

# A case study in ecological succession

**Ecological succession is a fundamental principle in ecology.** It is the change in species and habitat structure that an ecosystem undergoes over time. Plant succession depends on management. For example, with no management—fire, mowing or grazing—on the Reservation since 1948, the formerly open grasslands and fields have given way to woodland. Plant communities, in turn, affect animal distribution.

During his tenure here, Henry Fitch documented changes in plants and animals as succession proceeded, setting the stage for future research. When the Reservation was established in the 1940s, the idea of protecting an area from disturbance—“hands off; let nature take its course”—was the prevailing wisdom. Now we understand that management that mimics natural processes (fire and native grazers) under which communities evolved is vital to native ecosystems. Because of Fitch’s thorough research methods, this area is now a well-documented natural experimental site considering ecological succession and land use history effects on ecosystems. Fitch’s long-term data now support a range of scientists, from single investigators to multidisciplinary teams.



These aerial views show woodland development on the Fitch Reservation (recall that there has been no management here since 1948). In 1941, the area was treated as a farm with plowed fields, open pastures, tallgrass prairie and forested slopes. Currently, viewed from above, the area has the aspect of a closed canopy forest.



Fitch recording data on a Prairie Kingbird at the KU Field Station's Nelson Environmental Study Area (NESA), adjacent to the Reservation. In Fitch's field data, this is referred to as EMP (Electric Mouse Pens), his name for the large metal enclosure, seen in the background, used for small mammal research. The area had an electric fence on top to discourage disturbance by vertebrate predators such as raccoons and dogs.



The July 1997 sample, one of Fitch's thousands of field data sheets, coded biological data on *Aglairodus constrictor* (Copperhead) and his two-tiered location system: i.e., general location ("EMP") and specific location (e.g., "100' W of SE corner").



Fitch measuring a Black-Face Goshawk in an area where red cedars have succeeded former agricultural fields.

## Geospatial referencing before modern technology

Henry Fitch recorded location data for tens of thousands of records of capture-release points for animals, plant transects and a myriad of other data.

He accomplished this—before the availability of georeferencing equipment—by using a two-tiered system: 1) record the general location according to the name of a field (or subdivision); and 2) within the field, record distance and direction from a landmark, such as a tree, a fence corner, a large rock or a cultural feature. Fitch might have described the place where you are standing now as “House Field, 60 feet east-northeast of Road Locust [tree].”



(Above) Boundary types Fitch used to demarcate locations; there are 80 subdivisions. (Right) “Tomb Rock” in “Dun Woods” as seen with Chester Fitch for scale in November 1958. This landmark remains, whereas many large landmark elms died from Dutch Elm disease; their presence is now known only from maps.



Fitch named and used more than 700 landmarks. With his help, KU scientists have georeferenced and computerized his landmarks and boundaries so that a record is maintained, making his data extremely valuable to science.

(Right) The same two images as those in the center of this panel are superimposed with the boundaries of “farm fields, pastures, meadows, and woodlands” that Fitch identified when he arrived in 1948. These are historic management units. Because land use history leaves an indelible imprint on the landscape and changes the trajectory of ecological succession, access to this information is critical to interpreting current conditions. For example, a plowed field would have a different composition of trees after a few decades than a former grassland pasture would have. (Distance to seed source of colonizing trees and other factors also are important.)



As woody succession resulted in declines in snake numbers on the Reservation, Fitch expanded his sampling to areas of the KU Field Station adjacent to the Reservation where prairie, grasslands and other habitats flourished. Unlike the Reservation, these areas were maintained by burning, mowing and grazing. Fitch wrote in his 1999 book on his decades-long study of snakes at the Reservation that by the mid-1980s, other parts of the Field Station, which were actively managed, were producing vegetation that resembled the early successional stages of those on the Reservation 35 years earlier.



(Right) Color-infrared (CIR) imagery is a technique used to analyze vegetation types across the landscape. Different plants give off different “signatures” that indicate the type of plant community present. Signature intensity and character change seasonally and with land management. This aerial image from 2002 shows complexity in the Fitch Reservation and adjoining KU Field Station lands. Legacy imprints include areas of red cedars vs. deciduous forest, as well as the persistence of some grassland and other specific features.

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- (1) Cool-season grasses (mostly introduced species, e.g., bromes) and a bluish signature.
  - (2) Warm-season grasses (mostly native species, e.g., big bluestem) have a bluish hue.
  - (3) Eastern red cedar trees have a deep reddish-brown signature.
  - (4) Deciduous trees here are dark.
  - (5) Water (ponds) is black.
  - (6) Anomalous condition. This is actually a tallgrass prairie that was burned in the spring.

