2005 Final Report

Occurrence, Distribution, Relative Abundance, and Habitat Relationships of Amphibians and Reptiles in Bighorn Canyon National Recreation Area

Prepared for

The National Park Service, Greater Yellowstone Network,
and the
Bighorn Canyon National Recreation Area,
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By

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Executive Summary

The primary goals of this two-year study were to inventory ≥ 90% of the herpetofaunal species known to occur in the area, and to gather additional data regarding the distribution, relative abundance, and habitat relationships of these species to assist in their management and future monitoring. Surveys of amphibians and reptiles in Bighorn Canyon National Recreation Area (BICA) were conducted during the summer of 2001 in four weeks of sampling occurring from mid-May to early August, and in 2002 in six weeks of sampling occurring from late May to mid-July. A variety of sampling techniques was employed to maximize our chances of detecting the occurrence of all species. Visual encounter surveys were the primary method used (140 searches conducted). This method was supplemented with calling surveys, road driving, terrestrial funnel trapping, incidental observations, and contributed observations. In 2002, we used Geographic Information Systems (GIS) to design a stratified, random sampling scheme based on topography (slope and aspect) and vegetation cover. A total of 395 observations was recorded - 213 amphibians and 182 reptiles.

Thirteen (13) of the 15 species known to occur in Bighorn Canyon were found to be present by our surveys. Four of the 13 species were amphibians: Woodhouse's Toad (*Bufo woodhousii*), Plains Spadefoot (*Spea bombifrons*), Boreal Chorus Frog (*Pseudacris maculata),* and Northern Leopard Frog (*Rana pipiens).* The 9 reptile species found were Painted Turtle (*Chrysemys picta*), Spiny Softshell (*Apolone spinifera*), Greater Short-horned Lizard (*Phrynosoma hernandesi*), Common Sagebrush Lizard (*Sceloporus graciosus*), Eastern Racer (*Coluber constrictor*), Gopher Snake (*Pituophis catenifer*), Terrestrial Garter Snake (*Thamnophis elegans*), Common Garter Snake (*Thamnophis sirtalis*), and Western Rattlesnake (*Crotalus viridis*). One reptile species, Snapping Turtle (*Chelydra serpentina*), was observed outside the park boundary. One amphibian species, the Tiger Salamander (*Ambystoma tigrinum*) was documented in 1982 and 1985, but was not observed during our surveys. Also, one reptile species, the Pale Milk Snake (*Lampropeltis triangulum*), has been documented to occur in BICA, but was not detected during our surveys.

Species detected during our surveys ranged in distribution from limited to widespread, and their relative abundance ranged from uncommon to abundant. Amphibian species that have undergone significant declines in parts of Wyoming and Montana, such as Northern Leopard Frogs, had a limited distribution in Bighorn Canyon, but were found to be common at sites where they did occur. Woodhouse's Toads were encountered at the highest number of wetland sites

and were common at those sites. Boreal Chorus Frogs and Northern Leopard Frogs were also common at wetland sites but Plains Spadefoots were uncommon. Common Sagebrush Lizards were the most frequently encountered reptile species and were widely distributed and abundant. We found Painted Turtles, Eastern Racers, and Terrestrial and Common Garter Snakes to be limited in distribution but common. Gopher Snakes and Western Rattlesnakes were widespread and found to be uncommon to common, depending on the type of habitat. Greater Short-horned Lizards were uncommon with a spotty distribution. Observations of Snapping Turtles and Spiny Softshells were only recorded once during our surveys and these species are therefore considered limited and uncommon.

The amphibian species detected were found to occur in only aquatic or wetland habitats, while the reptile species detected were found in a variety of habitat types. Of the reptile species, Common Sagebrush Lizards were most frequently found in juniper/mountain mahogany or disturbed/barren habitats, while Gopher Snakes and Terrestrial Garter Snakes were primarily found in riparian or disturbed/barren habitats, and Western Rattlesnakes were detected most often in desert shrubland or disturbed/barren habitats.

Introduction

The primary goals of this two-year study were to inventory ≥ 90% of the herpetofaunal species known to occur in the area, and to gather additional information regarding the distribution, relative abundance, and habitat relationships of these species to assist in their management and future monitoring. Preliminary surveys of reptiles and amphibians in Bighorn Canyon National Recreation Area (referred to hereafter as 'Bighorn Canyon') were conducted during the summer of 2001 in four weeks of sampling occurring from mid-May to early August. These initial surveys allowed us to become familiar with Bighorn Canyon, to gather data concerning the occurrence of amphibians and reptiles, and to obtain information necessary to design a stratified, random sampling scheme for additional surveys that were implemented in 2002. The surveys conducted in 2002 occurred over a six-week sampling period from late May to mid-July.

While amphibians and reptiles are traditionally overlooked in management programs, they are important for several reasons. They are important biologically because they are functional components of ecosystems and elements of biodiversity in many areas, and they serve as bio-indicators of the health of many ecosystems. In addition to their economic value (such as pest control and use in biomedical applications), these animals possess an aesthetic value that is appreciated by an increasing portion of the public (Koch and Peterson 1995).

Evidence of recent global declines of some species of amphibians and reptiles has been described by recent studies (Rakestraw 1996, Youth 1997, Gibbons et al. 2000). In the Rocky Mountain Region, some formerly widespread, common species such as the Western Toad (*Bufo boreas*), Northern Leopard Frog (*Rana pipiens*), and the Common Garter Snake (*Thamnophis sirtalis*) have undergone declines (Corn and Fogelman 1984, Peterson et. al. 1992, Koch and Peterson 1995). These data indicate that we can no longer take the existence of these animals for granted, and that studies are needed to determine their status. As the primary mission of the National Park Service (NPS) "is to conserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment of this and future generations," scientific information about the condition of these natural resources must be obtained.

While many areas lack baseline data regarding the occurrence and distribution of amphibian and reptile species necessary to evaluate status and population trends, Bighorn Canyon is fortunate that an extensive survey of amphibians and reptiles was conducted prior to our surveys. Therefore, an opportunity to assess changes in the status of amphibian and reptile

species in this area exists. Prior to this study, two amphibian and reptile inventories were conducted in Bighorn Canyon. The University of Wyoming Cooperative Fishery and Wildlife Research Unit conducted an extensive inventory of the recreation area in 1985 to gather baseline data for species occurrence and distribution. The study also described the habitat associations of species along with their abundance relative to the habitats in which they were found (Redder 1986, Anderson et al. 1987). In 1998, the Montana Department of Fish, Wildlife and Parks Non-game Program conducted a limited survey on selected Bureau of Reclamation Impoundments in Montana, which included the Yellowtail Reservoir (Rauscher 1998). Despite these previous studies, further searching for undocumented species and additional information on reptile and amphibian occurrence and distribution are needed to better determine status changes in these animals over the past 15 years, as well as to assist in management by developing future monitoring protocol.

Objectives

The specific objectives of this study were:

1. To inventory and document ≥ 90% of all amphibian and reptile species occurring in Bighorn Canyon.
2. To design and implement stratified, random sampling surveys to assess occurrence, distribution, relative abundance, and species-habitat associations of amphibians and reptiles in Bighorn Canyon.
3. To compare our survey results with previous inventory work conducted in Bighorn Canyon to assess potential changes in amphibian and reptile status.

Study Area

Bighorn Canyon is a unique and highly diverse area because of the range of habitats that result from its geographical location. It lies in the rain shadow of the Absoroka-Beartooth Mountains of western Wyoming and Montana, between the Bighorn Mountains to the east and the Pryor Mountains to the west. Bighorn Canyon extends 90 km from north to south and is located approximately 12 km northeast of Lovell, Wyoming, and 40 km southeast of Billings, Montana (Figure 1).

The landscape encompasses 48,500 ha and consists of wide, flat valleys at the north and south ends with the central portion comprised of a rolling plain cut by the 335-m deep Bighorn

Canyon. High spatial variability in the climate exists due to wide geographic variation in temperatures and precipitation (Anderson et al. 1987). Yearly variability in temperature ranges from -39° C (-39° F) to 40.5° C (105° F) (Anderson et al 1987). According to 30-year climate data (1961-1990) recorded at a weather station in Lovell, Wyoming by the U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS) National Water and Climate Center, the highest average monthly temperature of 31.5° C (88.7° F) occurs in July. Elevation ranges from 1,120 m above sea level at the northernmost extent of the canyon near Fort Smith, Montana, to 2,355 m along the western extent of the recreation area in the Pryor Mountains, Wyoming. Because it lies in a rain shadow, a precipitation gradient exists between the southern and northern portions of the recreation area, causing variability in plant communities between the northern and southern portions of the recreation area. The southern end consists of desert receiving only 18 cm of precipitation per year, while the northern end consists of grassland receiving over 50 cm of precipitation per year (Anderson et al. 1987). Lovell, Wyoming receives an average of 17 cm of precipitation per year, with the lowest average precipitation (1.6 cm) during the summer months occurring in July (U.S. Department of Agriculture, National Water and Climate Center).

Plant communities in the south consist primarily of saltbush (*Atriplex* spp.) and greasewood (*Sarcobatus* spp.) in drier sites, with juniper (*Juniperus* spp.), sagebrush (*Artemisia* spp.), mountain mahogany (*Cercocarpus ledifolius*), and grasslands in the upland areas, and plains cottonwood (*Populus deltoides*) along the Bighorn River (Anderson et al. 1987). The central portion of the Bighorn Canyon consists primarily of upland areas with juniper, sagebrush, mountain mahogany, and grasslands. However, Douglas fir (*Pseudotsuga menziesii*) dominates the upper-most portions of the Pryor Mountains, with limber pine (*Pinus flexilis*) occurring on the lower benches. Several small creeks drain eastward from the Pryor Mountains and consist primarily of woody vegetation, such as narrowleaf cottonwood (*Populus augustifolia*), skunkbush (*Rhus trilobata*) (Anderson et al. 1987). In the north, the high plateaus are dominated by mixed grasslands inter-mixed with ponderosa pine (*Pinus ponderosa*) and Douglas fir occurring on north-facing slopes and mountain mahogany on south-facing slopes.

Methodology

Prior to our surveys, we compiled a list of species that have been documented to occur in Bighorn Canyon (Table 1) from the following sources: previous surveys (Redder, 1986;

Rauscher 1998); existing databases (Wyoming and Montana Natural Heritage Program Databases, Wyoming Biological Diversity Information Node); contributed observations (personal communication with park personnel); and the relevant literature (Baxter and Stone 1985, Stebbins 1985, Redder 1986, Anderson et al. 1987, Reichel and Flath 1995).

Four factors were considered to evaluate potential species occurrence: (1) Does the study area fall within the species predicted range? (2) Are the closest current/historic observation records nearby or within the study area? (3) Is appropriate habitat located within the study area, and is the elevation similar to observations made in other parts of the state? (4) Are there life history characteristics that make particular species difficult to detect. A species is predicted as "probably present" if at least three of these factors support presence within the study area. A species is predicted as "encroaching" if at least two of these factors support species presence within the study area. A species is predicted as "probably not present" if only one factor supports presence within the study area. If none of these factors were met for a species, it was left off our potential species list (Table 1).

Sampling Design

Prior to conducting surveys, we considered two broad categories of habitats to sample: (1) aquatic, wetland, and riparian sites, and (2) upland or terrestrial sites. Because all of the potential amphibian species breed in lentic habitats, we focused our amphibian sampling efforts in those habitats. Some reptiles are often found in both upland and riparian habitats, therefore our sampling for species such as Terrestrial Garter Snakes (*Thamnophis elegans*) and Gopher Snakes (*Pituophis catenifer*) occurred in both habitats. For the 2001 surveys, we restricted our sampling to areas where previous observations had been recorded during the 1985 surveys conducted by Redder (1986). We felt this was the best way to become familiar with the area and maximize our chance of detecting ≥ 90% of the species known to occur there. Our sampling was also restricted to areas in the south and central portions (i.e., "south unit") of Bighorn Canyon because most of the observations made during the previous survey were in this general area. Also, because the south and central portions are separated from the northern-most portion (i.e. "north unit") by the Crow Indian Reservation and no roads directly connect them (Figure 1), we felt that for our initial surveys it would be logistically easier to survey only the south and central areas. However, for our 2002 surveys, we sampled throughout Bighorn Canyon by

implementing a stratified, random sampling scheme designed using Geographic Information Systems (GIS).

A stratified, random sampling design was used to select sites for terrestrial trapping and visual encounter surveys (see below). Our stratified random sampling design was created using GIS, and utilized Digital Elevation Models (DEMs), and cover type maps. We used ArcGIS 8.1, ArcView 3.2, the Spatial Analyst, 3D Analyst modules, Model Builder (ESRI, Redmond, CA), and the Animal Movement extension (Hooge and Eichenlaub 1997) to develop a map of environmental types (or stratification units) based on topography and cover type. Three topographic categories were used based on slope and aspect: (1) flat (slope less than 5 degrees with no aspect); (2) northeast (slope greater than 5 degrees and an aspect between 315 and 135 degrees); and (3) southwest (slope greater than 5 degrees and an aspect between 135 and 315 degrees). We used 3D Analyst with the DEMs to create a triangular irregular network (TIN) representing the surface of the study area with polygons (triangles) of varying slope and aspect. We combined the categories from the cover type map to produce a map with 10 collapsed categories of cover. The three topographic and 10 cover categories were combined to produce themes for each of 30 potential environmental types (stratification categories). The Animal Movement extension of ArcView 3.2 was used to randomly select 20-point locations within each environmental type theme to ensure that there will be an adequate pool to draw from in the event that some of the predicted attributes of the polygons are not present. Sampling points within the stratification categories were selected using ArcGIS 8.1 by clipping all sampling points located between two buffers that were created around the study area roads, one indicating the closest trapping distance from roads (100m) and a second indicating the maximum hiking distance from roads (1500m). The geographic coordinates for the sampling locations were uploaded as waypoints into a GPS receiver (Garmin eTrex Garmin, Garmin International Inc., Olathe, KS) and used to navigate to these points in the field. Upon arriving at each site, we determined if its attributes fell within the vegetation, slope, and aspect categories indicated by the GIS and conducted visual encounter surveys or placed terrestrial funnel traps at that location. The classification accuracy of potential environmental types for terrestrial funnel trap locations was 92%, with 23 of the 25 sites correctly classified.

Sampling Techniques

Because no single technique is effective in detecting all species occurring in an area (Heyer et al. 1994, Olson et al. 1997), and to ensure that we maximized our chances of detecting

all species, we employed a variety of sampling techniques (Table 2). Visual encounter surveys and funnel traps were the primary method used to detect the presence of amphibian and reptile species in Bighorn Canyon. These surveys were also supplemented with road cruising and calling surveys.

Visual Encounter Surveys (Jones 1986, Crump and Scott 1994)

We felt the most suitable technique used for sampling amphibians and reptiles, when comparing the search effort to the number of species observed, was visual encounter surveys. Visual encounter surveys consisted of observers walking through these areas and recording observations of any species encountered. Geographic coordinates for species observations were determined with a Garmin eTrex Venture GPS unit. These GPS observation points were recorded with an accuracy of +/- 20 meters in UTM Zone 12N, North American Datum 1927 (NAD27). Visual encounter surveys were conducted at wetland/aquatic and upland terrestrial sites.

