# Past-paper walk-through

## Food Chains and Food Webs ▪ 1.11

eXercise

# Questions in this set

- 2026 Q1
- 2025 Set 1 Q1
- 2023 Set 2 Q2
- 2018 Q3
- 2016 Q1

# Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

# Question 1

2026 ▪ Q1

The following information applies to parts A, B, C, D, and E.

Climate change can affect both terrestrial and marine organisms. Researchers studying the effect of climate change on bird distribution mapped elevation zones at which five bird species lived within a tropical mountain range. Birds are distributed in part according to climate-related adaptations. Researchers modeled where the birds would most likely live in the future based on climate change predictions.

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**Bird Species Distribution**

# Question 1

[Diagram: a pyramid-shaped chart titled “Bird Species Distribution,” split into a “Current Distribution” half (left) and “Predicted Future Distribution” half (right), divided by a vertical center line. The pyramid is divided into four horizontal elevation bands, from top (narrowest) to bottom (widest): “High Elevations,” “Mid-High Elevations,” “Mid-Low Elevations,” and “Low Elevations,” separated by dashed lines. Each band shows bird-shape icons above the letters A, B, C, D, E (Current side) and A, B, C, D, E (Predicted Future side), indicating which species is present at that elevation. A legend defines a black bird silhouette = “Species present at elevation” and a gray bird silhouette = “Extinct species.”
Current Distribution:

- High Elevations: Species A and Species C present.
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# Question 1

- Mid-Low Elevations: Species B and Species D present.
- Low Elevations: Species B, Species C, Species D, and Species E present.

Predicted Future Distribution:

- High Elevations: Species A present; Species E shown extinct (gray icon).
- Mid-High Elevations: Species B and Species D present.
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# Question 1

The following information applies to parts F, G, and H.
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- Tank 1: 27°C and no sediment
- Tank 2: 32°C and no sediment

# Question 1

- Tank 3: 37°C and no sediment

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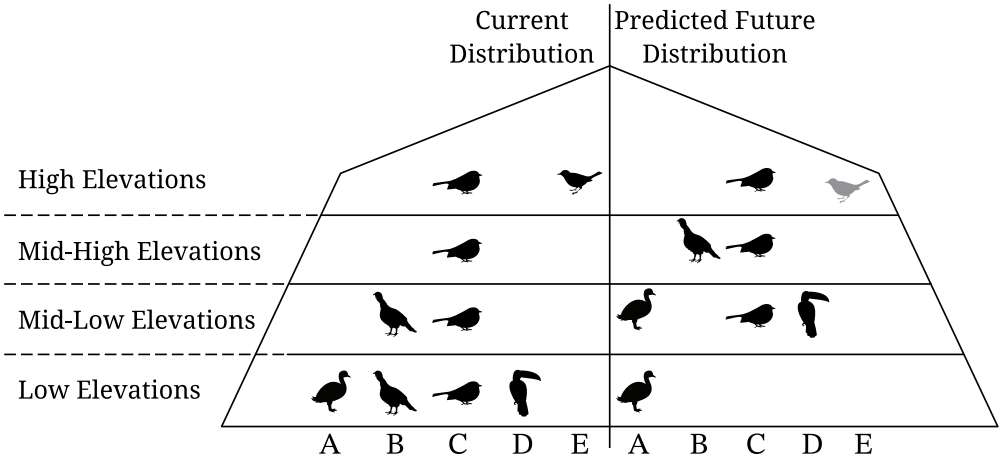
- Tank 1: 27°C and no sediment
- Tank 2: 27°C and moderate sediment
- Tank 3: 27°C and high sediment

**1.** Respond to parts A, B, C, D, E, F, G, H, I, and J.

**(a)** Based on the information in the diagram, **identify** the elevation zone that has the highest species richness for the current distribution.

# Question 1


Current Distribution
Predicted Future Distribution
High Elevations
Mid-High Elevations
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A B C D E
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2026 ▪ Q1

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Predicted Future Distribution:

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# Question 1

**1.** Respond to parts A, B, C, D, E, F, G, H, I, and J.

**(b) Describe** a climate condition at high elevations that is different than it is at low elevations.

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# Question 1

**1.** Respond to parts A, B, C, D, E, F, G, H, I, and J.

**(c)** A predator at low elevations currently feeds on Species C and D. Based on the information in the diagram, **describe** what could happen to the predator species in the future in response to the predicted changes in the prey community.

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**1.** Respond to parts A, B, C, D, E, F, G, H, I, and J.

**(d)** Species C is considered a generalist, while Species E is considered a specialist. **Explain** why Species C and E are predicted to respond differently to climate change.

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**1.** Respond to parts A, B, C, D, E, F, G, H, I, and J.

**(e)** Based on the information in the diagram, **explain** why the bird community at low elevations in the future would be less likely to recover from natural disruptions than the current low-elevation bird community.

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**1.** Respond to parts A, B, C, D, E, F, G, H, I, and J.

**(f) Identify** the independent variable in Experiment 1.

# Question 1

2026 ▪ Q1

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**1.** Respond to parts A, B, C, D, E, F, G, H, I, and J.

**(g) Identify** a likely scientific question for Experiment 1.

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**(h)** In Experiment 2 the temperature of the tanks was held constant, while the amount of sediment was varied. **Explain** how this modification could affect the results of this experiment.

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# Question 1

**1.** Respond to parts A, B, C, D, E, F, G, H, I, and J.

**(i)** Changes in climate also affect Arctic ecosystems. One impact of climate change is the loss of ice and snow in polar regions. **Describe** a positive feedback loop that results from the loss of ice and snow in polar regions.

# Question 1

2026 ▪ Q1

The following information applies to parts A, B, C, D, and E.

Climate change can affect both terrestrial and marine organisms. Researchers studying the effect of climate change on bird distribution mapped elevation zones at which five bird species lived within a tropical mountain range. Birds are distributed in part according to climate-related adaptations. Researchers modeled where the birds would most likely live in the future based on climate change predictions.

The results of this study are shown in the following diagram. Each unique shape in the diagram represents a different bird species, labeled A through E. Current distribution is shown on the left side of the figure, and predicted future distribution is shown on the right.

**Bird Species Distribution**

[Diagram: a pyramid-shaped chart titled "Bird Species Distribution," split into a "Current Distribution" half (left) and "Predicted Future Distribution" half (right), divided by a vertical center line. The pyramid is divided into four horizontal elevation bands, from top (narrowest)

# Question 1

to bottom (widest): “High Elevations,” “Mid-High Elevations,” “Mid-Low Elevations,” and “Low Elevations,” separated by dashed lines. Each band shows bird-shape icons above the letters A, B, C, D, E (Current side) and A, B, C, D, E (Predicted Future side), indicating which species is present at that elevation. A legend defines a black bird silhouette = “Species present at elevation” and a gray bird silhouette = “Extinct species.”
Current Distribution:

- High Elevations: Species A and Species C present.
- Mid-High Elevations: Species A present.
- Mid-Low Elevations: Species B and Species D present.
- Low Elevations: Species B, Species C, Species D, and Species E present.

Predicted Future Distribution:

- High Elevations: Species A present; Species E shown extinct (gray icon).

# Question 1

- Mid-High Elevations: Species B and Species D present.
- Mid-Low Elevations: Species A, Species C, and Species D present.
- Low Elevations: Species A present.]

The following information applies to parts F, G, and H.
Some organisms such as birds can move in response to environmental changes, while other organisms such as corals cannot. Researchers studying the effect of climate change on marine organisms conducted two experiments involving photosynthetic algae that have a symbiotic relationship with corals.
In Experiment 1, the researchers placed photosynthetic algal colonies living in corals in three different saltwater tanks. The temperature of Tank 1 was set to 27°C, the average temperature at which most corals live. Water circulation in each tank mimicked natural ocean currents. After 30 days, the researchers counted the number of bleached corals. The tank setups are shown in the following list.

# Question 1

- Tank 1: 27°C and no sediment
- Tank 2: 32°C and no sediment
- Tank 3: 37°C and no sediment

In Experiment 2, the researchers used the same photosynthetic algae living in corals but modified the conditions of the tanks as shown in the following list. Water circulation kept the sediment in the tanks suspended. After 30 days, the researchers counted the number of bleached corals.

- Tank 1: 27°C and no sediment
- Tank 2: 27°C and moderate sediment
- Tank 3: 27°C and high sediment

# Question 1

**1.** Respond to parts A, B, C, D, E, F, G, H, I, and J.

**(j) Describe** one problem that Arctic species, such as polar bears or ringed seals, face because of warming in polar regions.

