WHY LICHENS MATTER

The Benefits of Lichens to Humans and Nature

WHAT IS A LICHEN AND WHAT IS IT WORTH?

Lichens are symbiotic organisms consisting of a fungus and a green alga (or cyanobacterium or both!) growing together. Lichen lovers are not afraid to admit that they simply enjoy seeing the variety of forms and colors growing on the trees, rocks, and soils wherever they go. Many also know that lichens are indicators of air pollution and that both lichens and humans depend on clean air and a healthy environment. Less well known is that lichens play integral roles in keeping our natural world working. They provide food, cover, and nesting materials for a variety of birds, mammals, and insects, and contribute to forest and rangeland water and mineral cycles. Lichens also have many traditional human uses as food, medicines, and textiles and produce unique compounds with promising pharmaceutical potential as antioxidants, anti-cancer drugs, and antibiotics.

HOW DOES A LICHEN SYMBIOSIS WORK?

Algae and cyanobacteria produce food for the fungus, converting carbon dioxide gas into sugars via photosynthesis. Cyanobacteria also convert nitrogen gas into forms used to build proteins, nucleic acids, and other essential molecules. The fungus, in turn, serves as a home for the food-producing partner(s) and provides water, minerals, and other nutrients absorbed from the air, rain, and substrates.

CONTRIBUTIONS TO BIOLOGICAL DIVERSITY

Lichens contribute to the Earth's biological diversity. There are more than 5,500 species of lichens and lichen-dependent fungi in North America. Lichen diversity is promoted by good air quality, habitat continuity, availability of preferred substrates, and favorable climate.

A colorful diversity of lichens can be found on soil, rocks, trees, wood, human-made materials, invertebrates, and even under water.

FORAGE AND NESTING MATERIALS FOR WILDLIFE

Lichens are ecologically important as food, shelter, and nesting material for wildlife. Deer, elk, moose, caribou, mountain goats, bighorn sheep, pronghorn antelope, and various squirrels, chipmunks, voles, pikas, mice, and bats eat lichens or use them for insulation or in nest building.

Left: Many North American birds, like this Anna's hummingbird, use leafy and hairlike lichens as nesting material. Right: A deer grazes on tree beard lichens plucked from the ground after a wind storm. Shifts in lichen species indicate that climate is warming fastest in Oregon's high Cascades and that humidity is increasing along the Pacific Coast.

FOOD AND HABITAT FOR INVERTEBRATES

Bristletails, barklice, katydids, grasshoppers, webspinners, butterflies, moths, moth larvae, lacewing larvae, mites, spiders, snails, slugs, and many beetles live on, camouflage themselves as, or eat lichens.

Various insects, like this moth, hide from predators by mimicking common bark lichens.

LICHENS AND MICROBES

Distributions of soil, leaf, and aquatic microbes and invertebrates can be shaped by lichen-dominated habitats and their unique chemical compounds.

A variety of fungi, algae, and bacteria grow on or parasitize lichens; some are very specific to particular species.

HUMANS USE THEM

Throughout history, people have used lichens for food, clothing, dyes, perfume additives, medicines, poisons, tanning agents, bandaging, and absorbent materials. Compounds unique to lichens are used in perfumes, fiber dyes, and in medicines for their antibacterial and antiviral properties. Ornate lichens are harvested around the world for use in floral displays, decorations, and models.

The wolf lichen makes a bright yellow dye valued by the Chilkat people of southeastern Alaska for traditional blankets.

CONTRIBUTIONS TO NUTRIENT AND WATER CYCLING

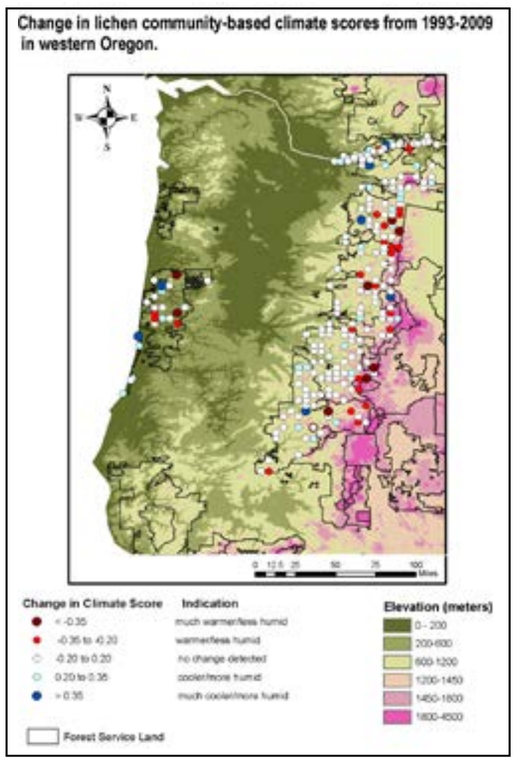
Lichens play significant roles in mineral and hydrological cycles, notably nitrogen fixation. Cyanobacterial lichens "fix" atmospheric nitrogen into forms useable by the lichen and by other plants and animals. When abundant, lichens and bryophytes growing on trees intercept and hold moisture, moderating humidity and temperature within the canopy. They also capture and slowly release nutrients from rain, dew, fog, air-borne fine particles, and gases, which might otherwise be lost or unavailable. Desert crusts of lichens, fungi, cyanobacteria, and moss reduce soil erosion by intercepting surface run-off and regulating infiltration of water into dry soils.

