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NPS/KERRY GUNTHER

Presence and Distribution of White-tailed Jackrabbits in Yellowstone National Park

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WHITE-TAILED JACKRABBITS (*Lepus townsendii*), the only hares which frequent Yellowstone National Park's grassland and sagebrush habitats, have persisted with very little fanfare in a limited range of the park since its creation in 1872. A January 2008 article published in the scientific journal *Oryx* and based on a study by Joel Berger, concluded that the park's jackrabbit population was extirpated (Berger 2008a), provoking debate and nationwide news coverage. Berger, a scientist at the Wildlife Conservation Society and professor at the University of Montana, inferred from historical publications that jackrabbits were once abundant across the northern portion of the park and claimed they were "virtually non-existent" by 1990–91, and that none had been seen there since (Berger 2008a). He also recommended the National Park Service (NPS) consider reintroducing white-tailed jackrabbits to restore ecological integrity.

After an Associated Press release about Berger's study (Brown 2008a), park staff received many phone calls and e-mails concerning jackrabbits. Some past visitors submitted anecdotal observations and others requested that the NPS immediately begin a jackrabbit reintroduction program. Berger later retracted his claim that jackrabbits were extirpated from the park (Berger 2008b), though he continued to imply that they were "markedly reduced in range" in Yellowstone National Park and jackrabbit abundance in both Yellowstone and Grand Teton national parks was caught in a "downward spiral" (Berger 2008c, Brown 2008b).

As a result of Berger's article and public interest, white-tailed jackrabbits became something of a mini-controversy and were given more thought and consideration in Yellowstone than ever before. Observations by the authors of this article and other anecdotal records did not support Berger's claims. Instead, they suggested that the jackrabbit abundance and distribution had not changed significantly in Yellowstone for at least the last 20 to 50 years and prompted a re-examination of the historical record.

Methods

Due to the interest and debate generated by Berger's research, we looked at historical information that might lend insight into the past abundance and distribution of jackrabbits in Yellowstone as well as contemporary park records and databases. We also queried biologists and naturalists who worked in the park on a long-term basis for information on current presence, abundance, and distribution. The methods we used in this study were a cost-effective means of obtaining basic, preliminary information on jackrabbits in a timely manner. We

do not consider this study to be a substitute for a systematic survey of jackrabbit abundance and distribution in the park.

We reviewed materials located by the park's library and archive technicians, including books, journals, and naturalist reports, for information concerning the abundance and distribution of jackrabbits in the park. We also searched the park's road-killed wildlife and rare animal databases for records of jackrabbits. We reasoned the chances of observing wildlife would be greatest along roads and in developed areas because of the number of people and amount of time people spend in those areas. Both of these databases are therefore biased toward animals seen near park roads. Naturalist-tracker James Halfpenny also conducted three ground surveys to detect jackrabbit tracks and other sign in northern Yellowstone in 2008.

Our field experience in the park spans five decades. Therefore, we were able to use our personal observations of jackrabbits from living and working in Yellowstone to assess the species' presence or absence and current distribution. We also queried 12 other professional biologists each with 3 to 50 years of experience in the northern portion of the park, the only area where jackrabbits were reported to occur during historical (1872–1949) and contemporary (1950–2008) periods.

The apparently limited distribution of jackrabbits in Yellowstone suggests that much of the park is not suitable habitat. We plotted locations of jackrabbit observations, road-killed carcasses, and their sign (i.e., tracks and fecal pellets) and compared them to maps of vegetation habitat types, elevation, and average annual precipitation zones to evaluate if any of those factors influence jackrabbit distribution.

Results and Discussion

Historical Record

Evidence from Lamar Cave. Barnosky (1994) found bones of at least one white-tailed jackrabbit in one of the upper levels of her excavation in Lamar Cave on the northern range. Radiocarbon aging of a piece of wood excavated at the same level indicated that the bones were from 0 to 419 years before 1994.

Ludlow's Expedition. In 1875, Captain William Ludlow made a reconnaissance trip from Carroll, Montana (Territory), to the park and back, accompanied by naturalist George Bird Grinnell. Ludlow's report (Ludlow 1876), which contained Grinnell's descriptions of the wildlife they observed, never mentions seeing jackrabbits while in the park, nor were jackrabbits on the list of species they observed in the park. Berger (2008a) inferred from Captain Ludlow's 1876 trip report that jackrabbits were once abundant in the park. In the report's discussion of prairie hares (another name for the white-tailed jackrabbit), they stated:

> *This species is very abundant in some localities, while in others, quite as favorable for it, it is not found at all. In fact, the abundance or scarcity of the Prairie Hare in any district depends almost altogether on the number of wolves to be found in the same tract of country. Where all the coyotes and gray wolves have been killed or driven off, the hares exist in great numbers; but where the former are abundant, the latter are seldom seen. We saw none near the Missouri River, where the buffalos [sic] and consequently the wolves, were numerous; but at Camp Baker, where there are scarcely any wolves, the hares were very common.*

Camp Baker is approximately 200 km (125 mi) north of Mammoth Hot Springs and 460 m (1,500 ft) lower in elevation, so the habitat and winter snow accumulation were likely very different there. The report gives us no insight into the presence or absence, abundance, or distribution of jackrabbits in the park in the 1870s.

