**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, lichens 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 antibiotics, anti-cancer drugs, and pesticides.

**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 15,000 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 variety of lichen species can be found on soil, rocks, trees, moss, human-made materials, snowdrifts, and even under snow.

**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 in or near buildings.

**FOOD AND HABITAT FOR INVERTEBRATES**

Birds, bats, butterflies, bees, grasshoppers, ladybugs, beetles, lizards, snakes, spiders, 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 partner to lichens; some are very specific to particular species.

**HUMANS USE THEM**

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

The wool 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 usable by the lichens and by other plants and animals. Where abundant, lichens and trees 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-born fine particles, and gases, which might otherwise be lost or unavailable. Desert cradles of lichens, fungi, cyanobacteria, and moss reduce soil erosion by intercepting surface run-off and regulating infiltration of water into dry soils.

**ENVIRONMENTAL INDICATORS**

Lichens are also important as indicators. Lichen communities change with usual plant succession. Land managers can use lichens to show forest continuity and the distribution of specialized microhabitats and microenvironments, 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 imply the need for continuity in the availability of substrate, and sensitivity to air pollution make many lichen species vulnerable to habitat disturbance or degradation.

**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 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 linked using indicator monitoring by lichen community composition.

**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 warns 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. Lichens and cyanobacterial partners are especially vulnerable to air pollutants like sulfur dioxide, ammonia, fluorine, and sulfuric acids. These highly reactive gases and acids interrupt essential processes like photosynthesis and respiration. Lichens are also sensitive to excessive nitrogen and sulfur, which favor smaller, fast-growing woody 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, and cyanobacterial fungi, and alpine plants are among the most affected. Because these air pollution-sensitive organisms are completely woven into the ecosystem, harm to them can impact more tolerant or economically valuable species. Air quality can be tracked using changes in lichen community composition, indicator species distribution, physiology, or appearance.

Northern flying squirrels, the primary prey of the northern spotted owl, consume large amounts of 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, including many that cause economic or environmental damage. Lichens provide great habitat for the variety of songbirds sought as food by birds.

Stories about lichen links to the ecosystem and ecosystem services in functioning, resilient ecosystems, plants and animals are interdependent. Two examples are discussed in this section.

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

Northern flying squirrels rely on air pollution sensitive, howlback 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 redlined Federal forest management in the U.S. Pacific Northwest. In summer, the squirrels’ 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 toxins, in turn, provide habitat for lichens, flying squirrels, spotted owls, and other organisms and provide wood products for people.

**ECOSYSTEM SERVICES: LICHENS, INSECTS, AND SONGBIRDS**

As a forest matures, canopy lichens increase and support larger, more diverse insect populations. Most songbirds are insectivorous, and a rich supply of insects helps ensure their breeding success. Songbirds consume copious quantities of insect pests across their migratory ranges, including many that cause economic or environmental damage. Lichens provide great habitat for the variety of songbirds sought as food by birds.