# 2023–2024 Alpine Mesocarnivore Study Progress Report
# California Department of Fish and Wildlife
# Inland Deserts Region 6
# Bishop Field Office

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**A Sierra Nevada red fox detected by remote camera in the Woods Creek study area, Sierra Nevada, California in April 2023.**

# I. Executive Summary

Since 2016, the Bishop Field Office of the California Department of Fish and Wildlife (CDFW) has conducted annual surveys for mesocarnivores in upper elevations of the Sierra Nevada south and east of Yosemite National Park. The impetus for these surveys is to improve our understanding of mesocarnivore distribution and occupancy in alpine environments where these animals have rarely been studied, and in a region of California where the population status of many species is unknown. As managers discuss recovery of endangered species like Sierra Nevada red foxes (*Vulpes vulpes necator*; SNRF) and wolverines (*Gulo gulo*), information about the contemporary distribution of these species, as well as the distribution of other sympatric carnivore species, is critical to informing conservation planning.

Each winter, we systematically deploy remote cameras at elevations above 3,000 m within a focal region such as a drainage basin, divide, or subrange. Surveys are designed to detect multiple mesocarnivore species; of particular interest are detections of rare, threatened, or endangered species like SNRF and wolverines. When cameras detect species of interest, we follow up with ground surveys to collect scats for genetic identification. We also maintain monitoring cameras in areas with prior detections of target species and deploy cameras opportunistically in locations where habitat is suitable and year-round access is logistically feasible. Over a study period of approximately 10 years (2016–2025), we will estimate the distribution and occupancy of numerous mesocarnivore species throughout the study area.

During the 2023 survey season we surveyed the Woods Creek study area, a region of Kings Canyon National Park and the Inyo National Forest between Taboose Pass and Kearsarge Pass. We detected SNRF on nine occasions at three sites during April–September 2023. During the 2024 survey season we surveyed the Kings-Kern Divide study area, a region of Sequoia and Kings Canyon National Parks (SEKI) and the Inyo National Forest between Kearsarge Pass and Lone Pine Creek. We detected SNRF on 20 occasions at nine sites during September–May 2024. These detections extended the known southern limit of the SNRF's range by approximately 35 linear km, and included the first confirmed detections in Sequoia National Park since the 1930s. There were no other unusual carnivore detections during either survey.

In addition to systematic camera surveys, we maintained opportunistic cameras during 2023–2024 and continued to detect SNRF relatively frequently in the Mono Creek, Mammoth Lakes, and Bishop Creek study areas, where we first detected SNRF in 2018, 2019, and 2020, respectively. As part of a separate project, we also maintained opportunistic cameras in a new study area, the Mono Basin east of Yosemite National Park (hereafter, the eastern Yosemite study area), where we first detected red foxes in 2023. We conducted systematic scat surveys

in these study areas and also collected scats opportunistically throughout the Sierra Nevada, including in the Woods Creek and Kings-Kern Divide study areas. We detected four individual red foxes by scat in the eastern Yosemite study area, two individuals in the Mammoth Lakes study area, one individual in the Mono Creek study area, and two individuals in the Bishop Creek study area. One of the foxes whose scat was sampled in the Bishop Creek study area was also detected by scat in the Woods Creek study area. We did not detect any red foxes by scat in the Kings-Kern Divide study area.

In May 2023, members of the public reported numerous sightings of an adult wolverine along an extensive stretch of the Sierra Crest. We were able to verify seven of the reports using photos, videos, and eDNA collected from the snow around the animal's tracks. These observations, presumed to be of a single individual, marked only the second time a wolverine has been detected in California in the last 100 years, and the first detections since 2018. Although we set six baited cameras in the vicinity of the sightings, and several of the observations were in relatively close proximity to our opportunistic monitoring cameras, our program did not capture any additional photos of the wolverine, and we have not received any sighting reports since May 2023.

Our camera survey methods continued to be effective at detecting mesocarnivore species such as SNRF and Pacific martens (*Martes caurina*) that occur at relatively low densities in alpine and subalpine zones of the Sierra Nevada. However, our sparse and predominantly unbaited camera array was not sufficient to detect a single wolverine traveling through our study areas. Our results confirmed the presence of SNRF in multiple locations of their historical range south of where the subspecies was thought to persist prior to this study, including in SEKI. In upcoming seasons, we plan to continue to monitor locations where we have detected SNRF and expand our camera surveys to adjacent areas of the Sierra Nevada identified as suitable habitat for SNRF.

This report details our activities during January 2023–December 2024.

# II. Introduction

The distribution, abundance, and even presence of many carnivore species in the alpine zones of the Sierra Nevada are poorly understood. Prior to our study, the most recent extensive survey effort targeting multiple carnivore species took place during 1996–2002 (Zielinski et al. 2005). This survey was intended to update carnivore distribution information as compared to the historical records compiled by Schempf and White (1977) and Grinnell et al. (1937). Zielinski et al. (2005) detected 13 carnivore taxa and did not detect SNRF or wolverines. Their study area

consisted primarily of forested habitats below 3,200 m in the southern Sierra Nevada and below 2,700 m in the central Sierra Nevada. Another systematic survey effort specifically targeting wolverines took place in SEKI in winter 2006 (Hudgens and Garcelon 2013). Hudgens and Garcelon (2013) detected four carnivore species and did not detect SNRF or wolverines. This survey included some higher elevation sites (2,744–3506 m), but survey sites were selected in part based on proximity to treeline and on the presence of trees for affixing cameras and bait stations. In contrast to these surveys, our study is focused on detecting carnivore presence in the highest-elevation, most barren regions of the range. Documenting the assemblage of species that use these alpine habitats can help land and wildlife managers understand predator-prey dynamics, conserve sensitive species, and anticipate the impacts of climate change, wildfires, and human land use.

As part of our long-term study of mesocarnivores in the alpine Sierra Nevada south and east of Yosemite National Park, each year we choose a focal area to survey intensively. In 2023 and 2024, we selected the Woods Creek and Kings-Kern Divide study areas, respectively. These are regions of alpine habitat that straddle the Sierra Crest in SEKI and the Inyo National Forest (Figure 1). Our primary study objective during 2023–2024 was to document mesocarnivore presence in these areas.

SNRF are of particular interest due to the endangered status of the Sierra Nevada Distinct Population Segment (DPS; U.S. Fish and Wildlife Service 2015; U.S. Fish and Wildlife Service 2021; Figure 1). Our surveys and other contemporary study efforts have detected SNRF along a 250-km stretch of the Sierra Crest encompassing much of the north-south extent of the species' historical range in the Sierra. Despite this extensive distribution, reproduction has been confirmed only in two areas separated by 120 km: the Sonora Pass and Mono Creek study areas, the latter of which was discovered during our study. We documented a resident, reproducing population of SNRF in Mono Creek during 2018–2020, as well as numerous SNRF detections both north and south of Mono Creek during 2018–2024. In our other opportunistic study areas, we have documented SNRF presence consistently for multiple years, including detections of the same individuals in multiple years, but the genetic samples we have collected have not yielded repeat detections of mated pairs or evidence of reproduction. Our objective in these opportunistic study areas during 2023–2024 was to continue to monitor SNRF presence via cameras and obtain genetic samples via scat in order to contribute to the wider picture of genetic structure, genetic diversity, relatedness, immigration, and reproduction in the Sierra Nevada DPS.

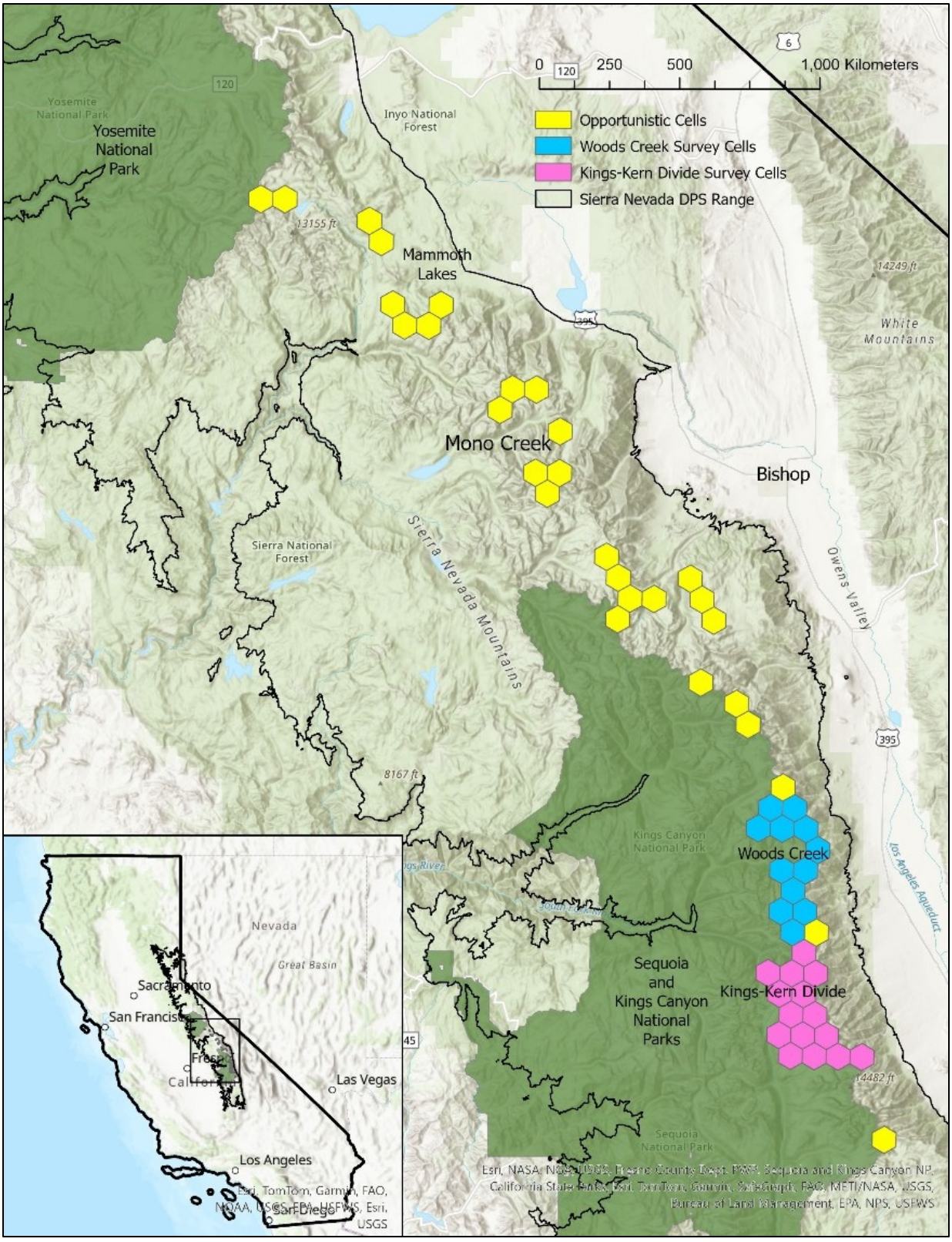


**Figure 1. Map of 2023-2024 alpine mesocarnivore study areas in the Sierra Nevada, California, including systematic survey cells and opportunistic cells.**

# III. Methods

We detected mesocarnivores using a combination of noninvasive methods: 1) systematic camera surveys aimed at documenting mesocarnivore presence within predefined geographic areas; 2) opportunistic cameras deployed in areas of suitable habitat with convenient year-round access or in locations where target species had been reported or detected previously; and 3) scat collection (both systematic and opportunistic) to obtain DNA from target species and identify individuals.

