National Park Service
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Pikas in Peril: Multi-Regional Vulnerability Assessment of a Climate-Sensitive Sentinel Species

Project Accomplishment Report 2010

ON THE COVER
Left: An American pika at Crater Lake National Park
Photograph by: Devin Stucki
Right: Talus typical of pika habitat at Great Sand Dunes National Park and Preserve
Photograph by: Justine Smith

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Abstract

The Pikas in Peril project will 1) document pika occurrence patterns and predict pika distribution across eight NPS parks (Crater Lake National Park [CRLA], Lassen Volcanic National Park [LAVO], Lava Beds National Monument [LABE], Craters of the Moon National Monument and Preserve [CRMO], Rocky Mountain National Park [ROMO], Great Sand Dunes National Park and Preserve [GRSA], Grand Teton National Park [GRTE], and Yellowstone National Park [YELL]) in two NPS regions, 2) measure gene flow and model connectivity of pika populations within five of those parks, and 3) project climate change effects on the future distribution, connectivity and vulnerability of pika populations in each park. By assessing the vulnerability of this sentinel species, the research team is providing park managers with insights into the expected rate and magnitude of climate-related changes in park ecosystems and critical information for park scenario planning and interpretive goals. A total of 677 randomly-selected sites were surveyed from mid-June through mid-October 2010. Occupancy of sites was determined by surveying for pikas, pika calls, fresh food caches, and fresh fecal pellets within plots with a 12-m radius. The proportions of sites surveyed where these detections were made were (by park, lowest to highest): 0.145 for LAVO, 0.214 for CRMO, 0.238 for LABE, 0.454 for GRTE, 0.549 for YELL, 0.647 for CRLA, 0.672 for ROMO, and 0.714 for GRSA. Detection probabilities have not yet been estimated and our estimates of the proportion of sites "occupied" are therefore preliminary and conservative. Consequently, we caution that no inferences should be made that compare the proportions among parks. A total of 387 fecal samples have been collected at the five parks where genetic work is funded. A customized relational database application, implemented in Microsoft Access, is being used to store and manipulate the data associated with this project. Analyses of occupancy results and fecal samples will occur this winter and spring. Additional surveys of new sites and existing sites are scheduled for 2011 and final reporting is planned for 2012.

Acknowledgments

Funding for this project was provided by the National Park Service Climate Change Response Program. Kerry Gunther, Tom Olliff, Stacey Ostermann-Kelm, Thomas Rodhouse, Billy Schweiger, and Kathi Irvine have contributed greatly to this project as project planners and advisors. Jessica Castillo, a graduate student at Oregon State University, is conducting field and lab work for Objective 2. Meghan Lonneker and Gordon Dicus coordinated GIS analyses and data management, including creating the Access database. Kathryn Mellander and Ann Rodman provided support by modeling pika habitat and producing essential field maps. Furthermore, Paulina Starkey and April Craighead coordinated many of the interpretive efforts, and thanks are owed to the interpretive staff representatives from each park for reviewing interpretive deliverables.

The following are park resource managers and biologists who contributed their support to the project and knowledge of the parks: John Apel, Ben Bobowski, Mac Brock, Fred Bunch, Sue Consolo-Murphy, Gregory Holm, David Larson, Michael Magnuson, Linda Mazzu, Michael Munts, and Nancy Nordensten. The authors are especially appreciative of the support from the park superintendents.

The following people served as dedicated and hard working field leads, technicians, and volunteers: Emilie Blevins, Megan Brady, Amanda Bramblett, Nathan Charleton, Janey Choy, Natalie Converse, Luke Dow, Liesl Erb, Craig Fischer, Katherine Gura, Jon Harris, Jackson Herring, Jeffrey Joh, Monica Lomahakluh, Forest Madsen, Molly McDevitt, Zachary Mills, Jonathan Morales, Jeffrey Murphy, Will Olson, Chris Paige, Corinne Ross, John David Sacklin, Will Scherer, Walter Sherrer, Ryan Sims, Justine Smith, Garrett Steensland, Ross Steensland, John Stephenson, Devin Stucki, Aimee Tallian, James Waddell, Jennifer Wilkening, and Travis Wyman.

Introduction

Climate change and its effects on species may be one of the more difficult challenges faced by natural resource managers, given that global temperatures could rise as much as 6.4°C (11.5°F) by the end of the twenty-first century (IPCC 2007). Climate change is already implicated in recently documented shifts in the distribution of a variety of species (Parmesan et al. 1999, Thomas and Lennon 1999, Walther et al. 2002, Parmesan and Yohe 2003, Root et al. 2003, Wilson et al. 2005, Parmesan 2006, Moritz et al. 2008). The American pika (*Ochotona princeps*), a charismatic and conspicuous inhabitant of many western mountain landscapes, is considered a sentinel species for detecting ecological effects of climate change (McDonald and Brown 1992, Hafner 1993, Hafner 1994, Lawlor 1998, Beever et al. 2003, Krajick 2004, Smith et al. 2004, Grayson 2005, Morrison and Hik 2007).

Climate change already may be a leading factor in the extinction of local pika populations in the Great Basin: of 25 populations recorded during 1898-1990, nine were extinct by 2008 (Beever et al. 2010). The lowest recorded occurrence of pikas has risen over 150 meters during the past century, both within Yosemite National Park (Moritz et al. 2008) and throughout the Great Basin (Grayson 2005), and the rate of uphill range retraction in the Basin now stands at nearly 130 m/decade (Beever et al. *in litt*.). In Craters of the Moon National Monument and Preserve (CRMO), pikas have been shown to be restricted to lava flow habitat in only the northern-most highest elevation portions of the park (Rodhouse et al. 2010). Recent habitat models (Craighead 2008) as well as dynamic models of climate-mediated extinction (Loarie et al. *in litt*.) predict that pikas may disappear from up to 80% of their current range by the turn of the century. Consequently, the species was recently considered for protection under the Endangered Species Act (USFWS 2009). Although the species was not listed as endangered or threatened, the USFWS acknowledged that “Climate change is a potential threat to the long-term survival of the American pika” (USFWS 2010). Regardless of the listing decision, it is imperative that parks actively plan for managing pika populations and pika habitat as climate changes.

This document reports on a research plan that will address critical shortfalls in our understanding of pika ecology and vulnerability to climate change. Products from this project will facilitate data-supported management actions in eight NPS units and more broadly across the west for pikas and their habitats, and will be integrated in an interpretive component. Systematic pika occupancy surveys are being conducted across a range of latitudes, longitudes, elevations, and substrate types (talus slopes vs. lava beds) from which researchers will develop both park-specific and regionally appropriate habitat models for assessing pika vulnerability to climate change (Objective 1). Using data on genetic variation from analyses of fecal DNA collected during occupancy surveys, recent gene flow patterns and habitat-based models of population and subpopulation connectivity within parks will be quantified (Objective 2). Finally, distribution, habitat, connectivity, and genetic data and models will be combined to conduct a quantitative vulnerability assessment that explicitly predicts pika response to climate change (Objective 3).

This project covers eight parks including Crater Lake National Park (CRLA), Craters of the Moon National Monument and Preserve (CRMO), Grand Teton National Park (GRTE), Great Sand Dunes National Park and Preserve (GRSA), Lassen Volcanic National Park (LAVO), Lava Beds National Monument (LABE), Rocky Mountain National Park (ROMO), and Yellowstone

National Park (YELL). These parks span over 1300 km in both latitude and longitude and include multiple physiographic divisions (http://water.usgs.gov/ GIS/dsdl/physio.gz) and climate divisions (http://www.esrl.noaa.gov/psd/data/usclimate/map.html). Genetic connectivity analyses are funded for five parks (CRLA, CRMO, GRTE, LAVO, and ROMO) that serve as representative study areas for each major genetic unit described by Galbreath et al. (2010) except central Utah and for each major substrate type (patchy montane talus and lava). The large geographic scale of this project provides a breadth of local and meso-scale settings that will enable meaningful analysis of drivers of pika occurrence under a shifting climate regime. Due to the habitat requirements and limited dispersal ability of American pikas, it is expected that habitat in national parks may be of increasing importance as refugia and therefore as source populations for future colonization events.

Methods

Pika site occupancy and habitat were evaluated at randomly-located sampling sites in eight national park sites following methods described in the peer-reviewed monitoring protocol developed by the Upper Columbia Basin Network (Jeffress et al. *in press*). Most habitat variables assessed were chosen as proxies for stresses related to climate change (e.g., elevation, slope aspect, substrate type), and several variables were collected in addition to those detailed in the protocol. The UCBN protocol uses tested sample and response designs and includes all the necessary instructions to ensure consistent data collection across parks and field crews. The project PIs used the protocol as well as expert knowledge to develop a collaborative survey manual, which served as a training manual and field guide for the various crews.

Sampling Frames and Site Selection

Survey site locations were drawn from GIS-based models of predicted habitat using the generalized random-tessellation stratified (GRTS) spatially-balanced sampling design described by Stevens and Olsen (2004). A GRTS sample design is a flexible, efficient, and statistically robust approach that accommodates many of the difficulties commonly encountered in field sampling (e.g., sample frame errors, inaccessibility), allows for inclusion of new sample locations in response to these difficulties, maintains spatial balance, and, through a modified variance estimator developed for GRTS samples, increases precision of status estimates (Stevens and Olsen 2003, 2004). These attributes help ensure that GRTS survey designs are representative of the target population of interest, may be efficiently implemented, and allow unbiased inference from sampled sites to un-sampled elements of the resource of interest. This last attribute of GRTS is possible because the design generates known inclusion probabilities (or "sample weights") and can adjust for biases in the design and be used in design-based inference. The sampling design also accounted for accessibility and safety concerns, determined on a park-by-park basis. Sites were further evaluated for their potential as pika habitat during field visits. A site had to contain ≥10% target habitat, which included talus, lava, outcrops or other forms of creviced rock that can provide shelter for pikas. Sites that did not meet the criteria were dropped from the sampling list and replaced with a GRTS oversample from the same stratum. Given variation among parks in data available for construction of the sampling frame, slightly different design specifications were used to select survey locations in each park. However, analyses of response variables will be compatible among parks in this project.

CRLA

In order to delineate a sampling frame for CRLA, a map of potential pika habitat was created using an automated process to define the boundaries of different habitat types in the park. NAIP imagery from 2007 was used as the base map. Polygons were delineated and then classified by habitat type. Those polygons containing potential pika habitat were identified and selected for inclusion in a map of potential pika habitat. As a final step, the potential pika habitat map was reviewed by a wildlife specialist at the park and edited where appropriate. For site accessibility considerations, the sampling frame only included areas within 1 km of roads. Furthermore, steep slopes (>35°), identified using digital elevation models in GIS, and traversable areas isolated by these steep slopes were excluded from sampling. The pika sampling frame for CRLA was then stratified by four elevational quantiles, with spatially-balanced samples distributed equally across each stratum.