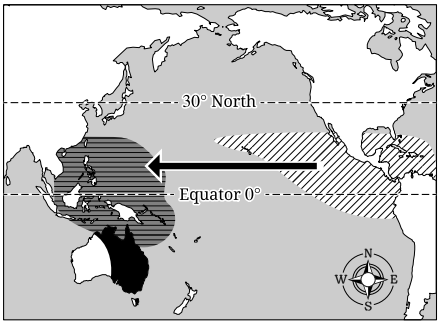
# Question 1

2025 Set 1 ▪ Q1

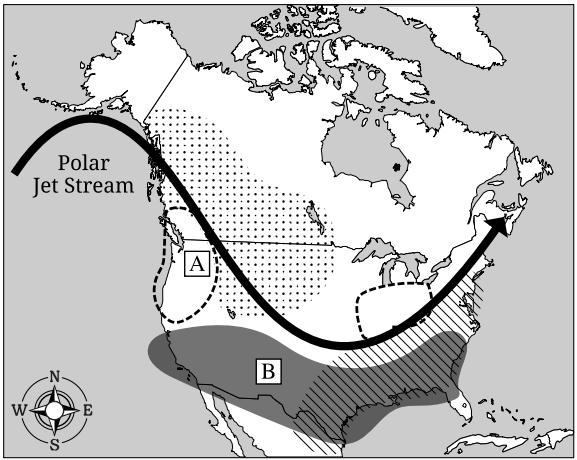
Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

**(a)** Describe one reproductive strategy used by a K-selected species such as the chickadee.

# Question 1


30° North
Equator 0°
N
W
E
S
Ocean water cooler than average
Ocean water warmer than average
Increased chance of precipitation
Stronger than normal trade winds

# Question 1



# Question 1

| Site | Species A | Species B | Species C | Species D | Species E | Species F |
|---|---|---|---|---|---|---|
| Urban park | X | | | X | X | |
| Grassland | X | X | X | X | | X |

# Question 1

2025 Set 1 ▪ Q1

Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

**(b)** Based on the information provided, explain how a decrease in spider populations could affect a lower trophic level.

# Question 1

2025 Set 1 ▪ Q1

Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

**(c)** Based on the data in Figure 1, identify the number of spiders per sample at 25% nonnative plants.

# Question 1

2025 Set 1 ▪ Q1

Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

**(d)** Based on the data in Figure 1, describe the trend in the number of insects per sample in relation to the percentage of nonnative plants.

# Question 1

2025 Set 1 ▪ Q1

Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

**(e)** Scientists hypothesized that the population of chickadees would be stable or growing with fewer than 25% nonnative plants. Describe one way that the data in Figure 2 support this hypothesis.

# Question 1

2025 Set 1 ▪ Q1

Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

**(f)** Insect biodiversity is important to maintain ecosystem health. A group of students was interested in learning about factors that affect ant biodiversity. They located two study sites near their school: a frequently mowed urban park and an unmowed grassland. The students used traps designed to collect ants. They loaded 10 of these traps with the same food and placed them randomly at different locations within each site. Students collected the traps after 24 hours and counted the number of different ant species in each trap to determine species richness.

**(f)(i)** Identify a likely scientific question for the students' investigation of ant diversity.

**(f)(ii)** Identify the dependent variable in the students' investigation.

# Question 1

2025 Set 1 ▪ Q1

Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

**(g)** The data from the student investigation of ant diversity are shown in the following table. An "X" in the table indicates that the species was present at that site.

Ant Species Present in an Urban Park and Unmowed Grassland

| **Site** | **Species A** | **Species B** | **Species C** | **Species D** | **Species E** | **Species F** |
|---|---|---|---|---|---|---|
| Urban park | X | | | X | X | |
| Grassland | X | X | X | X | | X |

# Question 1

**(g)(i)** Explain why the ant community of the unmowed grassland would be more likely to recover from a disturbance, such as a flood or fire, than the ant community in the mowed urban park would.

**(g)(ii)** Explain how the results of the investigation could have been altered if students had measured ant biodiversity at a paved playground rather than in the grassland.

# Question 1

2025 Set 1 ▪ Q1

Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

**(h)** Habitat fragmentation has impacts on a variety of species. Paved roads can lead to habitat fragmentation.

Describe one effect that a paved road in a forest can have on animal species such as deer or bears.

# Solution 1

**(a)**

**Mark scheme**

- Describe one reproductive strategy of a K-selected species (e.g., chickadee). Any one of: provides considerable parental care for offspring; has few offspring; parents expend significant energy per offspring; individuals reproduce more than once in their lifetime (iteroparity); has a long gestation period/reaches reproductive maturity later.

# Solution 1

**(b)**

**Mark scheme**

- Explain how a decrease in spider populations affects a lower trophic level: insects/insect populations would increase because they are no longer being preyed on/eaten as much by spiders; consequently plant populations would decrease because more insects are now eating the plants (a trophic cascade down through insects to plants).

# Solution 1

**(c)**

**Mark scheme**

- From Figure 1, the number of spiders per sample at 25% nonnative plants is 2.0 (accept 2).