A total of 58 visual encounter surveys were conducted at wetland sites. During 2001, a total of 34 visual encounter surveys were conducted in wetland habitats - two times at 14 sites and three times at two sites (Kane Cemetery Pond and Railroad Pond). A total of 24 wetland surveys were conducted in 2002 - twice at 10 sites and once at four sites (Table 4). During these surveys, geographic coordinates were determined with a GPS unit for each location where amphibians were located. Additional information taken at those locations was recorded onto a standardized data form (Figure 4) and included environmental data (air/water temperature, pH and water conductivity, cloud cover, and wind) and wetland site descriptions. Sites were visited once from May 21-31 to determine if breeding activity had begun and a second time from July 16-18 to assess breeding activity. These surveys (during which periodic samples are taken with dip nets) are very effective at detecting the larvae of frogs, toads, and salamanders (Crisafulli 1997). We used a fine-mesh dip net, and dipped every 5-7 steps around the perimeter of the wetland, as well as portions of the wetland that could be waded through. We also listened for calling amphibians.

Visual encounter surveys of upland terrestrial sites involved observers walking through sampling areas (e.g., along cliff faces, in washes, or 100 m transects in shrublands and grasslands) and turning cover objects, such as rocks and logs, to expose hiding animals. We conducted a total of 82 visual encounter surveys at upland terrestrial sites. In 2001, surveys were conducted at 21 terrestrial sampling areas (Figure 3a) where previous observations had been

recorded during the 1985 surveys (Redder 1986). In 2002, we conducted 61 surveys at 56 terrestrial sites. During these searches, we collected GPS waypoints to determine the general area searched along with the habitat types searched, the time spent searching each habitat, and the species observed. The habitat types assigned to our search areas were adapted from habitat classifications determined by Knight et al. (1987). Localities for all species observations were recorded with a GPS unit, and additional notes on environmental conditions (air temperature, cloud cover, and wind), and animal activity were taken at each locality.

Aquatic Funnel Trapping (Adams et al. 1997)

This technique was not used for the 2001 surveys, but was incorporated into our sampling methods for the 2002 surveys. Aquatic funnel traps consisted of standard minnow traps that have a holding chamber with two tapered openings that direct organisms toward the trap interior. This has proven to be an effective method of capture, especially for larvae (Adams et al. 1997). Traps were placed at designated areas with at least 10 cm of standing water, but not totally submerged. Trapping was conducted from June 25th to July 7th for two nights at six wetland sites with a maximum of ten traps placed at randomly selected locations within a designated area at each site (Figure 5c).

Terrestrial Funnel Trapping (Jones 1986, Beck 1997)

Terrestrial funnel traps consisted of a cylindrical holding chamber (60 cm. X 20 cm.) made of aluminum mesh hardware cloth with two tapered openings (funnels) that direct organisms toward the interior of the trap. These traps were not baited. The funnel traps were placed on top of a substrate or partially buried (approximately 3 cm) and a similar amount of soil will be placed inside the funnel traps to improve conditions for trapped organisms. They were protected with a rectangular piece of cardboard (weighed down by a rock) to protect captured animals from the heat of direct sunlight. In 2001, we experimented with supplementing terrestrial visual encounter surveys with individual terrestrial funnel traps-a total of 15 traps; three individual traps at five different locations were installed on August 9 and run until August 13 (Figure 5a).

This technique was coupled with visual encounter surveys during our 2002 surveys and accounted for approximately 40% of our sampling effort. In 2002, a total of 25 terrestrial trap sites were selected (2 traps per site) - 18 sites at the south unit (Figure 5a) and seven at the north unit (Figure 5b). Trapping localities were assigned throughout Bighorn Canyon using a

stratified, random approach designed using GIS (see above). We located each site in the field by uploading the geographic coordinates for each trapping location into a Garmin eTrex Venture GPS unit. At those sites, we placed two traps along natural features such as bases of cliffs, rocks, and logs. Terrestrial traps at the south unit consisted of 15 sites that were installed on June 2nd and 3rd and run until July 11th (39 trapping days) and an additional three sites were installed on June 28th and run until July 11th (12 trapping days). Terrestrial traps at the north unit consisted of seven sites installed on Jun 11th and run until Jun 21st (10 trapping days). All traps were checked every other day to minimize fatalities of reptile captures or incidental captures of small mammals. If any small mammals were captured they were removed and discarded in the wild.

Calling Surveys (Rand and Drewery 1994, Zimmerman 1994)

Calling surveys were used to determine the presence of calling male anurans at wetland sites (Figure 2). Surveys were conducted according to USGS North American Amphibian Monitoring Program protocol (http://www.mp2-pwrc.usgs.gov/NAAMP/protocol/index.html) and consisted of stopping at sites and listening for calling frogs for a five-minute period. The starting time for calling surveys varied throughout the summer depending on the time of sundown, but usually started no later than 30 minutes after sundown. Environmental conditions (cloud cover, moonlight, wind, and air temperature) were noted at each site. The species and numbers of calling anurans were noted using an amphibian calling index: category 1-individuals can be counted, but there is space between calls; category 2- calls of individuals can be distinguished but there is some overlapping of calls; and category 3 - a full chorus, calls are constant, continuous and overlapping. Calling surveys were conducted at wetland sites on six nights in 2001 and seven nights in 2002 during late spring and early summer to coincide with amphibian breeding activity. Surveys were conducted as early as May 21st and as late as June 19th (Figure 7a). We conducted calling surveys at wetland sites to identify amphibian species that provide audible calls. We also listened for calling anurans while conducting visual encounter surveys at wetland sites.

An Automated Recording System was used during our 2001 field season in conjunction with calling surveys to detect the presence of calling anurans. This method utilized an automated recording system (Frog Logger) that records sound at specified intervals (Peterson and Dorcas 1994). We planned to use information recorded as a reference to determine known sites where amphibians were present and calling and to provide us with information about when calling

began so we could perform calling surveys during the height of the breeding season. We placed Frog Loggers once at three sites and twice at another to determine if the nights we performed calling surveys were typical nights of calling, and that we did not sample on evenings when amphibians were not calling at reference areas. This also helped ensure that we did not overlook the presence of rare species. Our initial attempt with this technique proved to be unsuccessful, resulting in the recording of only one anuran calling, and was not used for the remainder of our inventory.

Road Surveys (Jones 1986, Shaffer and Jutterbock 1994)

Because some species are best found on roads after sunset, we performed road surveys via nighttime road driving (to the extent allowable by the limited roads within the park). When possible, we conducted road surveys on rainy as well as clear nights. Nighttime road surveys were conducted in the south unit on Highway 37 from the park entrance to Barry's Landing and in the north unit on the Ok-A-Beh marina road from Fort Smith to the marina (Figure 2). Roads were driven at low speeds (approximately 30 km/hour) between 1900 and 2400 hours. A total of 21 road surveys were performed over a period beginning on April 27th and ending on August 12th (Figure 7a). Approximately 26 hours were spent conducting these surveys.

Opportunistic and Contributed Observations

Species observations made while not conducting one of the above sampling techniques were denoted as opportunistic or incidental. Observations not made by trained technicians conducting surveys were listed as contributed. Species photos were shown to contributing observers to verify positive identification. Locations of contributed observations were determined by taking general location descriptions and collecting UTM coordinates by revisiting the site in the field with a hand-held GPS, or using GIS to on-screen digitize point locations on 7.5-minute quads. Opportunistic and contributed observations were not included in our evaluation of sampling techniques.

Results and Discussion

Our results are organized into the following sections: (1) observed species accounts; (2) unobserved species; (3) sampling technique evaluation; and (4) summary of species information (occurrence, distribution, abundance, habitat associations). Species distribution was categorized as: (1) widespread, species can be found over a wide area or extent; (2) limited, species are

confined to certain areas; or (3) spotty, species are irregularly or sparsely distributed throughout the park. Species abundance was categorized as: (1) abundant (> 22 observations); (2) common (8 – 22 observations); (3) uncommon (< 8 observations); or (4) rare (0 – 1 observations); see Appendix D and Figure 6b for definitions. During our 2001 and 2002 surveys, a total of 364 observations were recorded, 179 were observations of amphibian species and 185 were of reptile species. Refer to Table 2 for a checklist of amphibians and reptiles present during our surveys with notes on the occurrence, distribution, and abundance of each species.

Observed Species

Woodhouse's Toad (*Bufo woodhousii*). This species was detected best by visual encounter surveys and was found at 11 of the 19 (58%) sites surveyed (Table 4). This species accounted for 63 of 179 (35%) amphibian observations. Larvae and juveniles of this species were found during visual encounter surveys. Although adults can be difficult to find because they often bury themselves in sandy substrates, nine individuals were observed. For the total number of observations according to lifestage recorded during visual encounter surveys, refer to Table 3. Woodhouse's toads were found only in wetland habitat during our surveys (Figure 8), and were usually observed along muddy to dry silty shorelines and shallow water areas with sparse emergent vegetation. This species is limited throughout Bighorn Canyon and is common in wetland areas (Figures 9 and 23a-23c).

Plains Spadefoot (*Spea bombifrons*). It is listed by the Montana Natural Heritage Program (http://nhp.nris.state.mt.us/animalguide/) as a species of concern and was not detected during the 1985 surveys (Redder 1986). This species was recorded during our surveys from one opportunistic encounter. It was found at the edge of a gravel road near Railroad Pond. They are most likely present in greater numbers than were detected during our surveys, but were difficult to detect because they often burrow in dry, sandy substrates during the day and are active mostly at night, or during the day only after heavy summer rains. This species is also an opportunistic breeder and is difficult to detect using calling surveys because it typically calls and breeds on nights only after rain events. Plains Spadefoots have a limited distribution and are uncommon (Figures 10 and 24).

Boreal Chorus Frog (*Pseudacris maculata)*. We had more success detecting this species using nighttime calling surveys than with visual encounter surveys (Table 4). Boreal Chorus Frogs were difficult to detect with visual encounter surveys, due to their small size and cryptic color. They were detected at 12 of 19 (63%) wetland sites using calling surveys and were

detected at four of those 12 sites by visual encounter surveys. The total number of observations according to lifestage recorded during visual encounter surveys can be found in Table 3. Boreal Chorus Frog observations constituted 23 of 179 (12%) amphibian observations. This species was detected only in wetland habitat (Figure 8) and was more common at wetlands with emergent vegetation, such as cattails, sedges, and grasses. This species is limited throughout Bighorn Canyon and is common in wetland areas (Figures 9 and 25a-25c).

Northern Leopard Frog (*Rana pipiens*). The Bureau of Land Management and the U.S. Forest Service list this species under sensitive status in Wyoming and Montana. It is listed as a species of concern by the Montana Natural Heritage Program. Visual encounter surveys were the best method used to detect this species. We observed them at nine of 19 (47%) wetland sites (Figure 11). They accounted for 92 of 179 (51%) amphibian observations. The highest number of adults (12 individuals) was observed for this species when compared to all other amphibian species. For the total number of observations according to lifestage recorded during visual encounter surveys, refer to Table 3. Leopard frogs were found only in wetland habitat (Figure 8), usually in shallow water in or near emergent vegetation such as cattails, sedges, and grasses. This species was found to be limited in distribution throughout Bighorn Canyon and is common in wetland areas (Figures 12 and 26a-26c).

Snapping Turtle (*Chelydra serpentina*). This species was not detected during the 1985 inventory (Redder 1986) and was detected through one opportunistic encounter during our surveys. It was found next to Highway 37 near the Shoshone River bridge 8 km west of the Bighorn Canyon Recreation Area. It is important to note that the Shoshone River flows into the Bighorn River and it is likely that Snapping Turtles are also present in both riverine habitats. However, because this species was observed outside the park boundary its status has been listed as encroaching. Snapping Turtles prefer riverine habitat or permanent waters in lower river valleys. This species may be difficult to detect even with hoop nets because it prefers deep water or river bottoms where it buries itself in the mud (Baxter and Stone 1985). Snapping Turtles are limited and uncommon in Bighorn Canyon (Figures 13 and 27).

Painted Turtle (*Chrysemys picta*). This species was detected from two opportunistic encounters, one visual encounter survey observation, and one contributed observation. They accounted for four of 185 reptile observations. Painted turtles were observed at the Barry's Landing boat launch and at the sewage ponds and the Three-mile access of the Bighorn River near Fort Smith, Montana. This turtle frequents swampy habitats, small lakes and ponds, and

muddy streams, and is often found at the water's edge on logs (Baxter and Stone 1985). We found it to be limited and uncommon in Bighorn Canyon (Figure 14 and 28).

Spiny Softshell (*Apalone spinifera*). This turtle was not detected during the 1985 inventory (Redder 1986) and was observed during our surveys in one opportunistic encounter at the northeast corner of Pond 7 (Figure 3b). Spiny Softshells prefer permanent lakes and larger streams at elevations below 6000 feet (Baxter and Stone 1985). According to Baxter and Stone (1985), this species has been documented to occur in the Big Horn Basin. We found it to be limited and uncommon in Bighorn Canyon (Figures 15 and 29).

Greater Short-horned Lizard (*Phrynosoma hernandesi*). This lizard was detected through 10 contributed observations from park personnel and one opportunistic encounter during our surveys. They accounted for 11 of 185 reptile observations. This species was found on the east slope of the Pryor Mountains and on the desert shrubland flats south of Sykes Mountain. Greater Short-horned lizards typically inhabit grasslands and open shrublands with loose, sandy substrates and can be difficult to detect because they often burrow in loose sand and have coloration that allows them to blend in well with their habitat (Baxter and Stone 1985, Redder 1986). We found them to be spotty and uncommon in Bighorn Canyon (Figures 16 and 30).

Common Sagebrush Lizard (*Sceloporus graciosus*). This species was found to be the most abundant and widely distributed reptile throughout the areas surveyed in Bighorn Canyon. Visual encounter surveys were the most successful sampling technique at detecting this species. They accounted for 76 of 185 (41%) reptile observations. Common Sagebrush Lizards were found in a variety of habitats, but were most often found in juniper/mountain mahogany, disturbed/barren, and desert shrubland habitats. This species is widespread and abundant in Bighorn Canyon (Figures 17 and 31a-31f).

Eastern Racer (*Coluber constrictor*). This species was detected through two opportunistic encounters, one trap capture, and one visual encounter survey. They accounted for four of 185 reptile observations. Their distribution was restricted to the northernmost portion of the recreation area near Fort Smith (MT) where a wetter climate and the open grassland habitats they prefer are present. We found this species to be limited and uncommon in Bighorn Canyon (Figure 18 and 32).

Gopher Snake (*Pituophis catenifer*). Road driving was the most successful sampling technique for detecting this species. They accounted for 22 of 185 (12%) reptile observations. This species was commonly found on roads from late April through May in drier areas not far from riparian systems, such as the Crooked Creek area. Gopher Snakes are often found in

riparian, grassland, sagebrush, and scarp woodland habitats. This species is widespread and common in Bighorn Canyon (Figure 19 and 33a-33e)

Terrestrial Garter Snake (*Thamnophis elegans*). This species was detected best by visual encounter surveys. They accounted for 31 of 185 (17%) reptile observations. Terrestrial Garter Snakes were frequently detected in riparian habitats next to streams or near the water's edge at wetlands in areas such as Crooked Creek, Ewing-Snell ranch, and Hillsboro. They were rarely found far from water. This species is limited and common in Bighorn Canyon (Figure 20 and 34a-34d).

