

Climate scientists have found that Earth's climate is changing in many ways. One way is that the overall average temperature of Earth is increasing, a phenomenon scientists call "global warming." Although global warming might sound like a simple matter, Earth's ecosystems are complex. Also, many ecosystems exist in a delicate and sensitive balance that is easily upset by small changes. As a result, the specific effects of global warming are different from one place to the next, depending on the characteristics of each area. For example, global warming can increase the intensity of severe storms, such as hurricanes. This has more of an effect on areas that lie in the path of hurricanes than on others. Low-lying areas near the ocean are at more risk for flooding as sea levels rise due to glacial melting than are areas at higher elevations. Some areas may experience warmer, drier summers, while other areas become cooler and wetter. Arctic areas, in particular, face unique challenges as a result of global warming.



Global warming affects the Arctic region in unique ways.

## Arctic Ecosystems

An ecosystem is based on a complex system of interactions between biotic (living) and abiotic (non-living) elements. The abiotic elements of an ecosystem include things such as temperature, rain and snowfall, surface water sources, and available sunlight. The biotic elements of an ecosystem include all of the living things in the ecosystem. Insects, plants, animals, and microorganisms are all biotic elements of an ecosystem.

In an ecosystem, the abiotic elements provide the basic foundation for the biotic elements. On this foundation, biotic elements depend on one another. For example, plants in an ecosystem depend on soil, water, and sunlight to grow. Insects and some animals eat the plants, and larger predators consume the animals as their prey.



This Arctic wolf depends on smaller prey that lives in the region.

If one source of food in an ecosystem decreases due to habitat loss or disease, organisms that rely on that food source must find other sources of food if the organisms are to survive. In a rainforest, this might not be too difficult, since there are many other choices of organisms in the ecosystem that might serve as food.

By contrast, the disappearance of one food source could have significant results in an Arctic region. These ecosystems have cool temperatures year-round and land that is often covered with ice and snow. Light levels are extreme, ranging from 24-hour darkness to 24-hour daylight. Because of these harsh conditions, plant life on land surfaces is not abundant. There are no trees, and the few plants that can grow in the short growing season have shallow roots and grow close to the ground. As a result, Arctic plants and the organisms that depend on them are not very diverse compared with those in a tropical area. This lack of diversity limits the ability of Arctic animals to adapt to climate change. Many animals in Arctic ecosystems rely on limited primary food sources. This means that replacing one food source with another is more difficult, because there just are not that many possibilities to choose from. Polar bears, for example, rely primarily on ringed seals as their main food source. A decrease in the ringed seal population would significantly affect polar bears.

### **Global Warming and Sea Ice**

One of the largest threats to some Arctic animals is a decline in sea ice. Sea ice is frozen seawater. The freezing process removes the salt. While glaciers form on land, sea ice forms directly from the ocean. In winter, large areas of sea ice form near the edges of the ocean in Arctic areas. In summer, as temperatures rise, the ice partially melts. Some ice remains, but only as large



Arctic plants are low growing and have shallow roots. They have adapted to survive in the harsh Arctic conditions.



Partial melting of sea ice causes many floating pieces of ice.

floating chunks. As average global temperatures rise, less sea ice forms in winter. In addition, more ice melts in the summer, leaving fewer chunks.

The decrease in the amount of sea ice has a number of effects on an Arctic ecosystem. Phytoplankton in the water is the main producer in this ecosystem. Phytoplankton relies on the layer of freshwater left on the ocean's surface each spring by the melting sea ice. Less ice forming in the winter means less freshwater in the summer, and less phytoplankton at the base of the food web. Fish and krill depend on phytoplankton as a main food source.

These organisms, in turn, are food sources for larger animals such as seals. A change in phytoplankton could have a significant impact on the entire ecosystem.

Larger Arctic animals depend on the sea ice in another way. Polar bears, seals, and walrus spend much of their time on the sea ice, using it for resting and hunting. Since the sea ice is an important part of the habitat of these animals, loss of sea ice means a loss of habitat. This can cause an overall decline in the populations of these animals.

Although populations of some Arctic animals may decrease due to global warming and loss of sea ice, other populations may increase. For example, researchers think that Arctic plants may have a greater ability to adapt to a warming climate. Plants may be able to spread into new areas where they can survive. They may not be as negatively affected by loss of sea ice as animals, since they do not hunt.

There is another important effect of sea ice loss. Sea ice is very reflective. It reflects more of the Sun's energy back into space



Arctic mammals spend much of their lives on the sea ice.



Reflective surfaces such as snow and ice have high albedo.



than other surfaces, such as darker land or open water. This reflective quality is called "albedo." The high albedo of ice and snow has a cooling effect on Earth. Land and open water, by contrast, absorb more of the Sun's energy. An increase in open water with a decrease in sea ice means that temperatures go up. This, in turn, causes more melting. It is a difficult cycle to break.

Because the Arctic is more sensitive to climate change than other areas of Earth, scientists are watching the Arctic carefully. Changes to Earth's albedo must be factored into predictions about climate change. Researchers are working hard to discover possible solutions to problems caused by global warming. Because the problem is complex, however, solutions may be complex as well. Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic