Fire Ecology

Arkansas Natural Heritage Commission

Fire ecology is a branch of ecology that studies the origins of fire and its relationship to the environment.

Fire is studied as a natural process operating as a component of an ecosystem. To understand an ecosystem requires looking beyond the ecosystem's present state. Full understanding includes an investigation of the ecosystem's origin, the cycles the ecosystem progresses through, and possible future stages. Fire, similar to floods, earthquakes and storms, can be viewed as one means of promoting changes in an ecosystem.

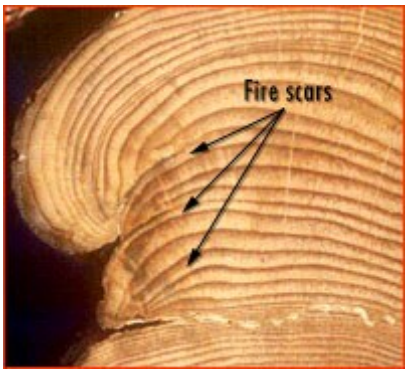
There are three key concepts important to understanding fire ecology – **fire dependence, fire history and fire regime**.

Fire Dependence

In the 1930's, researchers began to challenge the negative notions about fire in a natural landscape and this new thinking prevails today. They argued that fire was essential to many plant and animal communities. For example, in drier ecosystems around the world where there is not enough moisture to help in the decay of dead plants, fire is required to break down and help recycle the nutrients. This concept is fire dependence and applies to natural communities that are adapted to and rely on the effects of fire. For example, fire kills some large plants and prepares the soil for seeding by making nutrients more available for plant uptake. As a result, competition is reduced from other species that would have absorbed needed nutrients or shaded out sunlight the new plants require.

Fire History

Fire history is described as how often fires occur in a geographical area. Trees actually record fire history. Each year a tree adds a layer of cells, increasing the width of its trunk. When a fire passes through a forest, trees may be only scorched. A layer of charcoal remains on a living tree and, in time, is enveloped by a layer of new growth creating fire scars. These fire scars provide a record of the tree's history that scientists can use to determine when a fire occurred. Fire scarred trees that are petrified often retain these fire scar records as fossilized charcoal or fusain.



Fire Regime

The role fire plays in an ecosystem varies with the characteristics under which the ecosystem has evolved. This role is known as *fire regime*. The interactions of humidity, fuels, and ignition sources determine the fire regime for a particular land area. A fire regime is a function of:

- the frequency of fire occurrence,
- the fire intensity,
- the amount of fuel consumed.

Both frequency and intensity of fire vary but are interdependent. Frequency of fire is largely determined by the ignition source(s) and the duration and character of weather that favor the spread of fire. The quantity of fuels available and the fuels' combustion rates determine intensity of fire. Wind and topography influence the interaction between frequency and intensity of fires. The greater the wind velocity and the steeper the terrain, the more intensely the fire will burn.

Early Fire

People have used fire since precivilization to shape their environment, and the intentional use of fire has been a significant addition to the lightning-caused blazes that affected earlier forest development. Human fires also create different impacts and landscape patterns.

American Indian Uses for Controlled Burning

- Hunting - divert game into smaller, more confined areas
- Crop management and improving growth and yield- prevent fields from growing over and to clear
- Fireproof ing areas - protect certain medicine plants by clearing an area around the plants, as well as to fireproof areas, especially around settlements, from destructive wildfires.
- Pest management - reduce insects (black flies & mosquitos) and rodents, as well as kill mistletoe that invaded mesquite and oak trees and to kill the tree moss favored by deer (thus forcing them to the valleys where hunting was easier).
- Clearing areas for travel - to clear trails through areas that were overgrown with grass or brush. Burned areas helped with providing better visibility through forests and brush lands for hunting and warfare purposes.

A major change in fire conditions occurred with the advent of European settlement in the United States. Prior to that, American Indians used fire as their most powerful land management tool. Although popular myth often portrays the Indians as a limited population of nomadic people that did little to affect the environment around them, modern scholars are increasingly finding evidence of major populations that had extensive impact on the land. In addition to clearing land for agriculture, fire was used to favor plants desired for grazing or food; to reduce wildfire hazards around villages; to control dense vegetation, thereby eliminating cover for potential enemies; and to harass enemies during conflicts. Once ignited, a fire could bum for weeks or months under some conditions, because there were no efforts to suppress it.

With the arrival of European settlers and their wooden homes, fences, and towns, fire became a major threat and unwanted fires were extinguished wherever possible. In many areas, clearing or plowing land for agriculture fragmented the grass, brush, or forest areas that were previously free to bum when ignited. Livestock grazing removed many of the fine fuels (grass and herbs) that previously carried ground fires from place to place. Farmers, cowhands, and loggers---who saw in fire a force that destroyed resources they wished to use themselves---were quick to suppress any small fire they could control.
As the federal government began to take more of a role in western land management around the beginning of the 20th Century, fire control was one of its primary missions.

Thus, in a matter of decades---an eye-blink of ecological time---many forests went from a regular fire regime to a nonfire regime. The ecological impacts were significant, and many are still not well documented. Some facts are generally agreed upon, however. Forests where regular ground fires kept brush and young trees in check began to change once fire was eliminated.

Forests of massive, widely spaced oaks in the East, and pines in the South and West---the savanna structures---began to be filled in with species that could thrive in the shady conditions. As these newcomers grew larger and more competitive, the older trees often failed to survive. Forest diversity diminished as savannas gave way to dense forests. Open structures such as meadows and recovering burned areas diminished, as trees began to fill in the open spaces in the landscape. In some areas, the "edge" between forest and grassland began to shrink, as forests filled in the former open sites. Obviously, these changes affected wildlife habitat, as well as the cycling of rain, snow, groundwater, and nutrients.

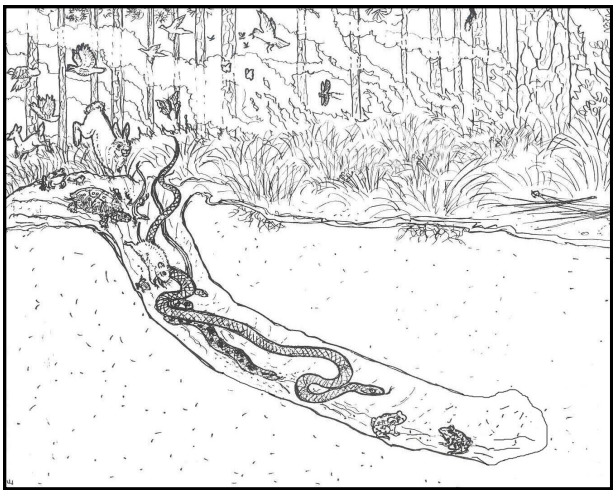
Living with Fire

All living things have some traits that are adaptations to disturbances and constraints of their environments. Disturbances include both physical and biological disturbances, including fire.

Animals

Most animals will either flee a fire or, in the case of burrowing animals, move deeper underground. White-tail deer, mourning doves and bobwhite quail simply run or fly ahead of the flame front. Insects like the tiger swallowtail and cloudless sulfur butterflies, as well as red-winged grasshoppers either fly ahead of the flame front or fly up to the safety of the tree crown. Birds such as the great crested flycatcher take advantage of this smorgasbord of insects. The fox squirrel simply climbs up a tree and moves to the safety of the canopy while the fire passes

Although some insect populations decline as a result of fire, ants seem to thrive. Ant populations have been recorded as more numerous in burned areas than in unburned areas. An important species in grasslands for loosening the soil and burrowing grass seeds, ant populations increase after a prairie fire. Many microbial organisms (decomposers) also increase in numbers following fire.



Plants

To survive a fire, a plant must be able to insulate itself from the heat of the flames. Bark thickness is one of the most important factors determining fire resistance of trees. Pines are examples of trees with thick bark that acts as insulation.

Small woody plants and shrubs, which normally have thin bark, tend to use the soil as an insulating layer to protect them. Individual plants resist being killed in fires by producing new growth (shoots) from underground roots or tubers.

Some plants protect their buds as an adaptive strategy to survive a fire. Buds can be protected by layers of succulent foliage. The buds of the short-leaf pine are protected by a thick cluster of needles. Some plants even protect their buds by locating them within the main stem and roots. A few species of poplar trees in several parts of the world possess this trait.

Retention of seeds by plants until a fire does occur and stimulation of seed dispersal by fire are other examples of fire adaptation. A number of pine species around the world, said to be serotinous, have cones that open only as the result of heat from a fire. Their cones are held closed by a resin that is sensitive to and opens in high temperatures generated by wildland fires.

The rare prairie sunflower (*Helianthus pauciflorus*) , pictured at the right, is a fire-dependent species that has recently been found on Chesney Prairie Natural Area. The primary roots of this perennial can be over seven feet long and help it survive prairie wildfires.