Common Garter Snakes (*Thamnophis sirtalis*). This species was detected best by visual encounter surveys. It accounted for seven of 185 reptile observations. They were detected during our surveys only in the northernmost portion of the recreation area near Fort Smith (MT) next to a rocky stream bank near Three-mile access. There have been no documented reports of this species occurring in the south unit. Like the Terrestrial Garter Snake, they frequent riparian habitats and are rarely found far from water. This species is limited and uncommon in Bighorn Canyon (Figure 22 and 36).

Western Rattlesnake (*Crotalus viridis*). This species was detected from contributed observations, opportunistic encounters, road driving, terrestrial trap captures, and visual encounter surveys. They accounted for 28 of 185 (15%) reptile observations. Western Rattlesnakes were detected in a many of the habitats throughout Bighorn Canyon, such as desert shrubland, disturbed/barren, grassland, juniper/mountain mahogany, riparian, and sagebrush steppe. Frequent encounters with this species occurred at the Ewing-Snell ranch, Hillsboro, and Sykes Mountain. We found this species to be widespread and common in Bighorn Canyon (Figure 21 and 35a-35d).

Unobserved Species

It is important to note that simply because a species was not detected during our surveys, it does not mean that the species is not present within the study area. We performed our sampling over a limited temporal scale, some sites were revisited infrequently, and others were not revisited throughout the duration of our surveys. Below we provide some information that can be used to assess the probability of predicted potential species occurrence throughout the study area.

Other amphibian and reptile species that have been listed as present in Bighorn Canyon, but were not detected during our surveys include one amphibian species, the Tiger Salamander,

and one reptile species, the Pale Milk Snake. These species may not have been detected during our surveys for several reasons.

Tiger Salamanders (*Ambystoma tigrinum*). The occurrence of this species in Bighorn Canyon has been documented only twice, one individual was found in 1982 (BICA Wildlife Observation File) and another was observed during a previous survey (Redder 1986). Adults of this species area primarily terrestrial but migrate to ponds and lakes in the spring breed and may remain there for much of the summer. They require still water to breed, but are not uncommon in desert regions where they have been dug out of burrows in sand dunes (Baxter and Stone 1985). This species has been observed by park personnel near residential areas, the afterbay, and sewage treatment ponds at Fort Smith (MT), and at the Ewing-Snell ranch (Redder 1986). Tiger Salamanders may be a rare species in Bighorn Canyon; as a result, they are most likely only detected through opportunistic encounters. The status of this species is probably present.

Pale Milk Snakes (*Lampropeltis triangulum*). This species, to our knowledge has only been detected through opportunistic encounters and is considered rare throughout Bighorn Canyon. Its occurrence has been documented on the north and south ends of the Big Horn Basin, with Bighorn Canyon located at the northwest edge of its range (Baxter and Stone 1985). This species is secretive, mostly nocturnal, prefers scarp woodlands at elevations below 6000 feet, and is almost never found in grassland habitats (Baxter and Stone 1985). Pale Milk Snakes have been observed at Ok-A-Beh and near Horseshoe Bend (Patterson et al. 1985). An observation of one individual was also recorded at the Ewing-Snell ranch during surveys conducted in 1985 (Redder 1986). This species is probably present in Bighorn Canyon, but due to its rarity and secretive life history characteristics, it is difficult to detect.

Sampling Technique Evaluation

The effectiveness of the sampling techniques implemented during our surveys varied greatly. We evaluated each technique based on the number of observations recorded per hour, the relative cost of implementing the technique, and the length of time to conduct each technique. We also considered which species were observed based on the survey techniques used. For example, even if few observations were made with a particular technique, it would still be important if it was the only technique that detected a particular species. The sampling techniques in order of success by species detected were visual encounter surveys (VES), terrestrial and aquatic funnel traps, nighttime calling surveys, and road driving (Table 2). A total of 220 observations were made during VES, 21 and 16 from aquatic and terrestrial funnel traps

respectively, 24 during nighttime calling surveys, and 13 during road driving. For a breakdown of the total number of observations recorded by each survey method along with the number of individuals recorded per species, refer to Figure 6. Sampling techniques according to the day of the year they were conducted can be seen in Figure 7a. For a list of the species encountered and the number of individual species recorded by each survey method, refer to Table 3 and Figures 6. For the time of year each sampling technique was conducted, refer to Figure 7a.

Visual encounter surveys (VES) were the most successful technique used to detect the presence of amphibians and reptiles. Because this technique is relatively inexpensive and time efficient, it was chosen as our primary technique. We spent a total of 106 hours conducting these surveys and gathered a total of 220 observations, resulting in approximately two observations per hour of searching.

Nighttime calling surveys were effective at detecting the presence of calling male anurans at wetland sites where species were not detected using visual encounter surveys. During our 2001 surveys, Woodhouse's Toads were detected at three sites and Boreal Chorus Frogs were detected at eight sites where they were not found by visual encounter surveys conducted at those sites. This is probably because breeding had not occurred at these sites or larvae were not yet present. Calling surveys take relatively little time to perform and are very cost effective. We recorded three of the four amphibian species observed during our surveys with this technique: Woodhouse's Toads, Boreal Chorus Frogs, and Northern Leopard Frogs. Frogloggers were also used to detect the presence of calling male anurans. In 2001, this technique only accounted for one observation and as a result was not used during our 2002 surveys.

Because we experimented with using terrestrial funnel traps during our 2001 surveys, they were only used for a period of five days, yet recorded a total of four observations (Table 8). This technique can be effective at locating species that are cryptic or nocturnally active. Terrestrial funnel traps require some time to install, but once they are installed, require relatively little time to check (every 2-3 days) and can capture species while other surveys are conducted. Therefore, this technique was coupled with aquatic funnel traps during our 2002 surveys. A total of 12 and 21 observations were recorded using terrestrial and aquatic funnel traps in 2002, respectively (Table 8a and 8b). The terrestrial funnel trap technique was not as successful in 2002 as we had hoped when compared to the capture rates from the initial five days of trapping conducted in 2001. However, they were effective for detecting some reptile species, such as Common Sagebrush Lizards and Western Rattlesnakes. Aquatic funnel traps were very effective for capturing species occurring in or near riparian and wetland habitats, such as Woodhouse's

Toads, Boreal Chorus Frogs, Northern Leopard Frogs, and Terrestrial Garter Snakes. Two Terrestrial Garter Snakes died as a result of drowning when trapped in aquatic funnel traps.

Road driving was not the most effective technique when comparing the number of observations recorded per hour with other techniques such as visual encounter surveys, but it was valuable for detecting certain species like Gopher Snakes. Four of the nine Gopher Snake observations in 2001 were recorded during road driving. Western Rattlesnakes and Terrestrial Garter Snakes were also observed while conducting road surveys. We spent a total of 26 hours driving roads and recorded a total of 13 observations, resulting in 0.5 observations for every hour of driving.

Summary of Species Information

Occurrence

A total of 15 amphibian and reptile species are now considered as present in Bighorn Canyon National Recreation Area (Table 1). Of the 15 present species, 13 were found during our surveys. Four of the five species of amphibians that have been documented in Bighorn Canyon were detected and consisted of Woodhouse's Toads (*Bufo woodhousii*), the Plains Spadefoot (*Spea bombifrons*), Boreal Chorus Frogs (*Pseudacris maculata*), and Northern Leopard Frogs (*Rana pipiens*). The occurrence of one amphibian species, the Tiger Salamander (*Ambystoma tigrinum*) was documented in 1982 and 1985 in Bighorn Canyon, but was not observed during our surveys. Nine out of 11 documented reptile species were found and consisted of Painted Turtles (*Chrysemys picta*), Spiny Softshells (*Apalone spinifera*), Greater Short-horned Lizards (*Phrynosoma hernandesi*), Common Sagebrush Lizards (*Sceloporus graciosus*), Eastern Racers (*Coluber constrictor*), Gopher Snakes (*Pituophis catenifer*), Terrestrial Garter Snakes (*Thamnophis elegans*), Common Garter Snakes (*Thamnophis sirtalis*), and Western Rattlesnakes (*Crotalus viridis*). Snapping Turtles (*Chelydra serpentina*) were detected outside the park boundary and were categorized as encroaching. One species, the Pale Milk Snake (*Lampropeltis triangulum*) has been documented to occur in Bighorn Canyon, but was not detected during our surveys.

A comparison of our results with Redder (1986) indicates that 10 of the 12 species detected by Redder were also detected in the current survey. We did not detect Tiger Salamanders or Milk Snakes but Redder had only few records for these species (two records for Tiger Salamanders and one record for the Milk Snake). We still consider these species to be present in Bighorn Canyon even though we failed to detect them. We detected three species that

Redder did not find: Plains Spadefoot, Spiny Softshell, and Common Garter Snake. In addition, we observed another species, the Snapping Turtle, near Bighorn Canyon and expect it to be observed within the Recreation Area in the future.

Distribution

Because the southern end of Bighorn Canyon National Recreation Area consists of a desert that receives only 18 cm of precipitation per year, the distribution of suitable habitat for some reptiles and wetland habitat for amphibians is limited (Figure 3b). The majority of the wetlands occur in the southern and northern portions of Bighorn Canyon. In the southern unit, they are found in the floodplain of the Bighorn River within the Yellowtail Wildlife Habitat Management Area. In the northern unit, they are near the afterbay of the Bighorn River near Fort Smith, Montana. As a result, the distribution of amphibians determined from our surveys is somewhat limited to wetlands in these general areas.

Of the amphibians detected, they were found to occur at 14 of the 19-wetland sites surveyed (Table 4). Woodhouse's Toads were found at all of the sites (9) where Northern Leopard frogs occurred. Also, Boreal Chorus Frogs were found at eight of the nine sites where Northern Leopard Frogs occurred. Boreal Chorus Frogs and Northern Leopard Frogs were found to co-occur at nine of the 11 sights (81%) where Woodhouse's Toads were found. However, Woodhouse's Toads occurred at only nine of 12 (75%) of the Boreal Chorus Frog sites. For more information on the co-occurrence of these species, refer to Table 5.

For reptiles, the majority of the species detected during our surveys were found to be limited in distribution (Table 2). The Common Sagebrush Lizard was the most frequently encountered species and is widespread throughout Bighorn Canyon. The Western Rattlesnake was the only other reptile found to be widespread. Gopher Snakes and Terrestrial Garter Snakes were limited in distribution and were found to occur in both the southern and northern portions of the recreation area. Eastern Racers and Common Garter Snakes were also limited in distribution, but were found to occur only in the north around Fort Smith, Montana. Greater Short-horned Lizards were detected by only one opportunistic encounter and a few contributed observations, and are spotty in distribution. All turtles were found to be limited in distribution.

Abundance

Within the wetland habitats surveyed, Woodhouse's Toads were encountered at the highest number of wetland sites and are common at those sites. Boreal Chorus Frogs were also

common and Northern Leopard Frogs were uncommon to common among wetland sites surveyed. Plains Spadefoot Toads were opportunistically encountered once during our surveys and are the only amphibian species considered to be uncommon at wetland sites.

All but one of the reptile species found during our surveys were either uncommon or common in abundance throughout Bighorn Canyon (Table 2 and Figure 6b). Common Sagebrush Lizards were the only species found to be abundant in Bighorn Canyon. Gopher Snakes, Terrestrial Garter Snakes, and Western Rattlesnakes are common throughout the area. Eastern Racers and Common Garter Snakes were common but their distribution was limited to the northern unit of Bighorn Canyon. Painted Turtles and Greater Short-horned Lizards were uncommon. Snapping Turtles and Spiny Softshells were opportunistically encountered once during our surveys and considered rare throughout Bighorn Canyon.

Habitat Relationships

The amphibian and reptile species encountered during our surveys were found in three major habitat categories (Figure 8). All amphibian species were found only in wetland habitats. Within wetland habitats, amphibians were found primarily in shallow areas of emergent vegetation, such as grasses, sedges, and cattails. Reptile species were most abundant in upland areas and were most frequently found in juniper/mountain mahogany, disturbed/barren, and riparian habitats. Some species, such as Terrestrial Garter Snakes and Common Garter Snakes, were almost always found in or near riparian habitats. Thirty reptile observations were made in disturbed/barren habitat (33%), 25 observations were collected in juniper/mountain mahogany habitat (27%), and 12 observations were recorded in riparian habitat (13%). For photos of habitat types, refer to Appendix B.

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Tables

Table 1. A list of amphibians and reptile species potentially occurring in the Bighorn Canyon National Recreation Area with current heritage rank, federal status, occurrence, and park status. Prepared from Stebbins 1985, Baxter and Stone 1985, Redder 1986, Anderson et al., 1987, and Reichel and Flath 1995. The current heritage ranking, federal status were compiled by the Wyoming Natural Diversity Database (Fertig and Beauvais, 1999), the Wyoming Bio-information Node, and the Nature Conservancy's Natural Heritage Program for Montana and Wyoming. Park status descriptions can be found in Appendix D.

Common Name	**Scientific Name**	**Heritage Ranks***	**Federal Status***	**Redder Surveys (1985)**	**Baum and Peterson Surveys (2001-2002)**	**Park Status†**
Amphibians						
Tiger Salamander	*Ambystoma tigrinum*	G5/S3S4	USFS R2-S	detected	not detected	probably
Woodhouse's Toad	*Bufo woodhousii*	S5		detected	detected	present
Plains Spadefoot	*Spea bombifrons*	S5		not detected	detected	present
Boreal Chorus Frog	*Pseudacris maculata*	S5		detected	detected	present
Northern Leopard Frog	*Rana pipiens*	G5/S3	USFS R2-S BLM-SS	detected	detected	present
Great Plains Toad	*Bufo cognatus*	G5/S3		not detected		probably not
Western Toad	*Bufo boreas*	G4T1Q/S1	USFS R2-S USFWS Cand.	not detected	not detected	probably not
Columbia Spotted Frog	*Rana luteiventris*	G4/S2S3	USFS R2-S BLM-SS	not detected	not detected	probably not
Reptiles						
Snapping Turtle	*Chelydra serpentina*	G5/S3	BLM-SS	not detected	detected	encroaching
Painted Turtle	*Chrysemys picta*	S5		detected	detected	present
Spiny Softshell	*Apalone spinifera*	G5/S4	BLM-SS	not detected	detected	present
Greater Short-horned Lizard	*Phrynosoma hernandesi*	S4		detected	detected	present
Common Sagebrush Lizard	*Sceloporus graciosus*	S5		detected	detected	present
Rubber Boa	*Charina bottae*	G5/S2S3		not detected	not detected	encroaching
Eastern Racer	*Coluber constrictor*	G5T5/S4		detected	detected	present
Milk Snake	*Lampropeltis triangulum*	G5/S2S3	USFS R2-S	detected	not detected	probably
Gopher Snake	*Pituophis catenifer*	S4		detected	detected	present
Terrestrial Garter Snake	*Thamnophis elegans*	S5		detected	detected	present
Western Rattlesnake	*Crotalus viridis*	S5		detected	detected	present
Plains Garter Snake	*Thamnophis radix*	G5T5/S4		not detected	not detected	probably not
Common Garter Snake	*Thamnophis sirtalis*	S5		not detected	detected	present

† Park status based on our 2001-2002 surveys.