# Solution 1

**(d)**

**Mark scheme**

- Trend in Figure 1: as the percentage of nonnative plants increases, the number of insects per sample decreases (equivalently, as nonnative plant percentage decreases, insects increase) — an inverse/negative relationship between nonnative plant percentage and insect abundance.

# Solution 1

**(e)**

**Mark scheme**

- One way Figure 2 supports the hypothesis that chickadee populations are stable or growing below 25% nonnative plants: below this threshold, the population growth rate shown is at or above replacement level (positive growth), meaning enough reproduction is occurring to replace or grow the population.

# Solution 1

**(f)**

**Mark scheme**

- This is background/stem text introducing the student investigation of ant biodiversity (10 baited traps placed randomly at a frequently mowed urban park and an unmowed grassland, collected after 24 hours, species counted). It is context for parts (i) and (ii) and carries no scoring point of its own.

# Solution 1

**(f)(i)**

**Mark scheme**

- A likely scientific question for the investigation: "Does the number of species/species richness/biodiversity differ between an urban park and a grassland?" or "Does mowing affect the number of species/species richness/biodiversity?"

# Solution 1

**(f)(ii)**

**Mark scheme**

- The dependent variable is the number of ant species / ant species richness / the presence-absence of different ant species observed at each site.

# Solution 1

**(g)**

**Mark scheme**

- This presents the data table of ant species present (X) at the urban park vs. the unmowed grassland (species A-F). It is context for parts (i) and (ii) and carries no scoring point of its own.

# Solution 1

**(g)(i)**

**Mark scheme**

- The unmowed grassland's ant community would more likely recover from a disturbance because, with a larger number of species, the grassland is more likely to have some species/individuals with adaptations that allow them to survive the disturbance; the grassland is more diverse, so the loss of any one species is less likely to cause collapse of the whole community/ecosystem.

# Solution 1

**(g)(ii)**

**Mark scheme**

- If biodiversity had been measured at a paved playground instead of the grassland, the playground would show fewer species than the grassland/urban park, because the paved area is not suitable habitat for many ant species, and/or because humans could trample the ants/ant habitat there.

# Solution 1

**(h)**

**Mark scheme**

- One effect of a paved road through a forest on animals such as deer or bears: animals can be hit by cars when trying to cross the road while hunting/migrating (roadkill); fragmentation can isolate individuals and reduce genetic diversity; noise pollution can damage hearing, cause stress, or mask sounds used to communicate/hunt; the road/noise can alter migratory routes or prevent movement to access resources; species that thrive in edge habitats might increase. Any one of these earns the point.

# Question 2

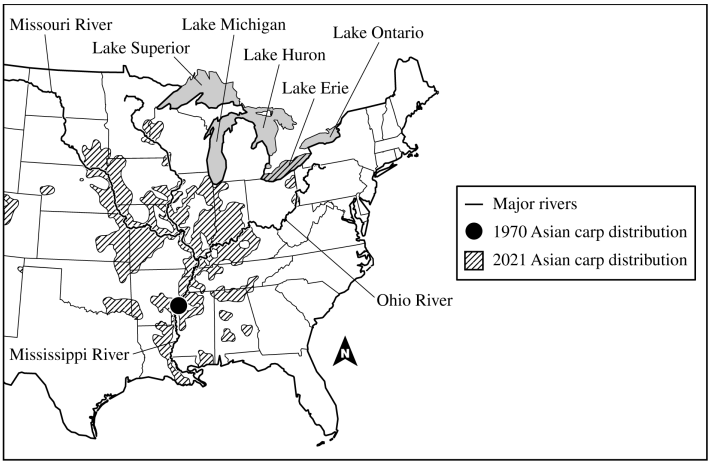
2023 Set 2 ▪ Q2

Asian carp were first introduced in the southern United States in the 1970s by fish farmers wanting to control algal growth in fish ponds. Asian carp can eat up to 40
**Distribution of the Asian Carp in the United States**
[Map of the eastern/central United States titled "Distribution of the Asian Carp in the United States". Labeled features: Missouri River, Mississippi River, Ohio River, and the five Great Lakes (Lake Superior, Lake Michigan, Lake Huron, Lake Erie, Lake Ontario), each shown shaded gray. A compass rose (N) is shown. Legend: a solid line = Major rivers; a filled black circle = 1970 Asian carp distribution (shown as a single point near the lower Mississippi River/southern states); a diagonal-hatched pattern = 2021 Asian carp distribution (shown spread widely along the Mississippi, Missouri, and Ohio River systems and extending toward the Great Lakes, with hatching also appearing over Lake Erie).]

