MAPPING MANGROVES

A teen draws attention to the threats facing one of nature's most important forest ecosystems

ESSENTIAL QUESTION: How do scientists monitor the health of ecosystems?

Not many teenagers can say they work at NASA. But then again, not many teens are quite like 16-year-old Liza Goldberg. For the past two years, she has helped researchers at NASA's Goddard Space Flight Center in Maryland develop new ways of protecting one of Earth's most important *ecosystems*: mangrove forests.

The shrubs and trees that make up mangrove forests grow only in the area between high and low tides along tropical coasts. These *intertidal zones* are hot, waterlogged, and salty. Mangroves have developed specialized *adaptations* that help them survive these conditions, which would kill most plants. Their most distinctive feature is their tall, stilt-like roots. They help anchor the plants in the mud and provide a *habitat* for birds, fish, and other aquatic creatures.

Unfortunately, mangroves are under threat almost everywhere they grow around the world, including the U.S. (*see Mangrove Range, p. 22*). Human development, agriculture, and *climate change*—long-term changes to global weather patterns—have taken a heavy toll on these ecosystems. Liza, now a junior in high school, is working with NASA to use satellite images to track the health of these priceless forests.

TEEN SCIENTIST

Growing up in Maryland, Liza wasn't thinking much about tropical mangroves. But she was worried about how a warming climate might affect plant life.

For a middle school science project, Liza researched how temperature changes affect the ability of maple trees to absorb carbon dioxide (CO_2) from the air. Plants use sunlight and water to convert this gas into food—a process known as *photosynthesis*.

Liza's work caught the attention of a science-fair judge, who recommended her for an internship at NASA. Two Goddard scientists—Lola Fatoyinbo, an environmental scientist, and David Lagomasino, a geologist—were impressed by the then eighth-grader's application. So they invited her to come work in their lab, which studies mangroves using *remote sensing*. This technique gathers information about Earth's physical characteristics using technology like imaging satellites.

Liza studied the topic by reading every scientific paper on remote sensing and mangroves she could find. What she discovered surprised her. "Mangroves have a higher rate of deforestation than rainforests," says Liza. "Over the past 50 years, we've lost half of all mangroves. And in many regions, those rates of loss are not going down."

VITAL ECOSYSTEM

NASA uses its satellites to study mangroves because of the trees'

CORAL PROTECTOR Mangroves protect coastal coral reefs by purifying water, stabilizing shorelines, and providing nursery habitats for fish.

ETHAN DANIELS/SHUTTERSTOCK.COM (TOP)

TONI L. SANDYS/THE WASHINGTON POST VIA GETTY IMAGES (LIZA INSET); MIREK KUJEWSKI/SHUTTERSTOCK.COM (BLUE TANG); COURTESY OF NASA'S GODDARD

CARBON SINK
Mangrove forests absorb 2 to 3 times more carbon dioxide per acre from the air than other forest ecosystems.

FISH HAVEN
Many tropical fish, like this *Paracanthurus hepatus*, raise their offspring in mangrove forests.

TEEN SCIENTIST: Liza keeps a busy schedule. In addition to presenting at conferences and working at the lab, she's a competitive swimmer.

ability to capture carbon dioxide from the air. CO_2 is a *greenhouse gas* that absorbs heat in Earth's atmosphere, warming the planet. "Mangroves store a lot of carbon in the trees and in the soil underneath their roots—two to three times more per acre than other ecosystems," says Fatoyinbo.

But these ecosystems do more than help remove CO_2 from the air. Many species thrive in and around mangrove forests. Their root systems protect fish laying their eggs and raising their young. The

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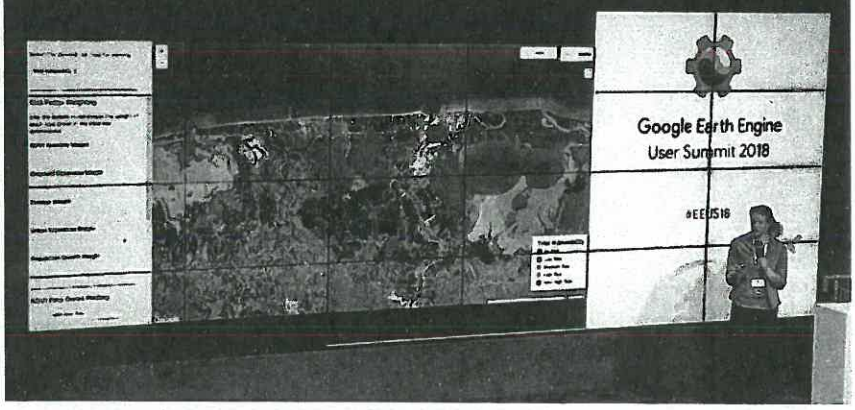
ECOMAP IN ACTION

Liza presents EcoMap at a conference in Ireland. The program shows where mangroves are at risk (red) and where they are healthy (green).