CRMO

Historical sightings, recent pilot data (Rodhouse et al. 2010), current vegetation maps (Bell et al. 2009), and geologic maps were used to develop the CRMO sampling frames. Sampling was limited to habitat within 1 km of roads or sections of the northern portions of the CRMO Wilderness Trail and Tree Molds Trail. Given that the pilot analyses found pika distribution restricted to the northern portion of the Monument above 1600 m (Monument and Huddle's Hole frames from Rodhouse et al. 2010), these areas as well as additional areas within 1 km of Highway 93 and the Minidoka-Arco road were combined into one primary sampling frame to be sampled at regular intervals. Furthermore, steep slopes (>35°), identified using digital elevation models in GIS, and traversable areas isolated by these steep slopes were excluded from sampling. This frame captured >400 m range in elevation and was stratified by two elevational strata, based on median elevation of the frame, and in two substrate strata (i.e., pahoehoe and aa lava). This yielded a total of four strata with spatially-balanced samples distributed equally across each stratum.

GRSA

The sampling frame was based on an NPS Vegetation Map (Salas et al. 2010) combined with a cost surface model providing travel times to any point in the park given slopes, distances, and land cover (ROMN 2008). This combination allowed survey sites to be placed within a broad spectrum of potential pika habitats, with controlled inclusion probabilities. Ten habitat classes were sampled (Mountain Mahogany Shrubland, Pinyon Pine / Rockland Woodland, Alpine Bedrock and Scree, Alpine Fell-Field, Cliff, Canyon and Massive Bedrock, Alpine Turf, Subalpine-Montane Limber-Bristlecone Pine Woodland, Krummholz Shrubland and Avalanche Chute Shrubland). The potential for creviced rock habitats to occur in each habitat class was estimated independently by each of two experienced pika researchers. Averaged estimates were used to apportion survey sites among habitat classes to attain a representative sample in which survey effort scaled with the putative availability of pika habitat. Results from the first survey will be used to update estimates of habitat availability across habitat classes as a basis for designing the second survey. Explicit stratification by elevation was not necessary because the available elevation gradient was adequately sampled by distributing survey sites across cost-class/habitat-class combinations as described. For surveys planned in 2010, a base or expected sample size of 100 with a very large oversample (500) was created. Prior to surveys, the base sample was reviewed by three experienced pika researchers who used a high-resolution aerial image of GRSA (NAIP 2006) to determine the accessibility of each site as well as the potential for presence of creviced rock habitats within 100 m of each site. Sites that were deemed inaccessible or in inappropriate habitat (n = 15) were replaced by sites from the oversample, following the appropriate sequence and matching habitat classes to maintain the integrity of the design. Crews attempted to survey as many sites in the resulting base sample as time allowed (83 of 100 sites).

GRTE

Potential pika habitat was identified using GRTE's 2005 Vegetation Map (Cogan et al. 2005). Talus polygons were created from vegetation layers classified as "cliff and talus sparse vegetation." For site accessibility, frame areas were restricted within 1 km of roads and 600 m of maintained and user created trails. Furthermore, steep slopes (>35°), identified using digital elevation models in GIS, and traversable areas isolated by steep slopes were excluded from the sampling frame. The pika sampling frame for GRTE was stratified by four elevational quantiles, with spatially-balanced samples distributed equally across each stratum.

LABE

A map of the black lava flows provided by the park was used to delineate available habitat for the LABE sampling frame. The sampling frame includes areas designated as wilderness and portions of the Callahan, Schonchin, Ross, and Devils Homestead Flows. This sampling frame also captured the majority of study area addressed by Ray and Beever (*in litt.*). For site accessibility considerations, the sampling frame only included areas within 1 km of roads and excluded steep slopes (>35°), which were identified using digital elevation models in GIS. Samples were distributed across two elevational strata based on median elevation of the frame.

LAVO

In order to delineate a sampling frame for LAVO, a map of potential pika habitat was created using an automated process to define the boundaries of different habitat types in the park. NAIP imagery from 2007 was used as the base map. Polygons were delineated and then classified by habitat type. Those polygons containing potential pika habitat were identified and selected for inclusion in a map of potential pika habitat. As a final step, the potential pika habitat map was reviewed by a wildlife specialist at the park and edited where appropriate. Given the remoteness of a significant amount of potential habitat, the sampling frame included areas within a 1 km buffer of trail sections in addition to the habitat within 1 km of roads. Starting from the trailhead, 1 km of each trail was buffered, and in a couple instances, >1 km of trail (≤3 km of the Butte Lake trails and 2 km of the southern portion of Kings Creek Trail). Furthermore, steep slopes (>35°), identified using digital elevation models in GIS, and traversable areas isolated by steep slopes were also excluded from the LAVO sampling frame. The pika sampling frame for LAVO was stratified by four elevational quantiles, with spatially-balanced samples distributed equally across each stratum.

ROMO

The same sampling scheme described for GRSA was also used in ROMO, with the following adjustments. Using an NPS Vegetation Map for ROMO (Salas et al. 2005), seven habitat classes were included within the sampling frame (Herbaceous Upland Alpine above 9600 ft, Fellfield, Herbaceous Upland Alpine, Krummholz, Talus, Rock Alpine-Upper Subalpine, Cliff Face-Bare Soil/Rock, Rock Foothill-Lower Subalpine). A base sample of 100 points was reviewed using a high-resolution aerial image of ROMO (Salas et al. 2005), and unsuitable sites (n = 11) were replaced by sites from a large oversample (n = 500), following the appropriate sequence and matching habitat classes. Crews attempted to survey as many sites in the resulting base sample as time allowed (75 of 100 sites).

YELL

Polygons of potential pika habitat were derived by combining talus habitat type polygons with colluvium landform polygons. These two mapping units were considered to have the most potential as being pika habitat and were combined in hopes to maximize the chances of drawing a sample from all potential pika habitat in YELL. The talus habitat type was defined as areas dominated by talus and rubble fields with very little vegetation other than lichens (Despain, Yellowstone National Park, personal communication). Talus habitat type polygons were obtained from the Vegetation Habitat Type map of Yellowstone National Park (Despain 1990, Dixon

1997). The colluvium landform was defined as areas of loose bodies of sediment that had been transported by gravity and deposited at the bottom of slopes. The colluvium landform polygons were obtained from the Landform and Parent Material Surficial Geology Map of Yellowstone National Park (A. Rodman, Yellowstone National Park, personal communication). For site accessibility considerations, the sampling frame included only areas within 1 km of roads and 1 km of maintained trails. Steep slopes (>35°), identified using digital elevation models in GIS, and traversable areas isolated by steep slopes were excluded from the sampling frame. The pika sampling frame for YELL was stratified by four elevational quantiles, with spatially-balanced samples distributed equally across each stratum.

Occupancy Surveys

A site was defined as a 12-m radius plot containing ≥10% target habitat. Although survey crews varied in size, survey effort was standardized among sites and parks, usually by having only one crew member survey each site. Surveys began with a 5-minute period of silent observation to allow for visual and aural detection. The surveyor then thoroughly examined the entire plot and recorded all evidence of pika activity that he/she detected, including pika sightings, calls, scat, and hay. Once the surveyor felt the survey was complete, he/she collected appropriate fecal samples (see below) and, in some cases, marked the plot if it was planned for resurvey. Finally, a vegetation survey and ancillary data were collected. A site was considered occupied for the purposes of this report if either a pika was seen or heard within the plot and/or fresh scat or fresh hay was found within the plot. Occupancy modeling has not yet been conducted for this project (but see Rodhouse et al. 2010 for an example), so all reports of "occupied" sites in this document refer to those sites at which fresh sign was detected. Detection probabilities have not yet been estimated and our estimates of the proportion of sites "occupied" are therefore preliminary and conservative. The proportion of sites "occupied" that are reported here vary widely by park. Because our results are preliminary, we strongly caution that no inferences should be made that compare the proportions among parks; for example, by concluding that CRLA has more pikas than LAVO. There are fundamental differences in the distribution and characteristics of suitable habitat and the coming detailed data analyses should provide more insight into factors affecting pika site occupancy. Furthermore, complete reporting of detection and occupancy probabilities will follow in future reports.

Genetic Sample Collection and Lab Techniques

Fecal pellets were collected both during occupancy surveys and opportunistically as a non-invasive technique for sampling genetic material. Samples were collected at each park by field crews during occupancy surveys, using a flexible protocol that allowed several collection methods depending on user preference. Care was taken to avoid contamination both from other samples and from the person handling the sample. Samples were considered to be associated with a survey plot if they were collected within the 12-m plot radius or up to 300 m from the plot center. Other samples were collected in transit between survey sites and are termed "opportunistic" within this report. A targeted, patch-based approach was employed to sample collection at CRLA to increase sample size and to support analyses at both the individual and population level. This patch-based approach will be extended to other parks during the 2011 field season. To avoid sampling the same individual multiple times, most fecal samples were collected at a spacing of approximately 50 m apart, although duplicates were sometimes collected at the same site to ensure that at least one high-quality sample was collected. A protocol for aging samples in the field was developed using a standardized set of age categories. Because fresh pellets will usually result in higher-quality DNA, only the freshest pellets available were collected.

Project researchers at Oregon State University have tested several extraction methods and have successfully extracted DNA from a small test set of fecal samples collected during the 2010 field season. The extraction process has been optimized by testing different amounts of fecal material. A preliminary set of five microsatellite loci has been screened using archive tissue (provided by C. Ray) and fecal DNA samples; all five loci have been amplified successfully from the test fecal DNA samples and have been visualized on an ABI 3730 DNA Analyzer. Additional markers are being screened and, if needed, redesigned to include up to twenty variable microsatellite loci.

Results

The pika occupancy survey season ran from mid-June until mid-October, although specific dates varied by park. A total of 677 sites were surveyed across the eight parks and 387 fecal samples for genetic analysis were collected across the five parks. An Access database with data entry manual was developed and provided to the field leads in late August. Data entry and quality assurance was completed in early November.

CRLA

Four people surveyed CRLA from August to September of 2010.

Occupancy surveys

A total of 85 sites were surveyed for evidence of pika activity. Fifty-five of the sites surveyed were considered occupied, seven sites had only old sign, and 23 sites lacked any evidence of pika activity within the plot. Therefore, the proportion of sites surveyed considered occupied in CRLA was 0.647. The locations of sites surveyed and detection results for CRLA are presented in Figure 1.

Genetic sampling

In CRLA, 190 fecal samples were collected for use in genetic analyses (Figure 2). In addition to samples collected during occupancy survey efforts, J. Castillo was able to target unsurveyed areas for additional sampling.

CRMO

One person surveyed CRMO in July and September of 2010.

Occupancy surveys

A total of 56 sites were surveyed for evidence of pika activity. Twelve of the sites surveyed were considered occupied, three sites contained only old sign, and 41 sites lacked any evidence of pika activity within the plot. Therefore, the proportion of sites surveyed considered occupied in CRMO was 0.214. The locations of sites surveyed and detection results for CRMO are presented in Figure 3.

Genetic sampling

In CRMO, 11 fecal samples were collected for use in genetic analyses (Figure 4).

GRSA

A crew varying in size from two to five people surveyed GRSA from August to October of 2010. This park was not included among those proposed for genetic analyses.

Occupancy surveys

A total of 49 sites were surveyed for evidence of pika activity (34 of the 83 site surveys attempted were abandoned due to lack of target habitat or difficulties with access). Thirty-five of the sites surveyed were considered occupied, six sites contained only old sign, and eight sites lacked any evidence of pika activity within the plot. Therefore, the proportion of sites surveyed considered occupied in GRSA was 0.714. The locations of sites surveyed and detection results for GRSA are presented in Figure 5.

GRTE

Twelve field personnel conducted pika occupancy surveys in GRTE. Surveys began in late June and were completed mid-October of 2010.

Occupancy surveys

A total of 119 sites were surveyed for evidence of pika activity. Fifty-four of the sites surveyed were considered occupied, 35 sites contained only old sign, and 30 sites lacked any evidence of pika activity within the plot. Therefore, the proportion of sites surveyed considered occupied in GRTE was 0.454. The locations of sites surveyed and detection results for GRTE are presented in Figure 6.

Genetic sampling

In GRTE, 112 fecal samples were collected for use in genetic analyses (Figure 7).

LABE

Two people surveyed LABE in June, August, and September of 2010. This park was not included among those proposed for genetic analyses.

Occupancy surveys

A total of 101 sites were surveyed for evidence of pika activity. Twenty-four of the sites surveyed were considered occupied, 22 sites contained only old sign, and 55 sites lacked any evidence of pika activity within the plot. Therefore, the proportion of sites surveyed considered occupied in LABE was 0.238. The locations of sites surveyed and detection results for LABE are presented in Figure 8.

LAVO

Three people surveyed LAVO from July to early September of 2010.

Occupancy surveys

A total of 76 sites were surveyed for evidence of pika activity. Eleven of the sites surveyed were considered occupied, six sites contained only old sign, and 59 sites lacked any evidence of pika activity within the plot. Therefore, the proportion of sites surveyed considered occupied in LAVO was 0.145. The locations of sites surveyed and detection results for LAVO are presented in Figure 9.

Genetic sampling

In LAVO, 15 fecal samples were collected for use in genetic analyses (Figure 10).

ROMO

A crew varying in size from two to five people surveyed ROMO from July to October of 2010.

Occupancy surveys

A total of 58 sites were surveyed for evidence of pika activity (17 of the 75 site surveys attempted were abandoned due to lack of target habitat or difficulties with access). Thirty-nine of the sites surveyed were considered occupied, seven sites contained only old sign, and 12 sites lacked any evidence of pika activity within the plot. Therefore, the proportion of sites surveyed considered occupied in ROMO was 0.672. The locations of sites surveyed and detection results for ROMO are presented in Figure 11.

Genetic sampling

In ROMO, 59 fecal samples were collected for use in genetic analyses (Figure 12).

YELL

Twelve people, two full-time pika technicians and ten part-time pika technicians, surveyed YELL from late June to late September of 2010. This park was not included among those proposed for genetic analyses.

Occupancy surveys

A total of 133 sites were surveyed for evidence of pika activity. Seventy-three of the sites surveyed were considered occupied, 16 sites contained only old sign, and 44 sites lacked any evidence of pika activity within the plot. Therefore, the proportion of sites surveyed considered occupied in YELL was 0.549. The locations of sites surveyed and detection results for YELL are presented in Figure 13.

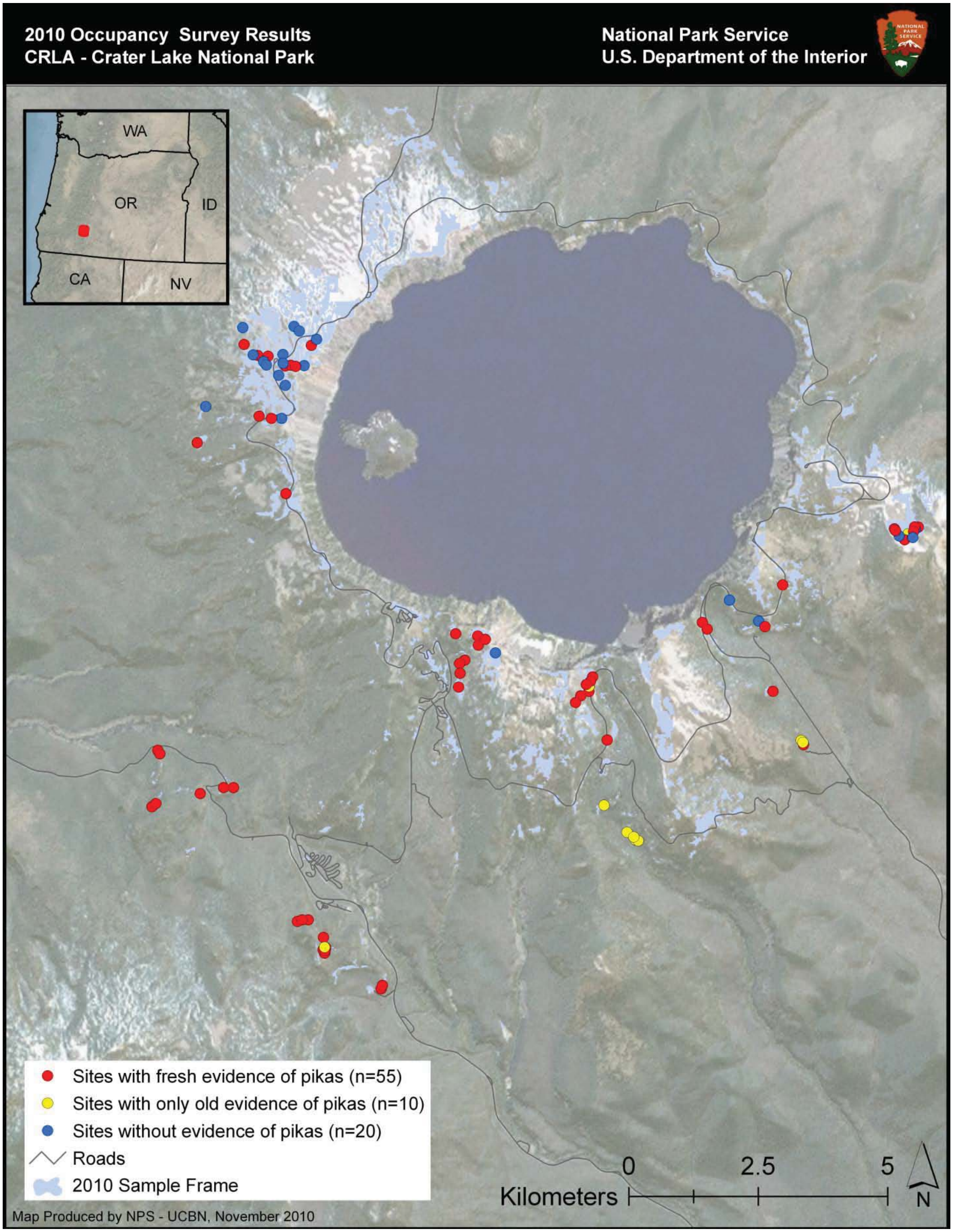

Figure 1. Map of sites surveyed with survey results for CRLA.

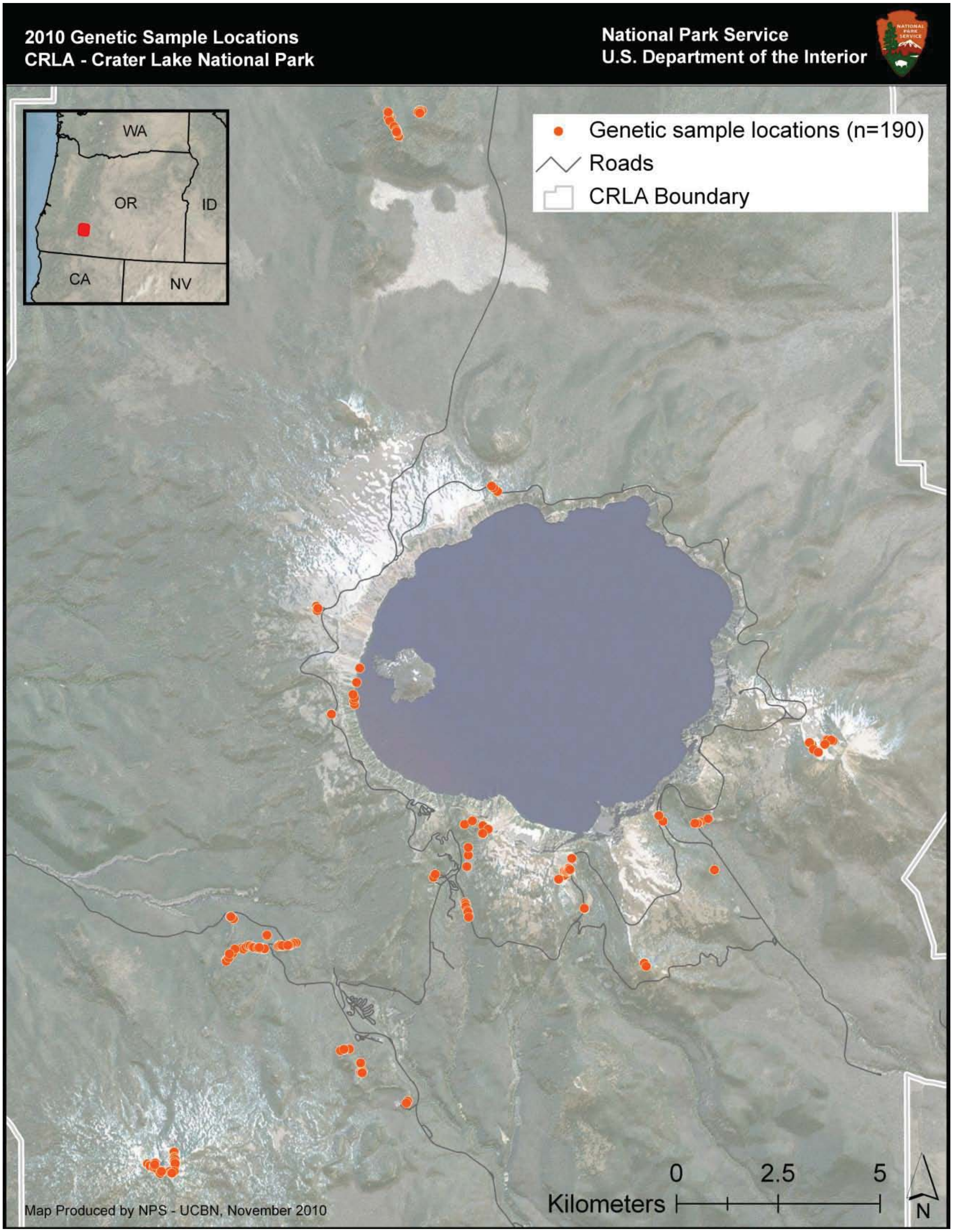

Figure 2. Map of locations in CRLA where fecal samples were collected for use in genetic analyses.