## *Systematic Camera Surveys*

Study Areas

We selected Woods Creek and the Kings-Kern Divide as the focal areas for our systematic camera surveys in 2023 and 2024 based on high habitat suitability for SNRF (Cleve et al. 2011; Green et al. 2023) and proximity to areas where we detected SNRF during prior systematic surveys.

The Woods Creek study area extended along the Sierra Crest between Taboose Pass and Kearsarge Pass, roughly centered on the headwaters of Woods Creek (Figure 2).

The Kings-Kern Divide study area began at the southern border of the Woods Creek study area and extended along the Sierra Crest between Kearsarge Pass and Lone Pine Creek and west to the headwaters of the Kern River (Figure 3).

Both study areas comprised barren alpine ridges and peaks, lake basins, meadows, and subalpine forests dominated by whitebark pine. This region of the Sierra Nevada receives most of its annual precipitation in winter (November–May), but the amount of precipitation is highly variable between years. The 2023 survey season was a record-setting wet winter, with 297% of April 1 average snow water equivalent measured in the southern Sierra. The 2024 survey season was an average winter, with 100% of April 1 average snow water equivalent (source: https://cdec.water.ca.gov/snowapp/sweq.action).

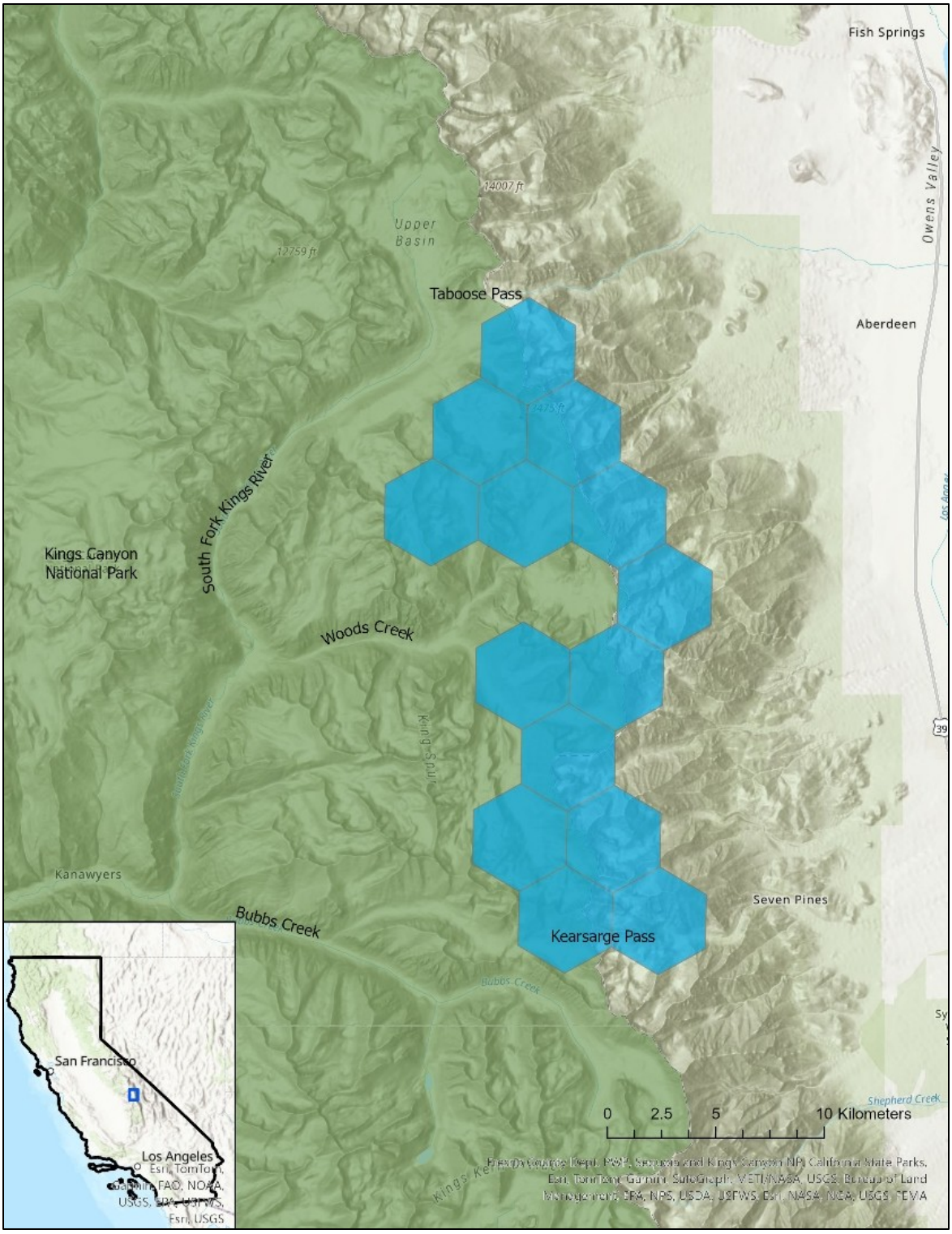


**Figure 2. Survey cells comprising the 2023 Woods Creek study area in the Sierra Nevada, California.**

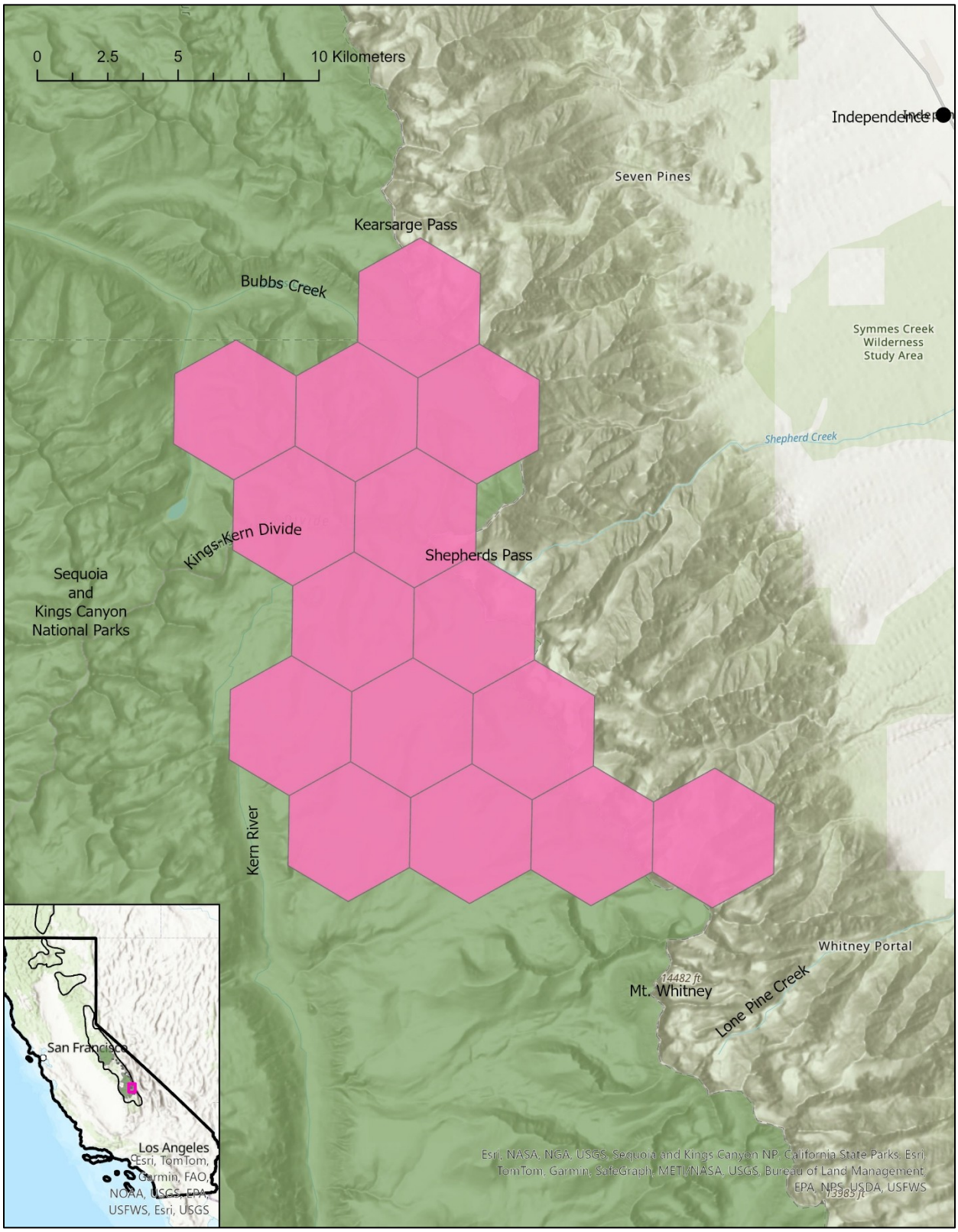


**Figure 3. Survey cells comprising the 2024 Kings-Kern Divide study area in the Sierra Nevada, California.**

## Field Methods

We determined placement for camera sites using a grid of 10.4-km$^2$ hexagons laid over each study area, adapting a CDFW protocol used successfully to detect SNRF and other mesocarnivores in the Sonora Pass area (Stermer 2015). We deployed two cameras per hexagon to increase the total area sampled. We used Lidar snow depth data at a 3-m pixel resolution (Airborne Snow Observatory, Mammoth Lakes, CA) to refine fine-scale site selection for cameras by identifying areas with low snow accumulation, such as barren alpine passes exposed to prevailing winds. Such passes may function as travel corridors for wildlife and are less likely to become buried in snow. In our experience, placing cameras on exposed passes can increase the number of days when cameras are operational. Approximately half of the winter camera placements in the Woods Creek and Kings-Kern Divide study areas were located on passes. The remaining cameras were located on windswept ridges, knolls, or other features that typically accumulated minimal snow, or along trails likely to be used by wildlife.