* A list of descriptions for the heritage rank codes, federal status codes are on the following page.

Descriptions for heritage ranks, federal status, statewide abundance, and range notes:

Heritage Ranks

Heritage ranks consist of a standardized ranking system developed by The Nature Conservancy's Natural Heritage Network to assess the global and statewide conservation status of each plant and animal species, subspecies, and variety. Each taxon is ranked on a scale of 1-5, from highest conservation concern to lowest. Codes are as follows:

G Global rank: Rank refers to the rangewide status of a species.
T Trinomial rank: Rank refers to the rangewide status of a subspecies or variety.
S State rank: Rank refers to the status of the taxon in Wyoming and Montana.
1 Critically imperiled because of extreme rarity (often known from 5 or fewer extant occurrences or very few remaining individuals) or because some factor of a species' life history makes it vulnerable to extinction.
2 Critically imperiled because of extreme rarity (often known from 5 or fewer extant occurrences or very few remaining individuals) or because some factor of a species' life history makes it vulnerable to extinction.
3 Rare or local throughout its range or found locally in a restricted range (usually known from 21-100 occurrences).
4 Apparently secure, although the species may be quite rare in parts of its range, especially at the periphery.
5 Demonstrably secure, although the species may be rare in parts of its range, especially at the periphery.

Federal Status

The following categories are now being used to rank listed and candidate species by the Bureau of Land Management (BLM), the U.S. Fish and Wildlife Service (USFWS) and the U.S. Forest Service (USFS):
BLM-SS: Bureau of Land Management Species of Special Status
USFWS Cand: U.S. Fish and Wildlife Service Candidate Species, taxa for which substantial biological information exists on file to support a proposal to list as Endangered or Threatened, but no proposal has yet been published in the Federal Register.
USFS R2-S: U.S. Forest Service Region 2, Sensitive Species

Table 2. A checklist of the amphibians and reptiles confirmed to occur in Bighorn Canyon National Recreation Area during our surveys with notes on the distribution, relative abundance, successful sampling techniques used to detect each species (listed in order of success in our surveys), and voucher records for each species within the study area. Descriptions for occurrence, distribution, and abundance categories can be found in Appendix D.

Common Name**	**Scientific Name**	**Occurrence (Park Status)**	**Distribution***	**Species Abundance***	**Successful Sampling Techniques***	**Voucher**
Amphibians						
Tiger Salamander	*Ambystoma tigrinum*	not detected	not detected	not detected		
Woodhouse's Toad	*Bufo woodhousii*	present*	limited	common*	ves, cs, aft, f	photo, tissue
Plains Spadefoot	*Spea bombifrons*	present*	limited	uncommon*	opp	photo, tissue
Boreal Chorus Frog	*Pseudacris maculata*	present*	limited	common*	cs, ves, aft	photo, tissue
Northern Leopard Frog	*Rana pipiens*	present*	limited	common*	ves, aft, cs	photo
Great Plains Toad	*Bufo cognatus*	not detected	not detected	not detected		
Western Toad	*Bufo boreas*	not detected	not detected	not detected		
Columbia Spotted Frog	*Rana luteiventris*	not detected	not detected	not detected		
Reptiles						
Snapping Turtle	*Chelydra serpentina*	encroaching*	limited	rare*	opp	photo, tissue
Painted Turtle	*Chrysemys picta*	present*	limited	uncommon*	opp	
Spiny Softshell	*Apalone spinifera*	present*	limited	rare*	opp	
Greater Short-horned Lizard	*Phrynosoma hernandesi*	present*	spotty	uncommon*	contr, opp	museum
Common Sagebrush Lizard	*Sceloporus graciosus*	present*	widespread	abundant	ves, opp, tft	museum
Rubber Boa	*Charina bottae*	not detected	not detected	not detected		
Eastern Racer	*Coluber constrictor*	present*	limited	uncommon*	opp, ves, tft	tissue
Milk Snake	*Lampropeltis triangulum*	not detected	not detected	not detected		
Gopher Snake	*Pituophis catenifer*	present*	widespread	common*	opp, ves, rd, contr	photo, tissue
Terrestrial Garter Snake	*Thamnophis elegans*	present*	limited	common*	ves, opp, rd, contr	museum, tissue
Western Rattlesnake	*Crotalus viridis*	present*	widespread	common*	opp, rd, ves, tft, contr	museum, photo
Plains Garter Snake	*Thamnophis radix*	not detected	not detected	not detected		
Common Garter Snake	*Thamnophis sirtalis*	present*	limited	uncommon*	ves, opp	museum
Classification Information: Names based on Integrated Taxonomic Information System (IT IS) website 2002		present probably encroaching probably not *based on our surveys	not detected widespread limited spotty *based on our survey	not detected abundant common uncommon rare *based on our survey	**Techniques employed:** aft - aquatic funnel traps cs - calling surveys contr - contributed f - froglogger opp - opportunistic rd - road driving tft - terrestrial funnel traps ves - visual encounter surveys	museum - museum specimen photo - digital photograph tissue - tissue sample

** All species are breeders and native to Bighorn Canyon National Recreation Area.

Table 3. The type and number of observations made during the 2001 and 2002 surveys with the number of individuals of each species recorded

Observation Type	# of Species Observed	Species Observed [1] (# of individuals of each species observed)
Aquatic funnel trap capture	21	BUWO (3); PSMA (2); RAPI (8); THEL (8)
Calling surveys	24	BUWO (9); PSMA (12); RAPI (3)
Contributed observations	25	CHPI (1); PHHE (10); SCGR (3); PICA (4); CRVI (6); THEL (1)
Opportunistic	45	BUWO (1); SPBO (1); RAPI (1); CHSE (1); CHPI (2); APSP (1); PHHE (1); SCGR (12), COCO (2); PICA (6); CRVI (9); THEL (7); THSI (1)
Road driving*	13	SCGR (1); PICA (7); CRVI (4); THEL (1)
Terrestrial funnel trap capture	16	COCO (1); PICA (1); CRVI (4); SCGR (10)
Visual encounter surveys	220	BUWO (6 adults, 38 juveniles, 6 larvae**); PSMA (1 adult, 2 juveniles, 1 metamorph, 5 larvae**); RAPI (21 adults, 54 juveniles; 4 larvae**; 1 egg mass); CHPI (1) SCGR (50); COCO (1); PICA (4); CRVI (5), THEL (14); THSI (6)
TOTAL:	364	BUWO (63); SPBO (1); PSMA (23); RAPI (92); CHSE (1); CHPI (4); APSP (1); PHHE (11); SCGR (76); COCO (4); PICA (22); CRVI (28); THEL (31); THSI (7)

* Five of the seven observations recorded during road cruises were road fatalities
** Indicates the number of large groups (100+ individuals) observed
[1]Species codes:

BUWO – *Bufo woodhousii*	SPBO – *Spea bombifrons*	THEL – *Thamnophis elegans*
PSMA – *Pseudacris maculata*	RAPI – *Rana pipiens*	THSI – *Thamnophis sirtalis*
CHSE – *Chelydra serpentina*	CHPI – *Chrysemys picta*	
APSP – *Apalone spinifera*	PHHE – *Phrynosoma hernandesi*	
SCGR – *Sceloporus graciosus*	COCO – *Coluber constrictor*	
PICA – *Pituophis catenifer*	CRVI – *Crotalus viridis*	

Table 4. Wetland sampling sites where amphibian species were detected using visual encounter surveys and calling surveys with the number of calling surveys and visual encounter surveys (VES) conducted at each site. (Refer to Figure 3b and 3c for site locations)

Site	Chorus Frog	Northern Leopard Frog	Woodhouse's Toad	# of calling surveys conducted	# of VES conducted
1. Pond 1*	–			1	2
2. Pond 2*	–			1	2
3. Pond 3*				2	2
4. Pond 4*				4	3
5. Pond 5	–	X	X	6	4
6. Pond 6	–		+	4	4
7. Pond 6.5	X	+	X	5	4
8. Pond 7	–	–	+	7	4
9. Pond 8	X	+	X	8	4
10. Pond 9	X	X	X	7	4
11. Pond 10**				0	0
12. Pond 11*				1	1
13. Classroom pond	–			3	3
14. Kane Cemetery pond	–	+	+	9	5
15. Leck Mayes pond	–	+	–	4	3
16. Railroad pond	X	–	–	9	5
17. Lime Kiln Creek wetland			X	1	2
18. Sewage treatment ponds				1	2
19. Three mile access		+	–	1	2

(–) Detected using calling surveys.
(+) Detected using visual encounter surveys.
(X) Detected by calling surveys and visual encounter surveys.

* Sites were almost completely dry during 2001 surveys.
**This site was not surveyed because it was completely dry by May in 2001 and 2002.

Table 5. This table represents the probability of amphibian species co-occurrence based on results from visual encounter surveys and calling surveys of 19 sampling sites (Table 4). Numbers in parentheses in row headings indicate the total number of sites where that particular species occurred. Reading across the rows, the numbers in the individual cells of the matrix represent the probability of co-occurrence between the two species, based on the number of sites where the species in that column occurs.

Species	**Chorus Frog**	**Leopard Frog**	**Woodhouse's Toad**
Chorus Frog (12)	X	0.66 (8/12)	0.75 (9/12)
Leopard Frog (9)	0.88 (8/9)	X	1.00 (9/9)
Woodhouse's Toad (11)	0.81 (9/11)	0.81 (9/11)	X

Table 6. Amphibian calling survey observations and frog logger calling data recorded during the Bighorn Canyon National Recreation Area 2001 surveys.

Date	Time	Species	Observer(s)	Location	Comments	CC (%)	Wind	Air Temp
29-Apr-01	2127	PSMA	Baum, R.	Pond 8	cat. 1	N/A	N/A	N/A
29-Apr-01	2130	PSMA	Baum, R.	Railroad Pond	cat. 1	N/A	N/A	N/A
21-May-01	2001	PSMA	Baum, R.	Pond 6 1/2	cat. 1	30	light	16 C
21-May-01	2001	PSMA	Baum, R.	Pond 7	cat. 1	30	light	16 C
21-May-01	2008	RAPI	Baum, R.	Pond 7	cat. 1	30	light	16 C
21-May-01	2014	PSMA	Baum, R.	Pond 8	cat. 1	30	light	16 C
21-May-01		0	Froglogger	Railroad Pond	none	N/A	N/A	N/A
22-May-01	2200	PSMA	Baum, R.	Pond 5	cat. 1	5	moderate	18 C
22-May-01	2205	BUWO	Baum, R.	Pond 5	cat. 1, north end	5	moderate	18 C
22-May-01	2234	BUWO	Baum, R.	Kane Cemetery Pond	cat. 2	5	moderate	18 C
22-May-01	2254	0	Baum, R.	Pond 6	none	0	light	18 C
22-May-01		BUWO	Froglogger	Kane Cemetery Pond	cat. 1	N/A	N/A	N/A
23-May-01	2110	PSMA	Baum, R.	Pond 9	cat. 3	10	light-moderate	21 C
23-May-01	2115	BUWO	Baum, R.	Pond 9	cat. 1, north end	10	light-moderate	21 C
23-May-01	2117	RAPI	Baum, R.	Pond 9	cat. 1, northeast end	10	light-moderate	21 C
23-May-01	2127	0	Baum, R.	Pond 10	none	10	light	21 C
23-May-01	2147	PSMA	Baum, R.	Pond 8	cat. 2	15	light	21 C
23-May-01	2157	BUWO	Baum, R.	Pond 8	cat. 2, southwest end	15	light	21 C
23-May-01	2159	BUWO	Baum, R.	Pond 6 1/2	cat. 1, north end	15	light	21 C
23-May-01	2201	PSMA	Baum, R.	Pond 7	cat. 1, northwest end	15	light	21 C
23-May-01	2209	RAPI	Baum, R.	Pond 7	cat. 1, north-northwest end	15	light	21 C
23-May-01	2211	PSMA	Baum, R.	Railroad Pond	cat. 3	15	light	21 C
23-May-01	2215	BUWO	Baum, R.	Railroad Pond	cat. 2	15	light	21 C
23-May-01		0	Froglogger	Pond 11	none	N/A	N/A	N/A
02-Jun-01		0	Froglogger	Hillsboro	placed next to wetland/riparian area above ranch	N/A	N/A	N/A
07-Jun-01	2125	0	Baum, R.	Classroon Pond	none	40	moderate	22.2 C
07-Jun-01	2159	PSMA	Baum, R.	Leck Mays Pond	cat. 3	30	moderate	22.2 C
07-Jun-01	2201	BUWO	Baum, R.	Leck Mays Pond	cat. 2	30	moderate	22.2 C
07-Jun-01	2215	BUWO	Baum, R.	14A Bridge over Bighorn R.	cat. 2, north side of bridge, west side of floodplain	30	moderate	22.2 C
07-Jun-01	2215	PSMA	Baum, R.	14A Bridge over Bighorn R.	cat. 3, north side of bridge, west side of floodplain	30	moderate	22.2 C
07-Jun-01		0	Froglogger	Kane Cemetery Pond	placed on south end of pond	N/A	N/A	N/A

*See following page for abbreviation codes

Abbreviation Codes for Amphibian Calling Survey Table:

Species: BUWO - *Bufo woodhousii*
PSMA - *Pseudacris maculata*
RAPI – *Rana pipiens*

Time: Military time (24 hours)

Location: General description of the area where the observation was made

Comments: Additional comments about the observation locality and about the organism observed
cat. 1 (category 1): single male calling sporadically
cat. 2 (category 2): a group of males calling with notable spaces between the calls
cat. 3 (category 3): group of males calling with no distinction between individuals

CC: Cloud cover (estimated as a percentage)

Wind: Wind speed (estimated as calm, light, light-moderate, moderate, high)
calm: less than 1 knot; smoke rises vertically
light: 4-6 knots; wind felt on face, leaves rustle, vanes begin to move
light-moderate: 7-10 knots; leaves and small twigs constantly moving
moderate: 11-16 knots; Dust, leaves, and loose paper lifted, small tree branches move
high: 17+ knots; small trees begin to sway and larger tree branches moving

Air Temp: Ambient temperature from a Schultheis thermometer, measured in degrees Celsius

Table 7. The habitat types searched in the Bighorn Canyon National Recreation Area (using visual encounter surveys) with hectares and percentages of each habitat (from Knight et al., 1987) along with the number and species of amphibians and reptiles found in each habitat, and search time per habitat.