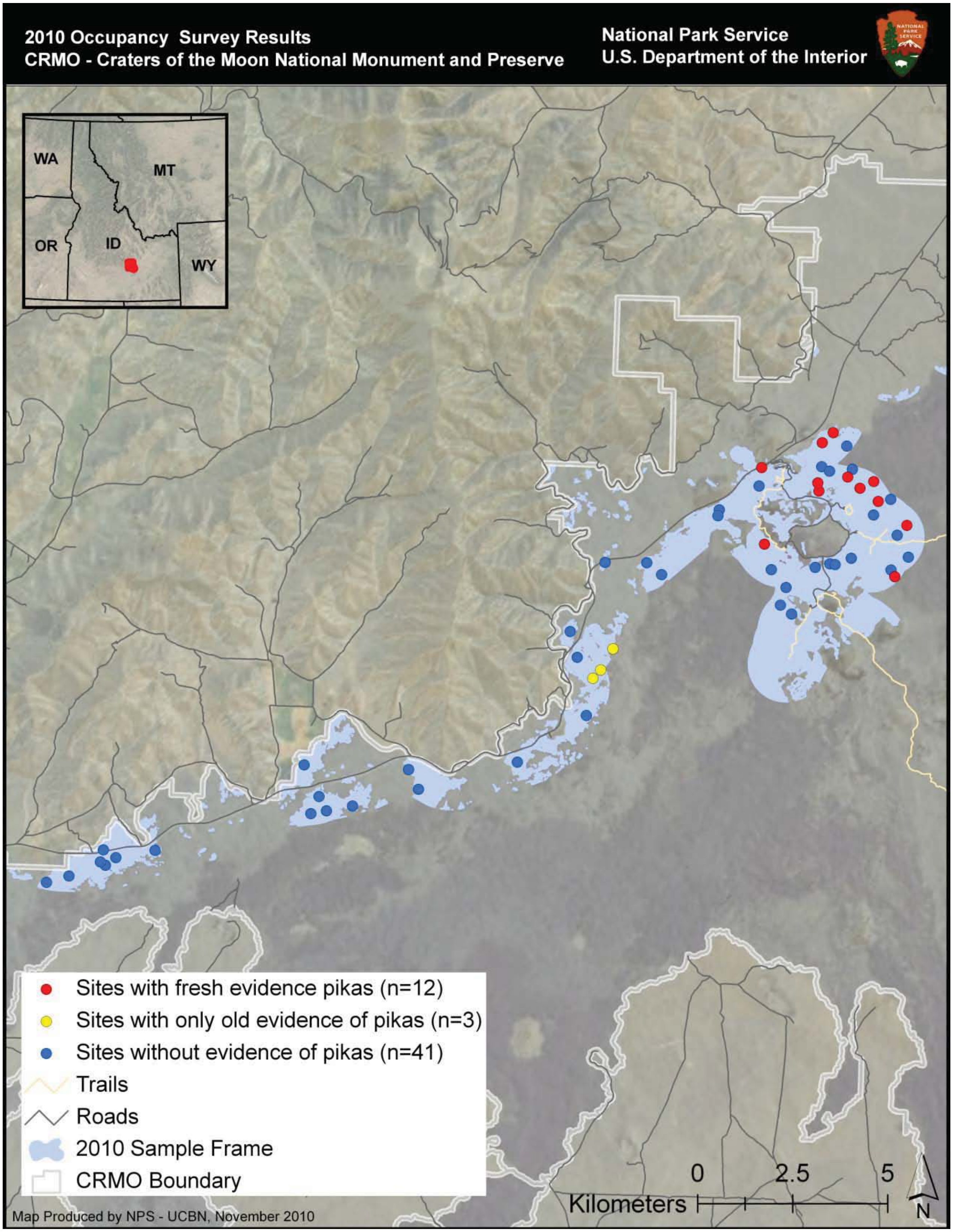

Figure 3. Map of sites surveyed with survey results for CRMO.

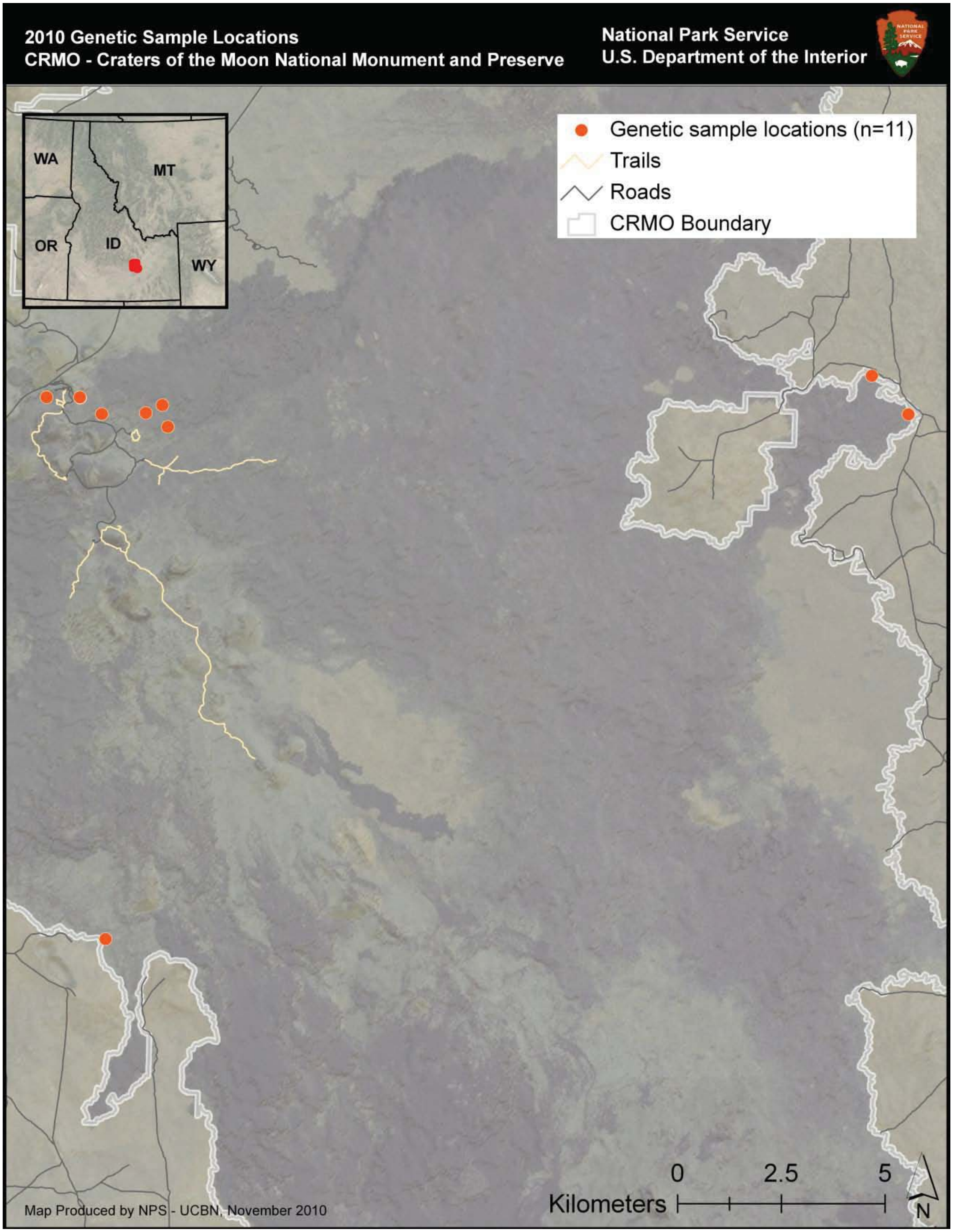

Figure 4. Map of locations in CRMO where fecal samples were collected for use in genetic analyses.