We deployed Reconyx motion detection cameras (Reconyx, Holmen, Wisconsin, USA) with commercial scent lure (Gusto, Minnesota Trapline Products, Pennock, Minnesota, USA) placed 3–5 m away from each camera to attract carnivores. We attached cameras with bungee cord or webbing straps to large rocks (Figure 4) or trees. We programmed camera triggers at a high sensitivity setting and set cameras to take 10 photos per trigger. Most stations were active for a minimum of 120 days, with a target revisit rate of at least once per camera during the survey season. During revisits, we added fresh lure, collected and replaced the cameras' memory cards and batteries, and adjusted the cameras as needed.

**Figure 4. A survey camera in the Woods Creek study area, Sierra Nevada, California. Photo by Brian Hatfield, CDFW.**

When we moved cameras from their original locations during a survey or set new cameras to replace ones that were buried, we treated the new locations as new sample points, adding them to the total number of sample points for that survey. In 2023, we deployed 31 camera stations across 14 grid cells in the Woods Creek study area at elevations from 3,312 m to 3,626 m. This included 27 initial camera placements and four cameras that were added to the survey or moved to more windswept locations in April and May 2023. In 2024, we deployed 32 cameras across 15 grid cells in the Kings-Kern Divide study area at elevations between 3,376 m and 4,042 m (the latter being the highest survey camera we have placed to date). This included 29 initial camera placements and three cameras that were added to the survey or moved to more windswept locations in May 2024.

## *Opportunistic Cameras*

We maintained opportunistic cameras in three primary study areas: Mono Creek (cameras active since 2018), Mammoth Lakes (cameras active since 2016), and Bishop Creek (cameras active since 2021). All are areas where we have detected SNRF consistently for multiple years and where we know or suspect that SNRF reside. In addition to these three primary study areas, we maintained opportunistic cameras in several other locations within our broader survey region (Figure 5), including the Ritter Range (cameras active since 2019), the Silver Divide (cameras active since 2020), Rock Creek (camera active since 2022), Bear Lakes Basin (cameras active since 2021), Humphreys Basin (cameras active since 2023), the Cirque Crest (cameras active since 2022), and the Miter Basin (cameras active since 2023). We maintained two cameras from the Woods Creek survey area as opportunistic cameras in 2024 because we had obtained SNRF detections on them. We maintained a total of 51 opportunistic cameras during all or part of 2023 and 2024.

### Study Areas

The Mono Creek and Mammoth Lakes study areas (Figure 5) were described in Hatfield et al. 2024. The Bishop Creek study area (Figure 5) encompassed the north and south forks of Bishop Creek Canyon west of the town of Bishop, from the alpine Sierra Crest at around 3,900 m to montane mixed-conifer forests at 3,000 m elevation. We surveyed the north fork of Bishop Creek systematically in 2016 and as part of the Goddard Divide survey in 2021. We surveyed part of the south fork of Bishop Creek as part of the Cirque Crest survey in 2022. We have maintained opportunistic cameras in the north fork since 2021 and in the south fork since 2022.

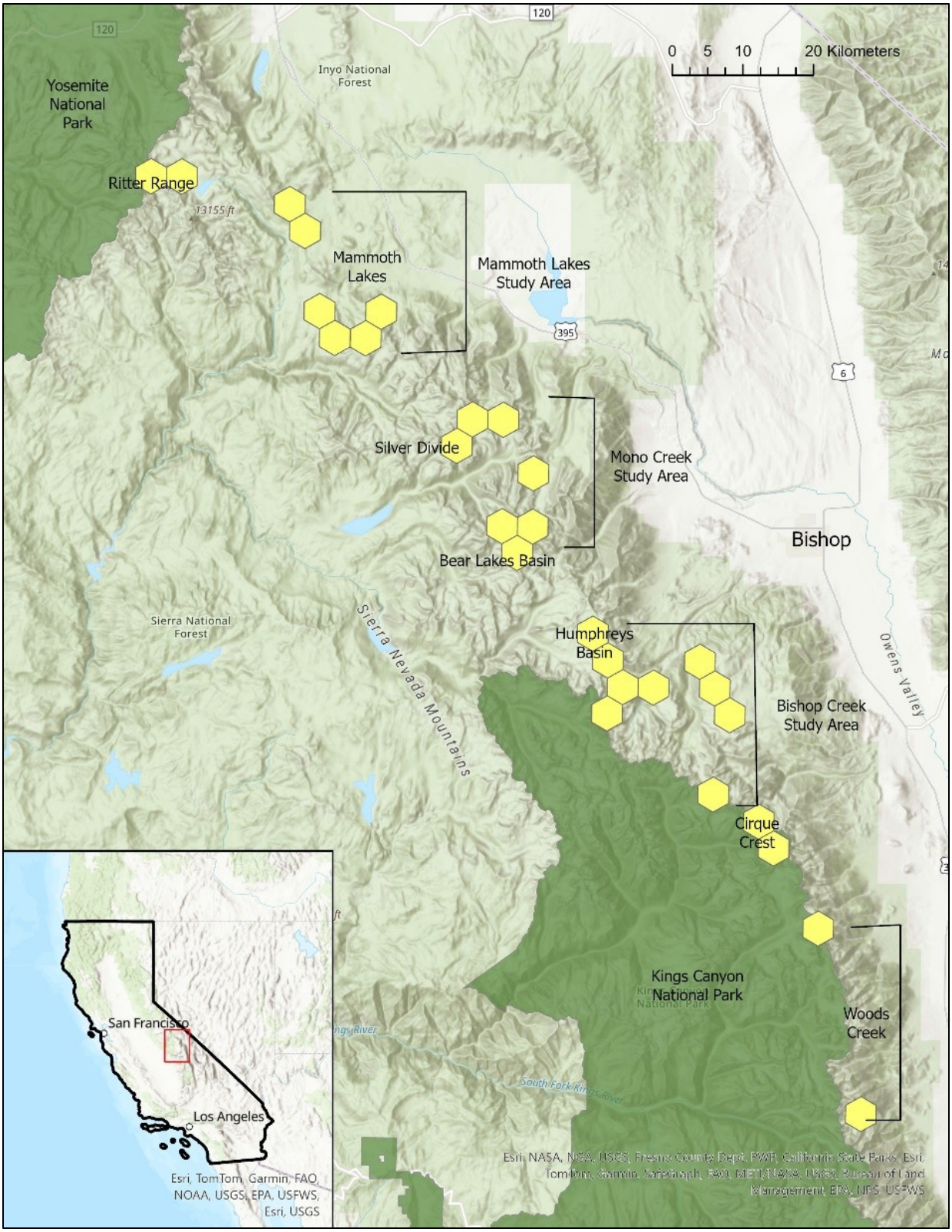


**Figure 5. Opportunistic camera locations in 2023 and 2024 in the Sierra Nevada, California.**

## Field Methods

We followed a similar protocol to deploy opportunistic cameras as that described above for systematic survey cameras (Figure 6). However, rather than being deployed systematically across a focal geographic area, opportunistic cameras were deployed in areas where we had previously detected SNRF, or in areas that were likely to remain windswept and had reasonable year-round access. Opportunistic cameras were also often left in place for longer than survey cameras—sometimes for multiple years—and were revisited and rebaited when possible based on conditions and staff availability. Due to these differing methods, we do not include results from opportunistic cameras in our summary statistics. Instead, we only present notable species detections from opportunistic cameras.

**Figure 6. Staff hiking in to maintain opportunistic cameras in the Mono Creek study area, Sierra Nevada, California. Photo by Crystal Dolis, CDFW.**

In the Mono Creek study area, we maintained opportunistic cameras in six locations where we have detected SNRF since 2018: Steelhead Pass, Crocker Col, Mt. Starr Ridge, Trail Pass, Mono Pass, and Gabbot Pass. These cameras were placed in barren alpine habitat at elevations from 3,467 m to 3,738 m.

In the Mammoth Lakes study area, we maintained opportunistic cameras in seven locations along the Mammoth Crest in subalpine forest and barren alpine habitat at elevations from 3,044 m to 3,409 m, and on a barren pass along the San Joaquin Ridge at 3,195 m. We selected these locations because they appeared to be potential wildlife travel corridors that were easily accessible by field staff during day trips and were unlikely to become buried in snow.

In the north fork of Bishop Creek we maintained opportunistic cameras in two alpine locations (3,629 m and 3,888 m) where we have detected SNRF since 2020, and one subalpine forest location (3,062 m) that was easily accessible year-round and appeared to be a wildlife travel corridor. In the south fork of Bishop Creek we maintained opportunistic cameras in five alpine locations ranging from 3,491 m to 3,687 m. These sites were chosen because of their accessibility and continuity of terrain to locations where we had detected SNRF previously.

We also maintained opportunistic cameras in two locations in the Ritter Range study area where we detected SNRF in 2019, in two locations in the Silver Divide study area, in three locations in Bear Lakes Basin, in one location in Rock Creek, in two locations in the Cirque Crest study area where we detected SNRF in 2022, and in two locations in the Woods Creek study area where we detected SNRF in 2022 and 2023.

When members of the public reported sightings of a wolverine in our study area in May 2023, we set six baited cameras with hair snares, four in locations where the wolverine had been seen and two along its anticipated travel route.

### *Photo Identification*

We classified photos containing images of wild animals by species and number of individuals per detection. A camera detection can be susceptible to two types of error: the same individual could be detected multiple times and counted as multiple individuals, or multiple individuals of the same species could be consolidated into a single detection. We defined a detection as a single species detected at a single camera within a 30-minute window. With this definition, we attempted to minimize both types of error. For each detection event, we classified each individual to species and counted the number of individuals per species. We did not attempt to identify mice or chipmunks to species, though several species were present in our study area. When photos clearly contained an animal but we were unable to identify the species, we

attempted to classify it to genus, family or order. Animal detections that we were unable to identify to order constitute a very small proportion of our results (approximately 6% in 2023 and 4% in 2024), and we do not report them here.

