**Reasons why**

Look at the food web diagram.

blackbird

chaffinch



bee



caterpillar



lavender

cabbage

owl



1. The population of owls decreased. This caused a decrease in the number of caterpillars.

Which statement explains why this happen?

|  |  |
| --- | --- |
| **A** | There were fewer cabbages for the caterpillars to eat. |
| **B** | The population of chaffinches increased, so they ate more caterpillars. |
| **C** | In a food web, if one population decreases all populations in that food chain will also decrease. |
| **D** | There were more bees eating the lavender, so there was less lavender for the caterpillars to eat. |

*Biology > Big idea BOE: Organisms and their environments > Topic BOE2: Organisms in their environments > Key concept BOE2.1: Ecosystem components and dynamics*

|  |
| --- |
| **Diagnostic question** |
| **Reasons why** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | The environmental conditions in different ecosystems, and in different parts of an ecosystem, affect and are affected by the organisms that live there. |
| Observable learning outcome: | Describe how changes in environmental conditions may lead to population change in ecosystems. |
| Question type: | Simple multiple choice |
| Key words: | food web, food chain, interdependence, community, ecosystem |

**What does the research say?**

Griffiths and Grant (1985) drew a distinction between students’ ability to recall that populations in a food web interact, and their ability to apply that principle to predict possible effects of a change in one population on others in the same food web.

Research has shown that when students are asked to predict possible effects of a change in a population within a food web, they tend to focus only on single food chains within the web, struggle to trace changes through more than one chain, struggle to think about the impact of a change in a population more than one trophic level away, and are more able to trace changes upwards through a chain than downwards (Webb and Boltt, 1990; Leach et al., 1992; Gotwals and Songer, 2010; Griffiths and Grant, 1985; Barman, Griffiths and Okebukola, 1995). These authors and others have identified specific misunderstandings about changes in food webs that are commonly held by school children, including that:

* a change in the size of a population will only affect another population if they are related as predator-prey;
* a change in the size of a population will only affect other populations in the same food chain within a food web (and will not affect populations in other food chains within the food web);
* if the size of one population changes, all other populations in the food web will change in the same way (e.g. a decrease in one population means all other populations will also decrease).

A study by Jin et al (2019) into student understanding of ecosystems focussed on student ability to explain the interdependent relationships in ecosystems and human impact on those relationships. Their aim was to develop a learning progression for systems thinking in ecosystems. Students were presented with real world phenomena about relations in ecosystems and their responses were graded based on the content of their explanations. They found that only 3% of the students were able to discuss mechanisms in their answers the vast majority of students were therefore unable to “use systems thinking concepts to construct a causal mechanism that explains phenomena about interactions in ecosystems”. 33% were able to identify distant relations and interactions in ecosystems but were not able to construct explanations, whilst the most 57% simply explained the relationships in terms of individual organism needs.

An ecology concept test used in a study of elementary students revealed several misconceptions about population change in ecosystems. It found students thought that ‘a change in one population will only affect another population if the two populations were related as predator and prey’ and that ‘ if the size of one population in a food web is altered, all other populations in the web will be altered in the same way’ (Özkan, Tekkaya and Geban, 2004). They found that students had difficulty determine the effect of change in numbers of population when the effect was transmitted along more than one route with pupils reasoning that the populations were too far apart or not closely linked.

**Ways to use this question**

Students should complete the confidence grids individually. This could be a pencil and paper exercise, or you could use the PowerPoint presentation with an electronic voting system or mini white boards.

*Differentiation*

You may choose to read the questions and suggestions to the class, so that everyone can focus on the science. In some situations it may be more appropriate for a teaching assistant to read for one or two students.

**Expected answers**

Students should recognise that the disappearance of one population could affect other populations in different ways in all parts of the food web, both up and down food chains, and in different interconnected food chains.

Students should be able to trace the implications of the disappearance of a population through the food web in various directions to provide potential explanations for the effects observed.

1. There were fewer cabbages for the caterpillars to eat – **wrong** – a fall in caterpillar numbers could be caused by a fall in their food source, but in this scenario the driving force is the loss of a predator indirectly linked to the caterpillars.
2. The population of chaffinches increased, so they ate more caterpillars.– **right-** if there are less owls predating on the chaffinches the number of chaffinches will increase, more food will be required to sustain the chaffinches so more caterpillars will be eaten and their population will fall.
3. In a food web, if one population decreases all species in that food chain will also decrease. – **wrong** this is a common misconception identified by the research.
4. There were more bees eating the lavender, so less lavender for the caterpillars to eat. – **wrong** – the number of bees could also fall as the number of blackbirds would increase. As a result, the amount of lavender would likely increase not decrease.

**How to respond - what next?**

If there is a range of answers, you may choose to respond through structured class discussion. Ask one student to explain why they gave the answer they did; ask another student to explain why they agree with them; ask another to explain why they disagree, and so on. This sort of discussion gives students the opportunity to explore their thinking and for you to really understand their learning needs. Responses often work best when the activities involve paired or small group discussions, which encourage social construction of new ideas (meaning making) through dialogue.

A number of authors have suggested using role play (e.g. Ford and Smith, 1994) and games (e.g. Biffi et al., 2016; Hartweg et al., 2017) to increase engagement and help develop students’ understanding of food chains and food webs. The following BEST ‘response activity’ could be used in follow-up to this diagnostic question:

* Response activity: Reindeer on Saint Paul Island
* Response activity: All change
* Response activity: The wolves of Yellowstone National Park

If students are unable to trace changes through food chains it may be useful to use revisit the diagnostic question “Through the food web”.

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