Habitat Type	Area* Hectares	%	Amphibians #	Species[1]	Reptiles #	Species[1]	Search Time (hrs.)	%
Wetland	293	1.3	3	BUWO, PSMA, RAPI	4	CHPI, PICA, THEL, THSI	47.1	34.8
Juniper/Mountain Mahogany	8909	39.6	0		2	CRVI, SCGR	16.0	11.8
Riparian	3667	16.3	2	BUWO, RAPI	6	SCGR, COCO, PICA, CRVI, THEL, THSI	33.8	25.0
Desert Shrubland	3330	14.8	0		2	CRVI, SCGR	8.4	6.2
Grassland	1912	8.5	0		1	SCGR	13.0	9.6
Coniferous Woodland	1350	6.0	0		0		2.8	2.1
Sagebrush Steppe	2633	11.7	0		1	SCGR	3.3	2.4
Great Plains Shrubland	23	0.1	0		0		0.0	0.0
Agriculture	382	1.7	0		0		0.0	0.0
Disturbed/Barren	N/A	N/A	0		4	CRVI, PICA, SCGR, THEL	11.0	8.1
Totals:	22,094	100.0					135.3	100.0

***** Area within Bighorn Canyon National Recreation Area.

[1]Species codes:

BUWO – *Bufo woodhousii*
PSMA – *Pseudacris maculata*
CHSE – *Chelydra serpentina*
APSP – *Apalone spinifera*
SCGR – *Sceloporus graciosus*
PICA – *Pituophis catenifer*
THEL – *Thamnophis elegans*
SPBO – *Spea bombifrons*
RAPI – *Rana pipiens*
CHPI – *Chrysemys picta*
PHHE – *Phrynosoma hernandesi*
COCO – *Coluber constrictor*
CRVI – *Crotalus viridis*
THSI – *Thamnophis sirtali*

Table 8a. A list of the terrestrial funnel traps with the species[1] and number of each species captured per site, the total number of trapping days, location names, habitat types, elevation and UTM locations. Refer to Figure 5 for a map of these locations.

Start Date	Stop Date	Trap Site	Location	Habitat Type	UTM Zone	Easting	Northing	Elev. (m)	Species captured (# of individuals)	Total Trap Days
9-Aug-01	13-Aug-01	Trap 1	West Sykes Mtn.	desert shrubland	12N	0713572	4980908	1165	CRVI (1), SCGR (1)	5
9-Aug-01	13-Aug-01	Trap 2	Crooked Creek	riparian	12N	0715624	4982702	1107	0	5
9-Aug-01	13-Aug-01	Trap 3	State Line	juniper/mtn. mahogany	12N	0715053	4989078	1398	0	5
9-Aug-01	13-Aug-01	Trap 4	Ewing-Snell Ranch	riparian	12N	0715334	4995788	1329	CRVI (1)	5
10-Aug-01	13-Aug-01	Trap 5	Trail Creek	riparian	12N	0717628	4998417	1172	0	4
10-Aug-01	13-Aug-01	Trap 6a	Hillsboro	disturbed/barren	12N	0717410	4997658	1208	SCGR (1)	4
10-Aug-01	13-Aug-01	Trap 6b	Hillsboro	riparian	12N	0717581	4997622	1208	0	4
10-Aug-01	13-Aug-01	Trap 6c	Hillsboro	riparian	12N	0717443	4997610	1189	0	4
2-Jun-02	11-Jul-02	South trap 1	Nortwest side of Sykes Mtn.	flat, desert shrubland	12N	713545	4980693	1177	0	39
2-Jun-02	11-Jul-02	South trap 3	North side of Sykes Mtn.	NE, desert shrubland	12N	713965	4981587	1177	SCGR (1)	39
2-Jun-02	11-Jul-02	South trap 4	Nortwest side of Sykes Mtn.	NE, desert shrubland	12N	713813	4980390	1173	SCGR (3)	39
2-Jun-02	11-Jul-02	South trap 7	S. Fork Trail Cr., east of Hillsboro	flat, juniper/mtn. mahogany	12N	716436	4997673	1274	0	39
2-Jun-02	11-Jul-02	South trap 9	Nortwest side of Sykes Mtn.	SW, desert shrubland	12N	713732	4980920	1191	0	39
2-Jun-02	11-Jul-02	South trap 10	1.5 miles NE of Ewing-Snell Ranch	flat, grassland	12N	716692	4996669	n/a	0	39
2-Jun-02	11-Jul-02	South trap 11	north of Crooked Cr.	flat, disturbed/barren	12N	715439	4984691	1161	0	39
2-Jun-02	11-Jul-02	South trap 12	Northwest of Devis Canyon	NE, juniper/mtn. mahogany	12N	715522	4990148	1368	0	39
2-Jun-02	11-Jul-02	South trap 14	0.25 miles south of Layout Cr.	flat, sagebrush steppe	12N	716336	4994628	1275	SCGR (1)	39
2-Jun-02	11-Jul-02	South trap 15	N. Fork Trail Cr.	flat, sagebrush steppe	12N	716741	4998523	1241	0	39
2-Jun-02	11-Jul-02	South trap 16	1 mile east of Ewing-Snell Ranch	NE, sagebrush steppe	12N	716505	4995753	1282	0	39
2-Jun-02	11-Jul-02	South trap 17	N. Fork Trail Cr.	NE, sagebrush steppe	12N	717108	4998607	1223	SCGR (3)	39
2-Jun-02	11-Jul-02	South trap 18	Northwest of Devis Canyon	SW, juniper/mtn. mahogany	12N	715361	4990249	1393	0	39
3-Jun-02	11-Jul-02	South trap 2	Southeast side of Sykes Mtn.	flat, desert shrubland	12N	716169	4977246	1175	0	38
3-Jun-02	11-Jul-02	South trap 8	Southeast side of Sykes Mtn.	SW, desert shrubland	12N	716153	4977355	1181	0	38
11-Jun-02	21-Jun-02	North trap 1	Northwest of Ft. Smith	NE, grassland	13N	269412	5021324	1038	PICA (1)	10
11-Jun-02	21-Jun-02	North trap 2	Northwest of Ft. Smith	NE, juniper/mtn. mahoganry	13N	269269	5021054	1087	0	10
11-Jun-02	21-Jun-02	North trap 3	Northwest of Ft. Smith	NE, grassland	13N	269306	5021155	1075	COCO (1)	10
11-Jun-02	21-Jun-02	North trap 4	Northwest of Ft. Smith	SW, grassland	13N	269649	5021303	1077	0	10
11-Jun-02	21-Jun-02	North trap 5	Northwest of Ft. Smith	SW, grassland	13N	269755	5021044	1082	0	10
11-Jun-02	21-Jun-02	North trap 6	Northwest of Ft. Smith	NE, coniferous woodland	13N	270779	5017843	1211	0	10
11-Jun-02	21-Jun-02	North trap 7	Northwest of Ft. Smith	NE, coniferous woodland	13N	270587	5017621	1278	0	10
28-Jun-02	11-Jul-02	South trap 5	Lockhart Ranch	flat, riparian	12N	716880	5001698	1320	0	12
28-Jun-02	11-Jul-02	South trap 6	N. Fork Trail Cr.	flat, riparian	12N	717461	4998504	1201	0	12

Start Date	Stop Date	Trap Site	Location	Habitat Type	UTM Zone	Easting	Northing	Elev. (m)	Species Captured (# of individuals)	Total Trap Days
28-Jun-02	11-Jul-02	South trap 13	Layout Cr. near Ewing-Snell Ranch	flat, riparian	12N	715347	4995784	1302	0	12

[1]Species codes:

BUWO – *Bufo woodhousii*
SPBO – *Spea bombifrons*
PSMA – *Pseudacris maculata*
RAPI – *Rana pipiens*
CHSE – *Chelydra serpentina*
CHPI – *Chrysemys picta*
APSP – *Apalone spinifera*
PHHE – *Phrynosoma hernandesi*
SCGR – *Sceloporus graciosus*
COCO – *Coluber constrictor*
PICA – *Pituophis catenifer*
CRVI – *Crotalus viridis*
THEL – *Thamnophis elegans*
THSI – *Thamnophis sirtalis*

Table 8b. A list of the aquatic funnel traps with the species[1] and number of each species captured per site, the total number of trapping days, location names, habitat types, elevation and UTM locations.

Start Date	Stop Date	Trap Site	Location	Habitat Type	UTM Zone	Easting	Northing	Elev. (m)	Species captured (# captured)	Total Trap Days
25-Jun-02	26-Jun-02	AT1	Pond 7	wetland	12N	721815	4967653	1113	0	1
25-Jun-02	26-Jun-02	AT2	Pond 7	wetland	12N	721812	4967637	1123	PSMA metamorphs (2); RAPI metamorph (1); BUWO larvae (40)	1
25-Jun-02	26-Jun-02	AT3	Pond 7	wetland	12N	721814	4967620	1131	RAPI larvae (15)	1
25-Jun-02	26-Jun-02	AT4	Pond 7	wetland	12N	721810	4967624	1129	0	1
25-Jun-02	26-Jun-02	AT5	Pond 7	wetland	12N	721817	4967628	1133	0	1
25-Jun-02	26-Jun-02	AT6	Pond 6.5	wetland	12N	721839	4967831	1123	RAPI larvae (1)	1
25-Jun-02	26-Jun-02	AT7	Pond 6.5	wetland	12N	721844	4967826	1115	0	1
25-Jun-02	26-Jun-02	AT8	Pond 6.5	wetland	12N	721885	4967793	1117	0	1
25-Jun-02	26-Jun-02	AT9	Pond 6.5	wetland	12N	721939	4967769	1118	0	1
25-Jun-02	26-Jun-02	AT10	Pond 6.5	wetland	12N	721935	4967742	1118	0	1
26-Jun-02	27-Jun-02	AT1a	Kane Cemetery Pond	wetland	12N	720537	4973516	1125	0	1
26-Jun-02	27-Jun-02	AT2a	Kane Cemetery Pond	wetland	12N	720534	4973504	1123	0	1
26-Jun-02	27-Jun-02	AT3a	Kane Cemetery Pond	wetland	12N	720532	4973450	1120	RAPI larvae (12)	1
26-Jun-02	27-Jun-02	AT4a	Kane Cemetery Pond	wetland	12N	720528	4973422	1119	RAPI larvae (9)	1
26-Jun-02	27-Jun-02	AT5a	Kane Cemetery Pond	wetland	12N	720506	4973365	1120	0	1
26-Jun-02	27-Jun-02	AT6a	Kane Cemetery Pond	wetland	12N	720339	4973141	1112	0	1
26-Jun-02	27-Jun-02	AT7a	Kane Cemetery Pond	wetland	12N	720389	4973142	1115	BUWO larvae (1)	1
26-Jun-02	27-Jun-02	AT8a	Kane Cemetery Pond	wetland	12N	720375	4973137	1121	RAPI adult (1)	1
26-Jun-02	27-Jun-02	AT9a	Kane Cemetery Pond	wetland	12N	720358	4973134	1122	RAPI larvae (1)	1
26-Jun-02	27-Jun-02	AT10a	Kane Cemetery Pond	wetland	12N	720349	4973133	1127	PSMA larvae (2)	1
28-Jun-02	30-Jun-02	AT1b	Pond 6	wetland	12N	718998	4975027	1143	0	2
28-Jun-02	30-Jun-02	AT2b	Pond 6	wetland	12N	718981	4974997	1138	0	2
28-Jun-02	30-Jun-02	AT3b	Pond 6	wetland	12N	718969	4975008	1115	0	2
28-Jun-02	30-Jun-02	AT4b	Pond 6	wetland	12N	718942	4974959	1124	0	2
28-Jun-02	30-Jun-02	AT5b	Pond 6	wetland	12N	718931	4974953	1128	0	2
6-Jul-02	7-Jul-02	AT6b	Pond 6	wetland	12N	719014	4974992	1127	0	1
6-Jul-02	7-Jul-02	AT7b	Pond 6	wetland	12N	719010	4974982	1128	THEL (1)	1
6-Jul-02	7-Jul-02	AT8b	Pond 6	wetland	12N	719003	4974973	1125	THEL (1)	1
7-Jul-02	11-Jul-02	AT1c	Ewing-Snell Ranch Pond	wetland	12N	715308	4995706	1283	THEL (3)	4
7-Jul-02	11-Jul-02	AT2c	Ewing-Snell Ranch Pond	wetland	12N	715311	4995711	1296	0	4
7-Jul-02	11-Jul-02	AT3c	Ewing-Snell Ranch Pond	wetland	12N	715312	4995709	1300	0	4
7-Jul-02	11-Jul-02	AT4c	Ewing-Snell Ranch Pond	wetland	12N	715311	4995702	1391	0	4
7-Jul-02	11-Jul-02	AT5c	Ewing-Snell Ranch Pond	wetland	12N	715304	4995687	1299	THEL (3)	4

Start Date	Stop Date	Trap Site	Location	Habitat Type	UTM Zone	Easting	Northing	Elev. (m)	Species captured (# captured)	Total Trap Days
8-Jul-02	9-Jul-02	AT1d	Kane Cemetery Pond	wetland	12N	720525	4973434	1120	RAPI larvae (40); RAPI metamorphs (5)	1
8-Jul-02	9-Jul-02	AT2d	Kane Cemetery Pond	wetland	12N	720543	4973469	1120	RAPI larvae (33); RAPI metamorphs (3)	1

[1]Species codes:

BUWO – *Bufo woodhousii*
PSMA – *Pseudacris maculata*
CHSE – *Chelydra serpentina*
APSP – *Apalone spinifera*
SCGR – *Sceloporus graciosus*
PICA – *Pituophis catenifer*
THEL – *Thamnophis elegans*
SPBO – *Spea bombifrons*
RAPI – *Rana pipiens*
CHPI – *Chrysemys picta*
PHHE – *Phrynosoma hernandesi*
COCO – *Coluber constrictor*
CRVI – *Crotalus viridis*
THSI – *Thamnophis sirtalis*

Figures

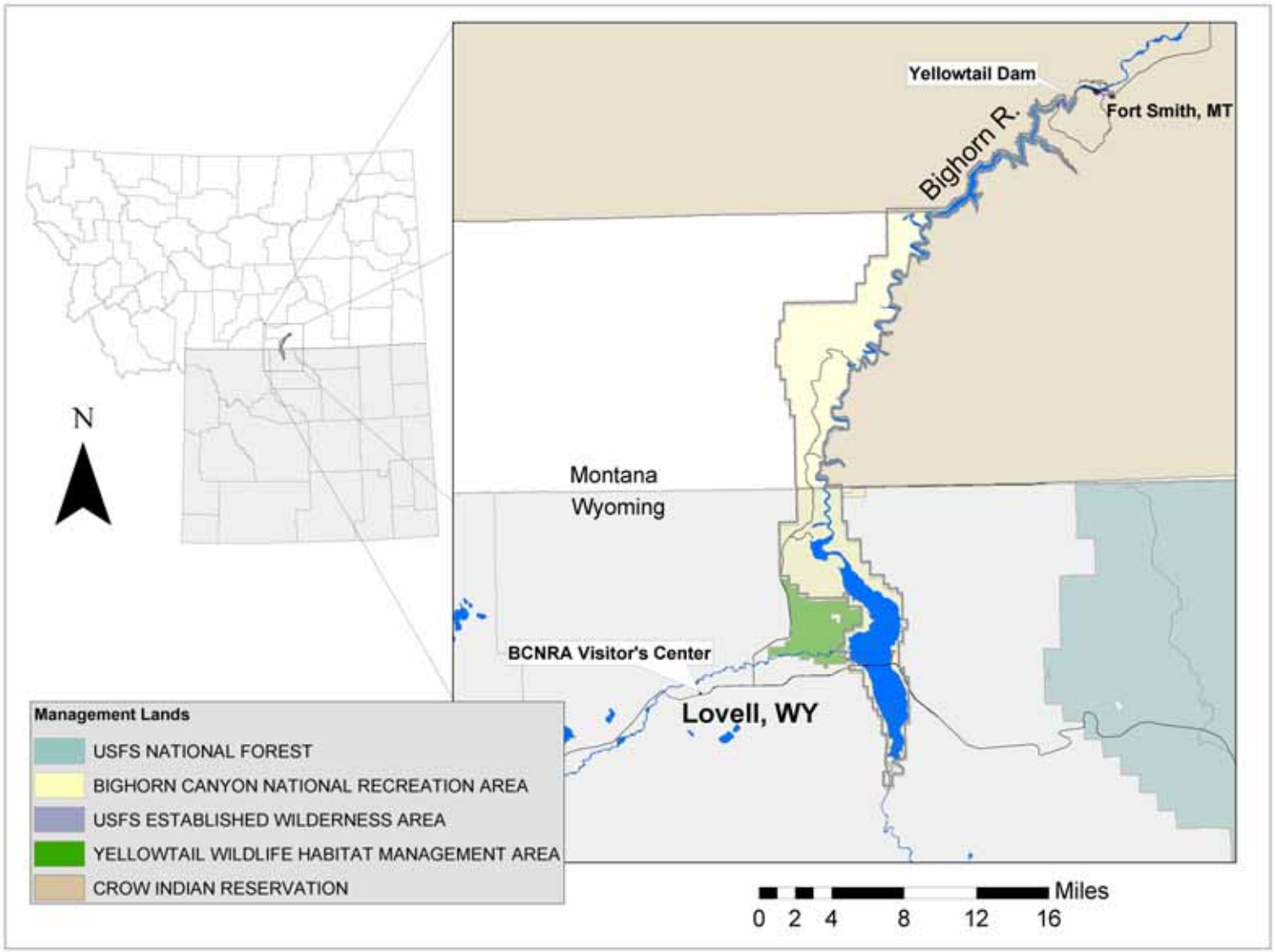


Figure 1. Location of Bighorn Canyon National Recreation Area.

