

Pastures of Plenty: A Case Study in Field Biology

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Cow pastures are taken for granted in rural parts of the northeastern United States, where they are common. We don't think of them as special habitats, yet they are. Cow pastures have been present in the northeastern landscape since the earliest farm families first carved agricultural lands from the forests. The best land in terms of soil fertility and drainage generally became arable fields, whereas more marginal lands went into pastures. Other marginal lands, often wetter, steeper, or more remote from the main property, were left as forest. But historically, every dairy farm had at least one pasture.

Field biologists work to discover patterns in nature—usually by observation—and then to understand the causal influences behind those patterns. More often than not, the explanations for patterns in nature are complex, a result of multiple factors interacting in various ways over time. Often it is not possible by observation alone to fully understand the cause of a given pattern.

Cow pastures are interesting from a scientific point of view because one factor—the presence of many large, hungry cows—is of overriding importance in determining the abundance and kinds of plants that occur. Whether a pasture began as a natural meadow or as planted forage, the grazing and trampling activities of cows, carried out over years or decades, produce a habitat of closely cropped edible plants interspersed with taller plants that are avoided by the cows due to their physical or chemical properties.

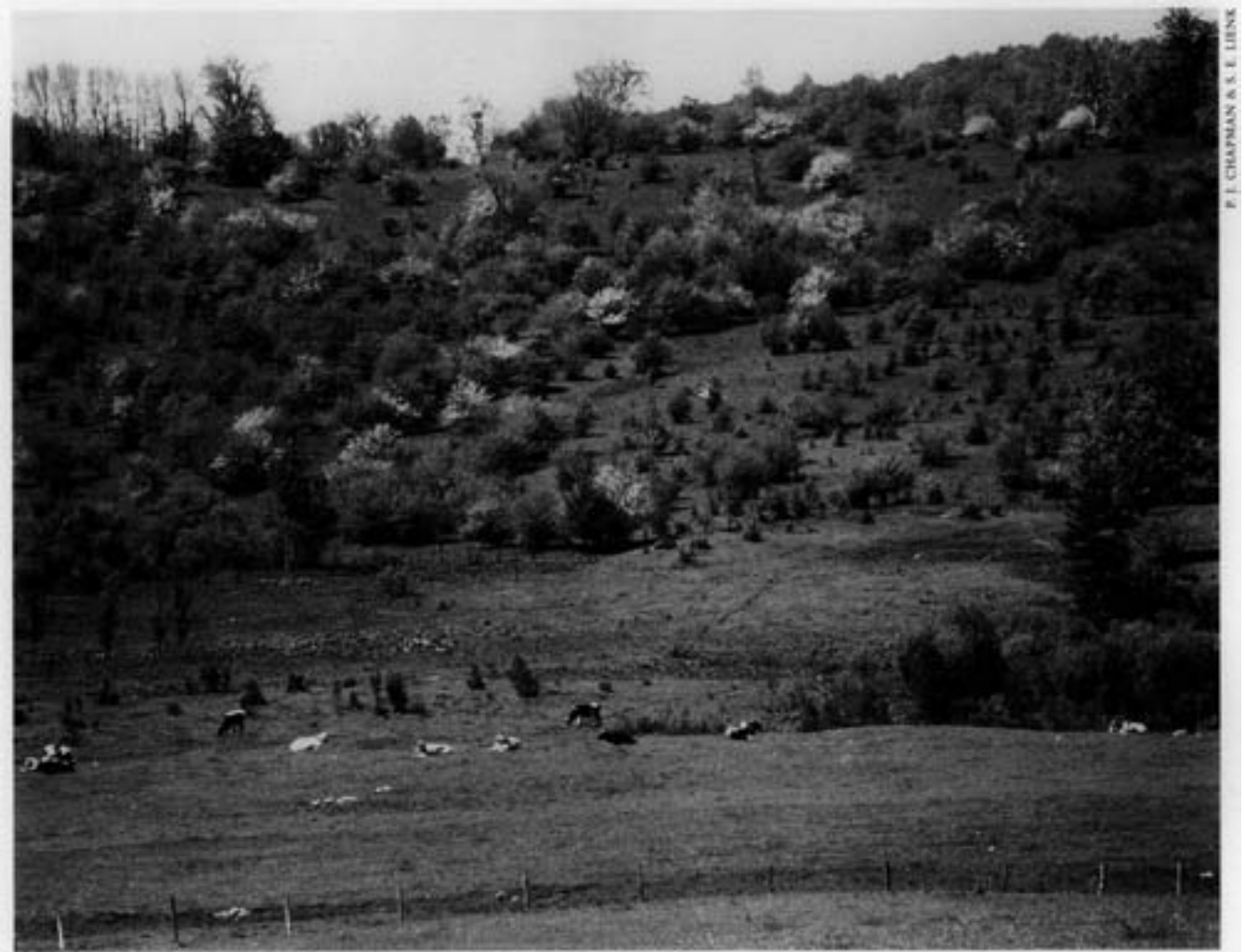
Pastures can be surprisingly beautiful, perhaps because they take on some of the features of landscaped yards and public gardens: large areas of mowed green grass with scattered drifts of taller herbs and small flowering trees—sometimes dramatically pruned into unusual shapes. How does this happen?