### *Scat Surveys*

We conducted scat surveys in all cells where SNRF were detected by cameras, as well as adjacent cells with connecting trails or terrain features. The purpose of scat collection was to obtain genetic samples to identify individual SNRF and determine their sex, genetic ancestry, and relationship to other SNRF in the Sierra. During scat surveys, field staff traversed terrain features where scat was most detectable, such as trails, ridges, and passes. We collected all apparent canid scats following a DNA sampling protocol developed by the Mammalian Ecology and Conservation Unit at the University of California, Davis (UC Davis; 2014). We also collected scat opportunistically during camera set-up and revisit trips. Samples were stored either in paper bags or in sample tubes with ethanol.

In 2023, an organization called Rogue Detection Teams conducted four days of scat surveys in the Mammoth Lakes study area. Each survey day consisted of a team (comprised of a human handler and a detection dog) traversing a section of ridgeline where SNRF had been detected by remote camera and collecting all apparent canid scats. Human handlers had the discretion to direct the dogs' survey route, and detection dogs were trained to alert their handlers when they detected scat from species of interest.

At the end of the field season, samples were mailed to UC Davis for DNA analysis. This analysis included identification of species, and, for SNRF samples, identification of individual, haplotype, sex, and pelage color. Samples from 2023 and half the samples from 2024 were first genotyped to species by the CDFW Wildlife Genetics Research Unit; further individual analysis of SNRF scats was then performed by UC Davis.

## IV. Results

### *Systematic Camera Surveys*

#### Woods Creek

During our 2023 Woods Creek survey, 31 survey cameras were operational for 6,248 nights out of 8,408 nights deployed (74%; Figure 7). These tallies include 27 survey cameras deployed in fall 2022 and an additional four cameras added to the survey or moved to new locations in spring 2023. We obtained 389 bird detections and 2,675 mammal detections representing at

least 14 bird species[1] and 19 mammal species. We detected 8 carnivore species, including SNRF (Table 1). We did not detect wolverines on our survey cameras, though a wolverine was photographed multiple times by members of the public to the north of the Woods Creek study area during the 2023 survey season.

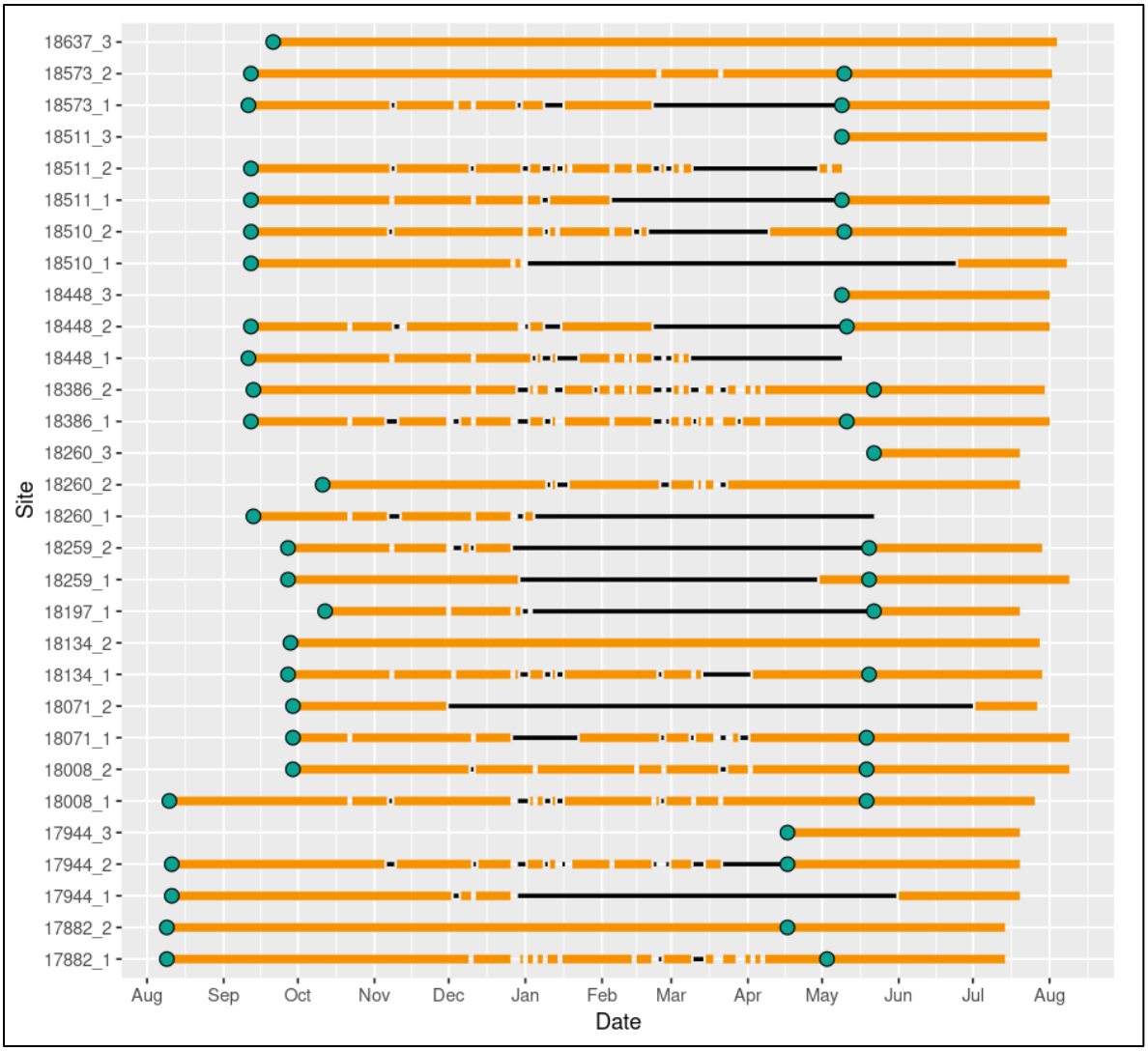


**Figure 7. Operational and nonoperational periods for remote cameras in the Woods Creek study area, Sierra Nevada, California during the 2023 survey season.**

[1] Buff-bellied pipit, Clark's nutcracker, common raven, dark-eyed junco, fox sparrow, gray-crowned rosy finch, mountain bluebird, mountain quail, northern flicker, rock wren, sooty grouse, white-crowned sparrow, white-tailed ptarmigan, and several unidentified flycatchers.

Kings-Kern Divide

During our 2024 Kings-Kern Divide survey, 32 survey cameras were operational for 8,098 nights out of 9,255 nights deployed (87%; Figure 8). These tallies include 29 cameras deployed in fall 2023 and three cameras added to the survey or moved to new locations in spring 2024. We obtained 349 bird detections and 2,431 mammal detections representing 13 bird species[2] and at least 20 mammal species. We detected 9 carnivore species, including SNRF (Table 2). We did not detect wolverines.

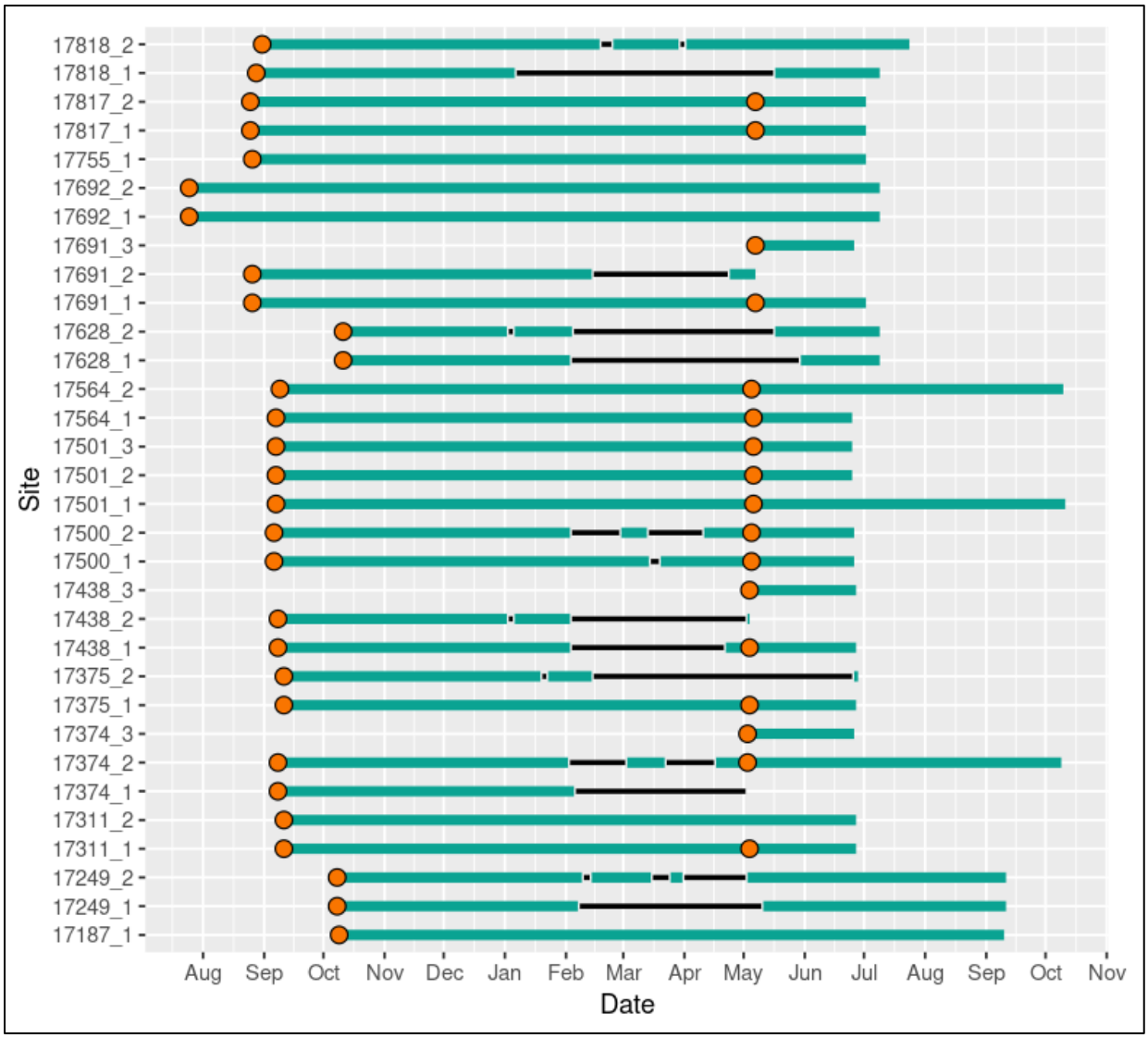


**Figure 8. Operational and nonoperational periods for remote cameras in the Kings-Kern Divide study area, Sierra Nevada, California during the 2022 survey season.**

[2] Buff-bellied pipit, chukar, Clark's nutcracker, common raven, dark-eyed junco, gray-crowned rosy finch, horned lark, mountain bluebird, mountain quail, rock wren, sooty grouse, white-crowned sparrow, and white-tailed ptarmigan.