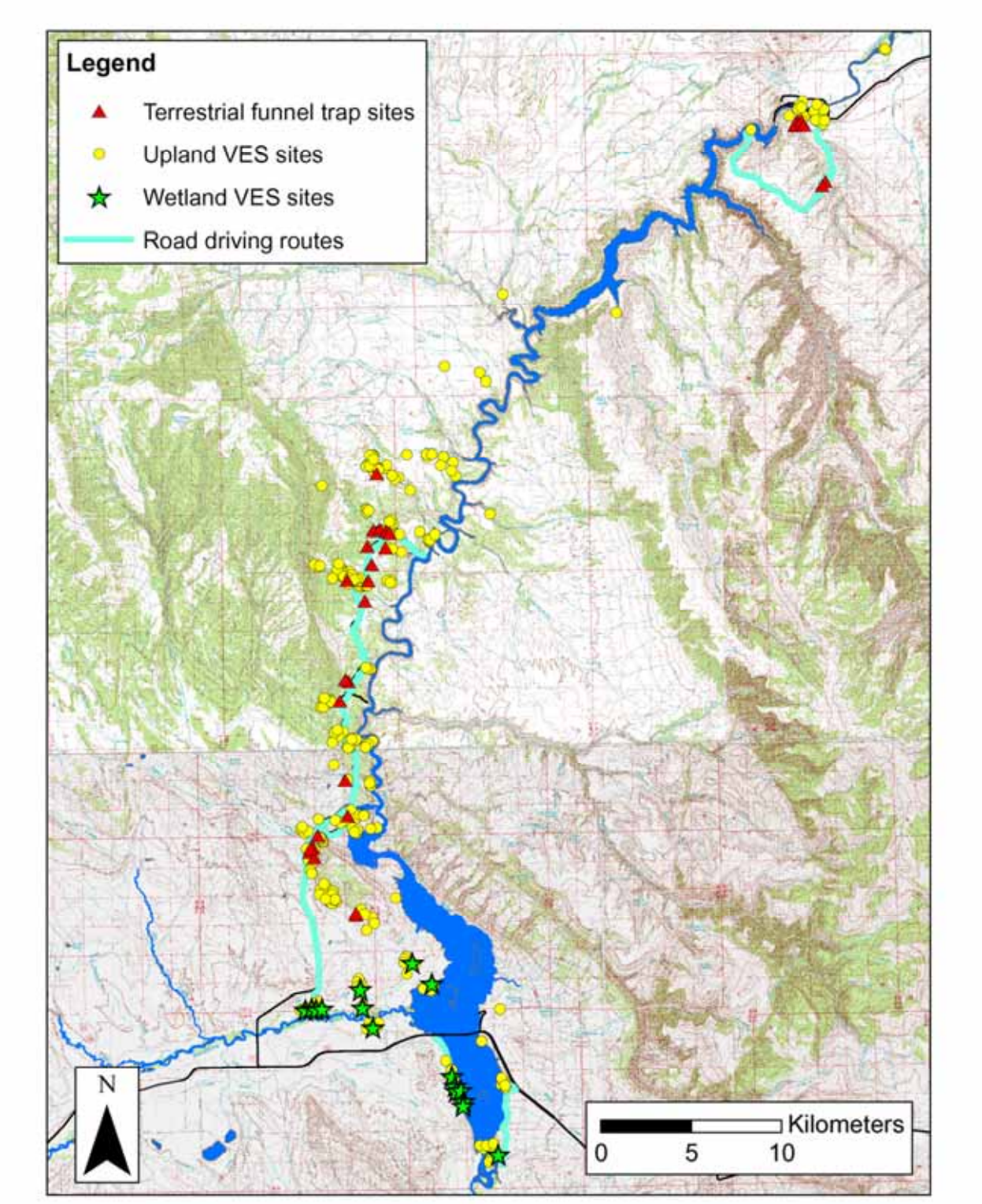


Figure 2. The sampling locations for the survey methods used in Bighorn Canyon. This map covers the southern portion of the study area (Powell Quadrangle, Wyo. 100k series).

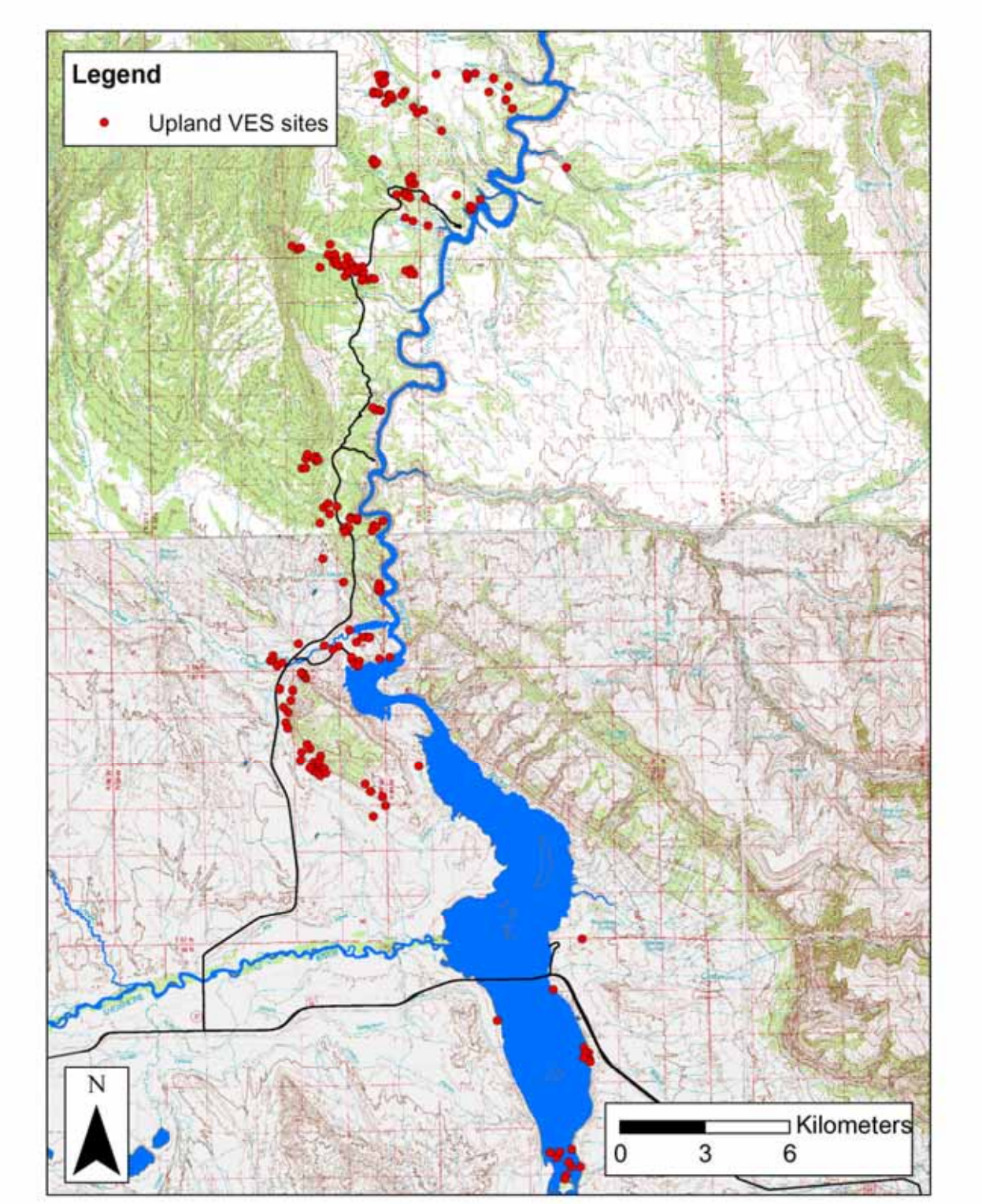


Figure 3a. Upland Visual Encounter Survey locations. Sykes Mountain and the Bighorn River floodplain are located at the south end of the map (Powell Quadrangle, Wyo. 100k series) with Upper Layout Creek and the Lockhart Ranch at the north end (Bridger Quadrangle, Mont. 100k series).

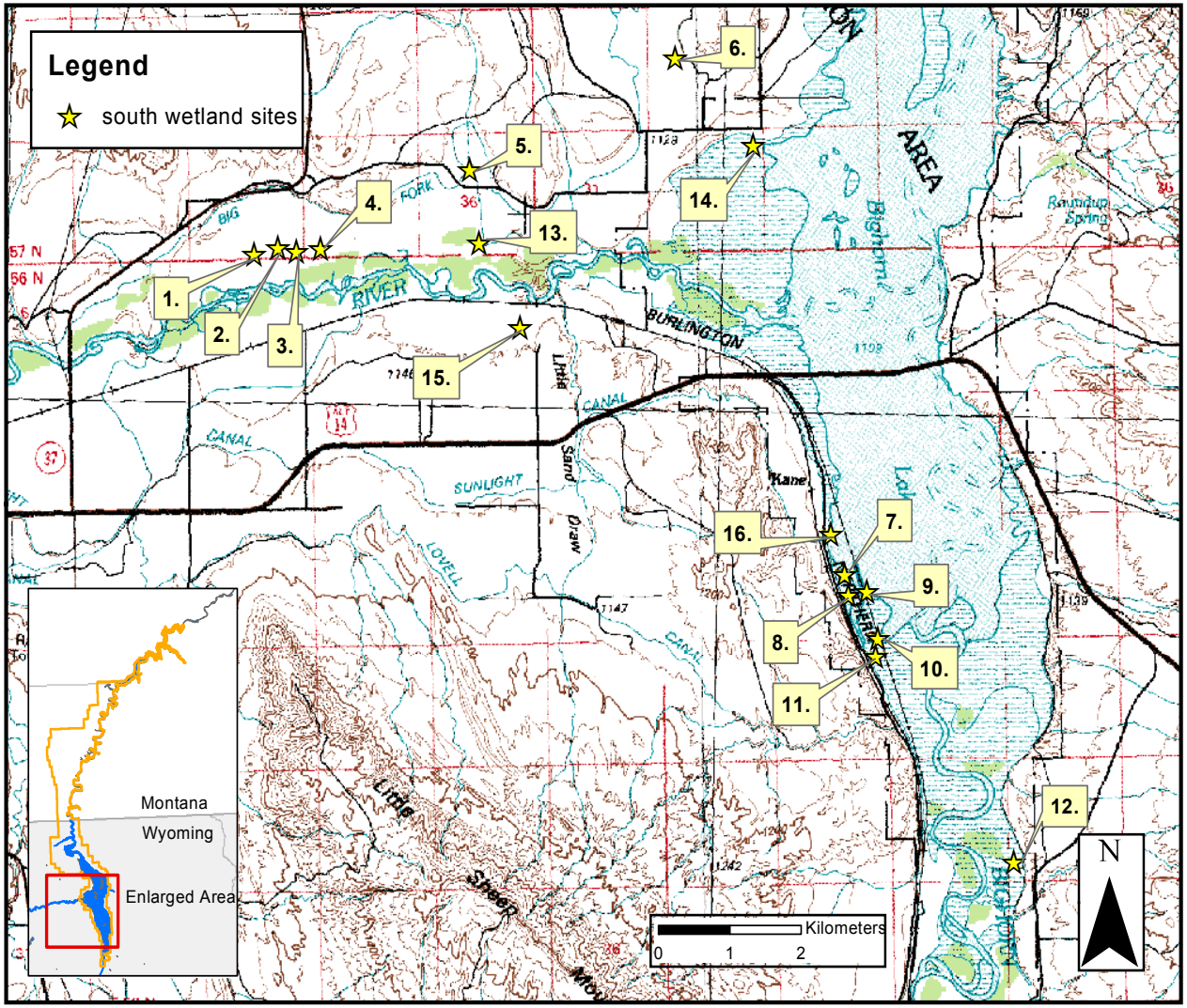


Figure 3b. Wetland Visual Encounter Survey sites. These wetland sites were located at the south end of the study area within the Yellowtail Wildlife Habitat Management Area (Powell Quadrangle, Wyo. 100k series). Refer to Table 4 for site names and a list of species detected at these sites.