Milton Skinner's *The Yellowstone Nature Book*. Milton Skinner's *The Yellowstone Nature Book* (1926) is the earliest reference that we were able to locate which documents both the presence and distribution of jackrabbits in the park. A more exhaustive search of the archives may reveal others. Skinner reported that "These big gray jack rabbits with their large white tails are common between Gardiner and Mammoth Hot Springs, and may also be seen almost anywhere in the open northern sections of the Park."

The first half of Skinner's description refers to the same area where jackrabbits are regularly observed today—near Reese Creek, Stephens Creek, Rifle Range Flats, Rattlesnake

NPS/JANINE WALLER

White-tailed jackrabbit on Rifle Range Flats, April 2008.

Mad as a March Hare

The Facts about White-tailed Jackrabbits

Body length: 565–655 mm (22–25 in)
Tail: 66–112 mm (3–4 in)
Rear feet: 145–172 mm (6–7 in)
Ears: 93–113 mm (4 in)
(After Hall and Kelson 1959)

WHITE-TAILED JACKRABBITS (*Lepus townsendii*) are a familiar, if not entirely predictable, sight to anyone driving from Mammoth Hot Springs to Stephens Creek in the morning and evening. Scientific study of white-tailed jackrabbits is limited, and in many parts of the country, jackrabbits are considered agricultural pests.

White-tailed jackrabbits are found in prairie-grassland and grass-shrub steppe habitat types in western high plains and mountains. They are sometimes associated with croplands and pasture when uncultivated land is present along fence lines (Dubke 1973). However, white-tailed jackrabbits generally prefer grass-dominated habitats. They have also been found to flourish above treeline in the alpine zone and avoid forested areas (Bailey 1936).


NPS/STACEY GUNTHER

Description

Jackrabbits are members of Lagomorpha, a well-distributed order containing 81 species of rabbits, hares, and pikas. Hares and rabbits are grouped together in the Leporidae family. Despite their name, jackrabbits are actually hares in the genus *Lepus*. Jackrabbits are easily distinguished from true rabbits by their large ears, large feet, and generally large body size. Hares use their ears to listen for danger and to radiate body heat. The flow of blood through the thin tissue of the ears allows them to dissipate excess body heat and tolerate body temperatures up to 41°C (106°F) (Forsyth 1999).

The summer coat of the white-tailed jackrabbit is grayish brown, with a lighter underside. The ears are rimmed with black. In southern areas of its range, the winter coat is very similar to the summer coat, though often paler. Further north, where there is persistent and widespread snow cover, as in Yellowstone National Park, the winter coat undergoes a striking color change to nearly white. The white-tailed jackrabbit is the only species of jackrabbit in North America to consistently exhibit two annual coat molts.

Behavior

Hares differ from other lagomorphs in that they rest and breed in shallow depressions or scrapes, known as forms, which are often located under shrubs or bushes. White-tailed jackrabbits are rarely seen in groups; in fact, they may be the least social of the hares (Lim 1987).

White-tailed jackrabbits exhibit nocturnal activity patterns, presumably to avoid detection by predators. Generally, white-tails forage in the open at night, but are less active during the day and retreat to denser cover (Fautin 1946, Lechleitner 1958). A full moon can delay their nocturnal foraging by several hours (Flinders and Chapman 2003). Once under cover of darkness they feed on grasses, forbs, and shrubs, selecting the newest and most succulent plant material (Flinders and Hansen 1972).

In the presence of a perceived threat, jackrabbits use their hearing to avoid a confrontation if possible. If surprised at close range, they rely on cryptic coloration and behavior, such as remaining motionless. If necessary, jackrabbits attempt escape by running at speeds from 56 to 80 kph (35 to 50 mph) and cover 2–3 m (6–10 ft) with each bound. White-tailed jackrabbits will also swim to escape pursuit, paddling with their front legs (Orr 1940, Lechleitner 1958).