In active pastures, the most conspicuous plants are those not eaten by cows. A striking feature of many of these plants is the presence

of thorns or their equivalent. Thistles (*Cirsium* spp.) are common in many pastures. And among woody plants that tend to catch our attention visually, wild or volunteer (not planted) apple trees (*Malus* spp.) and hawthorns (*Crateagus* spp.) stand out. Apple trees do not have true thorns, but their short side branches are sharp at the tips and function as thorns. These distinctive thorny woody plants allow many pastures to be recognized as such as we drive or walk along country roads. Pastures with hawthorns are especially easy to recognize at a distance because the hawthorn bark is light gray and the branches are horizontal in orientation, producing a distinctive growth form. Because they persist for many decades after a pasture is abandoned, the apples and hawthorns also provide a diagnostic legacy of former land use.

We now have a pattern to explain. Why are thorny woody plants so common in cow pastures? An obvious and important first thought is that the thorns prevent or reduce cows' feeding on these plants. This is consistent with other related observations. One is that a variety of non-thorny woody plants invade abandoned pastures, but not pastures where cows are still present. Another observation is that the apples and hawthorns that commonly invade pastures do so when the pastures are active. However, other thorny plants, such as multiflora rose (*Rosa multiflora*), invade a variety of open habitats, not just active pastures.

The implication is that pasture cows are a dominant influence. In their presence thorny plants hold an advantage, whereas on the same land without cows non-thorny plants have the edge. Presumably, plants without thorns cannot invade active pastures because cows eat them. In pastures abandoned for decades one can sometimes see both thorny and non-thorny woody plants. There are dense patches of thorny scrub where plants that started when the pasture was active have grown larger and taller; here few other woody plants have been able to invade.



An active cow pasture in spring, showing cows, closely cropped grass, and a mixture of apple and hawthorn trees. The apple trees range from closely pruned cones to larger trees in flower.

Other areas, where no apples or hawthorns were present at the time of abandonment, now have a variety of non-thorny trees and shrubs such as white ash (*Fraxinus americana*) and gray dogwood (*Cornus racemosa*).

A careful accounting of plant ages should reveal differences between the groups: the thorny plants that invaded when the pasture was active should be ten or more years older than the non-thorny trees that invaded after its abandonment. But inferring plant ages from plant sizes can be misleading. Decades after pasture abandonment, ash trees, which grow faster than apples, will be taller but younger.

Although thorns reduce the feeding pressure from cows, they do not prevent feeding alto-

gether. Indeed, the closely pruned hawthorn and apple plants are perhaps the most spectacular aspects of an active pasture. From a distance, it is difficult to believe these are wild plants, so exquisitely shaped are their crowns. Many look like inverted bowls or cones, whereas others look like old-fashioned hourglass timers. Closer inspection reveals that these geometrical shapes are made up of a proliferation of branches caused by the repeated release of side branches, which, in turn, is caused by cows eating the branch tips year after year. The resulting protective matrix of short, interwoven branches is so dense and rigid that cows can feed only on the plant bits that protrude from it. Conversely, leaves that are near the exterior of the matrix



A typically cone-shaped, closely pruned apple tree, photographed in winter, resides in an active cow pasture. The glove in the foreground provides scale.



The top part of this apple tree, now beyond the reach of hungry cows, shows a spurt of new growth, the tree takes on a characteristic hourglass shape

but recessed from the edge are protected from cows while still exposed to sunlight. The densely cropped apples and hawthorns and the cows achieve a kind of equilibrium, with the cows unable to penetrate the “shell” and the plants unable to grow beyond it. One of my students proposed the term “bovine bonsai” to describe this lovely piece of pasture horticulture.