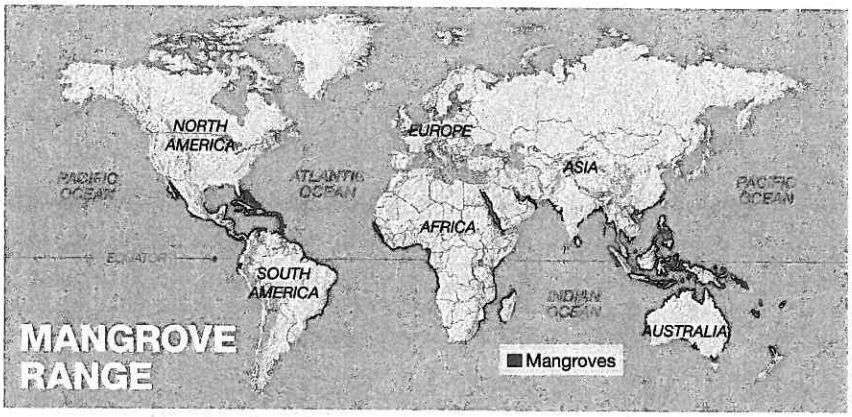


branches shelter many bird species. And all sorts of creatures—from insects to tigers—spawn, nest, find shelter, or hunt around mangroves. Together, these animals create a vast and intricate *food web*—an interconnected system where organisms eat other organisms to obtain energy (*see Mangrove Food Web, below*).

People also need mangroves. Large mangrove forests collect *sediment*, like sand and silt, which builds up shorelines. That helps prevent *coastal erosion*—the wearing away of coastlines by flooding and waves. In addition, deep-rooted mangroves serve as a buffer against big storms and enormous waves called *tsunamis*, protecting coastal communities further inland.

ECOMAP

While interning at NASA, Liza began using satellite data and software called Google Earth Engine to make a new research tool. "I wanted to create a program that predicts mangrove loss and identifies its causes," says Liza. "And I wanted it to function on a global scale."



SOURCE: FLORIDA MUSEUM

Working after school, on weekends, and over holidays, Liza has come close to her goal. She recently presented a *prototype*, or working model, of her Electronic Coastal Monitoring and Assessment Program, or EcoMap, at a conference hosted by Google in Ireland.

EcoMap assesses the health of mangrove forests based on factors like land use and sea level change. The risk level is color-coded and put on satellite images so people can see how and why particular mangrove forests are threatened (*see EcoMap in Action, p. 21*).

CORE QUESTION

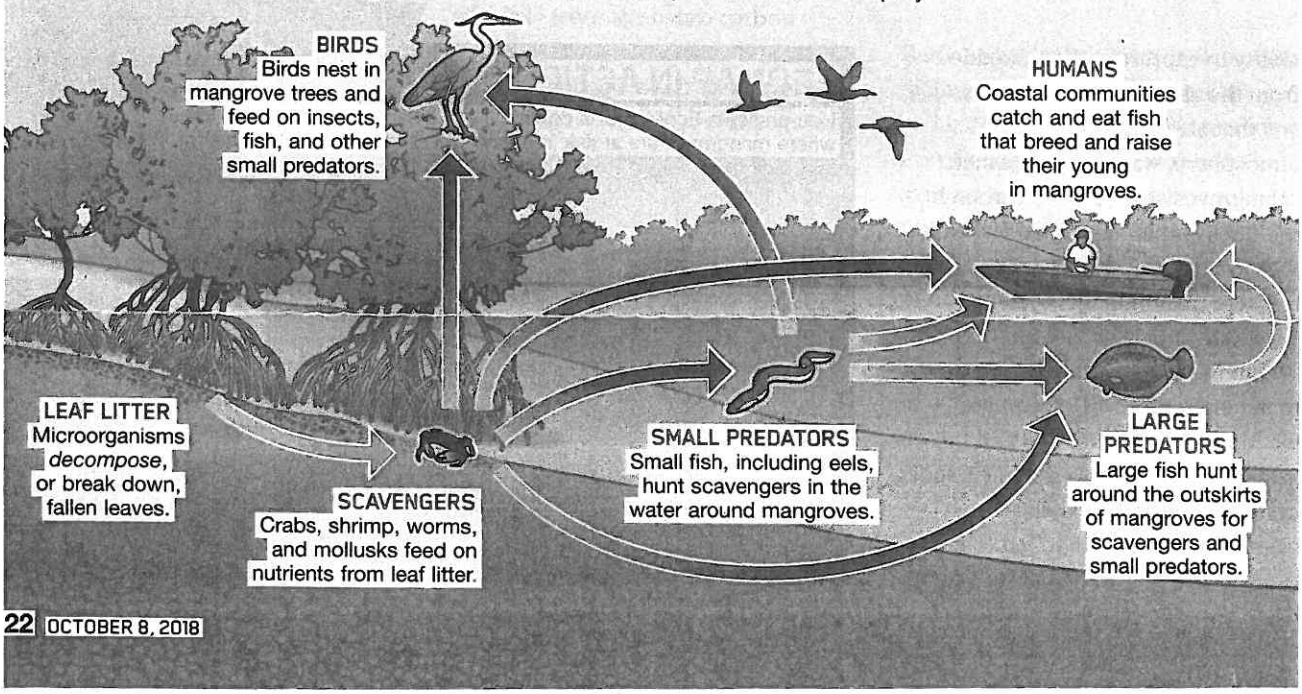
Would remote sensing be a useful way to monitor other ecosystems on Earth? Provide evidence to support your answer.

Liza hopes to provide this information freely to anyone who wants to use it to protect mangroves. "My dream is to use EcoMap and other satellite-based tools to help inform international policy and mangrove restoration," says Liza. "I want this program to give coastal communities the ability to track how their environments are changing, in order to benefit both their local region and the wider world."

—Jacob Batchelor

MANGROVE FOOD WEB

Many species live in and around mangroves. Together, these organisms make up a complex food web in which organisms feed on plants and predators seek out prey.



JIM MCMAHON ® MAPMAN (TOP); EYEWASH (DIAGRAM)