Breeding

Some hares exhibit energetic and unusual mating behavior in the spring. These potentially confusing displays have given us the expression "Mad as a March Hare" and the eccentric March Hare character in *Alice in Wonderland*. Jackrabbit mating begins with a vigorous pursuit of the female by the male. As the chase progresses, one jackrabbit will begin leaping while the other runs underneath.

Rabbits and hares are well-known for their prolific breeding abilities. White-tailed jackrabbits can breed in the spring following their birth and often have several litters annually thereafter. Jackrabbit reproduction is similar to that of other lagomorphs in that ovulation is induced, meaning that it requires an act of copulation. More than the black-tailed jackrabbit, white-tails show variation in their reproductive rate, ranging from a single litter per year to four litters annually. Litter size is similarly flexible, varying from 1 to 15. Gestation is 36–43 days, averaging 42 days (Kline 1963).

The young of jackrabbits, leverets, are much more precocious than other lagomorphs (young rabbits are referred to as kittens). Hare leverets, for example, are born fully furred and with their eyes open, while rabbit kittens are born hairless and blind. Jackrabbits can leave the form within 24 hours of birth, begin foraging at two weeks, and are usually weaned after a month, when rabbit kittens are still in a fur-lined nest underground.

In most areas, the breeding season of white-tailed jackrabbits averages 148 days and can extend from late February to mid-July. The timing of white-tail breeding in the northern Yellowstone ecosystem is not well documented.

Butte, Rescue Creek Trailhead, Gardner River High Bridge, and the Mammoth Terraces.

The second half of Skinner's description is more difficult to precisely interpret. Was he referring to areas where jackrabbits are regularly observed today as the "open northern sections of the Park"? Or was he referring to other northern sagebrush-grassland areas, such as Lamar Valley, Little America Flats, Junction Butte, Pleasant Valley, and Gardners Hole? We may never know. We were unable to locate any records of jackrabbits in Gardners Hole, only located documentation of one sighting in Lamar Valley, one set of jackrabbit bones from the Lamar Cave, and one vague reference to jackrabbits on the slopes of Mount Washburn. Therefore, it seems unlikely that Skinner was referring to those areas. The current range of jackrabbits in the park fits within the range described by Skinner in 1926, and we could find no evidence of range retraction or expansion since that time.

Park Ranger Newell Joyner's Article. In a short article entitled "The Prairie Hare" published in "Yellowstone Nature Notes," Joyner (1929) states: "In Yellowstone Park, particularly around the lower altitudes as at Mammoth, the hare attracts us not from an economic standpoint, but as an object of extreme interest."

Murie's Coyote Study. In some areas of the West, jackrabbits are an important prey species of coyotes. Adolph Murie conducted extensive research on coyotes in Yellowstone from 1937 through 1939. Murie (1940) stated that the jackrabbit "occurs only on the north side of the park and is not abundant, although tracks can always be found on its range" and that "the jackrabbit is often an important coyote food item in localities where it is abundant, but in Yellowstone it is of minor importance." Jackrabbit remains were found in 37 of 5,086 (<1%) coyote droppings he collected. If we subtract the approximately 3,500 coyote scats that were collected in interior areas of the park where jackrabbits were not present, jackrabbits still composed less than 1% (37 of 1,586) of the prey remains in coyote scats collected from jackrabbit range (Murie 1940). These results were similar to those of Olaus J. Murie's coyote study (1935), in which he identified only 10 occurrences (<1%) of jackrabbits from 2,145 individual food items collected from 64 stomachs and 714 feces of coyotes around Jackson Hole, Wyoming. As in the Yellowstone coyote study, not all of the Jackson Hole samples were collected within jackrabbit range. However, the finding of only 10 occurrences of jackrabbit remains suggests that they were either not a primary prey species of coyotes or were not abundant or widely distributed in that area. Since jackrabbits have a very limited distribution in Yellowstone and composed less than 1% of the diet of park coyotes in Murie's study, coyote predation on other species is unlikely to change significantly even if jackrabbits were extirpated.

Harold Brodrick's *Wild Animals of Yellowstone National Park.* Brodrick (1954) stated that jackrabbits were found in "open sections in the northern parts of the park. Has been seen on the highest slopes of Mount Washburn. Most frequently seen in the early morning and evening. Not numerous."

Contemporary Record

Streubel's Small Mammals of the Yellowstone Ecosystem. Donald Streubel (1989) reported that jackrabbits were found in northern Yellowstone, usually in open shrub-grass communities or in large openings in montane forests. Streubel never saw any jackrabbits in Lamar Valley, but suspected that it was likely good jackrabbit habitat due to the abundance of sagebrush-grassland habitat that dominates the valley (D. Streubel, pers. comm.).