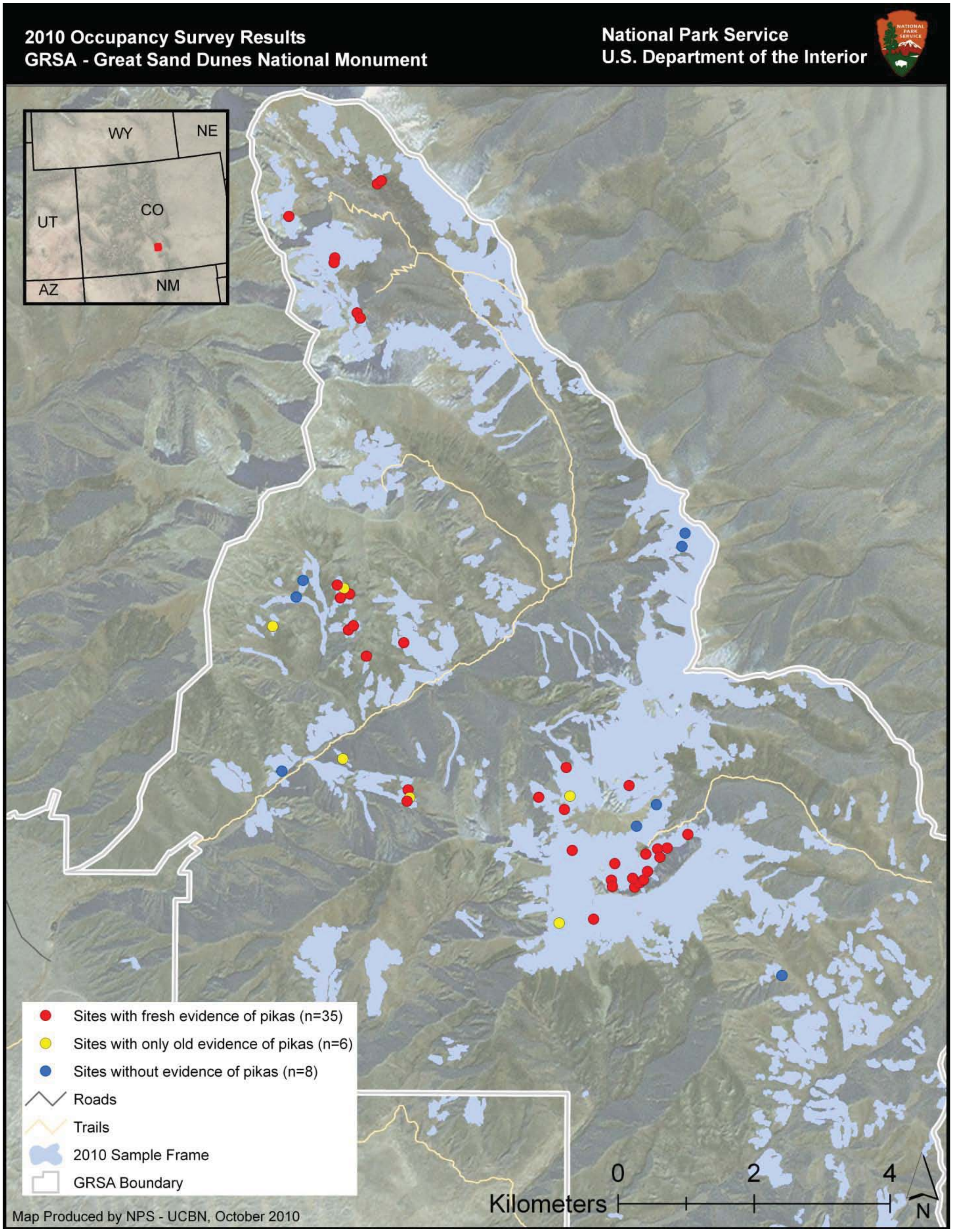

Figure 5. Map of sites surveyed with survey results for GRSA.

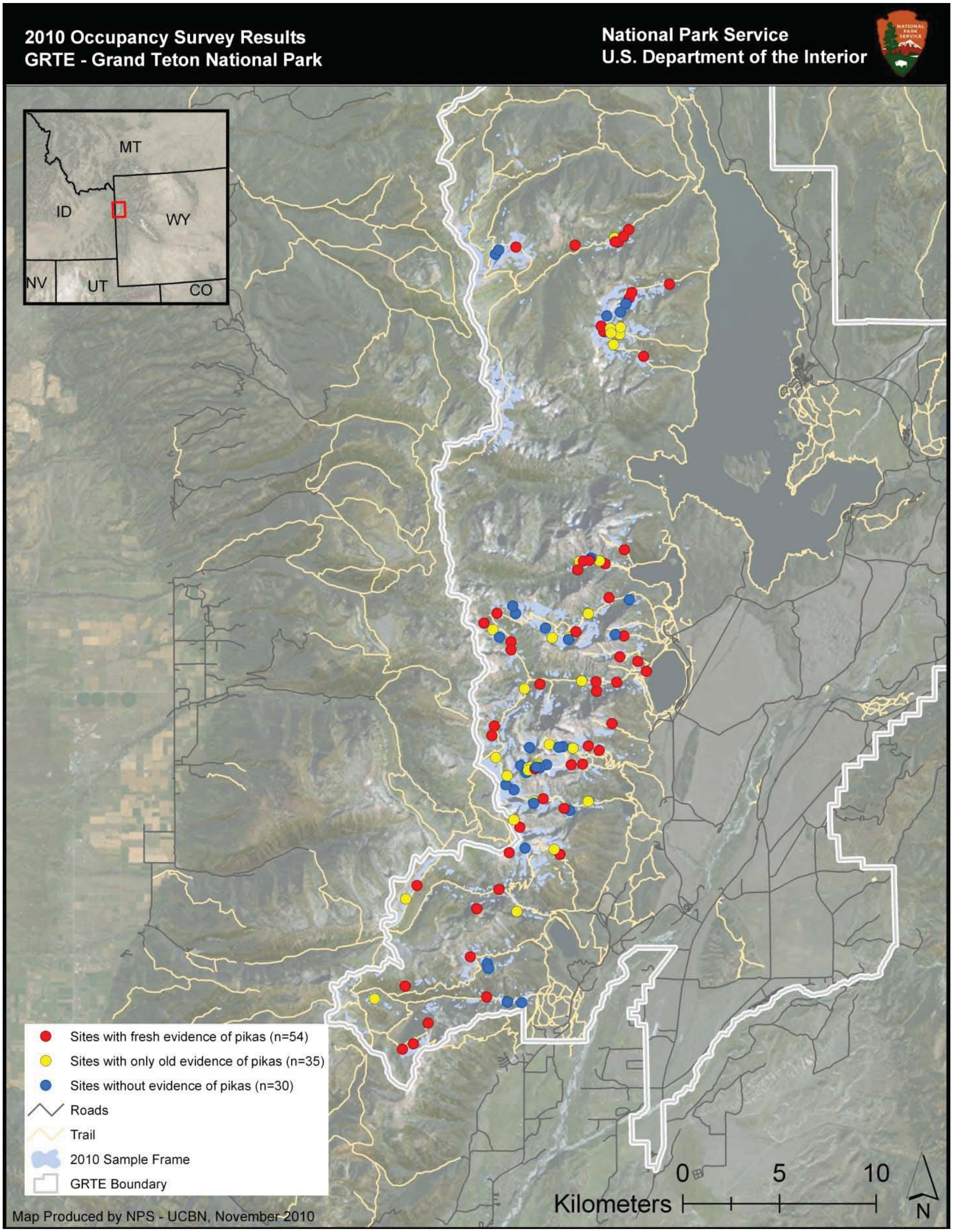

Figure 6. Map of sites surveyed with survey results for GRTE.

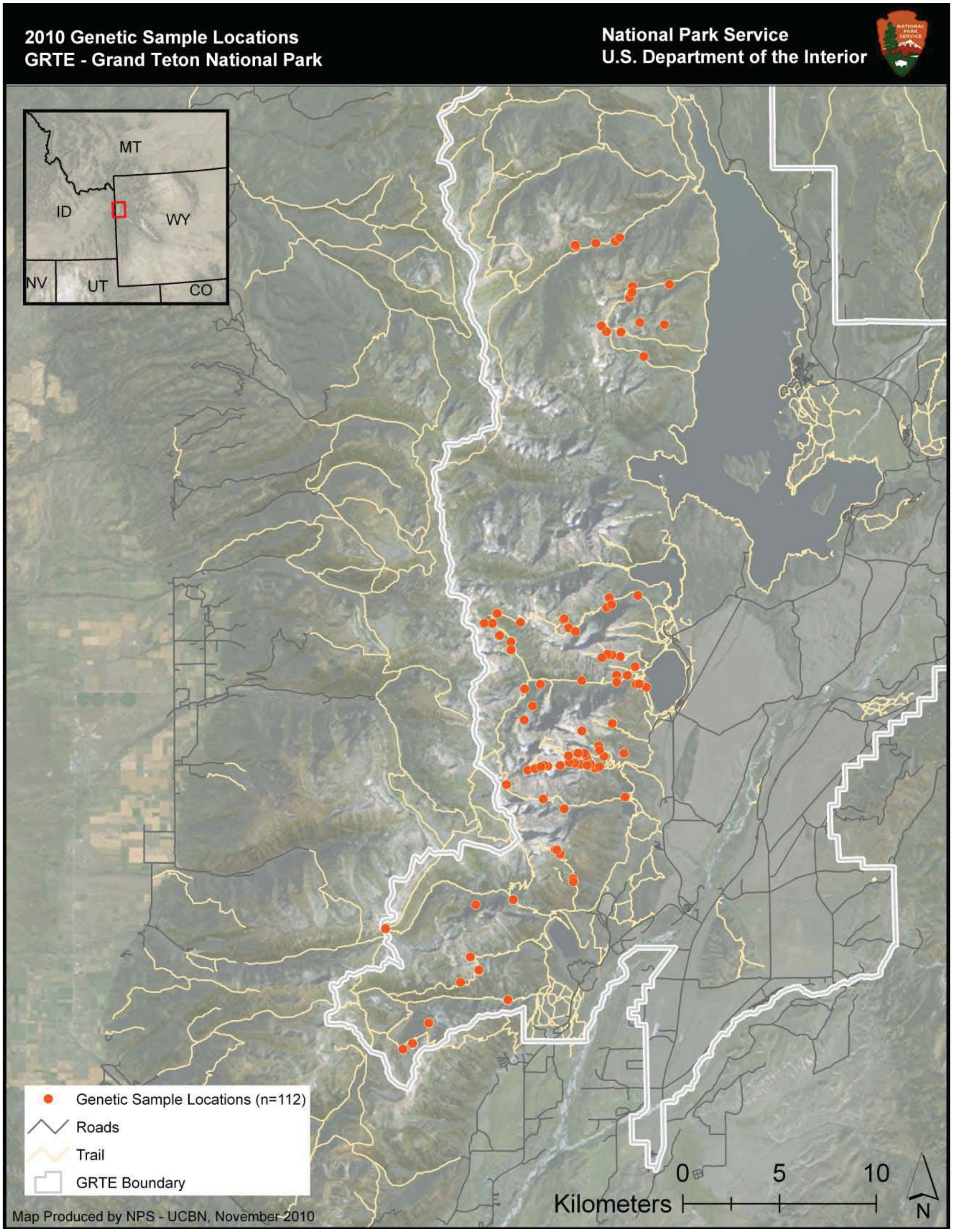

Figure 7. Map of locations in GRTE where fecal samples were collected for use in genetic analyses.

