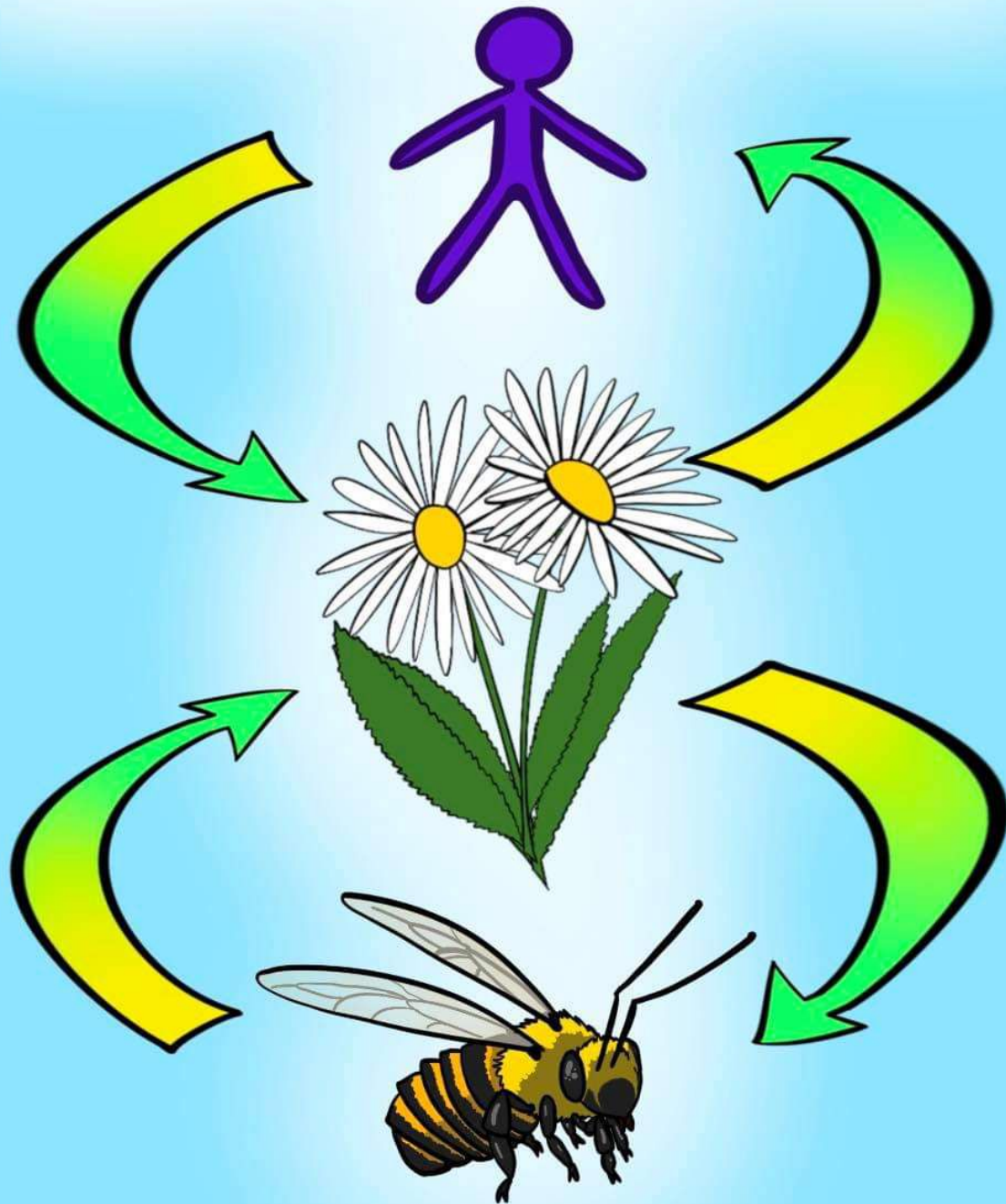


# Sustainable Services, People & Pollinators

Sustainable Ecosystems and Human Activity



# SUSTAINABLE SERVICES: PEOPLE AND POLLINATORS

*Grades 9 - 10, Science and Technology  
Prepared for Monarch Mayhem 2020*

## OVERVIEW & PURPOSE

This lesson will explore ecosystem services, how biological communities are beneficial to humanity and how people can help maintain these vital services.

**UNIT:** Sustainable ecosystems and human activity, climate change.

Estimated time to complete: 45 to 55 minutes.

## OBJECTIVES

To have students understand the incredible importance of ecosystem services. Participants will fill in a flowchart that illustrates the multiple benefits of conserving pollinators.

## MATERIALS NEEDED

1. Flowchart activity sheet.

## VERIFICATION

There are no definitive right or wrong answers to these questions. The students' answers to these should be discussed with the class.

- 1) Are there any arrows you could add to the flow chart? If so, add the arrows (you may have your arrows cross with others).
- 2) In the flowchart, you can see that *Humans* amplify the effects of *Climate Change*. What arrow could you draw into the chart that would help reduce the effects of climate change? (Hint: does anything on the chart diminish the effects of climate change?) What kinds of human activities would this arrow represent?
- 3) How can **you** actively contribute to these activities?

## PRESENTATION

### Pollination is a Vital Environmental Role:

As *primary producers*, plants are the base of the food pyramid. In addition, plant communities produce oxygen and sequester carbon dioxide from the atmosphere (see *greenhouse gases* below). The overwhelming majority of plant species on Earth are flowering plants, or *angiosperms*. Most angiosperms require pollinators to fulfill their lifecycle, therefore pollination is a vital *niche* for the Earth's terrestrial ecosystems. Similarly, pollinators have enormous economic importance. Virtually all farmed crops are domesticated flowering plants, so pollinators are directly responsible for maintaining our *food security*. With a basic understanding of the value of pollinators, we will now explore how human activities are threatening pollinator species.

