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EASTERN GRAY SQUIRREL

(*Sciurus carolinensis*)

Eastern gray squirrels endure in Center City despite a history of persecution and new exposure to predators and poisons.

Figure 2.1 An eastern gray squirrel hesitates before leaving the safety of a garden fence for an offering of a peanut in Rittenhouse Square.

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In 1748 the Swedish naturalist Peter Kalm came to Philadelphia to document the region's plants and animals. After naming eleven species of nut-bearing trees in Pennsylvania, he described how gray squirrels had shifted their food preference to corn, the cultivation of which had increased "infinitely." Squirrels devastated corn crops both in fields and in storage.[1]

Bounties for squirrels

Governments in Pennsylvania posted squirrel bounties of three pence per head. In 1749 they paid out £8,000—equivalent in bounties to 640,000 dead squirrels. Bounty hunting became so lucrative that young men abandoned employment to shoot squirrels. After payouts exhausted local treasuries, governments in Pennsylvania reduced the bounty by half. In other colonies, the squirrel bounty was two pence. In Maryland, mandates required every citizen to present to colonial officials four squirrel heads annually.[2]

Kalm described how adept the squirrels were at evading shooters:

> Though a grey squirrel does not seem to be very shy, yet is very difficult to kill; for when it perceives a man, it climbs upon a tree, and commonly chooses the highest about it. It then tries to hide itself behind the trunk, so that the shooter may not see it, and though he goes ever so fast around the tree, yet the squirrel changes its place as quickly, if not quicker; if two boughs bend towards each other, the squirrel lies in the middle of them, and presses itself so close that it is hardly visible. You may then shake the tree, throw sticks and stones to the place where it lies, or shoot at it, yet it will never stir. If three branches join, it takes refuge between them, and lies as close to them as possible, and then it is sufficiently safe. Sometimes it escapes on a tree where there are old nests of squirrels, or of large birds; it slips into such, and cannot be got out, either by shooting, throwing or any thing else; for the grey squirrels seldom leap from one tree to another, except when extreme danger compels them.[3]

Affection for squirrels

Despite persecution, squirrels were occasionally kept as pets. Kalm wrote:

> Of all the wild animals in this country, squirrels are some of the easiest to tame, especially when they are taken young for that purpose. I have seen them tamed so far that they would follow the boys into the woods, and run about everywhere, and when tired would sit on their shoulders. Sometimes they only ran a little way into the woods, and then returned home again to the little hole that had been fitted up for them. When they eat, they sit almost upright, hold their food between their fore feet and their tail bent upward. When the tame ones got more than they could eat at a time, they carried the remainder to their habitations, and hid it amongst the wool that they lay upon. Such tame squirrels showed no fear of strangers, and would suffer themselves to be touched by everybody, without offering to bite. They sometimes would leap upon strangers' clothes, and lie still on them in order to sleep. In the farmhouses, where they were kept, they played with cats and dogs.[4]

In the mid-eighteenth century squirrels were abundant outside the city, but within Philadelphia, wild squirrels disappeared, casualties of both hunting and deforestation. Etienne Benson at the University of Pennsylvania recently reconstructed the historic ebb and flow of populations of squirrels in downtown Philadelphia in the nineteenth century. He found that beginning in the late 1840s, the city introduced squirrels into public squares for the amusement of visitors. In 1864 the Committee on Entomolo-

gy of the Pennsylvania Horticultural Society blamed squirrels for adverse effects on populations of birds and insect pests; in response, the city captured or killed the squirrels and removed squirrel nest boxes from the squares. Starting in the 1870s, landscaped urban parks and renewed public support for squirrels improved conditions for squirrels, which dispersed widely in big East Coast cities, including Philadelphia.[5]

Safe haven from predators

The squares in the city gave squirrels safe haven from large raptors such as red-tailed hawks. In the early nineteenth century Alexander Wilson, whose interest in ornithology began in Philadelphia, had trouble getting close enough to red-tailed hawks to describe them. In his *American Ornithology,* he begins his account of them with a disclaimer:

> Birds naturally thinly dispersed over a vast extent of country; retiring during summer to the depth of the forests to breed; approaching the habitations of man, like other thieves and plunderers, with shy and cautious jealousy; seldom permitting a near advance; subject to great changes of plumage; and, since the decline of falconry, seldom or never domesticated—offer to those who wish eagerly to investigate their history, and to delineate their particular character and manners, great and insurmountable difficulties.[6]

In 1885, the legislature of the Commonwealth of Pennsylvania passed the "Scalp Act" establishing a fifty-cent bounty for a slain hawk or owl.[7] In the following two years, counties in Pennsylvania paid $90,000 in bounties for killing raptors.[8] Near the end of the nineteenth century, red-tailed hawks were still elusive, as reported by Benjamin Harry Warren, ornithologist for the Pennsylvania State Board of Agriculture:

> This hawk—the most abundant of our raptorial birds—is the detested "Hen Hawk" of the farmer. The Red-tailed Hawk is exceedingly shy and wary, and is taken with difficulty, unless approached on horseback or in a sleigh or wagon.[9]

In 1944, John A. Gillespie, a local birder, published an account of the birds of Rittenhouse Square, based on sixteen years of observation. The number of species he and his friends observed totaled ninety-four, including five species of raptors, but no red-tailed hawks.[10] In 1975 numbers of red-tailed hawks nesting in suburban Philadelphia were declining.[11]

In the second half of the twentieth century, a series of events coalesced to benefit red-tailed hawks. These included publication of Rachel Carson's *Silent Spring;*[12] banning of DDT;[13] passage of protective legislation and implementation of enforcement;[14] development of Hawk Mountain Sanctuary in Berks County, Pennsylvania;[15] and promotion of recreational birding.[16]

End of the safe haven

In the last four decades, numbers of red-tailed hawks in Pennsylvania have quadrupled, according to the Breeding Bird Survey.[17] Parks and campuses in the Philadelphia metropolitan area, including Rittenhouse Square, have become their hunting grounds. In a news story with the title "City's New Pastime: Talon Shows," Inga Saffron, writer for the *Philadelphia Inquirer,* described the transformation:

> So many YouTube videos document hawk kills in the city that they practically constitute a genre. Besides recording the mayhem on Market Street, humans have filmed hawks in mid-bite in Rittenhouse Square, on the University of Pennsylvania campus, in the Philadelphia Museum of Art's sculpture garden, and in the yards of Bella Vista row houses. One local bystander narrowly missed becoming collateral damage when a large redtail dived for a squirrel outside the museum. The squirrel got away.[18]

Photos accompanying her story show a crowd of bystanders photographing a young red-tailed hawk devouring a pigeon on the roof of a car parked at 8th and Market Streets.

In 1998, Marie Winn's *Red-Tails in Love* described red-tailed hawks returning over a succession of years to a nest on the façade of a building on Fifth Avenue across the street from Central Park, Manhattan.[19] In 2009 a pair of red-tailed hawks began nesting on a window ledge of the Franklin Institute, overlooking the Benjamin Franklin Parkway.[20] The Institute constructed a supporting structure for the nest and installed a video camera linked to the Internet for live monitoring on the Web. In 2012, it began providing dead rats for the mother of newly hatched chicks after her mate died in a collision with a truck on Interstate 76 outside 30th Street Station. Within days after his death, another male appeared, bonded with the female, and helped raise her chicks.[21] As of the fall of 2012, red-tailed hawks in this nest have raised nine chicks.

Figure 2.2 A pair of red-tailed hawks tends their brood on the Franklin Institute, May 26, 2012. The adult male has replaced the biological father, who died in a collision with a truck on the Schuylkill Expressway.

Figure 2.3 Fledgling red-tailed hawk stretches its wings.

Figure 2.4 Red-tailed hawk at Memorial Hall, Fairmount Park, Philadelphia. (Photo by Bradley Maule, Phillyskyline.com)

Resilience of populations of gray squirrels

Unlike urban deer and geese, urban red-tailed hawks continue to fit Alexander Wilson's description as "thinly dispersed over a vast extent of territory." Even though scarce compared to other urban birds, red-tailed hawks have the potential to deplete localized, vulnerable populations of prey. In one instance, red-tailed hawks reduced an adult ground squirrel population by over 90 percent.[22] Fear of hawks, independent of actual predation, has suppressed reproduction in sparrows.[23]

Populations of gray squirrels have proved resilient despite losses. Hunting killed 38 percent of gray squirrels in Virginia woodlots, but had no measurable impact on mortality rates.[24] In Ireland, where gray squirrels introduced from North America have proliferated, intensive trapping reduced populations of gray squirrels only temporarily; within ten weeks, young squirrels immigrating from neighboring areas restored these populations.[25]

The reproductive life of a wild female gray squirrel may last as long as 12½ years.[26] Females have produced two litters annually with around three offspring per litter.[27] High mortality offsets this high reproductive potential. In a North Carolina woodland, 75 percent of squirrels died in their first year, and mean life expectancy at birth was only one year.[28] Evidently the gray squirrel's mobility and reproductive potential can maintain populations despite high mortality, including that from red-tailed hawks.

Parks in downtown Philadelphia no longer endow squirrels with safe havens from red-tailed hawks, but they do provide them with refuge from hunters and other predators, including foxes, coyotes, bobcats, weasels, owls, snakes, and other raptors.[29] I have seen feral cats stalking gray squirrels in our backyard, but not in public squares.

In the past decade in Rittenhouse Square, traffic of people and their dogs has increased, preempting space on the ground where squirrels forage and bury nuts. In Independence National Historic Park, the crowds occupying squirrels' home ground are even bigger.

Figure 2.5 Rittenhouse Square, Sunday, April 15, 2012. In recent years, crowds have increased, preempting territory where squirrels forage.

The gray squirrel's natural rhythm of activity separates it from these crowds. In summer, its peak activity occurs shortly after sunrise and before sunset, circumventing the

times when crowds peak. In winter, when crowds are small, its activity is distributed evenly during daylight hours.[30]

Figure 2.6 Gray squirrel behind Independence Hall. Squirrels forage early in the morning, before the arrival of crowds of tourists.

Threats from Norway rats

Squirrels in Rittenhouse Square must contend not only with people, dogs, and hawks, but also with Norway rats (*Rattus norvegicus*), which are conspicuous near park benches in the evening. In 1831 John Davidson Godman, professor of natural history at the Franklin Institute in Philadelphia, described their depredations:

> The common, brown, or Norway rat, now so extensively diffused over this country, is not indigenous to our soil, but introduced from Europe, which received it from Asia in the eighteenth century, as late as the year 1750. There are few parts of the world now visited by navigators where this animal has not been introduced, and the immediate consequence of its introduction has been that all the native rats have been destroyed, or obliged to withdraw beyond the reach of this subtle and implacable enemy…It was brought to this country in European ships, and has been gradually propagated from seaports over the greater part of the continent.
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> He is one of the most impudent, troublesome, mischievous, wicked wretches that ever infested the habitations of man. To the most wily cunning he adds a fierceness and malignancy of disposition that frequently renders him a dangerous enemy, and a destroyer of every living creature he can master. He is a pure thief, stealing not merely articles of food, for which his hunger would be sufficient justification, but substances which can be of no possible utility to him.
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> The brown rat takes up its residence about wharves, storehouses, cellars, granaries &c. and destroys the common black rat and mouse, or entirely expels them from the vicinities it frequents. To chickens, rabbits, young pigeons, ducks and various other domestic animals, it is equally destructive when urged by hunger and opportunity. Eggs are also a very favorite article of food with this species, and are sought with great avidity; in fact, everything that

> is edible falls prey to their voracity, and can scarcely be secured from their persevering and audacious inroads.
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> When attacked and not allowed an opportunity of escaping, he becomes a dangerous antagonist, leaping at his enemy and inflicting severe and dangerous wounds with his teeth. The most eager cat becomes immediately intimidated in the presence of one of these rats thus penned up, and is very willing to escape the dangers of an encounter.
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> The cunning of these rats is not less than their impudence; it is almost impossible to take them in traps after one or two have been thus caught, as the rest appear perfectly to understand the object of the machine, and afterwards avoid it with scrupulous care, however tempting may be the bait it contains. The surest way to remove them is by poison, which, however, they frequently detect and avoid.[31]

Gray squirrels distance themselves from Norway rats. Gray squirrels nest in trees, whereas Norway rats nest in holes in the ground. Gray squirrels forage on the ground during the day, whereas Norway rats forage mostly at night.