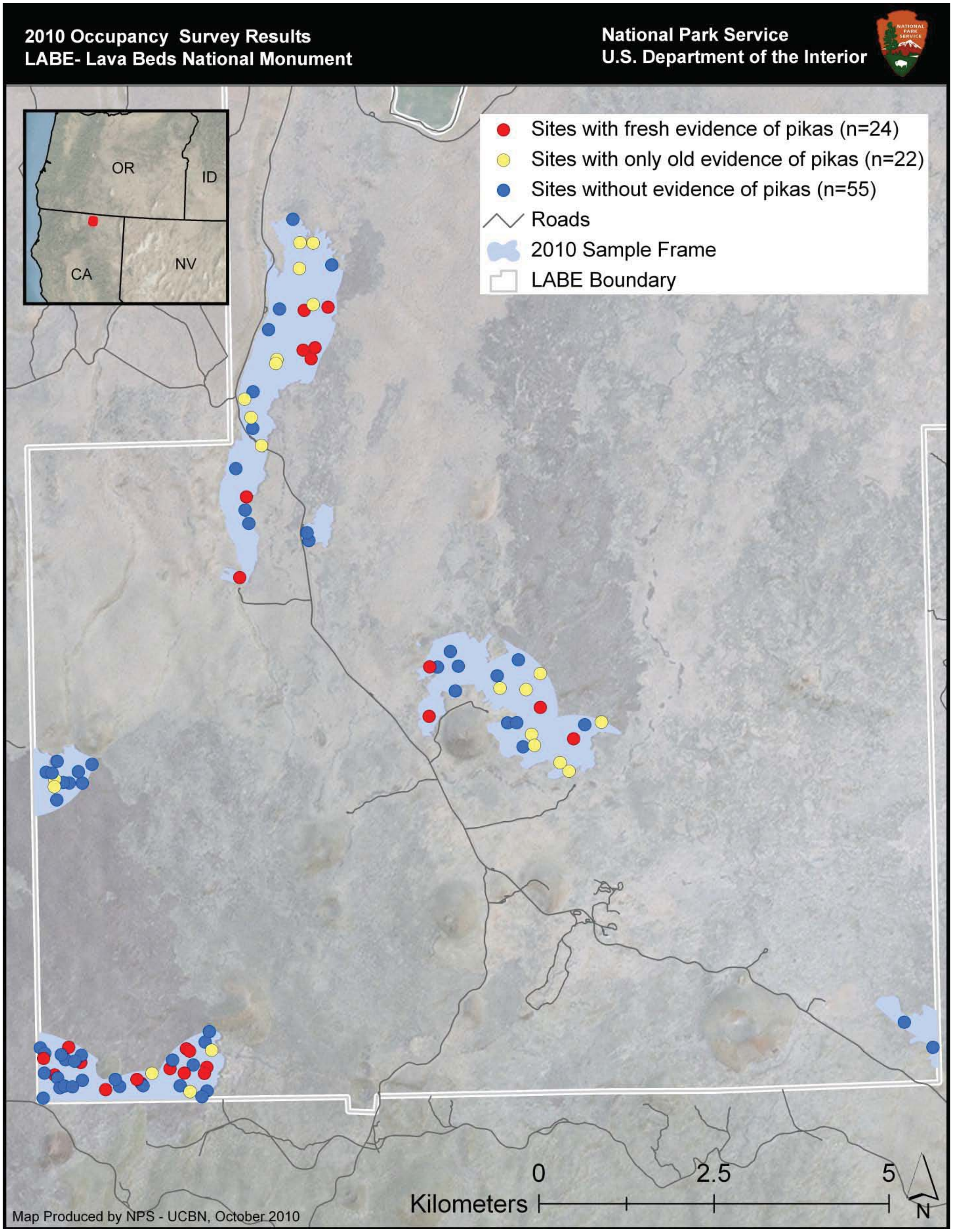

Figure 8. Map of sites surveyed with survey results for LABE.

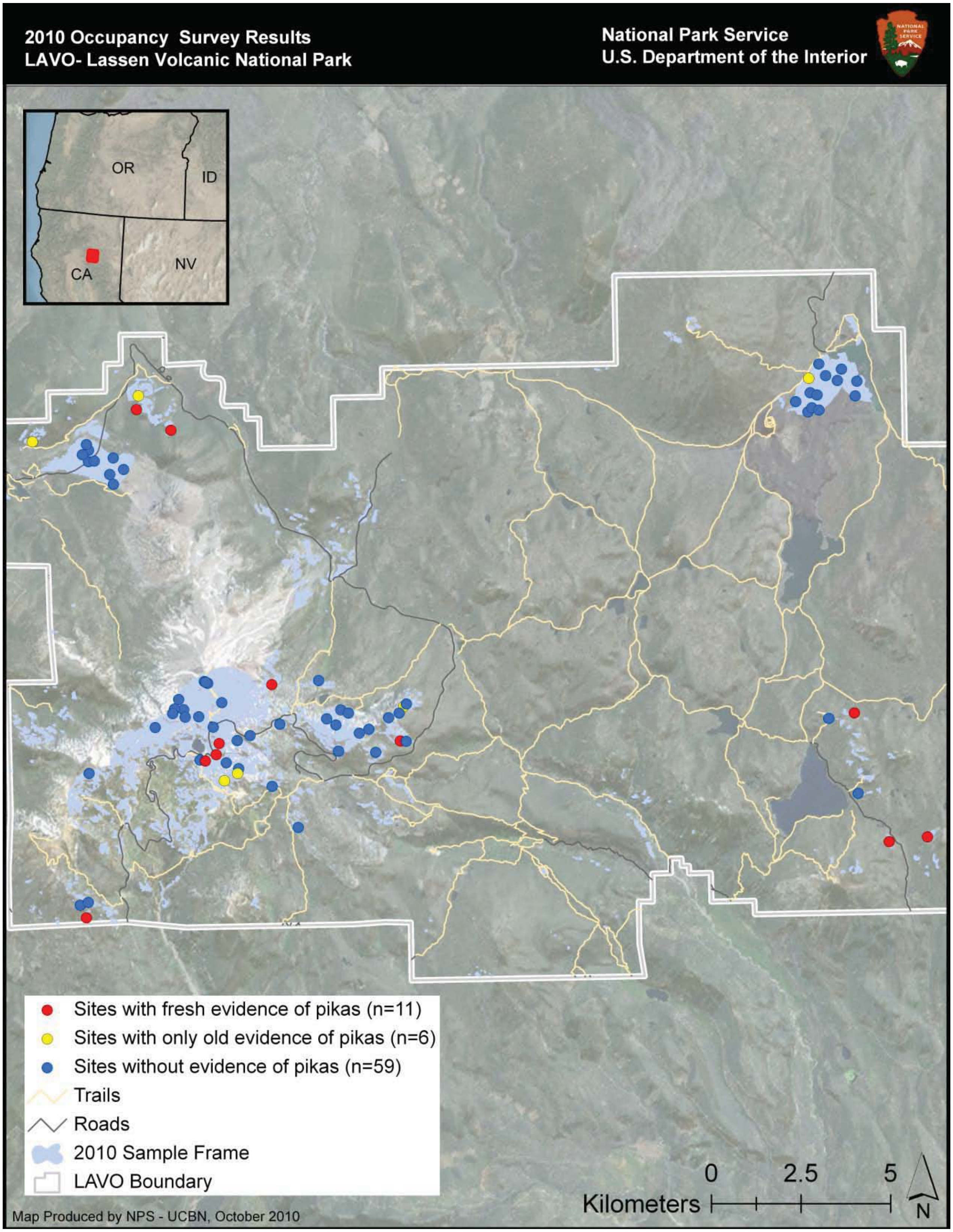

Figure 9. Map of sites surveyed with survey results for LAVO.

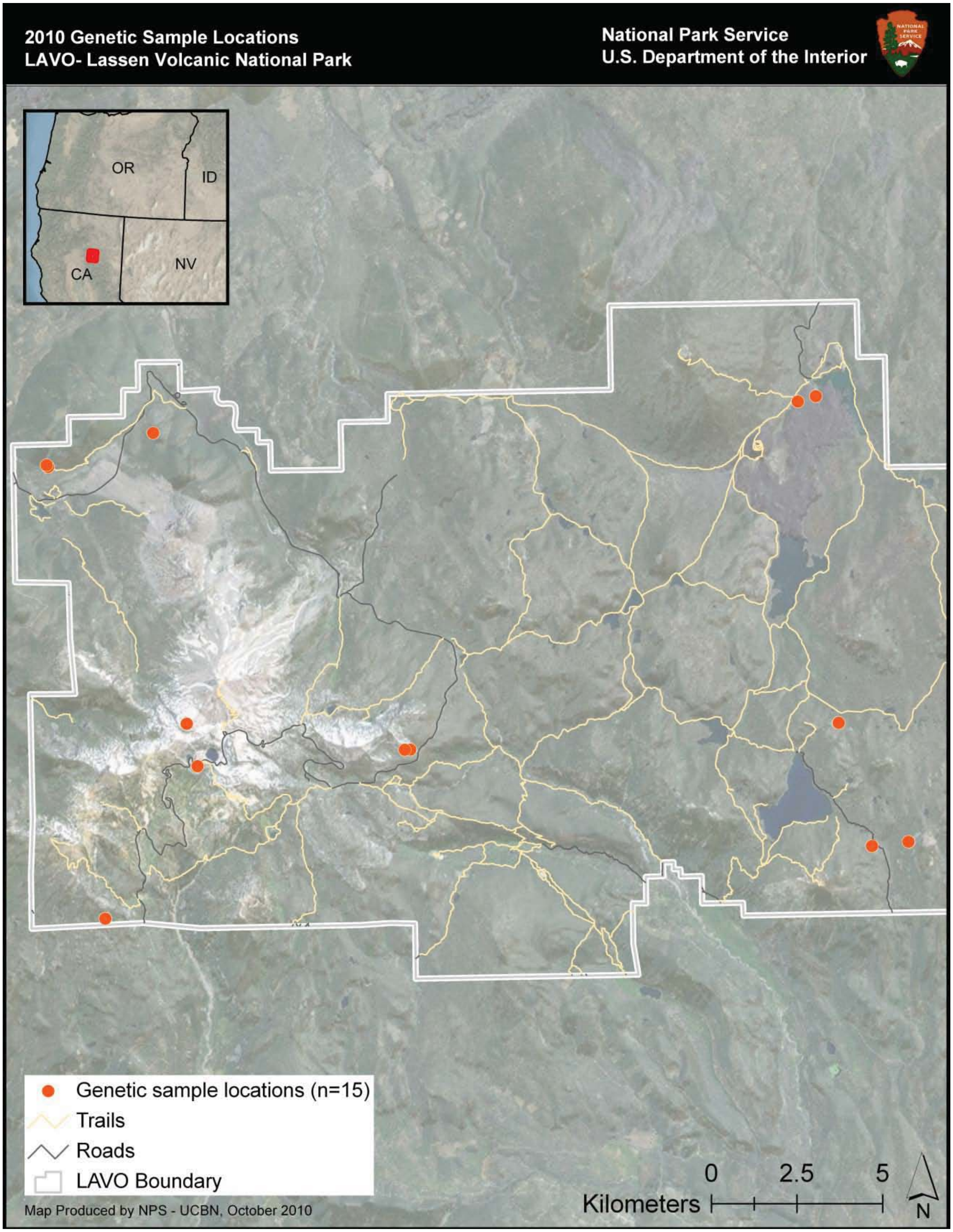

Figure 10. Map of locations in LAVO where fecal samples were collected for use in genetic analyses.

