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WHAT LANDSCAPE ASPECTS MAY HAVE BEEN IMPORTANT TO EASTERN COTTONTAIL (*SYLVILAGUS* SPP.) GAME FARMS DURING THE MID-20TH CENTURY IN THE UNITED STATES?

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Abstract: The Eastern cottontail (*Sylvilagus floridanus*) was an iconic game species during the mid-20th century in the United States. Game farms were set up to produce additional cottontail numbers for hunting purposes; however, for various reasons, many game farms were unable to propagate the necessary additional numbers of cottontails needed. The purpose of this paper is to review the landscape factors involved and offer recommendations on the importance of a landscape perspective with the use of game farms under a historical mid-20th century perspective. The results of this paper show that areas with more regional spatial scales and more than one game farm reared more cottontails and harvested than the single county, single game farm scenarios and soil for plant growth, topography and relief, and edges and boundaries of landscapes were some of the main landscape attributes that could have been important for the historical cottontail game farms. Further research could examine the number of game farms, suggestions for plot number and size, and landscape barriers to disturbance in order to help mitigate threats to cottontail game populations.

Key Words: game farms, *Sylvilagus* spp., landscape ecology, rabbit.

INTRODUCTION

The history of game management in the United States has taken a plethora of approaches, such as the organising of bag limits, delegation of hunting seasons, regulation of firearms, sustained yields for larger wildlife species, regulation from the hunting locality (for example, on hunting from boats or vehicles), and by the 1970s, the development of more long-term, quantitative surveys provided an improved ability to understand the larger effects of exploitation on wildlife populations (Braun, 2005).

The Eastern cottontail (*Sylvilagus floridanus*) has the largest distribution of all *Sylvilagus* spp., inhabiting such diverse landscapes as farmland, hedgerows, woodlands and brush, and occurs sympatrically with other *Sylvilagus* and *Lepus* species in the United States (Chapman *et al.*, 1980).

The Eastern cottontail was an iconic game animal during the mid-20th century in the United States, largely hunted for meat and sport (Stuber, 1938; Atzenhoefer, 1951). For example, records show that around 78 000-149 000 cottontails were taken between 1932 and 1935 in Massachusetts (Massachusetts Division of Fisheries and Game, 1933, 1936) and a range of 2-10 cottontails were taken per Pennsylvania resident licence from 1915-1945 (Beule, 1947). In addition, Chapman *et al.* (1980) reported that cottontails have an average of four litters per year, with mean litter sizes of 3-5 kits, and Bruna (1952) reported an average life span of 15 mo for cottontails in the wild.

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Game farming has been a type of management tool that attempted to facilitate cottontail numbers for hunting purposes (Gerstell, 1935; Wilson, 1946), as well as covering other broad ranges of objectives (Bolen and Robinson, 2003) including examining behaviour, longevity studies (Linduska, 1947), litter sizes, inter-species breeding (e.g. *Sylvilagus floridanus alacer*, *Sylvilagus floridanus mearnsi* —New York Pittman-Robertson Project, 1950—), and helping obtain more reliable population estimates (Edwards and Eberhardt, 1967). Many of the cottontail game farms were managed by the state and conservation agencies, such as in Ohio (Stuber, 1938), Pennsylvania (Studholme, 1948), Maryland (Sheffer, 1957) and New Jersey (Grant, 1959), and game farms used a variety of approaches including the use of enclosures (Gerstell, 1935; Grant, 1959), cages (Beule, 1947) and open areas (McDowell, 1955) during transport, breeding periods and holding areas. These studies were designed to assist with understanding cottontail habits in order to raise or study them more effectively, especially in a more cost effective way (Lemke, 1952), and the game farms tried to facilitate those means.

Issues of cottontail game farming included trying to re-stock a continually dwindling population of ever-needed cottontails to hunt (Beule, 1947) and increased hunting pressure, with smaller parcels of land designated for hunting (Hickie and Whitlock, 1940). Cottontail mortality on game farms has been due to heavier rainfalls (Grant, 1959, New Jersey Outdoors, 1962), overcrowding and spreading of disease (e.g. giardia) (Gerstell, 1935), or predation by snakes, skunks and cats (Beule, 1947), and smothering due to an abundance of rabbits that occupied warrens (Hiller, 1932). Flooding, overcrowded warrens and predation could indicate issues with the soil and, additionally, larger game farm areas could consider landscape topography and surrounding land uses around the game farms. However, there have been few quantitative comparisons between cottontail propagation numbers, harvests and patterns. As such, game farming has many considerations for landscape attributes and these examples demonstrate that a landscape perspective could have helped or bolstered game farm productivity for the Eastern cottontails (*Sylvilagus floridanus* sp.). The question this research aims to address includes: What landscape aspects might have been helpful for an Eastern cottontail game farm setting in the United States during the mid-20th Century? The aim is not only to assess quantitative aspects of historical cottontail game farms, but to gain a greater understanding of the more prominent aspects of landscapes in the cottontail game farm.

