EDITOR'S CHOICE FROM RANGELAND ECOLOGY & MANAGEMENT

Volume 72, Issue 2

Mortality and Flowering of Great Basin Perennial Forbs After Experimental Burning: Implications for Wild Bees

Byron G. Love and James H. Cane

Plants and animals are inextricably linked and combine their abilities to foster structure, function, and organization that characterize a healthy ecosystem. Plants have been on Earth for about 700 million years. Before that, the Earth was believed to be covered with barren rocks that had the occasional bacteria and algae growing in the rock cracks and crevices. Plants are primary producers that combine soil nutrients and water, atmospheric carbon, and sunlight into glucose. Although atmospheric carbon dioxide is sometimes called a pollutant, it is the basic essential chemical used by plants to manufacture simple sugars that provide the basic energy required by animals. Plants give off oxygen and water. It is likely that early plants also increased oxygen levels in the atmosphere high enough for animals to develop skeletons, grow larger, and diversify. About 50 million years after plants appeared, oxygen-breathing animals appeared and used the carbohydrates and oxygen to develop complex skeletons. Basically, plants use carbon dioxide to capture and store energy from the sun in the form of carbohydrates for animals and give off oxygen, whereas animals inhale oxygen and give off carbon dioxide used by plants. Nothing is more fundamental to healthy rangeland ecosystems and their management than the interdependent linkage between plants and animals.

Since early plants like mosses and liverworts created an environment for animals, these two kingdoms have evolved some very sophisticated interdependence and complex mechanisms that convey the ability for each to survive in a changing environment. A common example is when nitrogen-fixing bacteria attach themselves to the roots of some legumes that increase forms of nitrogen available for plants around roots. In return, the bacteria get carbon for energy from the plant. Many of the interdependent mechanisms that evolved are essential to the survival and growth of the associated plants and animals. On rangeland, honey bees are critical to the survival and growth of 80% of flowering plant species. This relationship is not only amazing, it is essential because bee pollination facilitates seed production necessary for plant population recruitment. In return, bees get nectar for honey and pollen used for protein and nutrients. Plants evolved colorful flowers attractive to honey bees that can be seen in a glance. The color vision of bees is the fastest in the animal world, which is five times faster than humans. So, while we may have trouble distinguishing one flower in a group from another, bees can instantly identify a special nectar and pollen-producing flower among a bouquet of flowers. Some flower petals appear to change color as bees fly around and their angle changes, which alerts bees to the status of plant nectar and pollen production. This occurs in the ultraviolet spectrum, and bee eyes evolved to detect this iridescence. Once bees detect and locate a nectar-producing flower, they follow the colored lines on many petals that guide bees to the exact location of nectar and pollen. Bees appear designed to collect and move nectar and honey. Some bees have a polished cavity surrounded by a fringe of hairs, into which the bee collects the pollen; other bees possess a dense mass of branched hairs into which pollen is pressed, with pollen grains held in place in the narrow spaces between the hairs. A honey bee moistens the forelegs with its protruding tongue and brushes the pollen that has collected on its head, body, and forward appendages to the hind leg and the pollen comb. Bees can carry about one-half their weight in pollen and will drop some of the pollen on the pistil of each flower they visit. Bees and plants evolved a very intricate relationship with elaborate body parts and mechanisms on which they both depend for survival and growth. However complex and amazing the mechanisms, rangeland managers must understand how their strategies affect the relationship between bees and plants critical to their coexistence.

Congratulations to Byron Love and James Cane, USDA-ARS scientists who earned the Editor's Choice award from volume 72, issue 2 of *Rangeland Ecology & Management* (March 2019) by helping understand how burning affects the delicate relationship between wildflowers and bees on the Great Basin rangelands. In the sagebrush steppe, the fate of bees depends on the effect that increasingly frequent wildfires have on their delicate wildflower partners. These researchers tested the after-fire survival and subsequent flowering of six common perennial rangeland wildflowers (representing five plant families) across a gradient of realistic fire severities. Five burning severities were created by varying intensity and duration of each fire. Each fire regime was applied to basalt milkvetch, Blue Mountain prairie clover, sulphurflower buckwheat, fernleaf biscuitroot, blue penstemon, and gooseberry leaf globemallow. As expected, as fire severity increased, plants were less likely to survive and produce flowers. Each species varied in their response to fire, which ranged from 80% survival (buckwheat) to complete mortality (bisciutroot and blue penstemon) at peak severity. Although basalt milkvetch survived well (85%), half of the burn survivors of milkvetch failed to flower the year following burning. The effect of fires on critical plant and bee interactions is a function of the bees' nesting habits and the plants' ability to produce flowers (nectar and pollen) after burning. Thus, plants' ability to survive and produce flowers after burning determines the fate of bees in cases where the interdependence is strong. These researchers have clearly shown that this plant and animal relationship is very delicate, and as sagebrush steppe is converted to annual grassland with increasing fire frequency and intensity, both wildflowers and bee communities are increasingly at risk.

Please take a minute and check out this exceptionally interesting and important article. It will be a great investment of your time.

Roger Sheley
Editor-in-Chief, Rangeland Ecology & Management

Rangelands 41(2):124–7
doi:10.1016/j.rala.2019.02.004

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