# Question 2

The Great Lakes are a group of five major freshwater inland lakes that all share the same watershed.
The following is an example of a simple food chain in the Great Lakes.
Algae $\rightarrow$ Zooplankton $\rightarrow$ Macroinvertebrates $\rightarrow$ Yellow perch $\rightarrow$ Rainbow trout
The blue pike, a fish that was endemic to the Great Lakes, was commercially fished from the late 1800s until their population crashed in 1958. In 1970, the species was declared to be extinct.
**(a)** Based on the information given, **identify** a body of water invaded by Asian carp that is labeled on the map.

# Question 2


Missouri River
Lake Michigan
Lake Ontario
Lake Superior
Lake Huron
Lake Erie
Major rivers
1970 Asian carp distribution
2021 Asian carp distribution
Ohio River
Mississippi River
N

# Question 2

2023 Set 2 ▪ Q2

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**(b)** Based on the information shown in the map, **describe** the change in the distribution of Asian carp since their introduction in the 1970s.

# Question 2

2023 Set 2 ▪ Q2

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**Distribution of the Asian Carp in the United States**



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**(c) Describe** one impact the introduction of Asian carp could have on the ecosystem services provided by the Great Lakes region.

# Question 2

2023 Set 2 ▪ Q2

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**Distribution of the Asian Carp in the United States**



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**(d) Propose** a realistic solution to help reduce the spread of the Asian carp from their current distribution.

# Question 2

2023 Set 2 ▪ Q2

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**(e) Justify** the solution proposed in part (d) by providing an additional advantage.

# Question 2

2023 Set 2 ▪ Q2

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**(f) Identify** the primary consumer in the Great Lakes food chain.

# Question 2

2023 Set 2 ▪ Q2

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**(g) Describe** what the arrows in the aquatic food chain represent.

# Question 2

2023 Set 2 ▪ Q2

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**(h) Describe** one possible effect of the introduction of the Asian carp on the Great Lakes food chain.

# Question 2

2023 Set 2 ▪ Q2

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**(i) Describe** one way that overfishing of blue pike illustrates the tragedy of the commons.

# Question 2

2023 Set 2 ▪ Q2

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**(j)** One potential solution to reduce overfishing is to use aquaculture. **Describe** one disadvantage of this solution.

# Solution 2

**(a)**

**Mark scheme**

- A body of water labeled on the map, e.g.: the Mississippi River, Lake Erie, the Missouri River, or the Ohio River.

# Solution 2

**(b)**

**Mark scheme**

- Since their introduction in the 1970s, Asian carp have become far more widely distributed — found in most of the watershed / a much larger area than before — moving up and down the Mississippi River and up the Missouri and Ohio Rivers (i.e., spreading northwest and northeast up the river systems).

# Solution 2

**(c)**

**Mark scheme**

- One impact on ecosystem services, e.g.: improved drinking water quality as carp consume algae; decreased recreational opportunities (boating/swimming) from the larger carp population; decreased fishing as carp outcompete native fish species; decreased drinking water quality as carp displace filter feeders like native mussels; or a decreased algae population leading to decreased photosynthesis and either increased greenhouse gases/warming or decreased oxygen production.

# Solution 2

**(d)**

**Mark scheme**

- A realistic solution such as: offering incentives for fishers to catch and kill carp; encouraging consumption of carp; building fencing/netting between waterways; using shock treatment (a dispersal barrier system); creating/using an Asian-carp-specific poison or deterrent (e.g., carpicide, CO2, microparticles); implementing a high-frequency sound deterrent system; or prohibiting the transfer of bait or ballast water from one body of water to another.

# Solution 2

**(e) Mark scheme**

- An additional advantage that matches the solution proposed in (d). For fencing/netting, sound deterrents, carp-specific poison/deterrent, or shock treatment: creates jobs in the Great Lakes fishing industry, causes little/no harm to native animal/plant populations, reduces carp's negative impact on watershed feeding relationships, or maintains revenue for the existing fishing industry/tourism. For encouraging carp consumption or incentivizing fishers to catch/kill carp: increases revenue in the fishing industry/from carp sales, reduces carp's negative feeding-relationship impacts, provides a new food source (domestically/internationally) or combats hunger, or allows native species to return as competition from carp decreases. For prohibiting bait/ballast transfer:

## Solution 2

causes no harm to native populations, reduces carp's negative feeding impacts, or maintains existing fishing/tourism revenue.

# Solution 2

**(f)**

**Mark scheme**

- Zooplankton — the primary consumer in the Great Lakes food chain.

# Solution 2

**(g)**

**Mark scheme**

- The arrows represent the flow of energy (or equivalently, the flow of matter) through the aquatic food chain.