The first objective of this paper is to understand the extent of historical cottontail game farms (1930-1965) in terms of: number of cottontails produced and released on game farms for sportsmen, number of cottontails harvested, number of cottontail game farms, extent of spatial scale of the game farm, how many counties participated in cottontail game farming, or if the cottontails were imported and which state they were imported from (if applicable). The second objective for this paper is to improve the understanding of landscape aspects on cottontail game farms from 1930-1965.

MATERIALS AND METHODS

Quantitative aspects of historical cottontail game farms

The study was carried out throughout a literature search and search criteria using electronic databases Google Scholar, Google Books, ISI Web of Knowledge and ProQuest. The keywords used included: cottontail game farm, released, harvested, generated, and included the years between 1930-1965.

The number of cottontails produced, released and harvested and the number of game farms were identified and reported. Spatial scale, size of the game farm (in hectares), and number of counties that participated in the propagation of cottontails were noted, along with the state the game farm was located in, as well as any documentation on where the cottontails were imported from (if applicable).

The number of cottontails produced refers to the number of cottontails that were either reared on the game farm or imported from another area to the game farm. The number of cottontails released refers to the number of cottontails that were released for hunting purposes, and number of cottontails harvested refers to the number of cottontails that were taken reported by hunters. The number of game farms refers to how many game farms were located in the study; the spatial scale refers to if the study was in a county or multi-county areas (region); the number of counties that participated refers to either one county game farm or the regional area (if other counties were involved); the

state the game farm or study was housed in; and where the cottontails were imported from (if applicable), as some cottontails were raised on the farm itself.

Landscape attributes

Literature was also scanned for landscape attributes mentioned about the game farms using the same above keywords and electronic databases. Any landscape attribute mentioned in the papers were noted and recorded.

RESULTS

Quantitative aspects of historical cottontail game farms

Eleven different studies from New York, Massachusetts, Maryland, Michigan, New Jersey, Ohio and Pennsylvania were identified for the analysis (Table 1).

In most cases, the number of cottontails harvested was less than the numbers of cottontails produced or released (Table 1).

It appears that situations with more regional spatial scales and more than one game farm provide more cottontails produced and harvested than the single county, single game farm scenarios (Table 1).

Table 1: Number of cottontails produced, released, harvested, number of game farms included, spatial scale, number of participating counties, state of cottontail propagation experiments, and where the cottontail was imported from (if applicable).

Reference	Produced (n)	Released (n)	Harvested (n)	Game farms (n)	Size of game farm (ha)	Spatial scale	Counties participated	State	Cottontail imported from (if applicable)
Massachusetts Fish and Game Annual Report, 1936	31	11	4	1	2.83	County	1	Massachusetts	Vermont and Massachusetts
Massachusetts Fish and Game Annual Report, 1937	202	55	10	1	22.66	County	1	Massachusetts	Vermont and Massachusetts
Baumgras, 1945	23	89	13	1	80.94	County	1	Michigan	Mason Game Farm and released on Swan Creek Expt station
New York Cottontail Investigations, 1950	60	28	41	1	0.81	County	1	New York	Gilbert Lake State Park Ostego Co. NY
Mangold and Peterman, 1954	51-141	248	44, 69	4	40.47	Region	1	New Jersey	Missouri
McDowell, 1955	122	28	14	1	56.37	County	1	Pennsylvania	Missouri and Kansas
Dell, 1957	5000	4438	220	10	50.99 (each)	Region	10	New York	Midwest
Sheffer, 1957	220	220	27	2	20.23, 16.18	Region	5	Maryland	Midwest
Sheffer, 1958	110	70	13	3	20.23, 12.14	Region	NR	Maryland	Midwest
New Jersey Outdoors, 1962-1963	79	50	5	1	196.61	County	1	New Jersey	Raised on farm itself
Ohio Division of Wildlife, 1972	NR	3403	1307	1	2151	Region	NR	Ohio	Trapped in Ohio and brought to game farm
Ohio Division of Wildlife, 1972	NR	1680	233	1	1618	Region	NR	Ohio	Trapped in Ohio and brought to game farm

NR: Not reported.

