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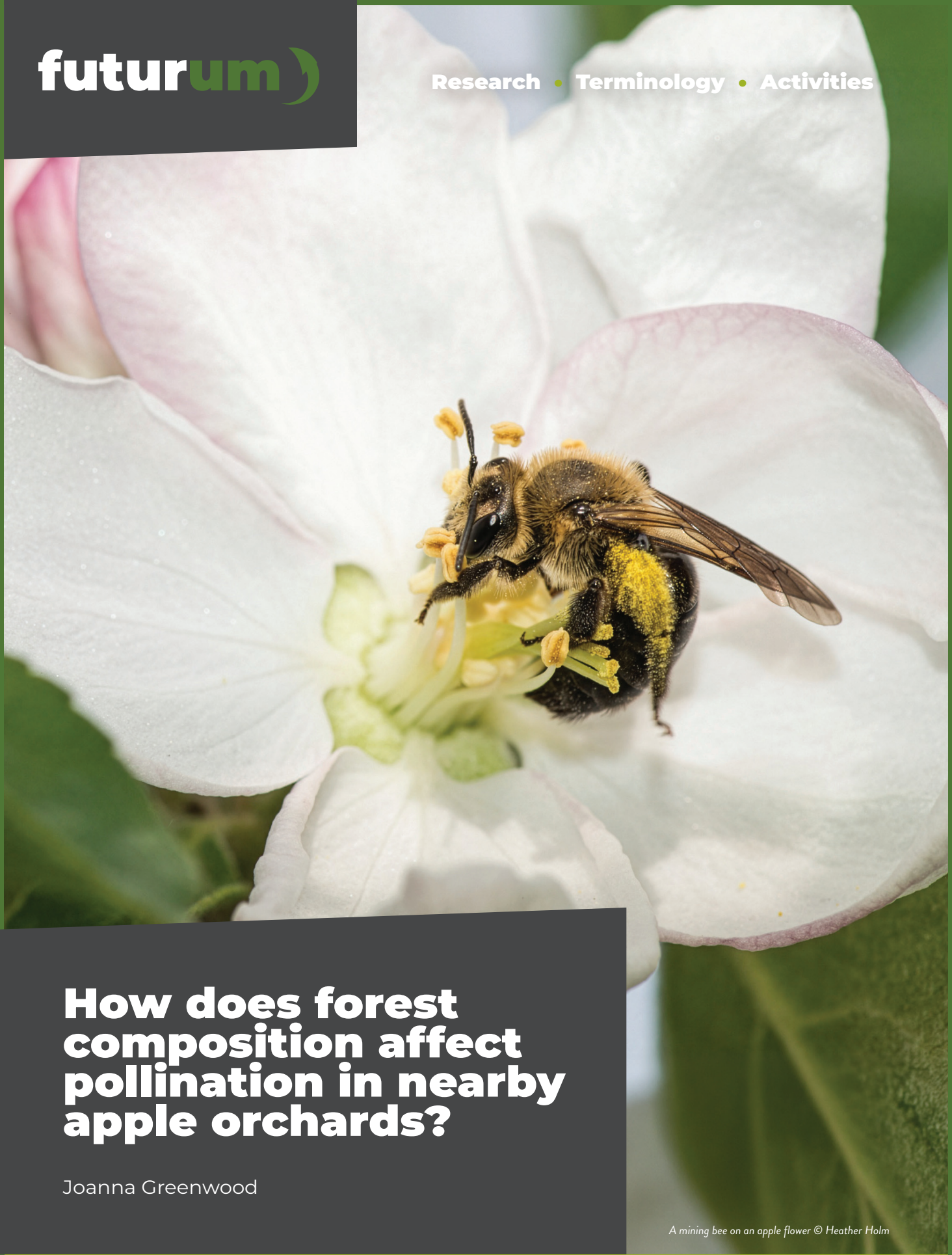
Research • Terminology • Activities



How does forest composition affect pollination in nearby apple orchards?