Anatomy of a Prescribed Burn

A prescribed burn is so named because land managers first write a "prescription" of criteria that must be met before ANY burning can be done. The parameters of this prescription include weather, fuel types (e.g., live and dead vegetation) and amount, nearby manmade structures and topography.

The burn crew in the picture above are using hand held "drip-torches" that contain a mixture of gasoline and diesel fuel. This mixture allows the burner to lay down a line of fire on the ground. They are wearing Nomex (fire-retardant) clothing, goggles to safeguard their eyes from flying ashes, and plastic hard-hats to protect the head from falling branches, and leather gloves and boots protect the hands and feet from heat.

The bottom left of the drawing shows part of a "fire break". A fire break is a plowed line around the area being burned. Plowing removes grasses, trees (i.e., fuel) that would otherwise allow the fire to continue to burn. The direction of the smoke indicates that the wind is pushing the flames. When a fire moves with the wind it is called a headfire. A fire pushing against the wind moves slowly and is called a backfire.

Restoring Tallgrass Prairies with Fire

Tallgrass prairies are primarily made up of grasses and forbs, with some shrubs and trees. Prairie plant communities are a result of fire and drought, although some community structure is in part from grazing by bison and elk. Drought acts both as a direct stress on the prairie ecosystem, and to make conditions more likely that fire will occur by drying potential fuels.

Fire in tallgrass prairies acts to burn above-ground biomass, killing woody plants, allowing sunlight to reach the soil, and changing the soil pH and nutrient availability. Grassland fires can cover large areas in a short time as fire fronts are driven by prairie winds. However, because grass provides a low quality of fuel, grassland fires usually are not intense.

Productivity usually increases following a fire in the prairie. Growth is stimulated by the removal of litter and preparation of the seedbed. In addition, perennials have greater seed production, germination, and establishment after a fire. The seeds of some forbs, such as prairie sunflower, scarify and leave dormancy following fire. Growth of native species such as big bluestem, little bluestem, and Indian grass all increase significantly following a fire. Fire promotes grasses at the expense of woody species; those woody species that do occur in savannahs are usually thick-barked species such as bur oak.

When fire is removed from a prairie ecosystem, woody shrubs and trees eventually replace grasses and forbs. In most managed prairies, prescribed fire is introduced on a two- to three-year cycle. The time of the year during which these fires are ignited is of primary importance. Plant recovery following a prairie fire is fastest in the spring and fall when soil moisture is high and plants are not producing seeds. If the area is burned when soil moisture is low, or when plants are starting to produce seeds, the recovery will take longer following the fire.

Fire Words

back fire: a slow moving fire that pushes against the wind

fire break: a plowed line around an area being purposely burned

fire dependence: Numerous species that inhabit fire-dependent ecosystems have evolved reproductive strategies to adapt to factors associated with fire. These adaptations are particularly evident in seeds that respond to the physical (i.e. temperature and light) and/or chemical (smoke, gas, nutrients) germination cues associated with fire. In fact, many species have evolved barriers to seed germination that are overcome only by fire-related cues.

fire ecology: a branch of ecology that studies the origins of fire and its relationship to the environment

fire history: how often fires occur in a geographical area

fire regime: the role fire plays in an ecosystem

headfire: a fire that moves with the prevailing winds

serotinous: a pine cone or other seed case that requires heat from a fire to open and release the seed

Background Control Burn

A poem by Gary Snyder

What the Indians
here
used to do, was
to burn out the brush every year,
in the woods, up the gorges,
keeping the oak and the pine
stands
tall and clear
with grasses
and kitkitdizze under them,
never enough fuel there
that a fire could crown.
Now manzanita,
(a fine bush in its right)
crowds up under the new trees
mixed up with logging slash
and a fire can wipe out all.
Fire is an old story,
I would like,
with a sense of helpful order,
with respect for laws
of nature,
to help my land
with a burn, a hot clean
burn
(manzanita seeds will only
open after a fire passes over
or once passed through a bear)
And then
it would be more
like,

Fire Books

Fire: The Story behind a Force of Nature by Jack De Golia

Fire's Effects on Ecosystems by Leonard F. DeBano, Daniel G. Neary, Peter F. Folliott

Fire, Native Peoples, and the Natural Landscape by Thomas R. Vale (Editor)

For young people

Fire in the Forest: A Cycle of Growth and Renewal by Laurence P. Pringle

The Charcoal Forest: How Fire Helps Animals & Plants by Beth A. Peluso

Fire: Friend or Foe by Dorothy Hinshaw Patent