# Solution 2

**(h)**

**Mark scheme**

- One possible effect, e.g.: there will be fewer zooplankton/macroinvertebrates/yellow perch/rainbow trout; there will be less food available for other species at the same trophic level; or there will be less food for species that don't eat carp but are higher on the food chain.

# Solution 2

**(i)**

**Mark scheme**

- The blue pike were a shared/common resource with unregulated access, so fishers maximized their own profits/catch, depleting (and ultimately causing the extinction of) the shared resource — illustrating the tragedy of the commons.

# Solution 2

**(j)**

**Mark scheme**

- One disadvantage of aquaculture, e.g.: it contaminates water with excess organic waste/antibiotics; escaped fish compete or breed with wild fish; facilities can spread disease to wild fish; high fish density increases disease; it causes job losses in the fishing industry; it puts pressure on wild fish stocks used to make food pellets; it decreases the genetic diversity of farm-raised fish; it causes habitat degradation from converting ecosystems to fish farms; or antibiotic overuse creates antibiotic-resistant bacteria harmful to humans.

# Question 3

2018 ▪ Q3

An Arctic food web includes the following organisms.




[Food-web diagram showing organisms connected by arrows pointing from prey to predator (from what is eaten to what eats it), labeled: "Orca", "Polar Bear", "Arctic Cod", "Ringed Seal", "Krill (zooplankton)", "Diatom (phytoplankton)". Arrows: Diatom (phytoplankton) → Krill (zooplankton); Diatom (phytoplankton) → Ringed Seal; Krill (zooplankton) → Arctic Cod; Arctic Cod → Orca; Arctic Cod → Polar Bear; Ringed Seal → Polar Bear; Ringed Seal → Orca; Polar Bear → Orca. Note: Figures not drawn to scale.]

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

# Question 3

| | **Organism from Arctic food web** |
|---|---|
| (i) Identify a primary producer | |
| (ii) Identify a primary consumer | |
| (iii) Identify a secondary consumer | |

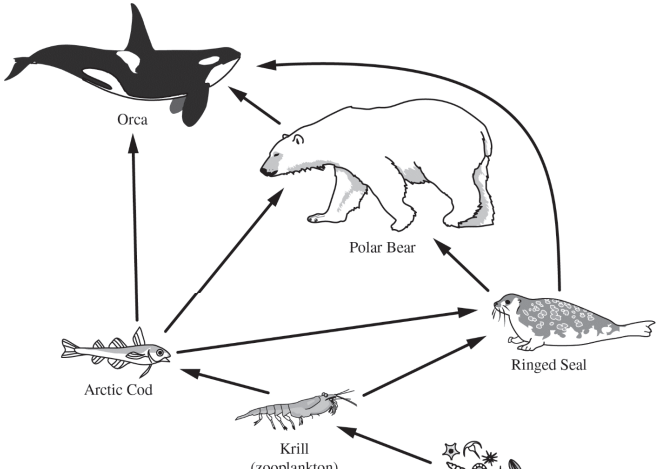
Identify a primary producer.

**(a)(ii)** Identify a primary consumer.

# Question 3

**(a)(iii)** Identify a secondary consumer.

# Question 3



# Question 3

(zooplankton)

Diatom
(phytoplankton)

Note: Figures not drawn to scale.

# Question 3

| | Organism from Arctic food web |
|---|---|
| (i) **Identify** a primary producer | |
| (ii) **Identify** a primary consumer | |
| (iii) **Identify** a secondary consumer | |

# Question 3

2018 ▪ Q3

An Arctic food web includes the following organisms.




[Food-web diagram showing organisms connected by arrows pointing from prey to predator (from what is eaten to what eats it), labeled: "Orca", "Polar Bear", "Arctic Cod", "Ringed Seal", "Krill (zooplankton)", "Diatom (phytoplankton)". Arrows: Diatom (phytoplankton) → Krill (zooplankton); Diatom (phytoplankton) → Ringed Seal; Krill (zooplankton) → Arctic Cod; Arctic Cod → Orca; Arctic Cod → Polar Bear; Ringed Seal → Polar Bear; Ringed Seal → Orca; Polar Bear → Orca. Note: Figures not drawn to scale.]

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

# Question 3

2018 ▪ Q3

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**(c)** 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.

Describe how the change in sea ice habitat is affecting polar bears’ ability to hunt and feed.

# Question 3

2018 ▪ Q3

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

# Question 3

2018 ▪ Q3

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

Provide one reason a species may migrate a long distance.

**(e)(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.

# Question 3

Describe one commercial activity, other than whaling, that may result in the death of right whales.

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

# Solution 3

**(a)(i)**

**Mark scheme**

- 1 point for correctly identifying a primary producer from the Arctic food web: Diatom (phytoplankton).