Johnson and Crabtree's Small Mammal Survey. Kurt Johnson and Bob Crabtree (1999) reported that "White-tailed jackrabbits are uncommon on the Northern Range. Extensive surveys conducted in the Lamar Valley and Blacktail Plateau during 1990 and 1991 resulted in only one sighting. Whitetails are somewhat more common in the lower sagebrush habitats around the Gardiner and Mammoth areas."

Halfpenny and Marlow's Track Surveys. Halfpenny (2008) and Halfpenny and Marlow (2008) conducted three track surveys for jackrabbit along 6.8 km (4.25 mi) of the Old Yellowstone Trail road from the Heritage and Research Center in Gardiner to the park boundary at Reese Creek. Tracks were identified as those of jackrabbits by length of foot, length of stride, rotary gallop pattern, and absence of pads on the bottom of the foot. Only tracks that were within 2 m (6.5 ft) of the road or crossed the road were counted. On March 2, 53 separate sets of jackrabbit tracks were observed in snow that was 10–12 hours old. The tracks were relatively evenly spaced along the entire length of the survey route, with an average density of 12.5 sets of tracks per mile of road. In the March 14 survey, conducted nine hours after snowfall had ceased, 11 sets

JAMES HALFPENNY

Jackrabbit tracks are regularly found at low arid elevations.

of jackrabbit tracks were counted with an average density of 2.6 sets per mile of road. In the March 15 survey, conducted 30 hours after snowfall had ceased, 47 sets of jackrabbit tracks were counted with an average density of 11.1 sets per mile of road. All jackrabbit tracks were field mapped and georeferenced using a CyberTracker Global Positioning System.

Yellowstone Road-killed Wildlife Database. This database contains records of large mammals (>14 kg [30 lb]) killed by vehicles on park roads from 1989 through mid-September 2008. We found 13 incidental records of jackrabbits that were struck and killed by vehicles in the park. Small mammals (<14 kg [30 lb]) are generally not reported because they are frequently hit, generally do not damage the vehicles that hit them, and do not require removal from the road for safety purposes. Consequently, these records indicate a minimum number of vehicle-strike mortalities. However, these carcasses provide proof that jackrabbits have been present in the park since 1992. The observed distribution of road-killed jackrabbits is consistent with the distribution observed through our personal sightings of live jackrabbits, the sightings by the biologists we queried, and the sighting and sign records in the rare animal database. All of the road-killed jackrabbits were on the Old Yellowstone Trail road, the Gardiner to Mammoth road, the segment of road between the Mammoth Chapel and the Gardner River High Bridge, or the road across from the Mammoth Terraces.

Yellowstone Rare Animal Database. The rare animal database contains anecdotal sightings of wildlife recorded from 1887 through mid-September 2008. It is neither a systematic survey nor a complete record of wildlife presence, absence, or distribution. However, reports of jackrabbits in the database could lend insight into the species' historical and contemporary distribution. We assumed sightings reported as jackrabbits were correct because it is the sole hare species that occurs regularly in the park's grassland and sagebrush habitats (Berger 2008a).

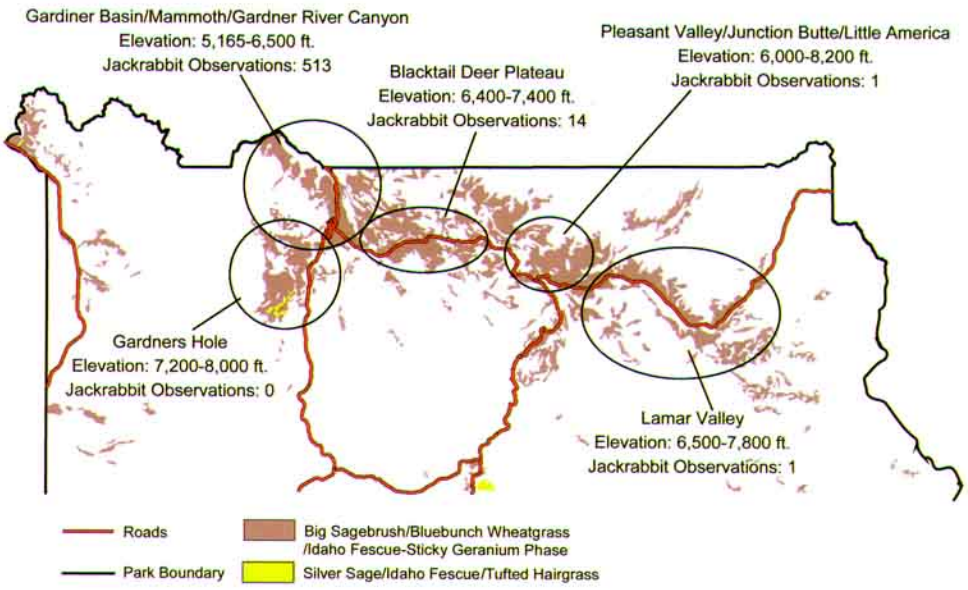

Figure 1. Concurrence of vegetation, elevation, and jackrabbit distribution in Yellowstone.