**Table 1. Mammal detections during 2023 in the Woods Creek study area, Sierra Nevada, California.**

| Species | Order | Detections | Sites (% of Total) |
|---|---|---|---|
| Coyote (*Canis latrans*) | Carnivora | 124 | 25 (81%) |
| Bobcat (*Lynx rufus*) | Carnivora | 51 | 16 (52%) |
| Pacific marten (*Martes caurina*) | Carnivora | 15 | 6 (19%) |
| Long-tailed weasel (*Mustela frenata*) | Carnivora | 11 | 8 (26%) |
| Red fox (*Vulpes vulpes necator*) | Carnivora | 7 | 3 (10%) |
| Short-tailed weasel (*Mustela erminea*) | Carnivora | 5 | 4 (13%) |
| American black bear (*Ursus americanus*) | Carnivora | 4 | 4 (13%) |
| Mountain lion (*Puma concolor*) | Carnivora | 1 | 1 (3%) |
| Canid *sp*. | Carnivora | 1 | 1 (3%) |
| Yellow-bellied marmot (*Marmota flaviventris*) | Rodentia | 792 | 23 (74%) |
| Golden-mantled ground squirrel (*Callospermophilus lateralis*) | Rodentia | 218 | 20 (65%) |
| Chipmunk *spp*. (*Neotamias spp*.) | Rodentia | 156 | 19 (61%) |
| Bushy-tailed woodrat (*Neotoma cinerea*) | Rodentia | 91 | 17 (55%) |
| Mouse *spp*. (*Peromyscus spp*.) | Rodentia | 64 | 8 (26%) |
| Cricetidae family (mouse or vole) | Rodentia | 50 | 4 (13%) |
| Douglas squirrel (*Tamiasciurus douglasii*) | Rodentia | 8 | 3 (10%) |
| Western gray squirrel (*Sciurus griseus*) | Rodentia | 2 | 1 (3%) |
| Unidentified rodent | Rodentia | 3 | 3 (10%) |
| White-tailed jackrabbit (*Lepus townsendii*) | Lagomorpha | 493 | 27 (87%) |
| American pika (*Ochotona princeps*) | Lagomorpha | 324 | 16 (52%) |
| Sierra Nevada bighorn sheep (*Ovis canadensis sierrae*) | Artiodactyla | 187 | 18 (58%) |
| Mule deer (*Odocoileus hemionus*) | Artiodactyla | 40 | 5 (16%) |

**Table 2. Mammal detections during 2024 in the Kings-Kern Divide study area, Sierra Nevada, California.**

| Species | Order | Detections | Sites (% of Total) |
|---|---|---|---|
| Coyote (*Canis latrans*) | Carnivora | 234 | 27 (84%) |
| Pacific marten (*Martes caurina*) | Carnivora | 54 | 14 (44%) |
| Red fox (*Vulpes vulpes necator)* | Carnivora | 20 | 9 (28%) |
| Bobcat (*Lynx rufus*) | Carnivora | 16 | 10 (31%) |
| American black bear (*Ursus americanus*) | Carnivora | 2 | 2 (6%) |
| Mountain lion (*Puma concolor*) | Carnivora | 2 | 1 (3%) |
| Long-tailed weasel (*Mustela frenata*) | Carnivora | 2 | 2 (6%) |
| Short-tailed weasel (*Mustela erminea*) | Carnivora | 2 | 2 (6%) |
| Western spotted skunk (*Spilogale gracilis*) | Carnivora | 1 | 1 (3%) |
| Yellow-bellied marmot (*Marmota flaviventris*) | Rodentia | 268 | 22 (69%) |
| Chipmunk *spp*. (*Neotamias spp.*) | Rodentia | 251 | 26 (81%) |
| Cricetidae family (mouse or vole) | Rodentia | 216 | 15 (47%) |
| Golden-mantled ground squirrel (*Callospermophilus lateralis*) | Rodentia | 160 | 15 (47%) |
| Bushy-tailed woodrat (*Neotoma cinerea*) | Rodentia | 74 | 12 (38%) |
| Mouse *spp*. (*Peromyscus spp*.) | Rodentia | 13 | 2 (6%) |
| Douglas squirrel (*Tamiasciurus douglasii*) | Rodentia | 2 | 2 (6%) |
| Northern flying squirrel (*Glaucomys sabrinus*) | Rodentia | 1 | 1 (3%) |
| Unidentified rodent | Rodentia | 32 | 6 (19%) |
| White-tailed jackrabbit (*Lepus townsendii*) | Lagomorpha | 693 | 26 (81%) |
| American pika (*Ochotona princeps*) | Lagomorpha | 264 | 15 (47%) |
| Mule deer (*Odocoileus hemionus*) | Artiodactyla | 49 | 7 (22%) |
| Sierra Nevada bighorn sheep (*Ovis canadensis sierrae*) | Artiodactyla | 17 | 8 (25%) |

## *Opportunistic Cameras*

We obtained repeated detections of SNRF on opportunistic cameras in the Mono Creek (n = 30), Mammoth Lakes (n = 11), and Bishop Creek (n = 14) study areas during 2023 and 2024, both on cameras that had detected SNRF in the past and on new cameras placed during this study period. We also detected one SNRF in 2023 on an opportunistic camera in Rock Creek that also photographed a SNRF in 2022. We did not detect SNRF on any other opportunistic cameras in 2023 or 2024. There were fewer SNRF detections across all opportunistic study areas in 2024 (n = 12) than in 2023 (n = 44; Figure 9).

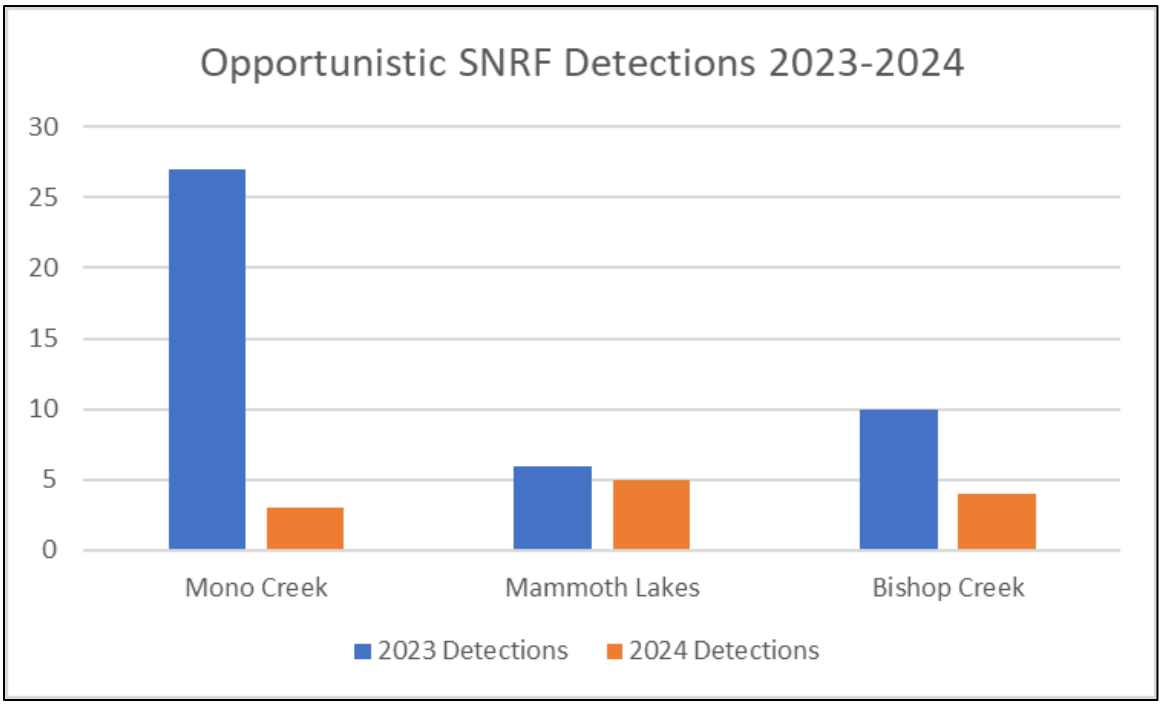


**Figure 9. Number of SNRF detections by opportunistic study area in 2023 and 2024.**

The baited cameras and hair snares we set in response to the wolverine detections in May 2023 did not detect wolverines, or any other species of interest.

## *Scat Surveys*

For clarity in reporting these results, we refer to the area east of Yosemite National Park between the Sierra Crest and Highway 395 as the eastern Yosemite study area. Although we have not systematically surveyed this area or maintained opportunistic cameras there as part of this project, we have obtained numerous scat detections of red foxes in this area, as well as photo detections on cameras deployed for other purposes (see “Other SNRF Detections in the Sierra,” below).

In 2023, we collected 126 scat samples and our collaborators, Rogue Detection Teams, collected an additional 67 scat samples. Of these 193 scat samples, 103 were from the Mammoth Lakes study area, 40 were from the Mono Creek study area, 36 were from SEKI (including the Woods Creek and Kings-Kern Divide study areas), 10 were from the eastern Yosemite study area, and four were collected opportunistically elsewhere in the Sierra; Figure 10; Table 4). The majority of scats from all study areas were coyote.