Although they avoid contact with rats, they are vulnerable to infestations of rats depleting their food supply. Norway rats are omnivorous and have been reported to consume even acorns.[32] Both species scavenge leftovers from people eating in the square. Competition for food may take a toll on gray squirrels. In a public park on the campus of the University of Kansas, scarcity of food in the spring contributed to deaths of young gray squirrels.[33]

Danger from rat poison

Gray squirrels are vulnerable to poisons used to control rats. In New York, postmortem examinations showed that rat poisons killed many kinds of wild animals, including red-tailed hawks and gray squirrels.[34] In April 2004 rat poison was blamed for the disappearance of squirrels in Rittenhouse Square. News reports attributed deaths of squirrels here to bromethalin, a neurotoxin the city's Vector Control team used against rats in Rittenhouse Square.[35]

Danger of rats to people in Philadelphia

The City of Philadelphia's Department of Health has long struggled with rats and their control. In 1891 the city's coroner listed rat poison (arsenic) sold under the name "Rough on Rats" as the most common poison used in suicides; eight cases were reported that year.[36] In June of 1912, epidemics of bubonic plague broke out in Cuba and Puerto Rico, threatening port cities such as Philadelphia. Rats are a reservoir for plague bacteria (*Yersinia pestis*). That year the city's Bureau of Health, offering bounties for rats dead or alive, examined 2,510 rats and found no evidence of plague.[37] In 1932 another survey in the city examined rats,[38] this time for a particular species of rat flea (*Xenopsylla cheopis*) that had been shown just the year before to transmit the pathogen responsible for a distinctive type of typhus, today called endemic, or murine, typhus.[39] Sixty percent of 4,629 fleas taken from 2,765 rats in the survey turned out to be this species.[40] This discovery occurred in the wake of past epidemics of typhus in Philadelphia.[41]

In 1967 a tugboat engineer who fell into the Schuylkill River was hospitalized with leptospirosis,[42] a potentially fatal disease caused by *Leptospira icterohaemorrhagiae,* a bac-

teria found in 11 percent of rats (*R. norvegicus*) sampled in Philadelphia; the rats' urine contained the pathogen.[43] From 1974 to 1996 the city received reports of over 600 rat bites, primarily involving children under age five bitten between midnight and 8 a.m. in poor neighborhoods.[44] The list of human pathogens potentially transmitted from rats to people is long.[45]

Figure 2.7 Philadelphia's Bureau of Health Rat Receiving Station at a wharf along the Delaware River near Pine Street, 1914. On the right is a baffle designed to prevent rats from using ropes to crawl from ship to shore. The city offered bounties for rats, dead or alive, that it received here. (Courtesy City of Philadelphia photo archives)

Norway rats breed all year long, and on average a female produces more than thirty-five offspring a year. In one month a population of Norway rats can increase in size by 50 percent, making up for losses due to predation or poison.[46] Red-tailed hawks are known to prey on Norway rats,[47] but in Rittenhouse Square they have not prevented outbreaks.

Barriers to rat control

Even if a predator or a poison eliminated every rat in the square, rats from surrounding areas would soon recolonize it. Philadelphia's nineteenth-century sewer system harbors rats. Instead of separate systems for storm and sewer drainage, one system serves both.[48] Infestation of rats in sewers is positively correlated with sewers' concentration of suspended solids[49] and with sewers' age; most occur in sewers over thirty years old.[50] Drain grates by the curb give sewer rats access to the street.

After poison kills rats, their numbers quickly rebound to levels set by availability of food and nesting sites.[51] The same principle applies to rat control by other methods, such as contraceptives, trapping, and fumigation of burrows.[52] In Rittenhouse Square, sustained reduction in populations of rats through poisoning requires ongoing application of poison. This is the strategy of the city's Vector Control unit. In theory, the

ideal strategy would be to effect complete removal of the food that people who use the park leave behind, but twice-daily removal of trash in Rittenhouse Square has not eliminated rats.