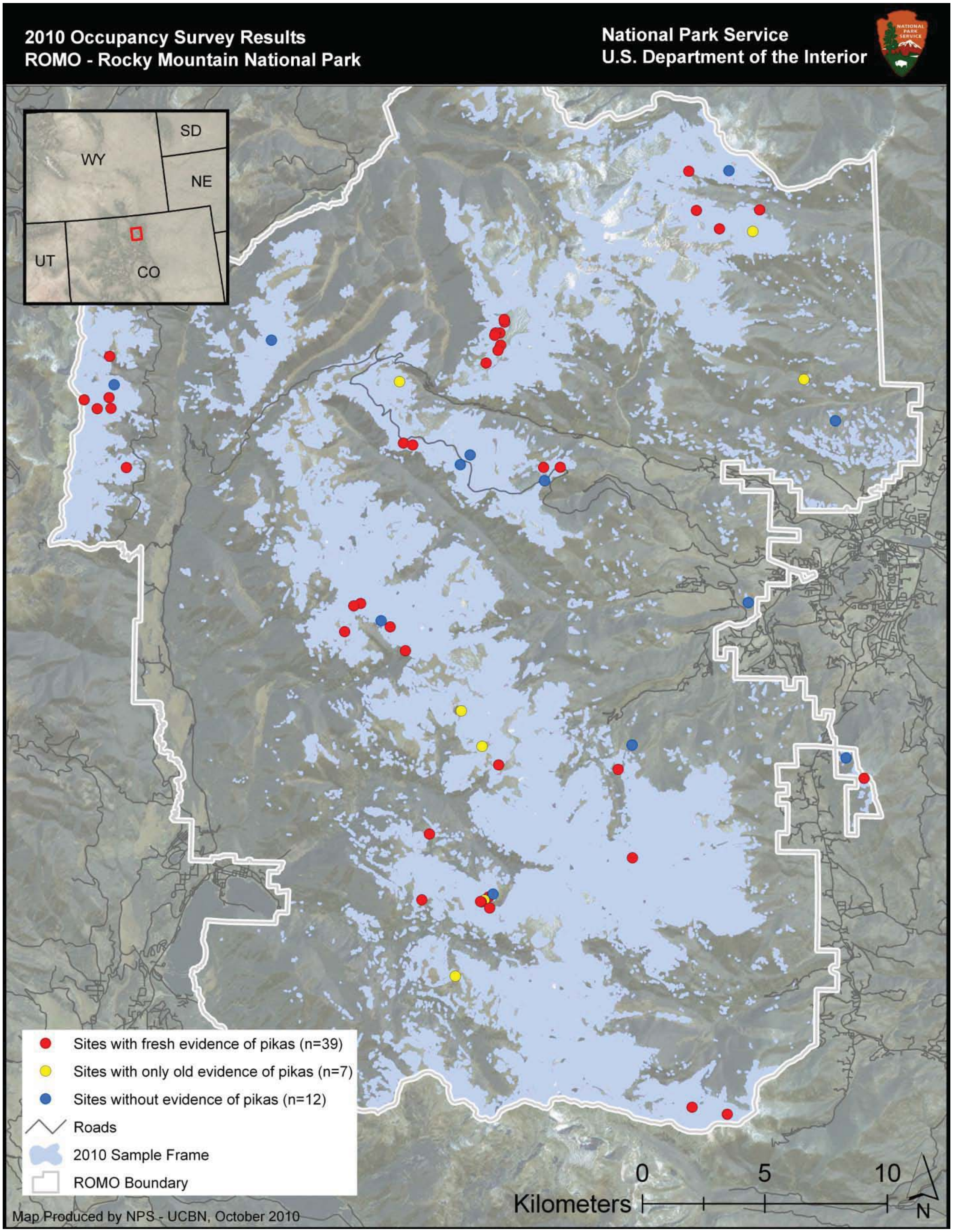

Figure 11. Map of sites surveyed with survey results for ROMO.

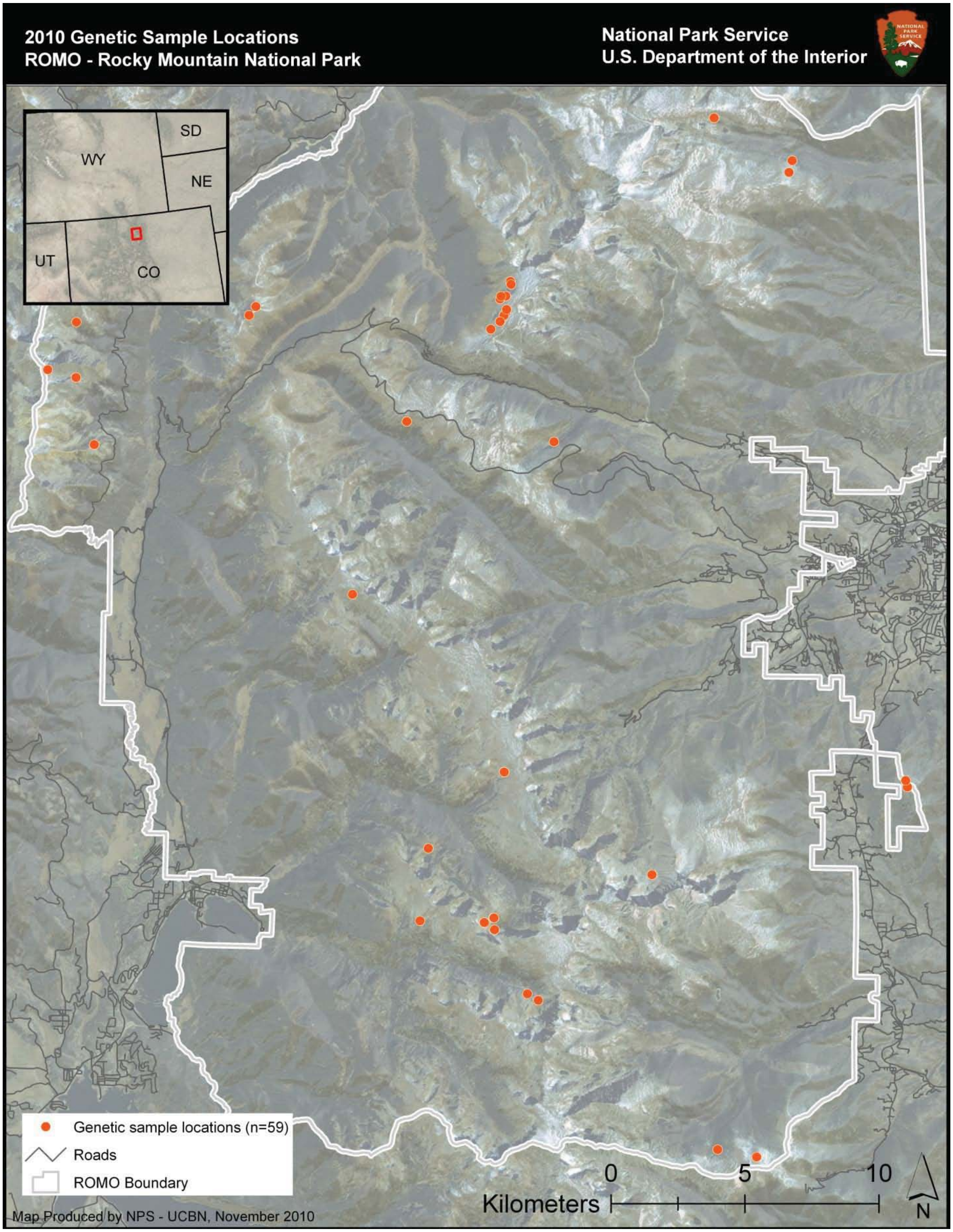

Figure 12. Map of locations in ROMO where fecal samples were collected for use in genetic analyses.

