

## Answer Guide

### Exploring Michigan

1. Most fossils in Michigan come from a time when it was **covered by a warm, shallow sea (between 500 and 350 million years ago)**. Then around 350 million years ago plant fossils revealed that Michigan was a **tropical rainforest**. During the Ice Age, the shape of Michigan was formed in part because of the glaciers.

2. **Serotinous cones are naturally glued shut by resin. A heat source, like a forest fire, is needed for the cones to open and release their seeds.** Because of this adaptation, forest fires become a vital part of the survival of jack pine.

**The lack of forest fires would lead to the greater presence of non-serotinous jack pine cones in the future.** The jack pine cones have adapted to the frequent forest fires. If the frequency of forest fires continues to decrease, the serotinous jack pine cones will not be able to release seeds and reproduce.

3. **Now that forest fires are less frequent, it has allowed oaks and hickories to mature and form closed canopy forests.** This can allow other types of trees that are more shade-tolerant and less fire-resistant to outcompete the oaks.

4. **The lack of forest fires in the oak-hickory ecosystem has affected the biodiversity, but not in a detrimental way like it would for the jack pine ecosystem.**

**Forest fires are a bit more vital in the jack pine ecosystem because of the serotinous cones of the jack pine. It would also affect the animals (like the Kirtland's warbler) that rely heavily on the young jack pines.** Without forest fires, the jack pine ecosystem would change. It would create competition for resources with other trees (like cherry trees) outcompeting the jack pine trees.

5. **They reduce flooding when there is heavy rain and/or snowmelt and help keep the water clean as they filter and break down contaminants**

**Pollution and urbanization** can lead to a greater risk of flooding and water contamination.

## Grades 9-12

6. **Perched dunes sit atop glacial moraines. Glacial moraines are ridges of sediment left by retreating glaciers. With erosion and wind pushing the sand up the moraines, the dunes were formed.**

**High waves continue to erode the moraines.** This allows for the wind to blow the sand upward and continue to affect the shape of the dunes.

7. **Rivers are important for transportation, flood protection and even drinking water.**

The rivers in Michigan have been affected by **pollution and urbanization**. Drainage from urban areas can spill directly into rivers. This can cause contamination and change the temperature.

Better water management is needed to help **keep litter and pesticides** out of the rivers.

8. **Non-native species are introduced by people.** This can be intentional or by accident. Not all non-native species are detrimental to the environment. Sometimes they can have little to no effect on an environment or even have a positive effect. Some non-native species are detrimental because they can hunt native species and/or become competition for resources. **When a non-native species has a detrimental effect, they are known as invasive species.**

**People have affected an ecosystem by introducing non-native species. Both beneficial non-native and invasive species may help maintain an ecosystem or cause it to change by creating greater competition.** People can also play a role in lessening the detrimental effects of invasive species in an ecosystem.