**(a)(ii)**

**Mark scheme**

- 1 point for correctly identifying a primary consumer from the Arctic food web: Krill (zooplankton).

# Solution 3

**(a)(iii)**

**Mark scheme**

- 1 point for correctly identifying a secondary consumer from the Arctic food web: Cod or seal.

# Solution 3

**(b)**

**Mark scheme**

- 1 point for a correct description of what the arrow direction indicates, other than which organisms are consumed by others. Accept: shows the flow of energy among trophic levels; OR shows the flow of matter through trophic levels.

# Solution 3

**(c) Mark scheme**

- 1 point for a correct description of how the changing sea ice habitat affects polar bears' ability to hunt/feed. Accept any one of: decreasing area of hunting ground (fewer seal breathing holes/less ice for hauling out) makes it more difficult for polar bears to get food; increasing distance between hunting grounds means polar bears must exert more energy to swim to find food, causing physical exhaustion and less energy available for hunting; increasing physiological stress (dehydration, exhaustion, cub mortality) because polar bears are not physiologically adapted to warmer temperatures; increasing the time between successful kills means bears spend more time waiting/hunting for prey.

# Solution 3

**(d)**

**Mark scheme**

- 2 points: 1 point for explaining the connection between melting ice and increased absorption of the sun's energy, and 1 point for explaining that this increased absorption leads to further ice melt (completing the positive feedback loop). Melting of sea ice leads to a decrease in albedo/reflectivity, causing water surfaces to absorb more of the sun's energy; AND this increasing absorption of the sun's energy warms the water surface further, which leads to further ice melt (completes the positive feedback loop).

# Solution 3

**(e)(i)**

**Mark scheme**

- 1 point for a correct reason a species may migrate a long distance. Accept any one of: limited food/water supply leads to migration to locations with more food/water supply; food supply migrates and the species follows its prey; more hospitable climate during certain seasons; availability of mates/breeding/birthing occurs in a different location; protection of offspring from predators.

# Solution 3

**(e)(ii)**

**Mark scheme**

- 1 point for a correct description of a commercial activity, other than whaling, that may result in right whale deaths. Accept any one of: fishing nets entangle whales as by-catch/fishing gear can accidentally trap whales; ships and whales use the same channels, which can increase the number of ship strikes; noise pollution from seismic surveys/sonar/engine noise can disrupt a whale's internal navigational system.

# Solution 3

## (e)(iii) Mark scheme

- 1 point for a correct strategy linked to the activity named in part (ii). If fishing gear/by-catch was named: require a change of fishing method (location, timing, or materials) that traps whales, to reduce the number of whales trapped in nets/gear; OR fines for discarded fishing gear so less gear is discarded, reducing whales trapped in gear. If ship strikes were named: improved navigational technology to spot whales close to ships to avoid collisions; OR increased education of ship captains/crews about whale habitat/migration routes/feeding behaviors; OR expansion of low-speed navigational zones around ports. If noise pollution was named: reduction of seismic survey activity/sonar use in coastal areas; OR installation of quieter motors to reduce/eliminate noise pollution.

# Question 1

2016 ▪ Q1

Read the following article from the *Fremont New Tribune*.

**Fremont New Tribune** — May 2, 2016

As another winter concludes, biologists are alarmed by the continued spread of white nose syndrome (WNS) in bats. WNS is a fungal disease that is decimating bat populations across eastern North American forests, with mortality rates reaching up to 100 percent at many sites. WNS has been found in at least 25 states in the United States and 5 Canadian provinces.

The fungus (*Pseudogymnoascus destructans*) grows well in cool conditions such as those found in caves and has been observed as white patches on the muzzles, noses, ears, and wings of many cave-dwelling bats. WNS has caused significant population declines for several bat species, including once-numerous species such as the little brown bat (*Myotis lucifugus*).

# Question 1

Little brown bats hunt using echolocation by emitting up to 200 high-frequency calls per second when pursuing their prey. When healthy, the little brown bat can live up to ten years and have one or two offspring (called pups) each year.
"Little brown bats provide tremendous value to the United States economy every year by the essential services they provide to farmers and other people. We need to understand how this deadly disease spreads and attempt to help reduce its impact on the little brown bat and other bat species," said Dr. Duke Serach of the Fremont office of the United States Fish and Wildlife Service. Dr. Serach concluded with, "It may yet be possible to save the little brown bats, but the remaining population will be alarmingly small."
**(a)** Diseases can devastate populations; however, most diseases do not drive their host to extinction. **Provide** one explanation for why diseases seldom cause extinction.