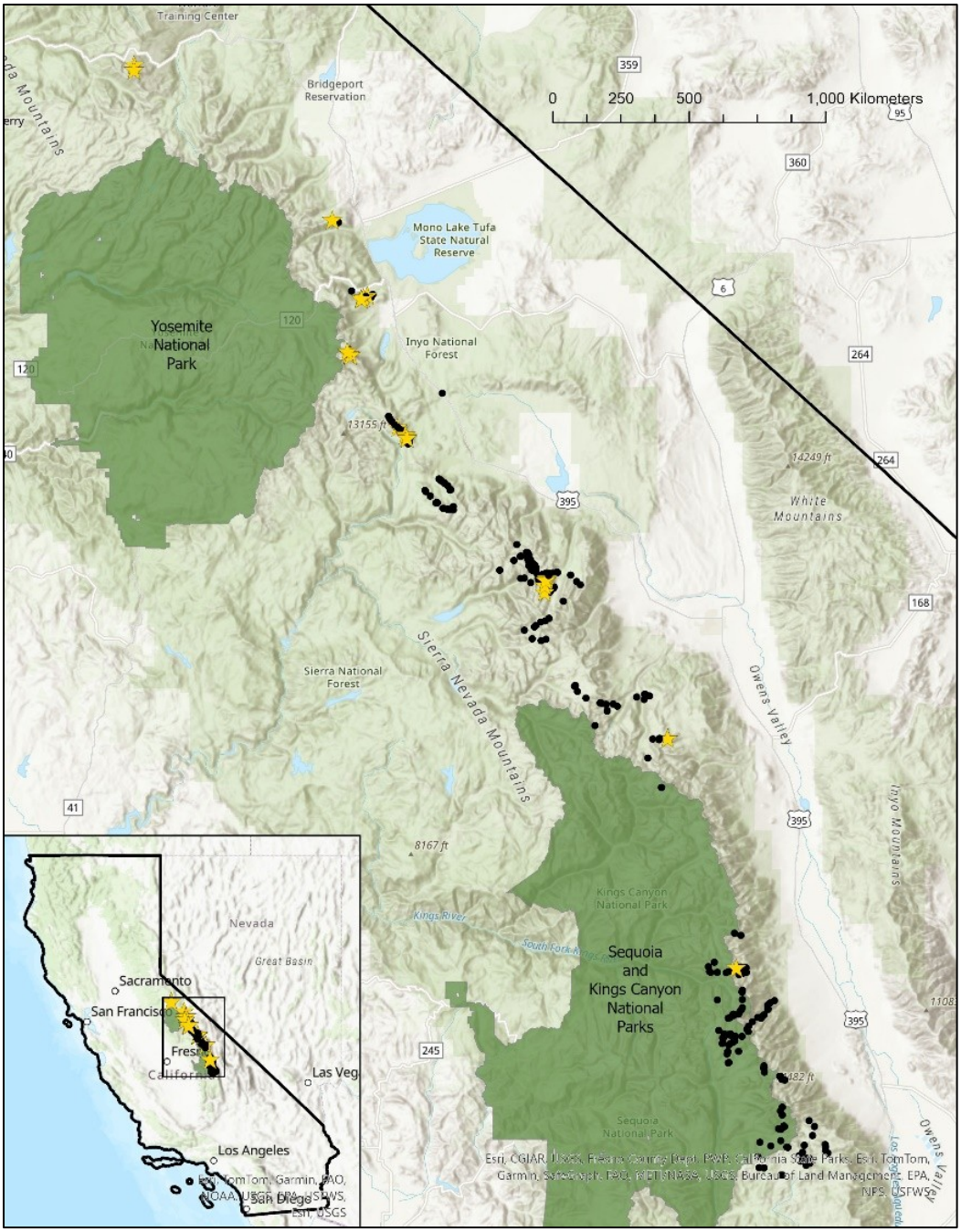


**Figure 10. Locations of scat samples collected in the Sierra Nevada, California in 2023 and 2024. Yellow stars represent SNRF scat samples.**

**Table 4. Scat samples from the Sierra Nevada, California collected during 2023 and genotyped to species.**

| | Eastern Yosemite | Mammoth Lakes | Mono Creek | SEKI | Other | Total |
|---|---|---|---|---|---|---|
| Coyote | 0 | 72 | 27 | 22 | 3 | 124 |
| Red fox | 5 | 6 | 1 | 4 | 0 | 16 |
| Bobcat | 0 | 4 | 2 | 3 | 1 | 10 |
| Pacific marten | 0 | 3 | 4 | 0 | 0 | 7 |
| Gray fox | 4 | 0 | 0 | 0 | 0 | 4 |
| Domestic dog | 0 | 2 | 0 | 0 | 0 | 2 |
| Black bear | 0 | 1 | 0 | 0 | 0 | 1 |
| Prey | 0 | 0 | 1 | 0 | 0 | 1 |
| Unable to determine | 1 | 15 | 5 | 7 | 0 | 28 |
| **Total** | 10 | 103 | 40 | 36 | 4 | 193 |

We collected 16 red fox scats from the eastern Yosemite, Mammoth Lakes, Mono Creek, and SEKI study areas (Figure 11) in 2023. In the eastern Yosemite study area we detected three individuals: an unrelated male and female (2021-2 and 2023-6) from the same location on the Koip Peak Pass trail, and a male (2023-12) on the Gibbs Lake trail whose ancestry indicated he was originally from the San Joaquin Valley west of the Sierra Nevada. In the Mammoth Lakes study area we detected an unrelated male and female (2022-13 and 2023-10) in the same location on the San Joaquin Ridge. The male had been sampled by other researchers the previous year near Carson Pass (B. Sacks, UC Davis, personal communication), approximately 150 linear km to the north of his location on San Joaquin Ridge. In the Mono Creek study area we did not detect either of the resident pair foxes (male 2017-6 and female 2018-1) that we sampled there annually during 2018–2022. However, we collected one scat from a male (2019-2) that had been sampled previously by other researchers near Ebbetts Pass (approximately 150 linear km to the north of Mono Creek), where he apparently had at least one offspring (Quinn and Sacks 2022). In SEKI, we detected one male red fox (2023-13) in the Woods Creek study area near Golden Trout Lake in July 2023, and the same individual near Bishop Pass (approximately 50 linear km to the north) in December 2023. We also detected another male red fox (2023-1) in the same location near Bishop Pass; this individual had been detected the year before on Sherwin Ridge in the Mammoth Lakes study area, approximately 60 linear km to the north, along with his brother, 2023-11 (Figure 11).

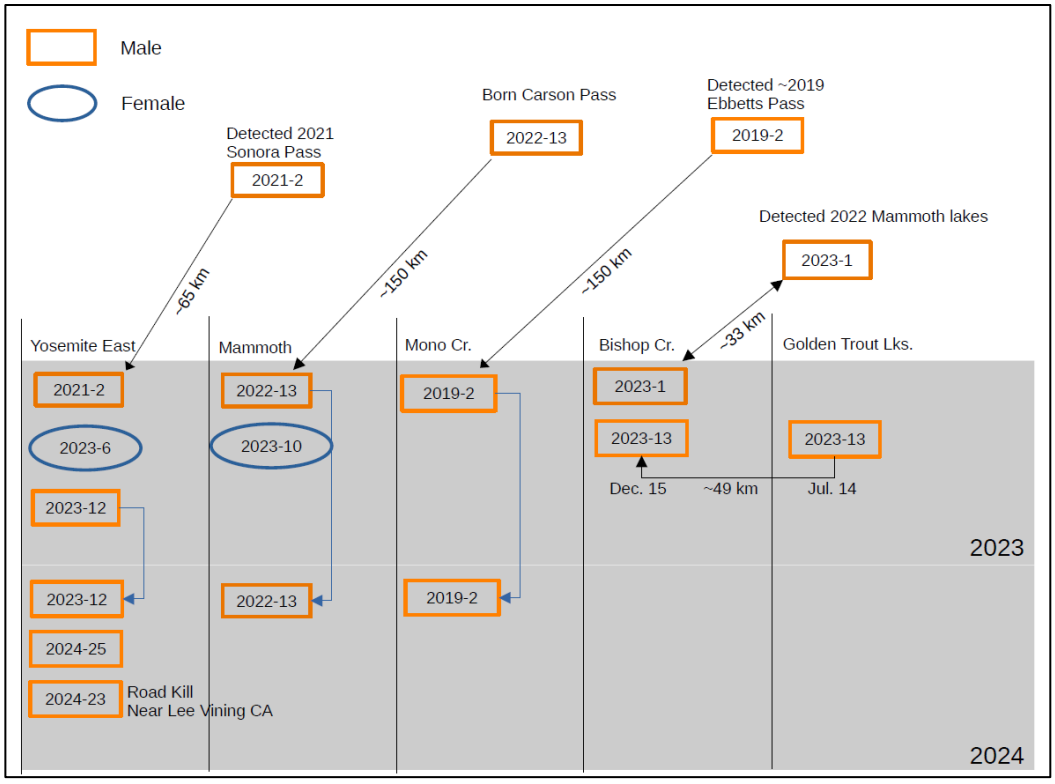


**Figure 11. Summary of locations and movements red fox individuals detected by scat in the Sierra Nevada, California, during 2023–2024.**

In 2024, we collected 383 scat samples (148 from SEKI [including the Woods Creek and Kings-Kern Divide study areas], 113 from the Mono Creek study area, 68 from the Mammoth Lakes study area, 34 from the eastern Yosemite study area, four from the Sonora Pass study area, and 16 that were opportunistically collected in other parts of the Sierra; Figure 10; Table 5). We also collected a road-killed male red fox from the highway north of Lee Vining (in the eastern Yosemite study area) and submitted an ear tissue sample to UC Davis for genetic analysis. The road-killed red fox was determined to be a previously undetected individual, 2024-23. We detected 16 red fox scats from the Sonora Pass, eastern Yosemite, Mammoth Lakes, and Mono Creek study areas (Figure 11) in 2024. The three red fox scats from the Sonora Pass study area were not able to be identified to individual. In the eastern Yosemite study area we again detected male 2023-12 on the Gibbs Lake trail, in the same location where we had sampled him in 2023. We also sampled a previously undetected male, 2024-25, on Copper Mountain. In the Mammoth Lakes study area, we re-sampled the male, 2022-13, that we had detected there in 2023, but did not detect the female (2023-10). In the Mono Creek study area, we did not detect the two resident foxes that were last sampled there in 2022, but we did collect several scats from the male 2019-2 that we first detected there in 2023. We did not detect any red foxes by scat in SEKI.