The balance between the growth of plants and the cropping by cows sometimes tips in favor of the plants—though just barely. Some thorny woody plants in active pastures expand the volume of their crowns slightly each year, despite

the bovine pruners. Much of this growth occurs in the lower half of the crown so that after twenty or thirty years of modest annual gains plants attain an inverted cone shape. Eventually, this slow lateral expansion reaches a point where cows can no longer reach the tops. This marks an important transition in the lives of these plants. After decades of tortuously slow growth, plants whose tops are beyond the reach of cows suddenly escape much of the bovine influence. Rapid shoot growth begins atop these plants and, in subsequent years, lateral growth increases once it is above the reach of the cows. Eventually a bizarre new growth form is achieved: the shape approximates an hourglass, consisting of a lower inverted cone whose closely cropped outer surface is still maintained by the cows, an upper upright cone that has rapid growth on the inside where the cows cannot reach, and a smoothed lower outer surface where protruding twigs are removed by the cows.

I have walked through a number of pastures, making observations and trying to understand more about the issues discussed above. In active pastures in early spring I have seen seeds from non-thorny trees like white ash scattered within the close cropped turf. Yet seedlings of the same non-thorny species are notably absent, suggesting that the bottleneck for the establishment of these plants is at the seedling stage. In contrast, seedlings of apples and haw-

thorns must at least occasionally become established in pastures in order to account for the larger plants that are so conspicuous later on. Interestingly, hawthorn and apple seedlings lack thorns. Why then can these seedlings survive in active pastures while other non-thorny seedlings cannot? Why doesn't eating and trampling by cows eliminate apple and hawthorn seedlings, as it apparently does the seedlings of non-thorny species? We don't know all the answers, but our understanding of how young plants get started in pastures is more complete for apples than for hawthorns.

Many pastures have apple trees around the edges or a few large, old apple trees within the pasture proper. In autumn, the fruits ripen and cows eat the apples that fall to the ground. The seeds pass through the cow unharmed and are deposited in "cow pies," where they spend the winter. Come spring, these seeds germinate into seedlings that grow directly from the cow pies. The rotting manure provides a locally fertile environment for apple seedlings in cow pastures. In addition, cows typically do not feed on plants growing in or near cow pies. This reprieve from feeding damage, which may last through the first growing season, allows apple seedlings to grow and create energy reserves so that they are more likely to recover the first time they are eaten or trampled upon by cows.

Since not all pastures have apple trees, and since only those cow pies produced when apples are ripe contain seeds, most cow pies do not have apple seedlings. But examining many cow pies in the spring should yield some with apple seedlings, which are recognizable by their two large rounded seed leaves, or cotyledons. One study conducted by Cornell thirty years ago found as many as 250 apple seedlings in a single cow pie!

I once harvested a closely cropped apple tree about five feet (1.5 m) tall in order to estimate its age by counting the annual growth rings on a cross section of the trunk. (Gaining access was not easy—I had to saw a hole in the side of the dense, rigid, sharply tipped branch matrix before I could reach the trunk.) The tree was about thirty years old, which was consistent with the ages reported in the Cornell study. However, even more interesting was the new dimension of pasture ecology it revealed: inside the protective branch shell of this apple tree grew several non-thorny woody plants.

I have since found a number of non-thorny woody species, including white ash, honeysuckle (*Lonicera* spp.), and chokecherry (*Prunus virginiana*), growing inside the protective shell of several apple and hawthorn trees in pastures. These species of trees and shrubs are among the same species that invade abandoned arable fields and pasture. In active pastures, species

intolerant of cattle grazing can generally grow only within the refuge provided by pruned apples and hawthorns.

This essay focuses on cow pastures in central New York State, but the issues raised here apply, to some extent, to cow pastures around the world. Elsewhere there are species equivalent to our hawthorns and apples, such as junipers. There are other kinds of pastures as well, and what is true of cow pastures is not necessarily true of sheep or horse pastures. Both the number of animals and the continuity of the grazing can influence the numbers and kinds of plants that are able to invade. Finally, the function of cow pastures seems to be changing in the Northeast as dairy farming becomes more



Apple seedlings emerging in spring from cow manure deposited the preceding fall.

intensive. Historically, pastures provided forage for dairy cows during the warm parts of the year. On today's large dairy farms, cows may not be pastured at all, and since many dairy cows now receive all their food indoors, cows that are pastured may not crop apples and hawthorns as closely as they did in the past. Even so, evidence of former pastures still remains in the large plants left behind.

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