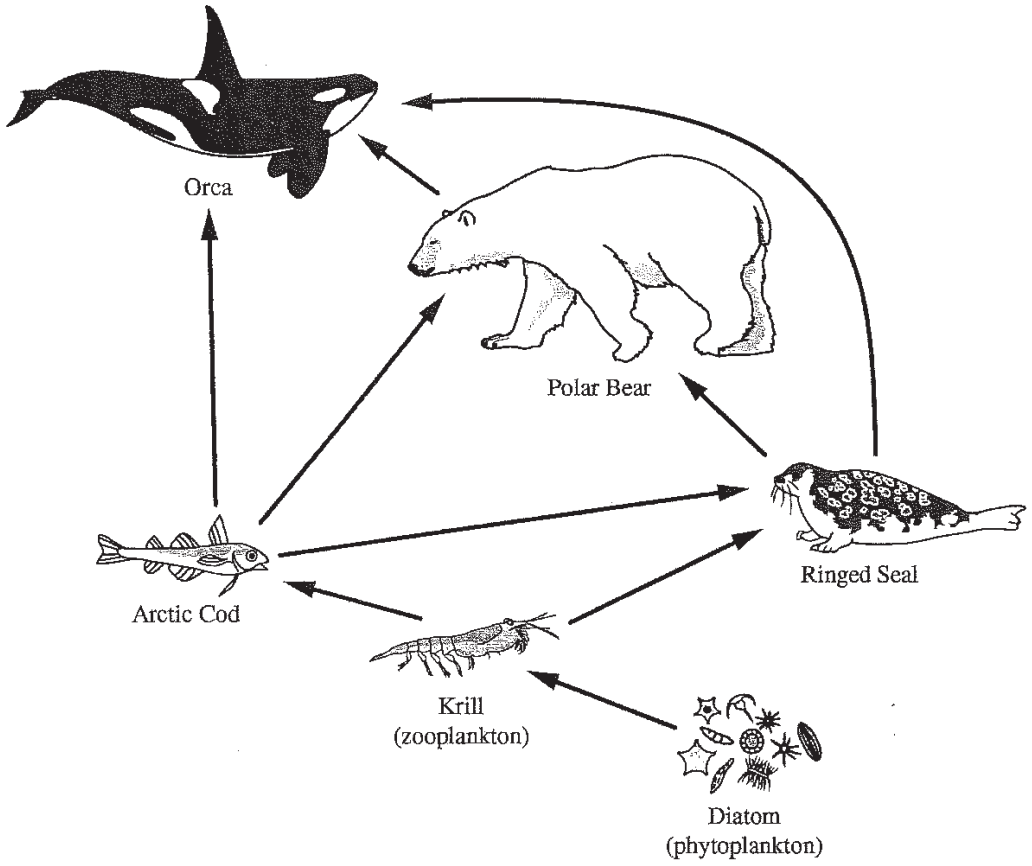
3c.i) Animals may migrate as a result of the changing of the seasons. For example, if a bird prefers warmer climates, it may fly south during the winter as it is warmer there during the winter, and may fly back north during the summer, as it isn't too hot in the north during the summer. This example is based on a bird in the Northern Hemisphere!

3eii) Large boats that are used for cruises or fishing often have sonar detectors on the bottom of the boat to measure the depth of the water. This can interfere with the whales own sonar system, causing the baby whales to seperate from their mothers due to their disorientation and be eaten by predators, or it can cause the whales to be disorientate so much that they never make it to their destination

3.e.iii) A way to reduce the sonar activity that interferes with the whales sonar systems is to create laws that prevent the use of sonar activity during certain times of the year, such as when the whales are migrating, in the areas where whales are likely to be found.

GO ON TO THE NEXT PAGE.

3. An Arctic food web includes the following organisms.



Note: Figures not drawn to scale.

(a) Refer to the food web above to complete the following table.

	Organism from Arctic food web
(i) **Identify** a primary producer	phytoplankton
(ii) **Identify** a primary consumer	zooplankton
(iii) **Identify** a secondary consumer	ringed seal

(b) Other than showing which organisms are consumed by other organisms, **describe** what is indicated by the direction of the arrows in the diagram.

As the amount of sea ice has decreased, larger expanses of the Arctic Ocean are now completely free of sea ice for several weeks each summer. Ringed seals, the preferred prey of polar bears, come to holes in the sea ice to breathe.

(c) **Describe** how the change in sea ice habitat is affecting polar bears' ability to hunt and feed.

(d) **Explain** how melting sea ice leads to a feedback loop that increases Arctic warming.

(e) Many species, including some whales and birds, will travel thousands of kilometers during annual migrations.

(i) **Provide** one reason a species may migrate a long distance.

(ii) The North Atlantic right whale migrates between subtropical and polar waters annually. Nearly 50 percent of right whale deaths are due to human activities. **Describe** one commercial activity, other than whaling, that may result in the death of right whales.