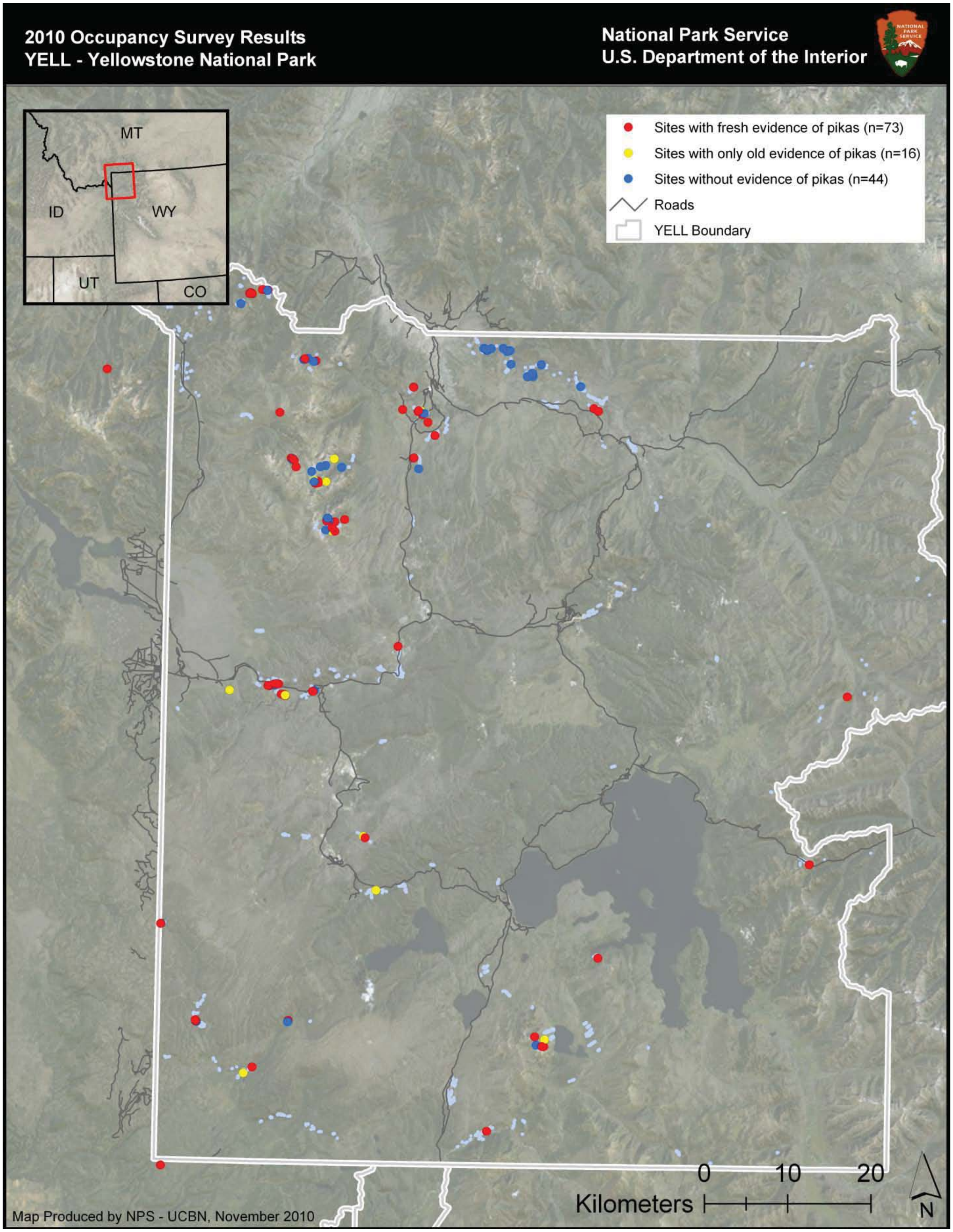

Figure 13. Map of sites surveyed with survey results for YELL.

Discussion

Data analyses are just beginning. Two overall project resource briefs have been created (see Appendixes A and B). Other project deliverables, such as park-specific resource briefs and an Objective 1 handout are in development. Once ready, these briefs will be reviewed by the appropriate NPS staff (i.e., resource managers, park interpretive representatives) and then posted to the “Pikas in Peril” website (http://science.nature.nps.gov/im/units/ucbn/monitor/pika/pika_peril/index.cfm). Additionally, web content for PikaNet, a pika surveying citizen-science program (http://www.citsci.org/cwis438/Browse/Project/Project_Info.php?ProjectID=275&WebSiteID=7), will continue to be developed.

Occupancy surveys and collection of fecal samples will continue the summer of 2011 and a similar Annual Accomplishments Report will be produced in the fall of 2011. A manuscript presenting multi-year analyses of occupancy data collected between 2010 and 2011 will be produced in 2012.

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Appendix A. Resource Brief – Project Summary

National Park Service
U.S. Department of the Interior

Resource Brief

Pikas in Peril

Multi-regional vulnerability assessment of a climate-sensitive sentinel species

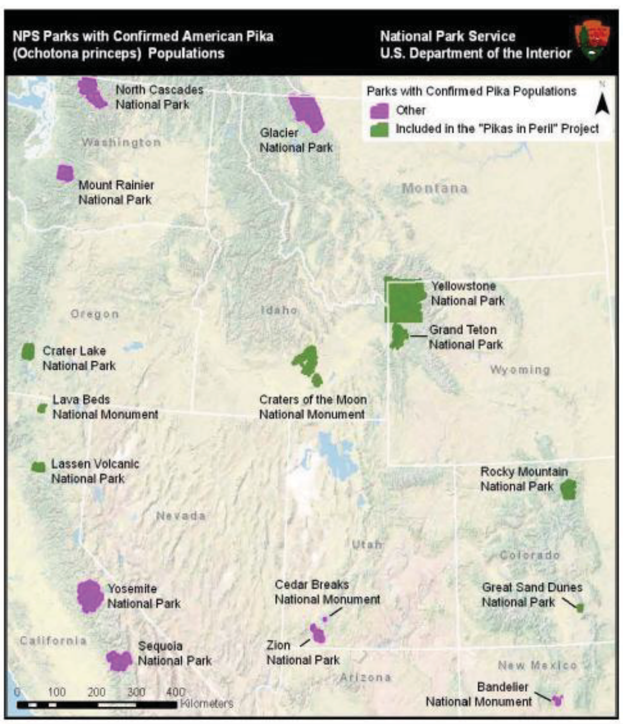
Importance: Species vulnerable to climate change

The American pika is considered an indicator species for detecting ecological effects of climate change. Results from recent studies suggest that in some areas pikas are being lost from lower elevations in response to increased warming, and thus, their suitable habitat is being reduced. In models designed to predict these patterns of loss, the importance of climatic factors has risen dramatically over the past decade. Recent habitat and extinction models predict that pikas may disappear from up to 80% of their current range by the turn of the century. Understanding the pika's vulnerability to climate change can provide important insights to park managers about potential impacts of climate change on park ecosystems. The National Park Service has a unique opportunity to assess the vulnerability of pikas to climate change by studying pika populations within the western U.S. parks. Sixteen western U.S. national park units have pika populations and eight of those units are included in this research effort (see map below).

American pika (*Ochotona princeps*)
Photo: John Apel, NPS

Parks involved in the project

- Crater Lake National Park, OR
- Craters of the Moon National Monument and Preserve, ID
- Grand Teton National Park, WY
- Great Sand Dunes National Park and Preserve, CO
- Lassen Volcanic National Park, CA
- Lava Beds National Monument, CA
- Rocky Mountain National Park, CO
- Yellowstone National Park, WY, MT, ID



Map of park units with confirmed pika populations and those involved in this project

Project background

This 3-year research project, funded through the National Park Service Climate Change Response Program, will address critical shortfalls in our understanding of pika ecology and vulnerability to climate change. A large team of academic researchers and National Park Service staff will work together to address questions regarding the vulnerability of the American pika to future climate change scenarios projected for the western United States. This team will also work with staff from the participating parks to develop information materials for the public and increase awareness.

http://science.nature.nps.gov/im/units/ucbn/monitor/pika/pika_peril/index.cfm September 2010

Project objectives

1. Document pika occurrence patterns and predict pika distribution across the eight park units.
2. Measure gene flow and model connectivity of pika populations within five park units representing major genetic subdivisions and habitat types.
3. Project climate change effects on the future distribution, connectivity and vulnerability of pika populations in each park unit.

Methods and Project Status

The research team is collecting occupancy and habitat data at each of the parks, following a modified version of the peer-reviewed protocol developed by the NPS in 2009 for several parks in the western U.S. Focal data include variables that serve as proxies for stresses related to climate change (e.g., elevation). Occupancy of sites is determined by surveying for pikas, pika calls, fresh food caches, and fresh fecal pellets within plots with a 12-m radius, which represents an average territory size. Field crews are conducting these surveys at 80-100 sites per park July-October of 2010 and a similar number of sites, including 40-50 new sites, will be surveyed in 2011. Using information on genetic variation from analyses of fecal DNA collected during occupancy surveys and additional patch-based sampling, the team will quantify recent gene flow patterns and develop habitat-based models of population and subpopulation connectivity within parks. Finally, the team will combine models of distribution, habitat, population connectivity, and genetic diversity to assess the vulnerability of pikas to climate change in each park. Throughout the project, the team will develop and consistently update general and park-specific resource briefs, produce annual accomplishment reports, and work with interpretive staff on communication materials such as a powerpoint presentation and website content.

Above: A technician conducting a pika survey at Great Sand Dunes. ***Photo: Jon Harris***
Below: A pika haypile and fresh scat. ***Photo: Michael Munts, NPS***

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Appendix B. Resource Brief - Interpretive

Climate Change Response Program
Pikas in Peril Project

National Park Service
U.S. Department of Interior

Photo courtesy of Michael Durham

American Pika (*Ochotona princeps*)

How is Climate Change affecting Pikas?

The American pika (*Ochotona princeps*) is a charismatic and conspicuous inhabitant of many western mountain landscapes. Pikas are related to rabbits, are slightly larger than a hamster, have short rounded ears and lack a visible tail. They are herbivores; grazing during summer and gathering grass and flowers for their haypiles to eat during the winter. They live in high elevation talus, boulder fields and lower elevation lava flows. Pikas are very active and have a high average body temperature of 104.2 °F, making them temperature-sensitive. Consequently, they adjust their behavior and activities to maintain this temperature, using the abundant crevices and cavities found in these areas that provide cover during the summer and insulation during the winter.

Climate change may pose a major threat to pika populations. Warmer summer temperatures may prevent them from foraging and finding enough food, and reduced snowpacks could mean they are more exposed to cold rain and wind. Results from recent research have shown that certain pika populations have been lost in lower elevations. In fact, 9 of 25 populations in the Great Basin have been lost over the past few decades, and there has been no evidence of recolonization.

Pika populations can be found in low and high elevations depending on their geographic location. Boulder fields are one of the typical pika habitats.

The Pikas in Peril Project

The National Park Service Climate Change Response Program has funded this project to address questions regarding the vulnerability of the American pika to future climate change scenarios projected for the western United States. A large team of academic researchers and National Park Service staff are involved in this project, and will be working in these 8 National Park Service Units: Crater Lake, Great Sand Dunes, Grand Teton, Lassen Volcanic, Rocky Mountain and Yellowstone National Parks, and in Craters of the Moon and Lava Beds National Monuments.

The research team will:

- Conduct pika occupancy surveys across a range of latitudes, longitudes, elevations, and substrate types (talus slopes vs. lava beds). An occupancy survey involves a search for evidence of pika presence at a site, such as observing pikas, hearing calls and finding fresh food caches or fresh fecal pellets . With these data, scientists will develop park-specific and regional maps of predicted pika distribution.
- Quantify recent gene flow patterns and develop habitat-based models of population connectivity within parks. In other words, they will determine how pika populations are related to each other. To achieve this, scientists will use information on genetic variation from analyses of fecal DNA collected during occupancy surveys.
- Combine these results to assess the vulnerability of pikas to climate change.

Above: Scientists searching for signs of pika in lava rocks and crevices. *Right:* Fresh pika scat on lava rock.

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If you want to learn more visit the Pikas in Peril Project website at:
http://science.nature.nps.gov/im/units/ucbn/monitor/pika/pika_peril/index.cfm