Landscape attributes

Literature identified eight references that had included landscape attributes from game farms in their studies (Table 2).

The mention of landscape attributes were hillsides, flat open land, thin soils and orchards, such as on the Loyalstock Farm and Corning Fish and Game Club, while the other landscape attributes cited included food for the cottontails and cover (Table 2).

DISCUSSION

Several authors (e.g. Gerstell, 1935; Lemke, 1952 and Guthrie, 1969) had mentioned that fewer cottontails were harvested or even produced from the cottontail game farms and similar results were found in this research. Perhaps some of these results could be due to issues of overcrowding (Wilson, 1946; Stuber, 1938), adverse climate conditions (Gerstell, 1935), territoriality issues between cottontails (Handley, 1952), increased susceptibility to predation (Handley, 1952), disease (Wilson, 1946) and parasite load (Hickie and Whitlock, 1940).

Successful outcomes from cottontail game farms seemed to examine the number of cottontails produced and hunter success (Stuber, 1938; Studholme, 1948; Grant, 1959). From the results of this research, it appears that areas with more regional spatial scales and more than one game farm provided more cottontails produced and harvested than the single county and single game farm scenarios. The mean home range of the cottontails included 0.95-2.8 ha for both bucks and does (Chapman *et al.*, 1980). Most of the game farms examined in this study were over the reported individual home range size; however, there were two game farms that were the size of the cottontail home range and those game farms had produced 31 and 60 cottontails (Table 1). Given the changes in the home range during various weather seasons or the breeding season, area is very important for consistency of wildlife persistence, as decreased space might facilitate increased spread of disease (e.g. Gerstell, 1935; Wilson, 1946), overcrowding (Gerstell, 1935) and general overuse of the land.

In addition to discussions of area for game farms, Chapman *et al.* (1980) reported cottontail population densities of 8.9-10.18 cottontails per hectare, where 10.18 cottontails per hectare was the highest density for a small island in Maryland. Gerstell (1935) reported overcrowding conditions at a calculated 28 cottontails per hectare. Additional research could further examine ideal cottontail densities on game farms.

Table 2: Game Farms and mentioned landscape attributes.

Game farm	Landscape attribute	Reference
Loyalstock Farm	Hillside and flat, woods, and open land.	Gerstell, 1935
Corning Fish and Game Club	Side hill, thin soil, old orchard.	New York Pittman-Robertson Project, 1950
Various locations in New York	Availability to food and cover.	Dell, 1957
Various locations in Pennsylvania	Cottontails did not inhabit cultivated land.	Beule, 1947
Various locations in Michigan	Cottontails frequently located in fallow areas with herbaceous vegetation and scattered brush, and south to southeast slopes, and nearby escape cover.	Friley, 1955
Forked River Game Farm	Ten brush heaps, 7 sections of board fence were placed on the ground flat (to let rabbits pass beneath them), switchgrass and clover were planted.	Grant, 1959
Gwynbrook State Game Farm	Clover, corn, orchard grass, wheat, multiflora rose, conifers, brush piles were placed on the game farm.	Sheffer, 1955
Deleware Wildlife Area, Ohio	Flat to gently rolling topography with some steeper slopes. Elevation was 277-294 m. Soils were calcareous clay loam glacial till.	Boyd and Henry, 1991

A related issue is water availability to cottontails and Beule (1947) estimated that cottontails would need around 37 litres of free water per annum, while during Grant's (1959) observations, very little water intake occurred amongst the wild cottontails. In the landscape, heavy rainfalls and drowning of nests was an issue encountered (Grant, 1959; New Jersey Outdoors, 1962).

While few studies mentioned landscape parameters around their game farms, it appears that a few cited landscape attributes that may have been important for cottontail game farms, such as soil for plant growth, topography and relief, and landscape edges and boundaries.