Of the 559 records of jackrabbits and their sign in the database, 26 are from outside the park in the Gardiner Basin and Paradise Valley. Jackrabbit records from the park include observations of live animals (n=218), sign (tracks, n=128; fecal pellets, n=173), and carcasses (n=14). Because of the recent interest in jackrabbits, the sighting records from the park are biased toward observations made in 2008. Prior to 2008, people generally did not report jackrabbit sightings because they were considered common within the range they occupied in the park. The database contains 3 records from the 1940s, 1 from the 1980s, 15 from the 1990s, 13 from 2000 through 2007, and 501 from January to September 10, 2008.

The distribution of jackrabbits in the park appears to be influenced by the presence of preferred sagebrush and

Table 1. Observations of white-tailed jackrabbits in different habitat types.

Habitat Type	Number of Acres in YNP	Percent of Total Acres	Observations	Percent of Total Observations
Big Sagebrush/Idaho Fescue	31,037	1.4%	345	65%
Bluebunch Wheatgrass/Sandberg's Bluegrass-Needle-and-Thread Phase	2,087	<1%	85	16%
Mud Flow Mosaic[a]	1,153	<1%	60	11%
Big Sagebrush/Blue Bunch Wheatgrass	1,635	<1%	36	2%
Idaho Fescue/Bearded Wheatgrass-Sticky Geranium Phase	79,072	3.6%	4	0.8%
All Other Non-forested Habitat Types (n=17)	324,237	14.7%	0	0%
Total Non-forested Habitat Types (n=22)	439,221	20%	530	99%
Forested Types				
Douglas fir/Snowberry	55,084	2.5%	3	<1%
All Other Forested Habitat Types (n=42)	1,701,801	77.5%	0	0%
Total Forested Habitat Types (n=43)	1,756,885	80%	3	<1%

[a]Grassland mosaic covering large mudflows near the north entrance.

Sagebrush-grassland Area	Elevation (ft/m)	Number of Jackrabbit Sightings
Pelican Valley	7,800–8,100 / 2,377–2,469	0
Hayden Valley	7,700–8,100 / 2,347–2,469	0
Gardners Hole	7,200–8,000 / 2,194–2,438	0
Lamar Valley	6,500–7,800 / 1,981–2,377	1[a]
Pleasant Valley/Junction Butte/Little America Flats	6,000–8,200 / 1,829–2,499	0/1[b]
Blacktail Deer Plateau	6,400–7,400 / 1,950–2,256	14
Upper Mammoth Terraces	6,400–6,600 / 1,950–2,011	5
Gardiner Basin/Mammoth/Gardner River Canyon	5,200–6,500 / 1,585–1,981	513

[a]Jackrabbit observation was at 2,000 meters (6,560 ft)

[b]Bones of one white-tailed jackrabbit were found in Lamar Cave (Barnosky 1994)

Table 2. Jackrabbit observations in areas of sagebrush-grassland habitat, shown by elevation.

grassland habitat types (Table 1) and elevation (Table 2, Fig. 1). Based on the records in this database, jackrabbits do not use all habitat types in the park in proportion to availability. While approximately 80% of the park is covered by forested habitat types (Despain 1990), less than 1% (n=3) of the jackrabbit observations occurred there (Table 1). The other 99% (n=530) of the jackrabbit observations occurred in non-forested habitat, of which 65% (n=345) were recorded in big sagebrush (*Artemisia tridentata*)-Idaho fescue (*Festuca idahoensis*) habitat types.

The database contains no records of observations of jackrabbits, their carcasses, or their sign from the higher elevation sagebrush-grassland habitats (Table 2) of Pelican Valley, Hayden Valley, Gardners Hole, or the Pleasant Valley-Junction Butte-Little America Flats area, and only one record from Lamar Valley. The database contains just 14 records from the sagebrush-grassland habitat on the Blacktail Deer Plateau and 5 records from the Upper Mammoth Hot Spring Terraces. Most of the observations (96%, n=513) were in sagebrush-grassland habitat at elevations below 2,000 m (6,500 ft) in the Gardiner Basin, Mammoth Hot Springs, Gardner River Canyon areas.