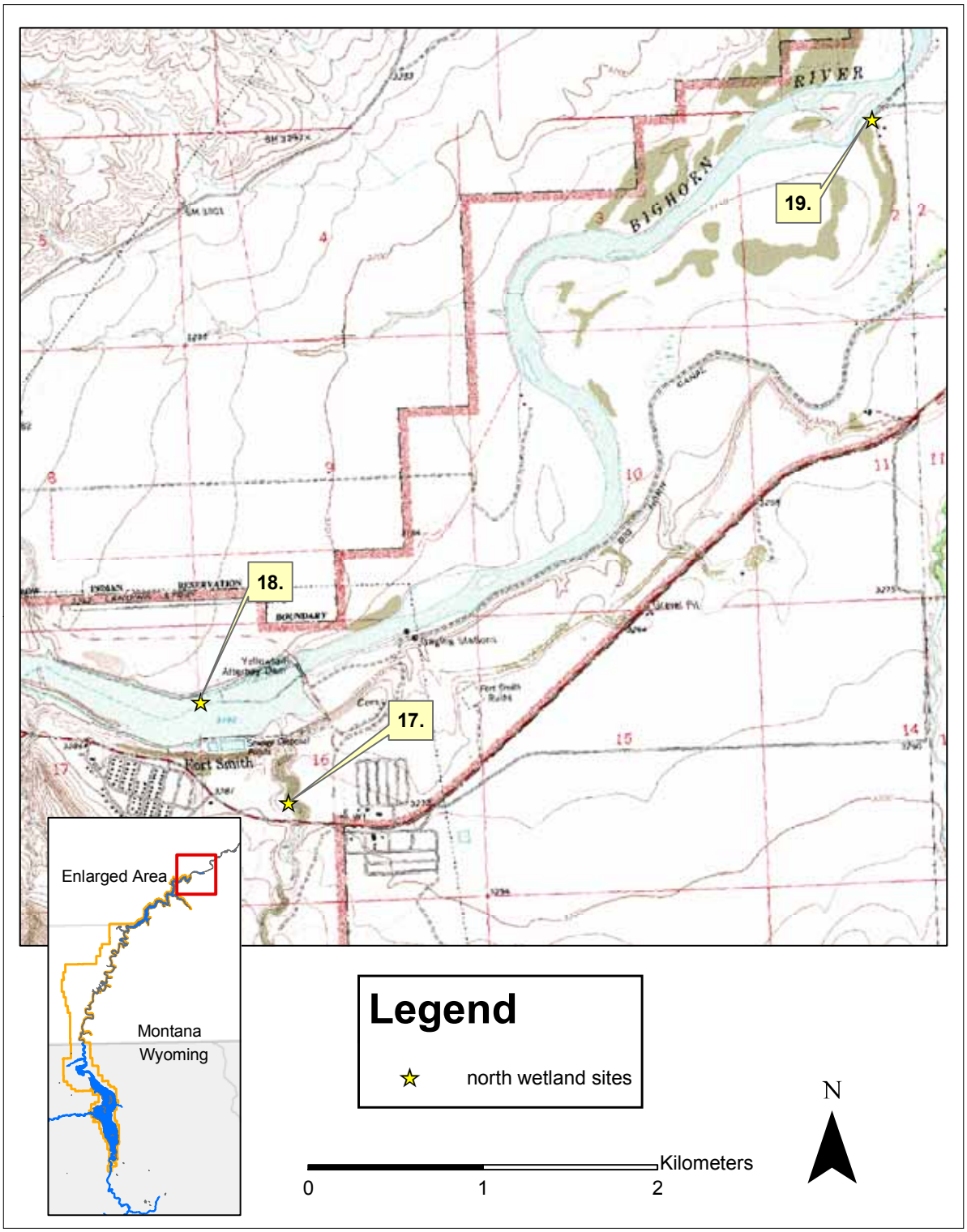


Figure 3c. Wetland Visual Encounter Survey sites. These wetland sites were located at the north end of the study area (Yellowtail Dam Quadrangle, Mont. 24k series). Refer to Table 4 for site names and a list of species detected at these sites.

AMPHIBIAN SURVEY DATA SHEET - modified after S.P. Corn, NBS, Fort Collins, CO (ver. 1 May 1996)

Herpetology Laboratory, Idaho State University and Idaho Museum of Natural History, Box 8007, Pocatello, ID 83209
(208) 236-3922 voice 236-4570 FAX e-mail: petechar@isu.edu

DATE		**BEGIN TIME**		**END TIME**		**OBSERVERS**		
LOCALITY								
STATE		**COUNTY**		**MAP NAME**		**OWNER**	**ELEVATION**	
T	**R**	**S**		**UTM ZONE/DATUM**		**NORTHING**	**EASTING**	
AMPHIBIAN AND REPTILE SPECIES PRESENT (INDICATE NUMBERS IN CATEGORIES IF POSSIBLE)								
SPECIES	**ADULT**	**JUVENILE**	**METAM.**	**LARVAE**	**EGGS**	**CALLING**	**TECHNIQUE(S)**	**VOUCHER**
FISH PRESENT		YES ??? NO		**FISH SPECIES:**				
ENTIRE SITE SEARCHED?		YES NO		**IF NO, IDICATE AREA:**			meters of shoreline habitat	
WEATHER:	**RADIATION:** CLEAR PARTIAL OVERCAST					**WIND**: CALM LIGHT MEDIUM HEAVY		
AIR TEMPERATURE (1 M SHADED)		**°C OR F**		**% CLOUD COVER:**		**PRECIPTATION:** SNOW RAIN		
WATER	**TEMPERATURE (1CM)**			**pH:**	**CONDUCTIVITY**	**SAMPLE?**		
	COLOR CLEAR STAINED				**TURBIDITY** CLEAR CLOUDY			
SITE DESCRIPTION	PUT SKETCH AND ADDITIONAL COMMENTS ON BACK OF SHEET							
ORIGIN NATURAL MAN-MADE MAN-MODIFIED				**DRAINAGE** PERMANENT OCCASIONAL NONE				
SITE TYPE TEMPORARY or PERMANENT LAKE/POND MARSH BOG STREAM SPRING/SEEP ACTIVE or INACTIVE BEAVER POND								
NATIONAL WETLAND INVENTORY CLASIFICATION				**GAP ANALYSIS COVER TYPE (IF KNOWN)**				
STREAM ORDER 1 2 3 4 5 6								
SITE LENGTH m	**SITE WIDTH** m			**MAXIMUM DEPTH** < 1M 1 - 2 M > 2 M				
PRIMARY SUBSTRATE SILT/MUD SAND/GRAVEL COBBLE BOULDER/BEDROCK OTHER:								
% OF LAKE MARGIN WITH EMERGENT VEGETATION 0 1 - 25 25 - 50 >50								
EMERGENT VEGETATION SPECIES (IN ORDER OF ABUNDANCE)								
NORTH SHORELINE CHARACTERISTICS		SHALLOWS PRESENT	SHALLOWS ABSENT	EMERGENT VEG PRESENT		EMERGENT VEG ABSENT		
DISTANCE TO FOREST EDGE m		**FOREST TREE SPECIES**						

Figure 4. Visual Encounter Survey data sheet.

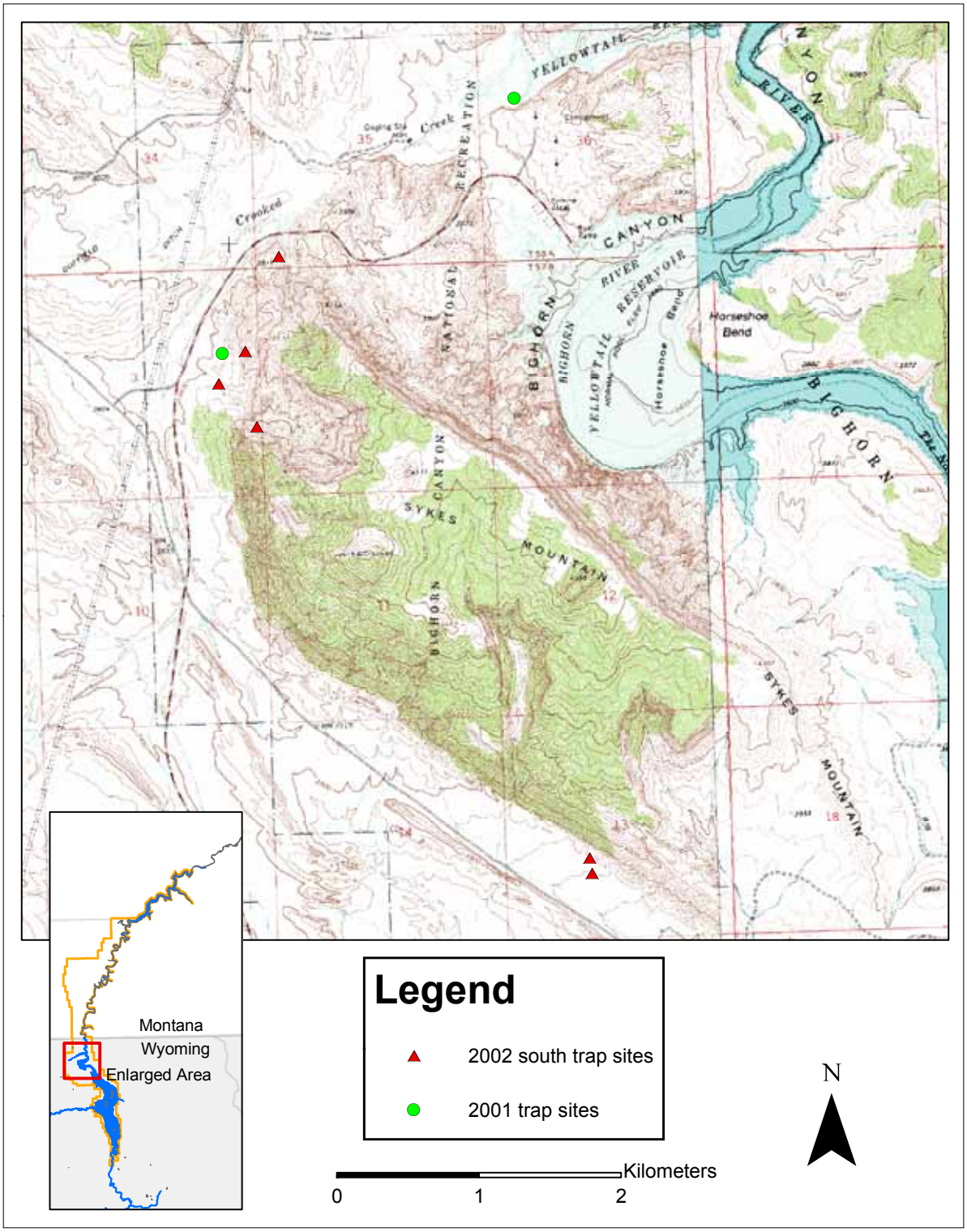


Figure 5a. Terrestrial Funnel Trap localities. This map includes Sykes Mountain and Horseshoe Bend at the south end (Sykes Spring and Natural Trap Cave Quadrangles, Wyo./Mont. 24k series).

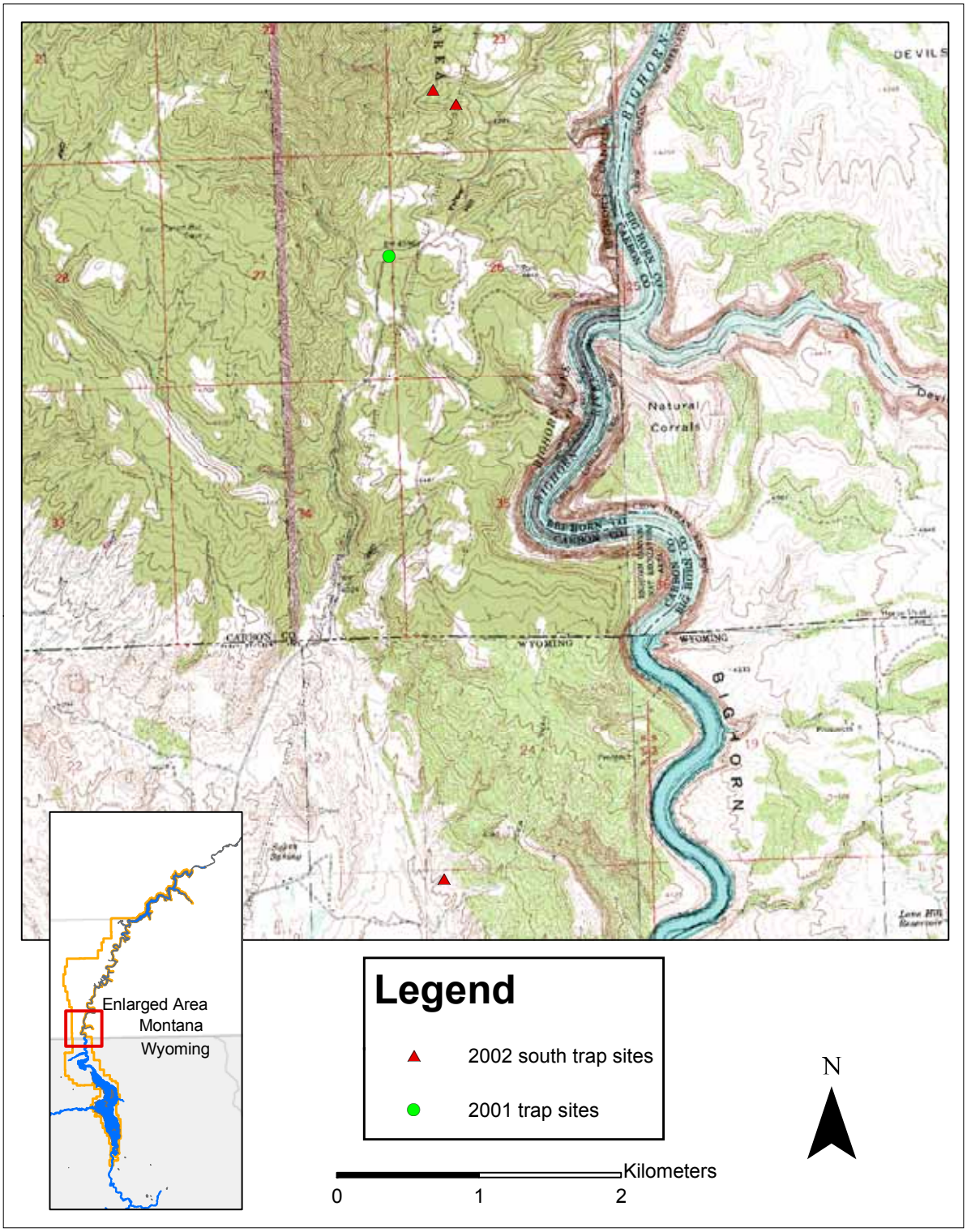


Figure 5b. Terrestrial Funnel Trap localities. This map includes Sykes Mountain and Horseshoe Bend at the south end (Sykes Spring, Natural Trap Cave, Mystery Cave, and Hillsboro Quadrangles, Wyo./Mont. 24k series).