Joanna Greenwood

A mining bee on an apple flower © Heather Holm

How does forest composition affect pollination in nearby apple orchards?

Many apple orchards in the northeastern US rely on wild bees for pollination. Orchards that are surrounded by a larger amount of forest tend to be visited by a more abundant and diverse community of pollinators. But does the *type* of forest surrounding an orchard matter as well? At **Rutgers University**, **Joanna Greenwood** is studying this question to learn more about the relationship between pollinators, orchards and their surrounding forests.

Joanna Greenwood

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Field of research
Ecology

Research project
Studying the effects of forest composition on pollinators and yield in adjacent apple orchards and linking forest management and crop production

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PROFILE

Talk like an ...
ecologist

Coniferous forest – forest dominated by cone-bearing, evergreen trees such as pine, spruce and fir

Deciduous forest – forest dominated by broad-leaved trees such as oak, beech and maple that shed their leaves annually

Insect collection vacuum – a device used to suck up insects for further observation

Yield – the amount of a crop that is produced in an orchard or other crop field

Picture yourself sat in the dappled shade of an orchard. A gentle breeze wafts the sweet scent of apple blossom through the air and gently rustles the leaves above you. All around, bees buzz from tree to tree, filling the warm afternoon with a soft, soothing hum. Believe it or not, this idyllic scene is the site of Joanna Greenwood's field research.

Joanna, a PhD student at Rutgers University, is studying the relationship between forests, pollinators and apple orchards in the northeastern US. "Work by other researchers has shown that apple orchards that are closer to forest or surrounded by a larger amount of forest are visited by a more abundant and diverse community of pollinators," she says. "Apple flowers can't produce fruit unless they are visited by pollinators, which transfer pollen between flowers, so the higher abundance and diversity of pollinators near orchards results in more apples."

But apple growers don't only care about how many apples they produce; they also care about the quality of those apples – for example, how big and round they are. "Apples with more seeds tend to be larger and rounder, and each seed requires a grain of pollen to fertilise it," says Joanna. "That means that more pollinators depositing more pollen can improve the quality of the fruit."

Busy bees

Many kinds of insects visit apple flowers in the northeastern US, but bees are the most important apple pollinators because they deposit the most pollen on flowers. "Many apple growers rent managed honey bees to help with pollination," says Joanna. "However, honey bees are expensive, and some wild bees, such as mining bees, are more effective at pollinating apple flowers." If their orchards are surrounded by good habitat for wild bees, some apple growers decide not to rent honeybees and rely entirely on wild bees instead. For these growers, understanding the relationship between their orchards, the surrounding habitat and their wild pollinators is crucial.

A bee's favourite forest

While several studies have found that the amount of forest surrounding an orchard impacts the number of pollinators it receives, Joanna wanted to find out whether the *type* of forest also has an impact. "The northeastern US has both coniferous and deciduous forests," she says. "We know that bees prefer deciduous forests because they have more flowers, which bees need for food." So, Joanna suspected that high