It is unlikely elevation alone is the factor limiting jackrabbit range in the park. Jackrabbits are found as high as 4,200 m (14,000 ft) in Colorado (Lim 1987). Instead, elevation is likely a surrogate for precipitation in Yellowstone. Snow, the most common form of precipitation in the park, generally begins to accumulate earlier, attains greater depths, and lasts later into spring with increasing elevation (Despain 1990). Most of the jackrabbit observations in the park (96%, n=512) were in very arid areas where average precipitation ranges from just 25 to 40 cm (10–16 in) annually (Table 3). The remaining observations were from areas that receive between 40 and 46 cm (16–18 in) (3%, n=16) and between 46 and 76 cm (18–30 in) (1%, n=5). No observations of jackrabbits, their carcasses, or their sign were reported in areas that receive more than 30 inches (75 cm) of precipitation annually.

Records in the rare animal database—all from the 1940s—contain information of additional interest. In a 1941 record, "Four whitetail jackrabbits, or prairie hares were seen between Gardiner and the Stermitz ranch during the general antelope count on March 24. This is a greater number than is usually seen on a half day's ride over the lower game range." This sighting suggests that jackrabbits were present but not abundant in the Gardiner Basin in the 1940s. In another 1941 record, "A large prairie hare or white-tailed jackrabbit was found dead on the road near the new Gardner River bridge on February 27, cause of death–accident struck by car, pelage–white winter coat beginning to shed." In a 1947 record, "Four jackrabbits have also been winter residents of the Lamar Station area and have become very tame. One can almost pick them up before they move. They feed around the hay stack and from the hay fed to the horses in the corrals." This is the only reported sighting we found for Lamar Valley, although a more thorough search of the archives may reveal others.

Table 3. Observations of white-tailed jackrabbits in zones of differing annual precipitation.

Average Annual Precipitation (inches/cm)	Number of Acres in YNP	Percent of Total Acres in YNP	Observations of Jackrabbits	Percent of Total Observations
10–12 / 25.4–30.5	895	<1%	79	15%
12–14 / 30.5–35.6	5,228	<1%	91	17%
14–16 / 35.6–40.6	16,512	1%	342	64%
16–18 / 40.6–45.7	43,834	2%	16	3%
18–20 / 45.7–50.8	48,507	2%	1	<1%
20–30 / 50.8–76.2	512,298	23%	4	1%
30–40 / 76.2–101.6	628,006	29%	0	0%
40–50 / 101.6–127	483,517	22%	0	0%
50–60 / 127–152.4	266,867	12%	0	0%
60–70 / 152.4–177.8	149,075	7%	0	0%
70–80 / 177.8–203.2	40,709	2%	0	0%
Total	2,195,448	100%	533	100%

The Foothills of A High Mountain Ecosystem: Home of the White-tailed Jackrabbit

C. HART MERRIAM WAS ONE of the first biologists to explore Yellowstone National Park. He described the plant and associated animal communities which occur at different elevation as "life zones." This concept describes the relationship of vegetation and wildlife communities to topography, climate, and elevation. The life zone concept is not as widely used today as in the past, (Smith 1974) but we are better able to interpret the limited information about the presence and distribution of the white-tailed jackrabbit within and around the park by applying the life zone idea to Yellowstone.

Yellowstone is part of a high mountain ecosystem within the central Rocky Mountains. The climate in mountain ecosystems varies dramatically with changes in elevation. Temperatures are warmer at lower elevations and cooler at higher elevations. The warmer temperatures at lower elevations increase evaporation, dry soils, and extend the growing season (Kershaw et al. 1998). Following Merriam's model, former Yellowstone biologist Terry McEneaney (1988) described four life zones that are represented in the park: *foothills, montane, subalpine* and *alpine*. In Yellowstone, white-tailed jackrabbits inhabit primarily the arid, low-elevation foothills zone and, to a lesser extent, the non-forested areas at the very lower elevations of the adjacent montane zone (Table 1).

The ***foothills zone*** occurs from the lowest elevations in the park (1,570 m; 5,165 ft) up to approximately 1,800 m (6,000 ft). It forms the transition between prairies and mountains. Vegetation is predominately open grasslands and sagebrush. Tree species include narrowleaf cottonwood and scattered Rocky Mountain juniper. Dry ridges in this zone may contain limber pine and wetter areas may support aspen. The upper reaches of the foothills zone in Yellowstone receives only 40–45 cm (16–18 in) of precipitation annually. The lower elevations of this zone which occur from the park boundary at Reese Creek east to Gardiner, Montana, and Rifle Range Flats, receive less than 38 cm (15 in) of precipitation annually, and contain "cold desert" vegetation. Big sagebrush, rabbitbrush, prickly-pear cactus, needle-and-thread, and junegrass are common.