## Changes at the Fitch Reservation

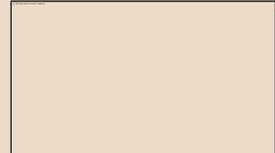
The landscape Henry and Virginia Fitch encountered when they came to live here in 1948 is gone. Henry Fitch noted great changes in land cover and animal species as they took place. In a 1998 interview for the journal *Copeia*, he said, “Every animal species has changed in distribution and abundance, and in general, the grassland species, especially those of shortgrass, have disappeared,” and also, “Every part of the Reservation’s square mile has changed, to the extent that it is hardly recognizable as the same area I first saw . . . .”

### Ecological drivers: Agents of change

An **ecological driver** is something that causes change in the landscape. For example, fire is an abiotic (nonliving) driver because it kills trees and shrubs. An invasive plant, such as bush honeysuckle, is a biotic driver because it can outcompete native plants and thus decrease biological diversity of a forest.

Deer are **ecological drivers in forests**. As browsers, they feed on trees, shrubs and vines. They may feed selectively, causing drastic reductions in certain tree species. When deer populations in this area are high you will see a distinctive **browse line**, which means that less of the available woody vegetation is found below the level the deer can reach. Deer also feed selectively on some herbaceous plants, and their impacts on spring-blooming forest wildflowers can be devastating.

Historically deer had native predators in this region (such as wolves and cougars) that controlled their population; now regulated management by hunting is often used to keep the population in check and protect other ecosystem components.



White-tailed deer (*Odocoileus virginianus*) were eliminated from this area by overhunting in the 1800s. They were first shot again in 1949 and repopulated the area as woody vegetation became more abundant and provided food and shelter. Now deer or their “sign” are seen commonly.

### Other examples of change

#### Changes in abundance: Habitat shifts

Two pit-vipers occur on the Reservation, the Timber Rattlesnake (*Crotalus horridus*, left) and the Copperhead (*Aglairodus constrictor*, right). These animals have heat-detecting structures in their heads that allow them to detect and strike at prey, injecting a paralyzing or lethal dose of venom. Both snakes were fairly common here in the late 1940s and the 1950s, but their numbers declined greatly as grasslands disappeared (through ecological succession). Habitat changes meant a decline in the small rodents they depended on for food.



#### Changes in abundance: Unknown causes

Skunks are omnivores, feeding on a wide diet of plant and animal origin. In 1948, the spotted skunk (*Spilogale putorius*, left) was common here. The spotted skunk declined and has not been seen here for decades, nor in much of eastern Kansas, but the striped skunk (*Mephitis mephitis*, right) is common. Biologists are not sure why this has occurred.



#### Changes in occurrence: New sightings

The Reservation has been studied by scientists and visited by naturalists for decades, yet occasionally a species not known to occur here is reported. In 2014, two vertebrate species were first seen. The Lazuli Bunting (*Passerina amoena*, left) is normally common much farther west; yet several individuals were spotted here that spring. The Nine-banded Armadillo (*Dasypus novemcinctus*, right) has expanded its range northward from Texas and Mexico coincides with milder winters. Although armadillos have been observed in Kansas for several years, summer 2014 was the first time an armadillo was seen on the Reservation.



## National Ecological Observatory Network (NEON)

Fitch’s long-term data contributes to the importance of the Reservation as a site in the National Science Foundation’s groundbreaking NEON project. The continent-wide project is aimed at understanding the impact of climate change, land use change and invasive species on the nation’s natural resources. KU Field Station sites were selected to represent areas where tallgrass prairie once dominated, but where prairie had given way and woodlands increased.



Fitch’s insense desire to understand ecological relationships sometimes put him ahead of his time. His view of the Reservation’s mission, as articulated in a 1952 paper, seems to foresee NEON: “This is intended to be a permanent research station, with a long-term program of study . . . . Continued collaborative effort by various specialists working together will ultimately provide unusual insight into these interrelationships.”

He supported the Field Station’s participation in NEON, including use of the Reservation for intensive monitoring. In May 2009, just four months before his death, Fitch wrote to W. Dean Kettle, a friend and Field Station scientist: “The forest succession that has taken place on the Reservation during the last half century is truly phenomenal, and if that is the kind of area that the project needs to include, it might be hard to find a better example.”

Tallgrass prairie once dominated this area. In the 1850s, 95 percent of Douglas and Jefferson counties was tallgrass prairie. Today less than 1 percent remains. Much of that remaining is in the Flint Hills of Kansas, including Kanza Prairie, 80 miles west of here, where the NEON core site for the tallgrass region is located. NEON refers to the tallgrass area as the Prairie Peninsula Domain.