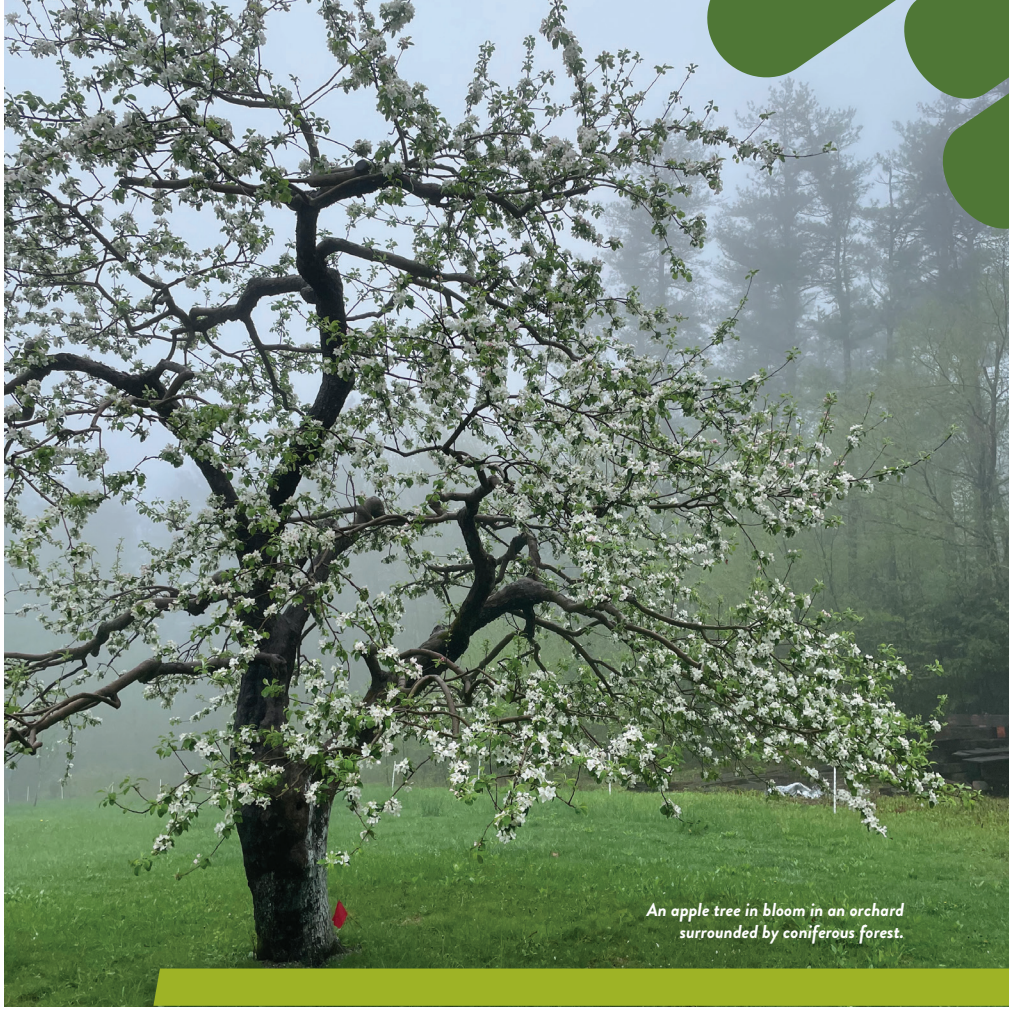
surrounding forest cover wouldn't benefit apple pollination if it wasn't the type of forest that bees prefer.

"I designed a study to answer two questions," says Joanna. "Firstly, do apple orchards surrounded by different types of forest (deciduous vs. coniferous) differ in the abundance and diversity of wild bees visiting apple flowers? And secondly, if that is the case, does this translate to differences in apple yield and quality?" To answer these questions, Joanna found six orchards surrounded by coniferous forest and six orchards surrounded by deciduous forest and collected data on the pollinators and apple yield at those orchards.

The big bee count

"To understand how many pollinator visits apple flowers were receiving at each orchard, we conducted visual visitation observations," says Joanna. "This involved counting how many and what kind of insects visited a clump of flowers for a set period of time, then calculating how many visits each flower received per minute, on average." However, it is difficult to identify most species of bee without looking at them under a microscope, so Joanna and her field technician, Kirah, also caught samples with an insect collection vacuum and took them back to the lab to determine which species were present in the orchards.

"We also determined the percentage of flowers that turn into fruits by marking branches on apple trees, counting the flowers and returning later to count the fruits," says Joanna. "When the apples were ripe, we collected them and recorded their mass, whether they were approximately symmetrical, and how many seeds they had." Counting the number of fruit allowed Joanna to figure out how many of the flowers were pollinated, and the number of seeds in each apple told her how well each flower was pollinated.



An apple tree in bloom in an orchard surrounded by coniferous forest.

The results are in...