The ***montane zone*** occurs immediately above the foothills at elevations from 1,800 to 2,300 m (6,000 to 7,600 ft). It contains a combination of open and forested habitats. Open valley bottoms dominated by sagebrush and grasslands are prevalent in the lower elevations of the montane zone. Forested areas occur at the upper elevations of this zone. Douglas fir is considered the defining tree species of these areas. Other trees in this zone include aspen, narrowleaf cottonwood, limber pine, lodgepole pine, Rocky Mountain juniper, subalpine fir, and Englemann spruce. Shrub species in this zone include big sagebrush and willow.

The ***subalpine zone*** extends from the upper edge of the montane forest at approximately 2,300 m (7,600 ft) up to the treeless alpine zone at approximately 3,000 m (10,000 ft). The subalpine zone is predominately forested, interspersed with non-forested areas.

The ***alpine zone*** is the treeless zone that occurs from timberline at approximately 3,000 m (10,000 ft) up to the top of the rocky slopes of Eagle Peak, the park's highest point at 3,462 m (11,358 ft). This zone is dominated by alpine tundra.

Latitude, geology, slope direction, and slope angle also influence the boundaries between life zones (Fisher et al. 2000). For example, north-facing slopes in Yellowstone are generally cooler and wetter than south-facing slopes. Due to these differences, the boundary between life zones can be as much as 200 m (700 ft) higher on south-facing slopes than on north-facing slopes (McEneaney 1988). Of 533 records of white-tailed jackrabbits in the Yellowstone rare animal database, 72% (n=384) occurred in the foothills zone, and 28% (n=149) occurred in the lower elevations of the montane zone. Most of the jackrabbit observations in the montane zone (87%, n=129), occurred below 1,900 m (6,500 ft). We were unable to locate any sightings of white-tailed jackrabbits in the alpine zone, and found only one reference to jackrabbits being observed in the subalpine zone (Brodrick 1954) in Yellowstone National Park.

Table 1. Rare animal database records of white-tailed jackrabbits in different life zones.

Life Zone	Elevation (ft/m)	Records of White-tailed Jackrabbits
Foothills	5,165–6,000 / 1,574–1,800	384
Montane	6,000–7,600 / 1,800–2,300	149
Subalpine	7,600–10,000 / 2,300–3,000	0
Alpine	10,000–11,358 / 3,000–3,462	0

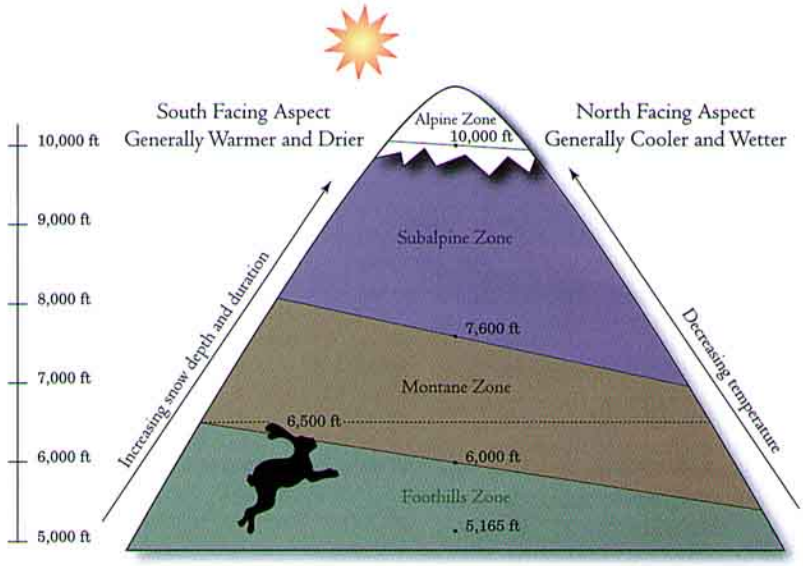

Figure 2. Jackrabbit distribution in the life zones of Yellowstone.

Observations by Park Biologists and Researchers. Our personal observations, as well as those of 12 biologists that we queried, indicate that jackrabbits are present but not abundant in northern Yellowstone. From the late 1950s through mid-September 2008, we regularly observed jackrabbits in the park's arid sagebrush-grassland communities below 1,980 m (6,500 ft), including the area from Beattie Gulch west of the park boundary at Reese Creek, east to Gardiner, Montana, south to the Mammoth Terraces, and southeast to the Gardner River High Bridge.