# Question 1

**Fremont New Tribune** **May 2, 2016**

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**(b)(i)** Dr. Serach suggests that even if the impact of WNS on little brown bat populations can be reduced and the extinction of the species avoided, the bat populations are likely to remain alarmingly small.

**Describe** TWO threats (other than WNS) to the survival of the bat species if the total number of bats becomes very small.

# Question 1

**(b)(ii)** If the little brown bat species does not become extinct and can potentially recover, the rate of recovery is likely to be slow. **Discuss** one aspect of bat biology that might slow the recovery of little brown bat populations to pre-WNS numbers.

# Question 1

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**(c)** Bats are found in ecosystems around the world. **Describe** TWO ways in which other organisms in an ecosystem could be affected by a decline in a bat population.

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**(d)** The Eastern deciduous forest in which the little brown bats live is an important ecosystem. **Identify** TWO ecosystem services that forests provide, and **explain** how each service benefits human society.

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**(e)** WNS is an emerging disease in bats. Humans are also subject to emerging diseases, such as Ebola. A recent study suggests that the number of emerging infectious diseases affecting human populations has been steadily increasing in recent decades. **Provide** a likely reason for the increase in emerging infectious diseases affecting human populations. Include an explanation for the reason you provided.

# Solution 1

**(a)**

**Mark scheme**

- 1 point for any one valid explanation of why diseases seldom cause extinction: genetic diversity in wild populations lets some resistant individuals survive and reproduce; disease organisms often co-evolve with their hosts, allowing hosts to evolve resistance; pathogens/disease organisms that drive their host population to extinction jeopardize their own survival; initial deaths thin (reduce the density of) the population, making it less likely the disease will continue to spread.

# Solution 1

## (b)(i) Mark scheme

- 2 points: 1 point for each of TWO described threats (other than WNS) to a very small bat population — only the first two distinct threats given earn credit. Acceptable: difficulty finding mates when the population is small/widely dispersed or has a skewed sex ratio; competition from other species with a similar niche (e.g., nesting sites, food); problems from reduced genetic diversity (small gene pool, lack of hybrid vigor, a disease affecting all members, bottleneck effect); susceptibility to reduced fitness from decreased group protection (not enough individuals to create heat, less protection from predators, increased predation risk without safety-in-numbers); increased vulnerability to environmental disturbances (must name a specific disturbance).

# Solution 1

**(b)(ii)**

**Mark scheme**

- 1 point for a correct discussion of one aspect of bat biology that would slow recovery to pre-WNS numbers: low fecundity/few babies per year; long generation times; advanced age at first reproduction; or increased parental care requirements.

# Solution 1

**(c) Mark scheme**

- 2 points: 1 point for each of TWO described ways other ecosystem organisms could be affected by a bat population decline — only the first two given earn credit. Acceptable: increase in bat food sources (e.g., insect pest populations rise); increase in West Nile virus and other insect-borne diseases; decrease in the spread of rabies; decrease in the fungus that causes WNS; decrease in bat guano (affecting guano-dependent organisms); decline in plants that bats pollinate or disperse seeds for; decline in bat predators due to decreased food supply; increase in numbers of animals with similar food/habitat needs; a resulting trophic cascade.

# Solution 1

**(d) Mark scheme**

- 2 points: 1 point for each of TWO correctly paired ecosystem services with their human benefit. Acceptable pairs — resource material (tree/forest): lumber, building materials, fuel, paper, food; oxygen production: human respiration; soil formation/protection: forestry, agriculture, flood control, water quality; protection of water supplies: drinking water, recreation, irrigation, fishing; habitat (specify, e.g., shade/temperature moderation): animals/plants humans use for fishing, hunting, food; biodiversity: food, medicine, gene diversity, breeding stock; carbon sink/sequestering: slows climate change; aesthetic/cultural/social value: inspiration for art/music/poetry, research, education, recreation, tourism.

# Solution 1

**(e) Mark scheme**

- 2 points: 1 point for a valid reason for the increase in emerging infectious diseases, plus 1 point for a correctly linked explanation of how that reason increases disease emergence. Acceptable pairs — climate change/global warming: allows pathogens and disease vectors to survive in places previously too cold or dry; increase in global travel: increased likelihood of contracting/spreading disease; increased exposure to animals (zoonotic): changes in agricultural practices increase rodent exposure, trade in exotic species, intrusion into wild habitats, urban sprawl; increase in population density/distribution: increased likelihood of contracting/spreading disease from others; lack of vaccinations: increases human susceptibility, reduces herd immunity; antibiotic resistance: new

## Solution 1

disease strains evolve; decrease in medical care/public health: poverty, war, migration, human behavior (refusing condoms, sharing needles, refusing aid).