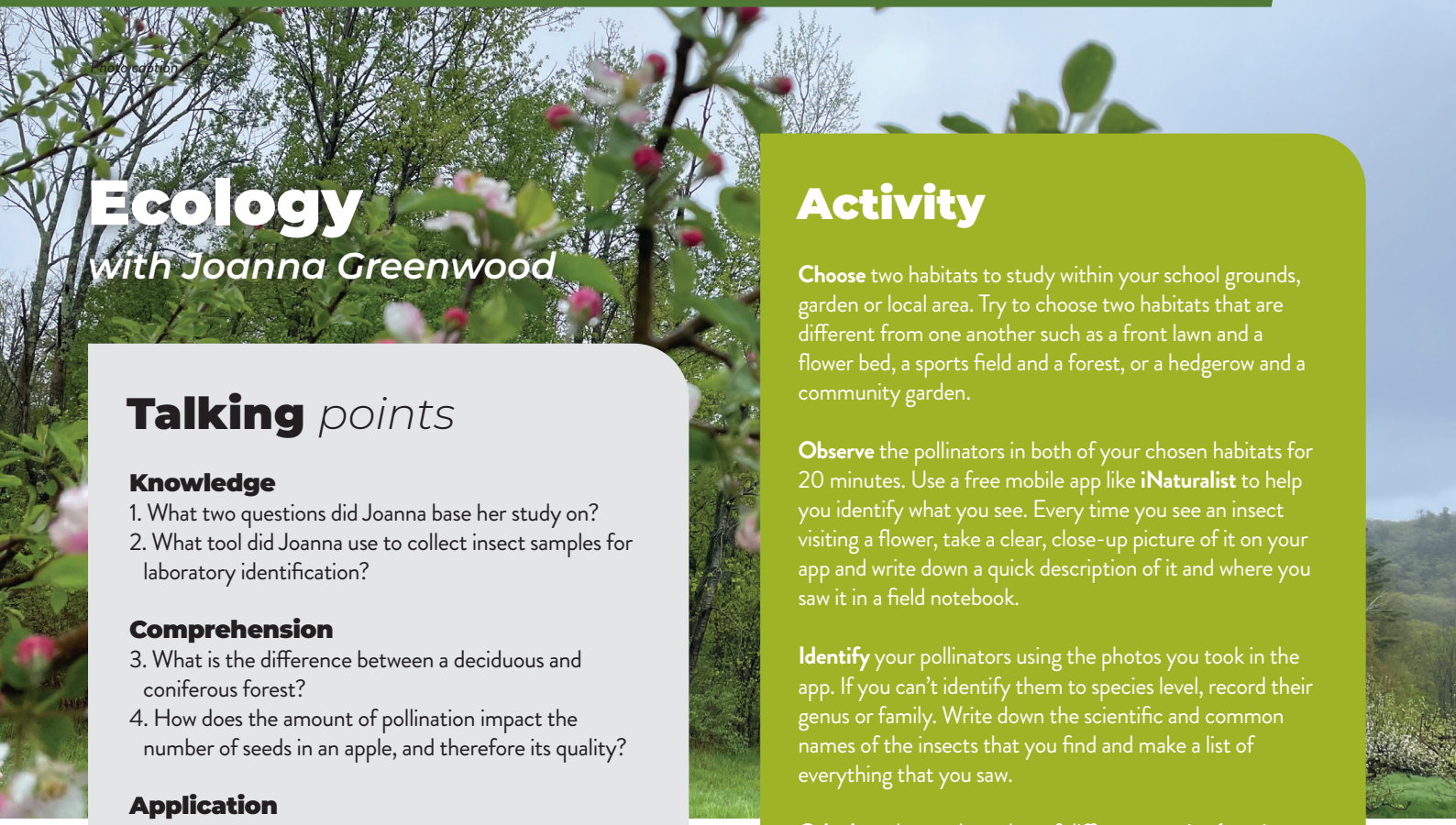
"Contrary to our expectations, we did not find a large difference in the diversity or visitation rate of wild bees in orchards surrounded by coniferous and deciduous forests," says Joanna. However, she did find that orchards with higher wild bee diversity and visitation rates had apples with more seeds. "These apples were larger and more symmetrical, making them more valuable," Joanna continues. "So, our results confirm that higher abundance and diversity of wild bees contributes to the production of higher-quality apples."