Soil for plant growth

The soil for plant growth is a key factor to consider in cottontail habitat, as previous studies have suggested the importance of specific flora for the cottontails located at game farms. For example, Beule (1947) stated that cottontails ate herbs, grasses, shrubs, clover, dandelion and bark, while Gerstell (1935) reported that the cottontails ate wild carrot, wild parsley, golden rod, sedges, tender bark of alder, cherry and apple trees, and Wilson (1946) noted that the cottontails ate blue grass and pine trees. Similarly, Chapman *et al.* (1980) reported that blue grass was important across all seasons and, moreover, that herbaceous plants were important during growing seasons and woody vegetation was important during more dormant seasons. Many of these plants listed are C_3 plants and the C_3 plants might have impacted the soil in terms of soil moisture and nitrogen content (e.g. Pearcy and Ehleringer, 1984); therefore, the growth of the C_3 plants might have impacted the soil ecology on game farms. Without this knowledge, it would have been difficult for game farms to consider this when planning landscape features for game farms. In addition, the temperature, season and depth of soil contribute to oxygen and carbon dioxide concentrations for soil (White, 2013). For example, in soil respiration, more oxygen is consumed and carbon dioxide is released during the summer months (White, 2013). Furthermore, lower temperatures and excess water lead to less oxygen available (Money, 1965) and, therefore, an amalgam of these conditions could have perhaps contributed to the suffocation that Hiller (1932) had described. Furthermore, Bruna (1952) investigated soils for the cottontail rabbit habitat in Kentucky and reported that heavy silt loam, moderate to strong acid soils, well drained, gentle slopes and karst topography were characterised as good soils, whereas strong silt loam, more acidic soils and steep slopes were characterised as poor soils for cottontails, as the weights of the cottontails were lower on the poor soils. These are all issues related to soil for plant growth on cottontail game farms.

Topography and relief

A variety of soils and topography is important because it is less likely that there will be a single land use (Edminster, 1949). Because of their elusive nature, cottontails require a lot of cover for their young and protection from predators. Forms, cover and underground burrows were facultative and sometimes brush piles, foliage and herbaceous vegetation were also used for cover and food (Beule, 1947). Chapman *et al.* (1980) reported various sizes of forms made by does that ranged from 125-180 mm in length and 91-119 mm deep; therefore, the ability for cottontails to dig in the soil for form construction is important. In addition, burrowing activity from animals such as rabbits also contributes to changes in soil slope profiles (White, 2013). Wilson (1946) noted that washed out stream beds and gullies could be re-vamped to plant white pines that could provide temporary cover for the cottontails. All of these are issues related to topography and relief on game farms.

Edges and boundaries

Hedgerows can be important for wildlife habitat (Edminster, 1949) and edges and boundaries may be an important consideration for cottontails that were on game farms and cottontails needed scattered brush for protection from predators (Hiller, 1932; Friley, 1955). Dramstad *et al.* (1996) also suggested that a straight boundary tends to have added species movement along it and that curvilinear boundaries may provide less soil erosion and more wildlife usage. To those ends, Wilson (1946) described a successful cottontail game farm strip planting approach conducted in Maryland for cottontail rabbit farming with white pine trees, blackberries, blue grass, clovers and other annual plants such as soybeans, followed by pine trees. In addition, Bruna (1952) found that more cottontails in Kentucky utilised mostly bluegrass or orchard grass pasture with cash crops and cover such as small, scattered parcels, long

narrow fencerows or overgrown gullies, while landscapes with the lesser distributed cottontail populations had solid blocks of cover such as briar, brush or broom sedge. Bruna (1952) also suggested that conifers should be widely spread or in small clumps. Dramstad *et al.* (1996) mentioned creating a landscape barrier to disturbance where a larger plot would be divided into two smaller patches. For the cottontail game farms, this could have meant perhaps some clear cutting between patches to reduce damage due to fire, floods, spreading of disease and predation on game farms. These issues are all applicable to landscape edges and boundaries on game farms.

Overall, the mid-20th century reflected a unique time in the history of game management in the United States and the cottontail game farms in particular, as the demand for cottontail game hunting at that time was greater than ever seen before in the United States and the challenges that had surfaced with artificial propagation, importing and shipping cottontails to the game farms.

Edminster (1949) asked an eminent question at the time: "How could game be grown on certain lands that does not hinder human welfare?" Contour strip cropping, terracing, woodland protection, windbreaks or shelter-belts were some of the ideas that were suggested to increase game and allow farming to continue (Edminster, 1949). Likewise, an amalgam of sound conservation farming, appropriate wood-harvest practices, productive wildlife habitat and a variety of soils and topography could help bolster the game populations for wildlife management (Edminster, 1949).

Based on this research, the soil for plant growth, topography and relief, and edges and boundaries of landscapes may have been important landscape aspects for historical cottontail game farms. Many of the landscape attributes mentioned were to provide food and cover for the cottontail (Table 2) rather than for example, issues of surrounding land uses, soils, number of patches (e.g. conifer stands) surrounding the game farm, how landscapes could be designed to reduce threats to animal populations, and slopes. This research also found that areas with more regional spatial scales and more than one game farm provided more cottontails produced and harvested. Implications for future research could examine the number of game farms, suggestions for patch number and size, and further examination of landscape barriers to disturbance could help mitigate some of these issues in cottontail game populations.

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