ScienceNews

Teacher Background Sheet: Corals and Climate Change

Use this background sheet to introduce and discuss concepts about climate change and keystone species with your students.

Brief overview
Coral reefs are composed of huge colonies of thousands or millions of individual tiny animals called coral polyps. The coral polyps secrete calcium carbonate exoskeletons that build up over time to form the reef. Within the exoskeletons, the corals host single-celled algae and a variety of bacteria. The algae and bacteria provide the coral polyps with energy (from sugars) and other essential nutrients.

Rising ocean temperatures have increased the frequency of marine heat waves, in which local water temperature rises above seasonal thresholds for at least five consecutive days. Sharp spikes in local water temperatures cause stress to corals. In response to the heat, the algae and bacteria that live inside the corals may emit toxins. As a result, the corals expel the algae and lose their color, a process known as bleaching. Corals can survive coral bleaching if water temperatures drop to normal levels within a short period of time and the algal symbionts return to their coral hosts. If the heat stress is too great or lasts too long, the corals may starve and die without the nutrients provided by their symbionts.

When ecologists and other scientists discuss the environmental impacts of climate change, they commonly focus on keystone species. Keystone species are organisms that play an essential role in maintaining the integrity of the ecosystem. Keystone species can be foundation species around which entire ecosystems are constructed. Examples include corals and mangroves. Keystone species can be apex predators, which are at the top of the food chain and control populations of other organisms. Examples include sharks, mountain lions, wolves and bears. And ecosystem engineers that modify the environment and change the distribution of resources in the ecosystem can be keystone species. Examples include termites and beavers.

Use the following questions to guide a class discussion.

1. How is the health of corals related to the presence and health of symbiotic microbes?

Corals are combinations of multiple types of organisms. They include coral polyps that act as hosts for bacteria and algae. The algae turn energy from the sun into energy that can be used by the corals. Bacteria cycle nutrients and fight pathogens, which help keep the coral polyps healthy.

2. Why are corals endangered by rising ocean temperatures?

Corals are adapted to specific temperatures and pH levels. When the temperature or pH of the water changes, the algae that live inside the coral release toxic chemicals, and the corals kick the algae out. Heat stress also causes the bacterial communities within and around the corals to change, which disrupts the benefits the bacteria provide to the corals. This "bleaching" process breaks down the symbiotic relationships,

causing all of the symbionts to struggle. This starves the corals of energy for life processes, which causes the corals to die.

3. What role do corals play in coral reef systems? What would happen to coral reef ecosystems if all of the corals succumbed to heat stress caused by rising water temperatures?

Corals are foundation species in coral reef ecosystems. They form the rigid structure in, on and around which all other species in the system live, search for food and reproduce. They also form one of the lowest tiers in the reef food chain. If all of the corals succumbed to heat stress, the living core of the coral reef system could not provide the ecosystem services required to support the other forms of life, such as buffering waves and currents, providing food and shelter for fish and invertebrates and producing nutrients that are carried out into the deeper marine ecosystems.

4. What research questions or topics might have driven the scientific research described in the article?

Students will need to infer these questions from the description of the research conducted on corals. Students might say: How can we protect corals from the effects of marine heat waves? How might dosing corals with a mixture of beneficial bacteria affect how corals respond to heat stress? Which coral symbionts are better able to respond to heat stress? How can coral's algal and bacterial symbionts help coral respond to and survive heat stress?

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