(iii) **Describe** one strategy that could reasonably be implemented to decrease right whale deaths caused by the commercial activity you described in part (ii).

ai. One primary producer is phytoplankton, or diatom.

aii. A primary consumer is zooplankton, or krill.

aiii. A secondary consumer is a ringed seal.

b. As one organism is consumed by another, energy is transferred to the consumer. The arrows in the diagram indicate energy flow up the food web. Those who feed at higher trophic levels need to consume more of their prey because only around 10% of the energy an organism has can be used by the organism feeding upon it.

c. Because there is no need for air holes for the seals (due to the large expanses of open ocean), polar bears cannot wait by the nonexisting holes for seals to come to the surface to breathe. Because of this, polar bears have a decreased ability to hunt and feed.

d. As sea ice melts, the water temperature increases due to melting ice. This warmer temperature makes more ice melt, which creates a positive feedback loop (it appears to increase indefinitely)

ei. One reason a species may migrate a long distance is because of seasonal temperature changes, which makes the species move to their ideal temperature zone.

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eiii Overfishing, a human commercial activity due to Tragedy of the Commons, leads to the death of right whales because there is not enough prey (fish) for them to feed on.

eiii One strategy to decrease right whale deaths from overfishing would be to put caps on the amount of fish brought in by each country. This would allow fish populations to regenerate, which provides more food for right whales and a population rebound.

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2018 SCORING COMMENTARY

Question 3

Overview

The intent of this question was for students to evaluate an Arctic food web and to describe the impact of climate change on organisms in the food web. The questions also asked students to describe migration and the impact of human activity on the migration of right whales.

In the first part of the question, the stimulus provided an Arctic food web with several aquatic organisms that was used to assess the students' knowledge of the flow of energy and feeding relationships. Students were asked to identify a primary producer, a primary consumer, and a secondary consumer from the Arctic food web. Students also had to describe what was indicated by the directions of the arrows in the food web. These concepts were drawn from the following section of the course description: II. The Living World, B. Energy Flow.

Students were then asked to describe how the loss of sea ice in the Arctic was affecting the ability of polar bears to hunt and feed. Students were also asked to explain how the melting sea ice leads to a feedback loop that increases Arctic warming. These concepts were drawn from the following section of the course description: VII. Global Change, B. Global Warming.

Sample: 3A
Score: 10

The response earned 3 points in part (a): 1 point in (a)(i) for correctly identifying diatom as a primary producer; 1 point in (a)(ii) for correctly identifying krill as a primary consumer; and 1 point in (a)(iii) for correctly identifying Arctic cod as a secondary consumer. The response earned 1 point in part (b) for describing "[t]he arrows in the diagram represent the flow of energy." The response earned 1 point in part (c) for describing "[w]ith shrinking ice, the seals can breach the surface virtually anywhere which means the polar bears on the ice cannot attack them." Two points were earned in part (d): 1 point for explaining that "less ice is reflecting the Sun's rays which leads to the warming of the water" and 1 point for completing the positive feedback loop by explaining that "the warming of the water which goes back to melting more ice." The response earned 3 points in part (e). One point was earned in (e)(i) for identifying that species may migrate "to go where food is more plentiful." One point was earned in (e)(ii) for describing how cargo ships can collide with whales and indicating that "if a whale breaches the surface in front of a ship, there is not anything to do to stop the ship from hitting it." One point was earned in (e)(iii) for describing an activity of requiring "those in operation of large commercial ships to have an awareness of right whale migratory patterns."

Question 3 (continued)

Sample: 3B
Score: 8

The response earned 3 points in part (a): 1 point in (a)(i) for correctly identifying diatom as a primary producer; 1 point in (a)(ii) for correctly identifying krill as a primary consumer; and 1 point in (a)(iii) for correctly identifying Arctic cod as a secondary consumer. The response earned 1 point in part (b) for identifying that the arrows represent "the movement of energy." The response earned 1 point in part (c) for describing that "the seals can come up to breathe anywhere, making it hard for the polar bears to identify the location of the seals, and making it harder for them to get food." No points were earned in part (d). The response earned 3 points in part (e). One point was earned in (e)(i) for correctly identifying that "[a]nimals may migrate as a result of the changing seasons," with a further explanation of more hospitable climate being sought. One point was earned in (e)(ii) for describing "[l]arge boats that are used for cruises … have sonar detectors on the bottom of the boat," and noting that "[t]his can interfere with the whales own sonar system." One point was earned in (e)(iii) for describing a strategy of "creat[ing] laws that prevent the use of sonar activity during certain times of the year."

Sample: 3C
Score: 6

The response earned 3 points in part (a): 1 point in (a)(i) for correctly identifying phytoplankton as a primary producer; 1 point in (a)(ii) for correctly identifying zooplankton as a primary consumer; and 1 point in (a)(iii) for correctly identifying ringed seal as a secondary consumer. The response earned 1 point in part (b) for stating that the arrows "indicate energy flow." The response earned 1 point in part (c) for describing that there are "large expanses of open ocean" and that polar bears "cannot wait by the nonexisting holes," so "polar bears have a decreased ability to hunt and feed." No points were earned in part (d). The response earned 1 point in (e)(i) for identifying that species migrate "because of seasonal temperature changes, which make the species move to their ideal temperature zone."