They are occasionally observed on Blacktail Deer Plateau (M. Haroldson, Interagency Grizzly Bear Study Team, pers. comm.; B. Crabtree, pers. comm.; J. Halfpenny, unpublished data), which we believe is at or near the upper elevational limits of the species' suitable habitat in the park. The Blacktail Deer Plateau receives 40–50 cm (16–20 in) of precipitation annually, which is 10–20 cm (4–8 in) more than the Gardiner Basin and 5–10 cm (2–4 in) more than the Mammoth Hot Springs-Gardner River Canyon area, the two places in the park where jackrabbits are regularly observed. Wind-aided snow removal may allow jackrabbits to inhabit the Blacktail Deer Plateau in winter (B. Crabtree, pers. comm.).

We found no records of observations of jackrabbits, their carcasses, or their sign in the large sagebrush-grassland habitats of Pelican Valley, Hayden Valley, or Gardners Hole, and only one anecdotal observation each from Lamar Valley and the slopes of Mount Washburn. However, these are high elevation sagebrush-grassland habitats with snow cover 30 cm or more deep that persists for three months or more (B. Crabtree, pers. comm., 2008), which may prevent jackrabbit access to shrub forage and shrub cover in winter. The winter diet of jackrabbits consists primarily of shrubs such as sagebrush and rabbitbrush (Bear and Hansen 1966, Lowery 2006), and suitable jackrabbit habitat generally consists of sagebrush-grasslands in arid areas with low winter precipitation (B. Crabtree, pers. comm.).

In addition, jackrabbits were observed beyond the park boundary in the Gardiner Basin and in Paradise Valley north of Yankee Jim Canyon to Livingston, Montana. Paradise Valley contains sagebrush-grassland habitat, is lower in elevation than the park, and has low winter precipitation and snow accumulation as well as wind-aided snow removal, making it suitable winter jackrabbit habitat. Since northern Yellowstone appears to be the terminus of jackrabbit range in this area, the connectivity provided by the Paradise Valley corridor likely facilitates immigration, emigration, and gene flow with populations outside the park.

Although we have not personally observed jackrabbits in the large sagebrush-grassland habitats of Pelican Valley, Hayden Valley, Gardners Hole, Lamar Valley, or the Pleasant Valley-Junction Butte-Little America Flats area, nor had any of the biologists we queried, we cannot conclusively determine whether or not jackrabbits inhabit those areas because they have not been systematically surveyed.

Conclusion

Historical references to the abundance and distribution of jackrabbits in Yellowstone are very limited. The few references we located all suggest that jackrabbits were never abundant and had a very limited distribution in the park. Because we did not conduct systematic surveys over the entire known range of jackrabbits in Yellowstone, we cannot determine their population numbers, trends, or precise distribution. However, a qualitative assessment of the data we collected suggests that the distribution and abundance of jackrabbits in the park has not changed significantly since the late 1950s. In addition, a review of the historical record does not indicate any significant change in distribution or abundance since the 1920s and 1930s. We found no evidence that jackrabbits were significantly more abundant or more widely distributed when the park was created in 1872 than they are today.

In 2008, jackrabbits are still regularly observed from the park boundary at Reese Creek east to Gardiner, Montana, and south to the Mammoth Terraces. Within eight months of their argued extirpation, we were able to collect more than 500 observations of jackrabbits, their sign, and their road-killed carcasses.

We believe that the arid, sagebrush-grassland habitat types in the park that occur at elevations below 1,980 m (6,500 ft) and receive less than 40 cm (16 in) of annual precipitation provide a good representation of the current distribution of

white-tailed jackrabbits in the park (Fig. 2). If this distribution accurately represents suitable jackrabbit habitat in the park, then very little (<1% or approximately 18,676 acres) of the park is likely suitable for jackrabbits. The winter snow accumulation and snow persistence above 1,980 meters likely inhibits occupancy at higher elevations of the park. The lowest elevation areas of the park may represent the upper limits of jackrabbit range in this region.

We concur with several points Berger made in the *Oryx* paper. These include: (1) an appreciation of historical conditions is crucial to understanding functional relationships, (2) lacking information about historical conditions makes it difficult to determine whether current systems function ecologically like past ones, and (3) a bottom-up approach to reintroduction of extirpated species may result in the establishment of dynamic ecological processes that were intact prior to extirpation (Berger 2008a). Although jackrabbits are not as popular or studied as other fauna, they continue to persist—apparently as they have for some time—relatively unnoticed, within a very small suitable range in the arid, lower elevation sagebrush-grassland habitats of Yellowstone.

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