**Table 5. Scat samples from the Sierra Nevada, California collected during 2024 and genotyped to species.**

| | Sonora Pass | Eastern Yosemite | Mammoth Lakes | Mono Creek | SEKI | Other | Total |
|---|---|---|---|---|---|---|---|
| Coyote | 1 | 3 | 51 | 65 | 98 | 9 | 227 |
| Gray fox | 0 | 19 | 0 | 0 | 16 | 0 | 35 |
| Bobcat | 0 | 2 | 3 | 2 | 10 | 0 | 17 |
| Red fox | 3 | 5 | 1 | 7 | 0 | 0 | 16 |
| Domestic dog | 0 | 0 | 2 | 4 | 1 | 5 | 12 |
| Pacific marten | 0 | 0 | 0 | 9 | 0 | 0 | 9 |
| Black bear | 0 | 1 | 0 | 0 | 1 | | 2 |
| Unable to determine | 0 | 4 | 11 | 26 | 22 | 2 | 65 |
| **Total** | 4 | 34 | 68 | 113 | 148 | 16 | 383 |

## *Other SNRF Detections in the Sierra*

In addition to the alpine mesocarnivore monitoring program described in this report, in 2023 we initiated a trapping study with the objective of capturing and collaring up to 10 SNRF and using data from GPS collars and from biological samples obtained during captures to document habitat selection and space use of SNRF, investigate reproductive biology, estimate vital rates, determine cause-specific mortality, collect morphological measurements, perform genetic and disease analysis, and improve the sampling design of noninvasive surveys. We set baited cameras and paired camera-cage trap sets in several locations where SNRF had been detected or in suitable SNRF habitat where year-round access was feasible. Although we did not capture a SNRF, this project resulted in numerous SNRF detections by camera and scat, including at unusually low elevations and in areas where SNRF had not previously been documented by our alpine mesocarnivore program. We detected SNRF on trapping cameras near Sonora Pass (10 detections), on Copper Mountain north of Lundy Canyon (three detections), near Gibbs Lake (12 detections), on San Joaquin Ridge (six detections), in Mono Creek (two detections), on Table Mountain in Bishop Creek (two detections), and at an atypical location at 1,893 m in the southern Owens Valley west of the town of Independence (one detection). As described above under “Scat Surveys,” scat searches near the camera detections on Copper Mountain and near Gibbs Lake resulted in the identification of two male red foxes, 2024-25 and 2023-12. A full description of the trapping study will be presented in a separate report.

Beyond our study area, other researchers continue to detect SNRF in many locations throughout the central and northern Sierra. During 2023, cameras in Yosemite National Park photographed SNRF in one new location and three locations with previous detections, all in the northeastern part of the park (M. McDonald, NPS, personal communication 2024). In 2024, cameras in Yosemite National Park obtained 45 SNRF detections in the northern and southeastern parts of the park (A. Townsend, NPS, personal communication 2025). CDFW Headquarters staff detected two SNRF individuals by scat at Raymond Lake north of Ebbetts Pass (2022-1, a female thought to have been born in that area, and 2024-24, a male new to the study area with ancestry indicating he may have come from the San Joaquin Valley; B. Sacks, UC Davis, and C. Stermer, CDFW, personal communications 2025). Members of the public and U.S. Forest Service staff from the El Dorado and Tahoe National Forests submitted photographic detections of red foxes north of Carson Pass (October 2023, M. Rambo, USFS, personal communication 2024), near the town of Markleeville (February 2024, S. Zanetti, USFS, personal communication 2024), near the town of Gardnerville (early 2024, T. Rawlinson, USFS, personal communication), in the Martis Valley north of Lake Tahoe (March 2024, T. Rawlinson, USFS, personal communication), and on Lyon Peak northwest of Lake Tahoe (July 2024, T. Rawlinson, USFS, personal communication).

# V. Discussion

In our systematic surveys, we detected more carnivores in 2024 (n = 333) than in 2023 (n = 219). We detected almost twice as many coyotes (n = 234), almost three times as many SNRF (n = 20), and almost four times as many Pacific martens (n = 54) in 2024 than in 2023 (n = 124, 7, and 15 respectively). The number of Pacific marten detections in 2023 was the lowest number of detections of this species in any year of our study. Pacific martens were detected at only 19% of sites (6/31) in 2023, versus 44% of sites (14/32) in 2024. By contrast, we detected more than three times as many bobcats in 2023 (n = 51) as in 2024 (n = 16). This may reflect different carnivore occupancy between the two study areas, or may be related to the much heavier snowfall in 2023. The record-breaking winter of 2023 buried many of our cameras, resulting in a lower proportion of days when cameras were able to detect wildlife. Heavy snowfall and severe winter weather may also have impacted carnivore movements and survival.

In both systematic survey study areas, as in all previous years of our study, coyotes were the most commonly detected and widespread carnivore species. Pacific martens were the second most commonly detected and widespread carnivore species in the Kings-Kern Divide study area, as they have been in all years of our study except 2023, when bobcats ranked second behind coyotes in the Woods Creek study area (Figure 12). The only unusual carnivore species detected in either study area was the SNRF. Each study area also yielded an unusual rodent

detection: a western gray squirrel at 3,402 m in the Woods Creek study area in June 2023 (Figure 13), and a northern flying squirrel at 3,522 m in the Kings-Kern Divide study area in April 2024. Both species are typically associated with forested habitat at lower elevations (Grinnell and Storer 1924; Ingles 1947; Meyer et al. 2005; Wilson et al. 2008).


**Figure 12. Juvenile bobcats detected by remote camera in the Woods Creek study area, Sierra Nevada, California, in 2022.**


**Figure 13. Western gray squirrel detected by remote camera in the Woods Creek study area, Sierra Nevada, California, in 2023.**

In May 2023 a wolverine was observed numerous times by members of the public in the vicinity of several of our opportunistic cameras, but it was not detected in our survey areas or by any of our survey or opportunistic cameras. Based on their close proximity and lack of overlap, these detections appear to represent a single individual. Yosemite National Park staff who observed the animal near Tuolumne Meadows (Figure 14) were able to collect the snow around its tracks, which was analyzed for environmental DNA (eDNA) by the U.S. Forest Service National Genomics Laboratory for Wildlife and Fish Conservation in Missoula, Montana. The species identification, already certain based on photographic, video, and track evidence, was further confirmed via this method, although the animal's sex and ancestry were unable to be determined (J. Tucker and K. Pilgrim, USFS, personal communications 2023).

**Figure 14. Wolverine observed by Yosemite National Park staff in Tuolumne Meadows, California, Sierra Nevada in May 2023. Photo courtesy of NPS.**

The wolverine was traveling north during the time period of the detections, but we presume it initially traveled south into our area since the closest known populations of wolverines are in Washington and Idaho. Several months later, a remote camera on the Tahoe National Forest was retrieved and found to have photographed a wolverine on April 28, 2023 (T. Rawlinson, USFS, personal communication 2023). The camera was located in the Carpenter Valley area north of the town of Truckee, approximately 300 linear km north of the first sighting within our study area on May 17, 2023. It is probable that this detection was the same individual on its way south. We surmise that the ten-day period when the animal was detected in May coincided with an unusually high density of backcountry skiers in the area it was traveling through. Its behavior also suggested it was unwary of humans. Although we suspect that our

survey and monitoring camera methods would detect a wolverine or multiple wolverines that resided in our study area, this event demonstrates that even a relatively widespread camera array may not be able to detect a single individual passing through our study area (Figure 15), particularly given that our cameras are typically not baited, whereas wolverine survey methods suggest using large bait items that are regularly replenished to attract wolverines to camera stations (Zielinski and Kucera 1995).

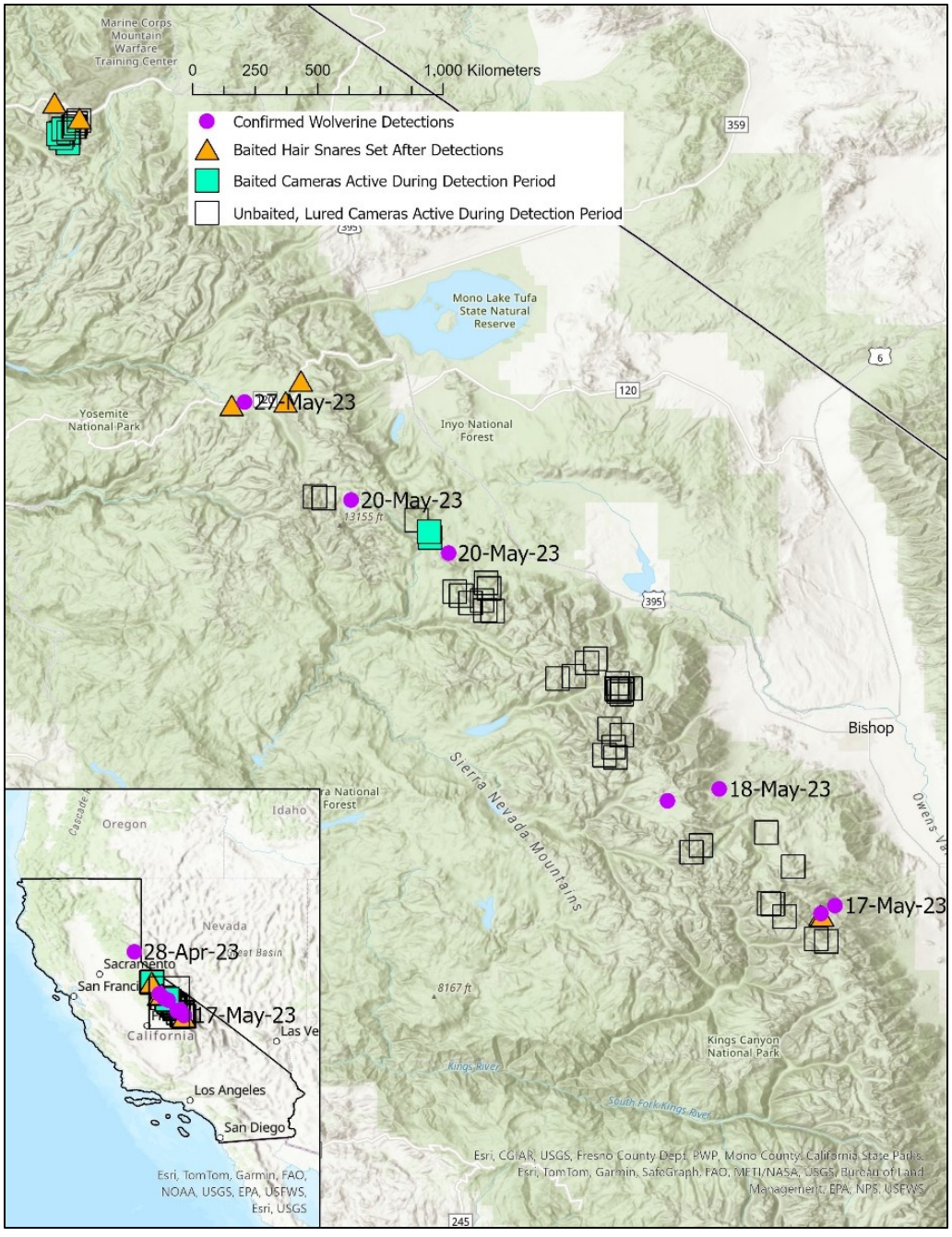


**Figure 15. Locations of wolverine observations relative to baited and unbaited camera stations in the Sierra Nevada, California.**

We detected SNRF on seven occasions at three sites in the Woods Creek study area. At least two individuals were recognizable in the photos based on pelage. The one red fox scat we collected from the vicinity of these detections was from a red-pelage male, 2023-13, that was detected later in the same year by scat and opportunistic camera in the Bishop Creek study area, approximately 45 linear km north. We left two cameras in place after the 2023 survey season to monitor locations where SNRF were detected in the Woods Creek study area.