### Human Activities and Their Consequences:

Human activities have greatly modified the landscape and natural systems. Unfortunately, these changes often have negative consequences for wildlife. Examples of environmentally damaging activities include:

- Land usage: agriculture, as well as development for urban, suburban, and industrial purposes have reduced the amount of natural habitat available for wildlife.
- Invasive species: Humans have introduced many non-native species into foreign environments. In many instances those invasive species are capable of out-competing species that are native to the environment, thus lowering their populations and even putting them at risk of extirpation/extinction.
- Pollution: Virtually all human activities emit pollutants into the environment. The different types of pollution include:
  - o Chemical pollution: substances that are toxic to people and/or wildlife (e.g., pesticides).
  - o Thermal pollution: industrial or domestic activities that alter the surrounding temperature (e.g., urban heat island effect).
  - o Organic pollution: introducing too many nutrients (e.g., fertilizer from farm run-off leads to toxic algal blooms in downstream aquatic systems).
  - o Ecological pollution: naturally occurring introduction of a pollutant into an environment (e.g., storm surges can introduce saltwater into near shore freshwater habitats).
- Climate Change: combusting fossil fuels (coal, oil, and natural gas) emits carbon dioxide (CO<sub>2</sub>) and other *greenhouse gases* that trap heat within the atmosphere, gradually warming the global climate. The effects of climate change will be discussed in more detail.

These stressors may have direct and/or indirect effects on wildlife populations. For example, many chemical pollutants, such as insecticides, are toxic to pollinator species. This is a direct effect. Conversely, the use of herbicides reduces the amount of

plants that feed pollinators, so chemical pollutants indirectly harm pollinator populations as well.

### Climate Change:

Climate change is often the most widely discussed environmental challenge because it is so widespread and poses a rich range of problems, many of which are not fully understood or are yet to be discovered. Climate does not just refer to average temperature, but also weather conditions such as precipitation and humidity. For the purposes of this lesson, we will be talking about two broad effects of climate change: *gradual climate change* and *extreme weather events*.

Gradual climate change is the warming trend the world is currently facing. It is measured by observing how average temperatures have changed over time in a given area. Note that these averages are measured globally and at local, or regional, scales. Two of the main ways that gradual climate change affects wildlife populations are *phenology* and *range shifts*.

*Phenology* refers to the cyclical nature of how plants and animals live their lives and complete their lifecycles (e.g. the time of year at which a plant species flowers). The phenological events of one species are often synchronized with those of other species. This synchronization occurs because one or both species benefit from the phenology of the other. For example, many migratory birds time their migration so that they can stopover at horseshoe crab nesting sites at the time when eggs are laid so they can exploit that rich food source.

The *range* of a species is defined by its geographic extent, i.e. where the species can be found on Earth. The range of a species is determined by environmental conditions, such as climate and geographic boundaries, such as mountain ranges or oceans. A species that can only thrive within specific environmental conditions is likely to have a small geographic range. Conversely, a species that can thrive in more varied environmental conditions may have a much larger range.

Temperature is one of the main environmental conditions that affects where species can live. An organism can only thrive within a limited range of temperatures, but since climate change is increasing average temperatures worldwide, species may respond by gradual migrations towards higher latitudes (or sometimes, even altitudes) that allow them to remain within those desired temperature conditions. This movement is called a *range shift*, and the phenomenon is raising concerns among conservationists, namely:

- Range shifts may be hindered by geographic boundaries: a species migrating poleward may be blocked by a geographic boundary, forcing them to remain in a habitat subjected to increasing temperatures.
- Range shifts may introduce novel or invasive species: some species respond to climate change differently than others. Some species migrate more rapidly than

others, so some previously separated species may eventually have to share a habitat, where they previously did not.

- In terms of the pollinator-plant relationship, one species involved in the mutualistic relationship may be forced to migrate more rapidly than the other, resulting in the separation of the two species.

Extreme weather events are also a problematic side-effect of climate change. With the changing climate, weather extremes, such as hurricanes or heatwaves (e.g., wildfires), are predicted to become more severe. These weather events alone are dangerous for wildlife and are often causes of mass die-off, thus being a direct threat to wildlife.

Climate change and other environmental issues must be considered by everyone, from personal choices to industrial processes and governmental action. After completing the activity included in this lesson, think of some ways in which you could personally help pollinators.

## ACTIVITY

### Climate Change Effects: Flow Chart

The flowchart represents the interconnected relationships between climate change, pollinators, and humans. Complete the flowchart by filling in the blanks with terms found in the word bank. Fill in the brackets for each arrow to answer if the arrow represents an amplifying effect (+), or a diminishing effect (-).

### Answer Key:

3) Extreme Weather Events

4 & 5) Climate-Driven Range Shift/Phenology Mismatches

7) Pollinator-Plant Relationship

8) Wild Plant Populations

10) Carbon Sequestration

11) Agriculture and Food Security

Answer Key Continued:

Amplifying Effect (+):

Climate Change → Extreme Weather Events  
Climate Change → Gradual Rising Temperatures  
Gradual Rising Temperatures → Climate-Driven Range Shift  
Gradual Rising Temperatures → Phenology Mismatches  
Pollinator-Plant Relationship → Wild Plant Populations  
Pollinator Plant Relationship → Pollinator Populations  
Wild Plant Populations → Carbon Sequestration  
Pollinator Populations → Wild Plant Populations

Diminishing Effect (-):

Climate-Driven Range Shift → Pollinator-Plant Relationship  
Phenology Mismatches → Pollinator-Plant Relationships  
Mass Die-Off → Pollinator-Plant Relationship  
Carbon Sequestration → Climate Change