Protection of squirrels from rat poison

After the accidental poisoning of squirrels in 2004, populations of squirrels in Rittenhouse Square recovered. Workers from the city's Vector Control unit locate the rats' holes, pour poison down the holes, and then cover up the holes. They monitor the holes, and if a hole they have covered opens, they repeat the process.[53] The poisoning of rats theoretically benefits squirrels by reducing competition. In 2004, the city's Vector Control unit reported that its rat poison in Rittenhouse Square reduced the number of rat burrows from fifty to six.[54]

How populations of squirrels in Rittenhouse Square endure

1. Adaptation

The population of gray squirrels in Rittenhouse Square survives in part because it is well adapted. It nests in trees, safe from people and dogs. It supplements its diet of acorns and nuts with handouts and leftovers. Its daily rhythm keeps it away from rats and crowds. It habituates to the bustle of the city. It tolerates infection by West Nile virus[55] and squirrel pox virus.[56] It does not defend territory;[57] city parks have supported population densities as high as fifty individuals per hectare.[58] Its reproductive power can buffer its population from losses, such as from red-tailed hawks and rat poison.

2. Luck

The gray squirrel survives here also because of good fortune. Rittenhouse Square is endowed with an abundance of nut-bearing trees, including oaks (*Quercus*) and horse chestnuts (*Aesculus sp.*). It has no understory brush to support ticks and chiggers, which infest squirrels in woodlands.[59] Unlike rats, the gray squirrel does not endanger public health. Exterminators spare it. Rittenhouse Square offers squirrels no downspouts to clog, attics to invade, birdfeeders to rob, or crops to ravage. In this setting, people and squirrels can coexist with impunity.

3. Charisma

Neither luck nor adaptation alone is sufficient to explain the success of gray squirrels in populating downtown. In contrast to Norway rats, gray squirrels have charisma. The affection that people reserve for squirrels dates back to our earliest records, when farmers in Pennsylvania kept them as pets despite the existence of bounties for killing them. People take pleasure in the anthropomorphic way gray squirrels sit upright, holding nuts between their two front paws. They enjoy their antics and the look of their white chests. On the other hand, appreciation of squirrels is far from universal. In Philadelphia, charisma has brought less attention to squirrels than to red-tailed hawks, which attract paparazzi and webcams.

4. Personality

The gray squirrel may misjudge its welcome and crawl too close to a visitor in Rittenhouse Square, but it can sense hostility and withdraw. It is skilled at calibrating an optimal stance, be it hiding behind a tree or soliciting a handout. Its treatment of people as patrons or predators matches people's treatment of it. Downtown, its way with people may be the gray squirrel's greatest strength.

Recently my wife and I observed squirrels in Rittenhouse Square, where feeding animals is forbidden but tolerated if the offering consists of only a single peanut. As we approached squirrels, they ignored us or scampered off. Extending her hand holding a peanut, my wife caught the attention of one squirrel foraging beneath shrubbery behind a low garden fence. Through the bars of the fence it eyed the nut, but did not budge. She backed off, holding the nut toward it, but the squirrel stayed behind the bars. She then placed the nut on the sidewalk, but kept a finger on the nut; the squirrel crept toward the nut, but stopped a meter shy. Finally she stepped back and the squirrel inched forward. It hesitated, reversed course, then continued, paused again, and eventually crawled just within reach of the nut. With all four feet on the pavement, it craned its neck forward, grabbed the nut in its teeth, and scampered off.

Figure 2.8 Squirrel watching until the hand by the peanut is withdrawn.

Squirrels in Rittenhouse Square are part of a community of people, dogs, rats, hawks, pigeons, and sparrows. The community endures even though relationships among some members are antagonistic. Historically, the relationship of the gray squirrel to people has been ambiguous, a mixture of hostility and affection, but always, at least for the gray squirrel, fraught with danger.

Gray squirrels in Rittenhouse Square have recently declined in number. During the day when I strolled through the square I used to see them consistently; now I see them only rarely.