The Oregon lung lichen dominates the lichen biomass of old-growth, temperate rainforests of Northwestern North America, where it contributes significant amounts of new nitrogen to nitrogen-limited forest ecosystems.

ENVIRONMENTAL INDICATORS

Lichens are also important as indicators. Lichen communities change with vascular plant succession. Land managers can use lichens to show forest continuity and the distribution of specialized microhabitats and microclimates, to detect hotspots of biological diversity over the landscape, and to assess water and air quality. Overall, lichens grow and disperse slowly compared to vascular plants. Specialized habitat requirements, the need for continuity in the availability of substrate, and sensitivity to air pollution make many lichen species vulnerable to habitat disturbance or degradation.

Rare, old-growth forest cyanolichens, like the Rainier speckle belly lichen, indicate hotspots of rich biodiversity.



CLIMATE INDICATORS

Climate strongly influences lichen community composition, i.e., which lichens are present. A few lichens tolerate large fluctuations in climate, but most require more specific regimes. Even a 1 °C shift in mean annual temperature can drastically increase or decrease the probability of finding certain lichens. Climate change and biodiversity can be tracked and indicated by monitoring lichen community composition.

Shifts in lichen species indicate that climate is warming forest in Oregon's high Cascades and that humidity is increasing along the Pacific Coast.

AIR QUALITY INDICATORS

Two properties make lichens useful air quality indicators they are especially sensitive to some important pollutants, and they concentrate many pollutants in proportion to environmental availability. The first property can be used to demonstrate that air pollution is causing environmental harm and warn of incipient broader ecological effects; both properties are useful for assessing relative pollution levels over geographic space and time. When lichens are wetted, pollutants deposited to their surfaces as gases, vapors, or fine particles dissolve and are absorbed. Lichen algal and cyanobacterial partners are especially vulnerable to air pollutants like sulfur dioxide, ammonia, fluorine, and nitric and sulfuric acids. These highly reactive gases and acids interrupt essential processes like photosynthesis and respiration. Lichens are also sensitive to excessive nutrients, especially nitrogen, which favor smaller, fast-growing weedy species over the larger more ecologically valuable species. Air quality can be tracked using changes in lichen community composition, indicator species distribution, physiology, or appearance.

LINKS BETWEEN LICHENS, ECOSYSTEMS AND ENVIRONMENTAL CHANGE

As nitrogen- and sulfur-containing air pollutants increase, the ecological impacts increase too. Sensitive lichens, diatoms, bryophytes, ectomycorrhizal fungi, and alpine plants are among the first affected. Because these air pollution-sensitive organisms are completely woven into the ecosystem, harm to them can adversely impact more tolerant or economically valuable species that need the sensitive species for food, habitat or cover.

Air pollution and habitat alteration threaten prize forage species like the long beard lichen.

STORIES ABOUT LICHEN LINKS TO THE ECOSYSTEM AND ECOSYSTEM SERVICES

In functioning, resilient ecosystems, plants and animals are interdependent. The following are two examples.

LICHENS, FLYING SQUIRRELS, THE NORTHERN SPOTTED OWL, MYCORRHIZAL FUNGI, AND HEALTHY TREES

Northern flying squirrels rely on air-pollution sensitive, horsehair lichens as a principal winter food source and nesting material. These squirrels are a primary prey of the northern spotted owl, an endangered species whose protection has redefined Federal forest management in the U.S. Pacific Northwest. In summer, the squirrel's main staple is underground-fruiting fungi. Scampering through the forest, the squirrels disperse fungal spores in their droppings. The spores germinate and form mycorrhizal associations with tree roots critical for tree growth. The trees, in turn, provide habitat for lichens, flying squirrels, spotted owls, and other organisms; and they provide wood products for people.

Northern flying squirrels, the primary prey of the endangered northern spotted owl (above), eat lichens in winter and underground fungi in summer.

LICHENS, INSECTS, AND SONGBIRDS

As a forest matures, canopy lichens increase and support larger, more diverse insect populations. Most song birds are insectivorous, and a rich supply of insects helps ensure their breeding success. Songbirds consume copious quantities of insect pests across their migratory ranges, providing a valuable ecosystem service that enhances the production of wood, fruit, and other crops.

Lichens provide great habitat for a variety of insects sought as food by birds.

Sitka black-tailed deer photo by Karen Dillman; flying squirrel photo by Marshia and Mike Crowley; downy woodpecker photo by Bob Armstrong; owl photo by John and Karen Hollingsworth, U.S. Fish & Wildlife Service; and all other photos by Stephen Sharnoff. Text by Linda Geiser. Map by Doug Glavich. Artwork and design by Emily Underwood.