In the Kings-Kern Divide study area, we detected SNRF on 20 occasions at nine sites. This represents the most detections in any survey season to date, and the first confirmed detections of SNRF in Sequoia National Park since the 1930s (Grinnell et al. 1937). The detections occurred over a period of nine months (September 2023 through May 2024) throughout a relatively broad area (i.e., roughly equivalent to the Mono Creek study area, which we suspect may have been the breeding home range of a pair of SNRF). Unfortunately, none of the scats we collected from this area were genetically identifiable as SNRF, so we cannot confirm whether multiple individuals were present or what their relationships and ancestry might be. Although it is difficult to confidently distinguish between individuals in nighttime photos, we suspect at least two individuals were present based on visible differences in physical characteristics such as pelage pattern and tail length (Figure 16; Figure 17). We left three cameras in place after the 2024 survey season to monitor locations where SNRF were detected in the Kings-Kern Divide study area. These opportunistic cameras have continued to detect SNRF, including at least one individual that is clearly distinct from the fox(es) sampled during the survey period based on pelage color.

On opportunistic cameras, there were fewer SNRF detections in 2024 (n = 12) than in 2023 (n = 47; Figure 8). Although we collected twice as many scat samples in 2024 as in 2023, and the same number of SNRF scats, we sampled fewer SNRF individuals by scat in 2024 (n = 4) than in 2023 (n = 8), and we detected no females. Despite detecting two possible breeding pairs (an unrelated male and female in the same location) in the eastern Yosemite and Mammoth Lakes study areas in 2023, we did not re-sample either female in 2024, nor did we detect any evidence of breeding in these study areas in 2023 or 2024.

In Mono Creek, we did not find scats from male 2017-6 or female 2018-1, despite sampling them every year during 2018–2022 and sampling their offspring in 2020. Instead, we detected a new male, 2019-2, in this study area in both 2023 and 2024. In combination with the notable reduction in photo detections in this study are between 2023 (n = 27) and 2024 (n = 3), we speculate that 2017-6 and 2018-1 may have died. It is possible that 2019-2 moved into their territory or established a new overlapping territory. His presence there raises other questions, since he was known to have had a litter approximately 150 linear km north near Ebbetts Pass

(based on collection of scat from his offspring and mate; B. Sacks, UC Davis, personal communication 2024). The red fox is described as a territorial carnivore (Voigt 1987; Larivière and Pasitschniak-Arts 1996), and a long-distance movement away from a territory where it has successfully bred is unexpected behavior. Before appearing in Mono Creek in 2023, 2019-2 was last sampled in 2021 near Ebbetts Pass. In 2022, he and his mate were not sampled in that area, but scat from another mated pair and their offspring was found in 2019-2's former territory. It is possible that 2019-2's mate died, and/or that the new pair pushed him out of his territory, leading to his dispersal to Mono Creek (B. Sacks, UC Davis, personal communication 2025).


**Figure 16. All SNRF detected in the Kings-Kern Divide study area (Sierra Nevada, California) during the survey period appeared to have a cross pelage pattern, making it difficult to distinguish between individuals. However, certain physical characteristics appeared to differ, such as a) darker pelage, lump of fur or tissue on abdomen vs. b) lighter pelage, no visible lump and c) long, fluffy tail vs. b) apparently shorter, thinner tail.**

Our noninvasive dataset is well-suited to documenting the presence of SNRF, but limited in its ability to demonstrate residency or describe the territories of individual SNRF. We have only detected breeding in a single study area, Mono Creek (Hatfield et al. 2023). However, in several other cases we have strong evidence of residency. In two instances, we have detected the same individual by scat in the same location over multiple years (2022-13 on the San Joaquin Ridge in the Mammoth Lakes study area, and 2023-12 on the Gibbs Lake trail in the eastern Yosemite study area). This suggests the individuals reside in those areas, but we do not have evidence of breeding (detections by scat of a mate and offspring, or photos of juvenile foxes). In the Bishop Creek and Kings-Kern Divide study areas, we have detected multiple individuals (based on pelage) by remote camera over multiple years and throughout areas that fall within the range of measured SNRF territories (Sierra Nevada Red Fox Conservation Advisory Team 2022). Although these detections suggest that SNRF reside in these areas, we have not confirmed the presence of the same individuals year-to-year or detected breeding via scat samples or photos of juvenile foxes. Despite the lack of evidence of breeding, the repeated detections in these areas are not consistent with dispersal or vagrancy, and instead indicate that our survey area likely encompasses multiple SNRF territories.

The increase in opportunistic detections of SNRF between Carson Pass and Truckee may indicate a range expansion from Sonora Pass, continued immigration from the Great Basin and San Joaquin Valley (Quinn et al. 2019), or simply an increase in monitoring or reporting. Based on the repeated and widespread detections of SNRF throughout the Sierra in recent years, it is likely that the SNRF population is genetically continuous from Lake Tahoe in the north to Sequoia National Park in the south (Figure 17).

Our camera survey methods have demonstrated the prevalence of native carnivores like coyotes, Pacific martens, and bobcats in alpine habitat throughout the Sierra Nevada south of Yosemite National Park. Our surveys have also documented SNRF occupancy throughout nearly the entire eastern portion of their historical range in the southern Sierra Nevada, greatly expanding the scope of future efforts to recover this endangered population.

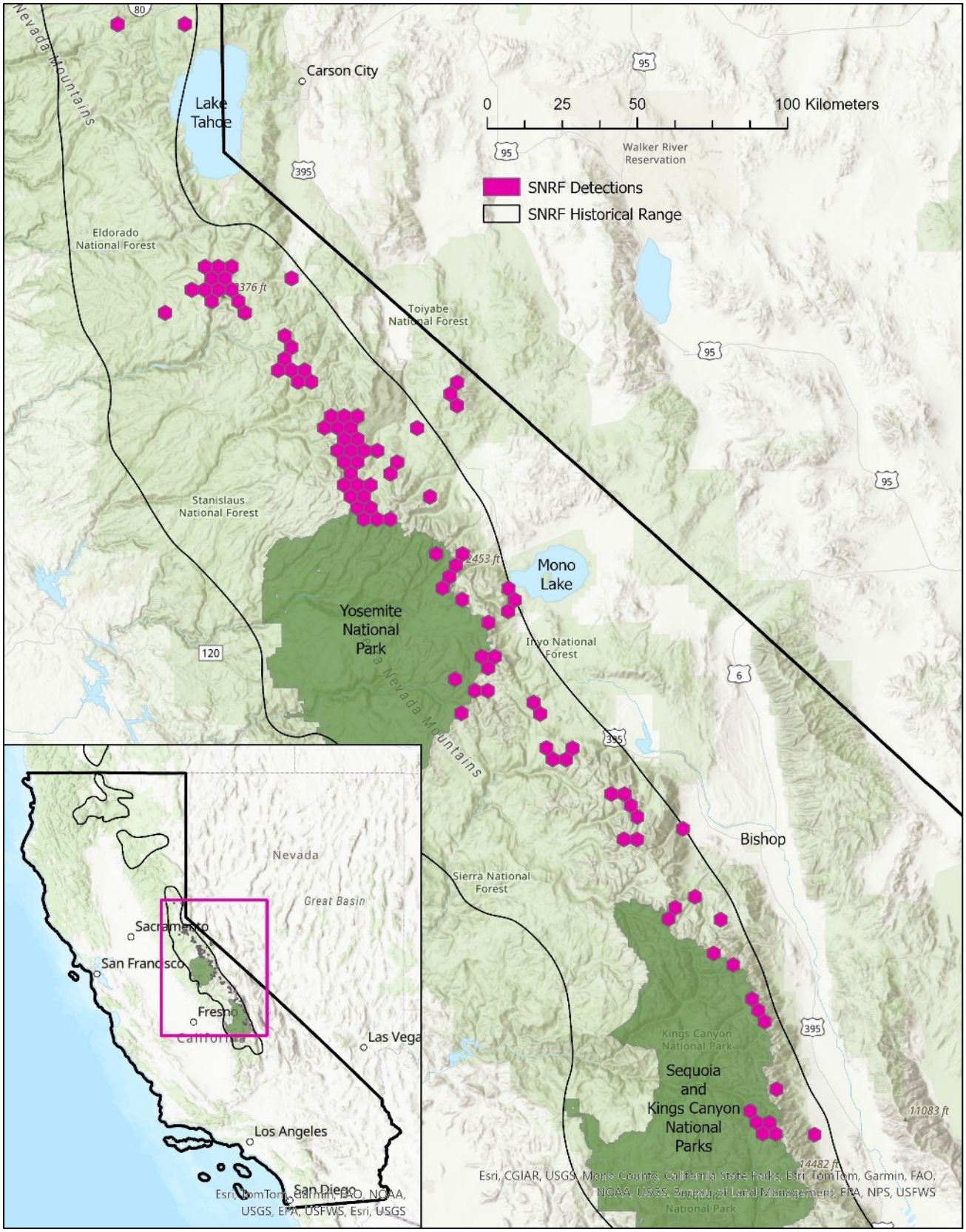


**Figure 17. Cells where SNRF have been detected in the Sierra Nevada, California, during 2010–2024. Detections were obtained by multiple agencies and methods. Historical range is adapted from Grinnell et al. 1937.**

# VI. Acknowledgements

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