Joanna is unsure why she didn't find the results that she expected, so she will be doing more data analysis to dig a little deeper. "If we could repeat the study with more orchards, we may be able to better understand these relationships," she says. "It is also likely that other variables – such as the amount of pesticide used in the orchards – affected our results."

For the love of bees

"As crop pollinators, bees are critical for human wellbeing – but I find them fascinating in and of themselves; there are over 20,000 species of bees worldwide, and each one is unique and beautiful," says Joanna. "My favourite part of my job is spending time outdoors collecting data, but I also love talking to people about my research and about bees in general." Despite not finding the results that she expected, Joanna is excited to continue her investigation of the relationship between bees and orchards. When she's in an orchard surrounded by sweet apples and buzzing insects, there's really no place she'd rather *bee*.

Joanna records how many flowers are on a branch then returns to see how many turned into fruit.



Ecology
with Joanna Greenwood

Talking *points*

Knowledge
1. What two questions did Joanna base her study on?
2. What tool did Joanna use to collect insect samples for laboratory identification?

Comprehension
3. What is the difference between a deciduous and coniferous forest?
4. How does the amount of pollination impact the number of seeds in an apple, and therefore its quality?

Application
5. Imagine you own an apple orchard. How would you determine the average number of pollinator visits per minute for trees on your orchard?
6. How do you think an apple grower could improve the size and symmetry of their apples?

Analysis
7. Joanna suggests that the use of pesticides on orchards might have impacted her results. What other variables do you think could have affected her results, and why?
8. Compare Joanna's initial hypothesis with her results. What is the difference between the two, and why do you think the results did not confirm the hypothesis?

Synthesis
9. Imagine that you own an orchard in the northeastern US. Based on Joanna's article, how would you design a plan to improve the yield and quality of your apples?

Evaluation
10. Joanna mentioned that repeating the study at more orchards might help her better understand the data. How do you think a larger sample size would affect the reliability and validity of her results, and why?
11. Even though her results did not support her hypothesis, Joanna will publish her findings and speaks openly about what she doesn't understand. To what extent do you think it is important for scientists to share 'unexpected' or 'negative' results with the agricultural community as well as 'positive' results?

Activity

Choose two habitats to study within your school grounds, garden or local area. Try to choose two habitats that are different from one another such as a front lawn and a flower bed, a sports field and a forest, or a hedgerow and a community garden.

Observe the pollinators in both of your chosen habitats for 20 minutes. Use a free mobile app like **iNaturalist** to help you identify what you see. Every time you see an insect visiting a flower, take a clear, close-up picture of it on your app and write down a quick description of it and where you saw it in a field notebook.

Identify your pollinators using the photos you took in the app. If you can't identify them to species level, record their genus or family. Write down the scientific and common names of the insects that you find and make a list of everything that you saw.

Calculate the total number of different species (species richness) and the total number of individual insects (abundance) that you found in each habitat. Use this data to make a bar graph comparing the species richness and abundance between your two habitats.

Write a three-paragraph report explaining your results. In the first paragraph, use your data to describe which habitat supported a healthier, more diverse community of pollinators. In your second paragraph, use information from Joanna's article and your own research to explain why you think there was a difference between your two habitats. And in the third paragraph, propose two management practices for each habitat that could support its pollinator community.

Reflect on your study by answering the following questions: What limitations or potential errors might have affected your data collection and results? How could you improve the reliability and validity of your results? What have you learnt from taking part in this ecology field study?

More *resources*

- Watch this video to learn more about iNaturalist: **youtube.com/watch?v=Xigf85KgsmQ&t=55s**
- Learn more about bees and agriculture: **museumoftheearth.org/bees/agriculture**
- Discover how to become an ecologist: **cieem.net/i-want-to-be/how-to-become-an-eem**

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