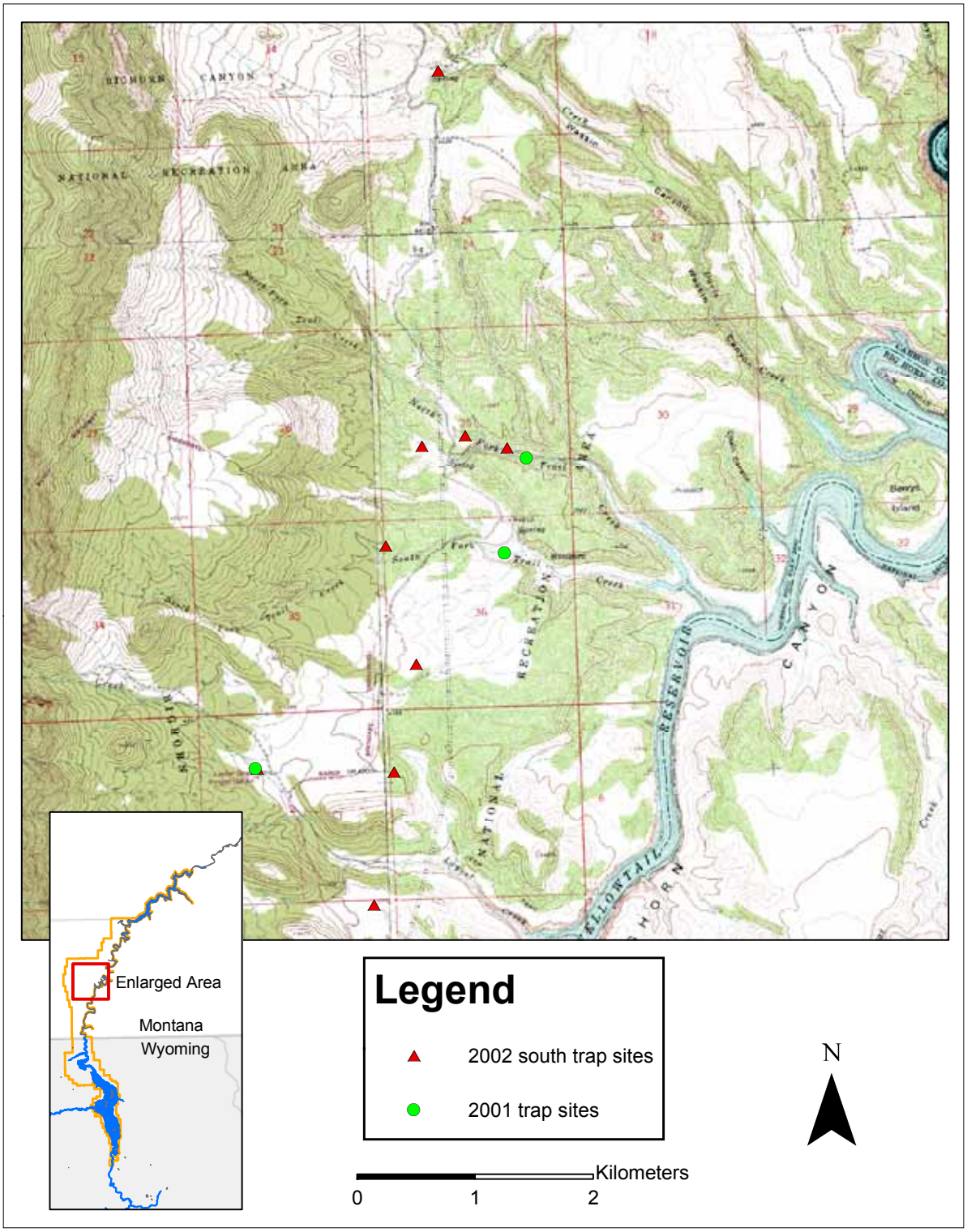


Figure 5c. Terrestrial Funnel Trap localities. This map includes Sykes Mountain and Horseshoe Bend at the south end (Dead Indian Hill, Mystery Cave, and Hillsboro Quadrangles, Mont. 24k series).

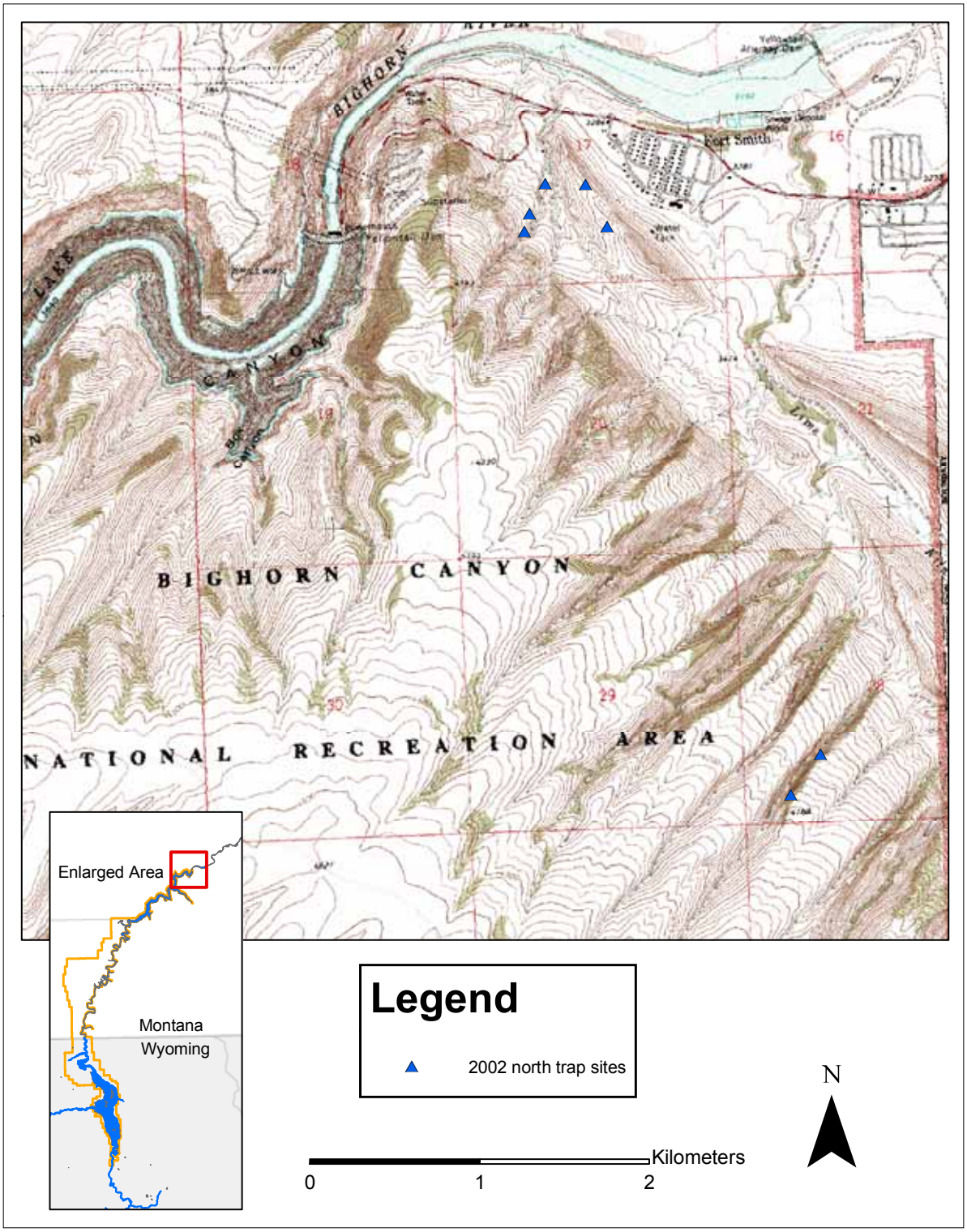
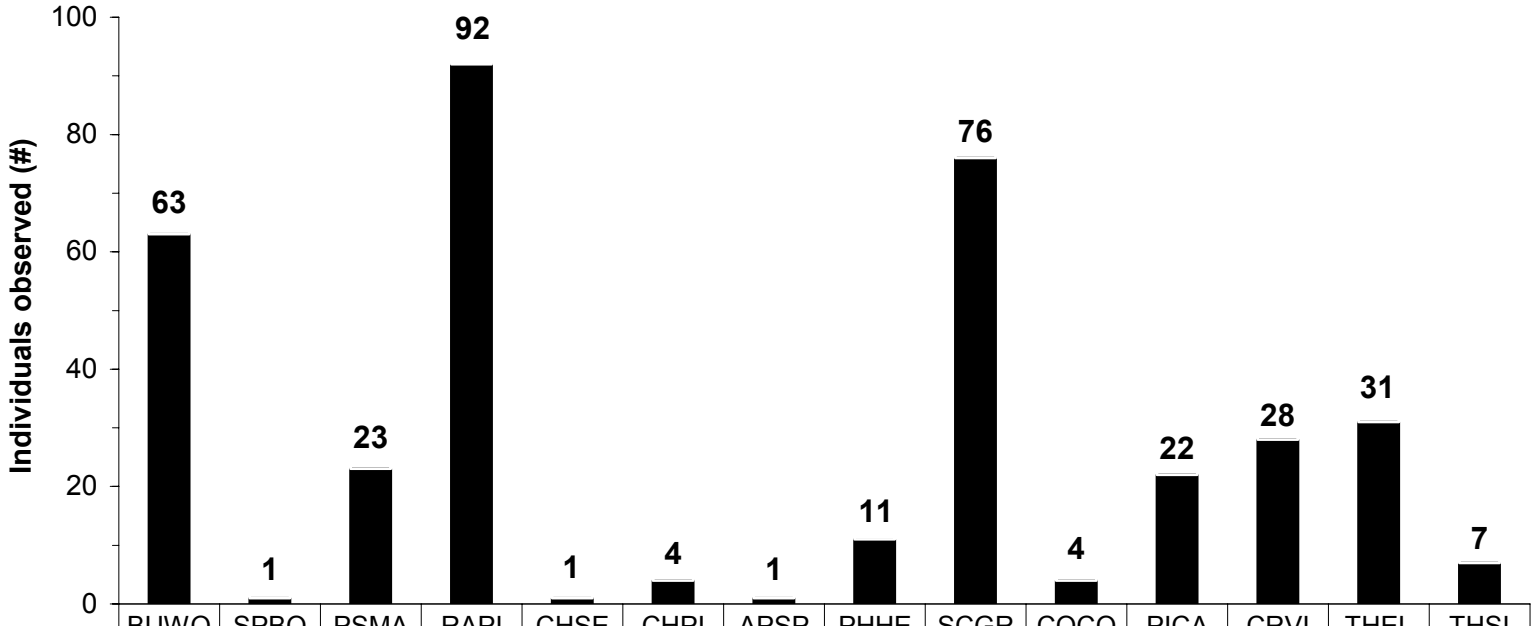


Figure 5d. Terrestrial Funnel Trap localities. This map includes Sykes Mountain and Horseshoe Bend at the south end (Yellowtail Dam Quadrangle, Mont. 24k series).



	BUWO	SPBO	PSMA	RAPI	CHSE	CHPI	APSP	PHHE	SCGR	COCO	PICA	CRVI	THEL	THSI
Aquatic Trap	3	0	2	8	0	0	0	0	0	0	0	0	8	0
Calling	8	0	12	3	0	0	0	0	0	0	0	0	0	0
Froglogger	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Contributed	0	0	0	0	0	1	0	10	3	0	4	6	1	0
Opportunistic	1	1	0	1	1	2	1	1	12	2	6	9	7	1
Road Driving	0	0	0	0	0	0	0	0	1	0	7	4	1	0
Terrestrial Trap	3	0	2	8	0	0	0	0	0	0	0	0	8	0
VES	50	0	9	80	0	1	0	0	50	1	4	5	14	6
Totals	63	1	23	92	1	4	1	11	76	4	22	28	31	7

Figure 6a. The total number of observations recorded by each survey method along with the number of individuals recorded per species in Bighorn Canyon National Recreation Area during our surveys (BUWO – *Bufo woodhousii*, SPBO – *Spea bombifrons*, PSMA – *Pseudacris maculata*, RAPI – *Rana pipiens*, CHSE – *Chelydra serpentina*, CHPI – *Chrysemys picta,* APSP – *Apolone spinifera*, PHHE – *Phrynosoma hernandesi*, SCGR – *Sceloporus graciosus*, COCO – *Coluber constrictor*, PICA – *Pituophis catenifer*, CRVI – *Crotalus viridis*, THEL – *Thamnophis elegans*, THSI – *Thamnophis sirtalis*).

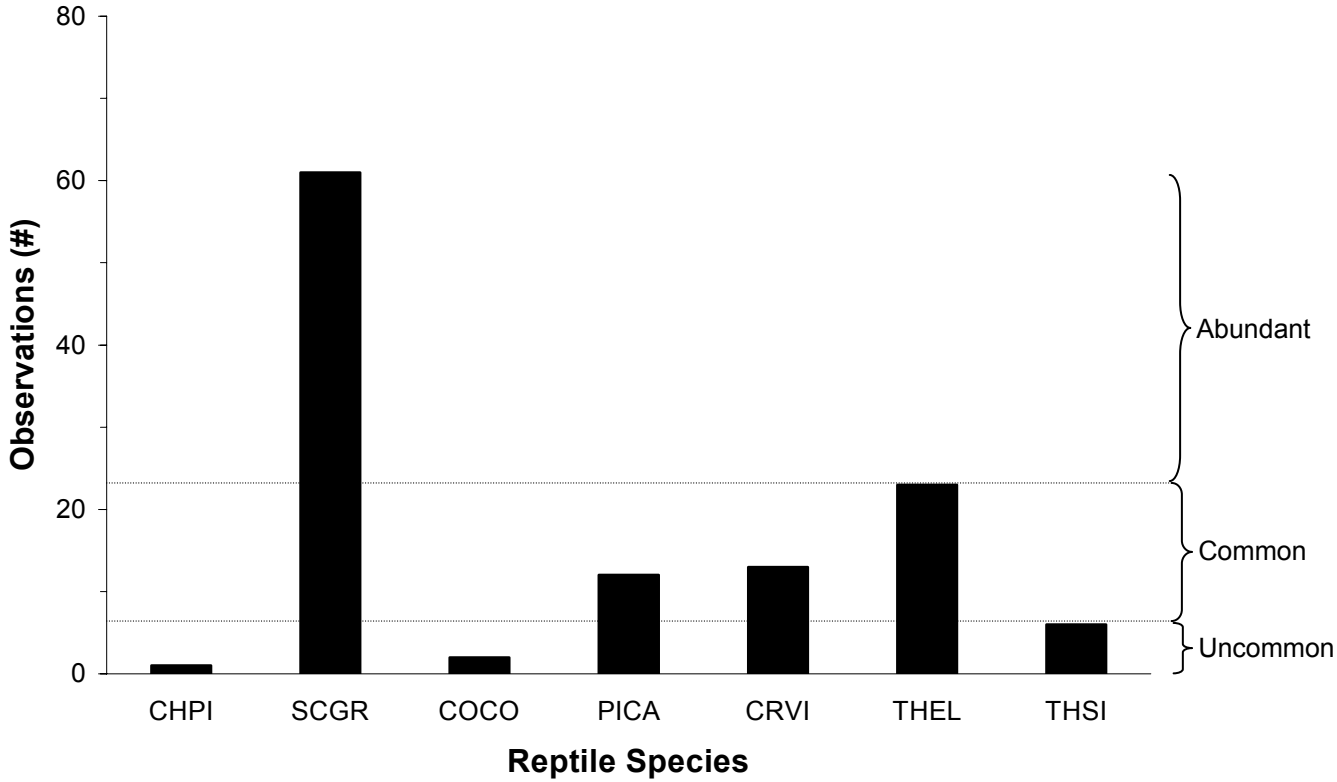


Figure 6b. Relative abundance of reptile species based on the number of observations made using 2001-02 survey techniques (aquatic and terrestrial funnel traps, road driving, and visual encounter surveys). Refer to Appendix E for abundance code descriptions.

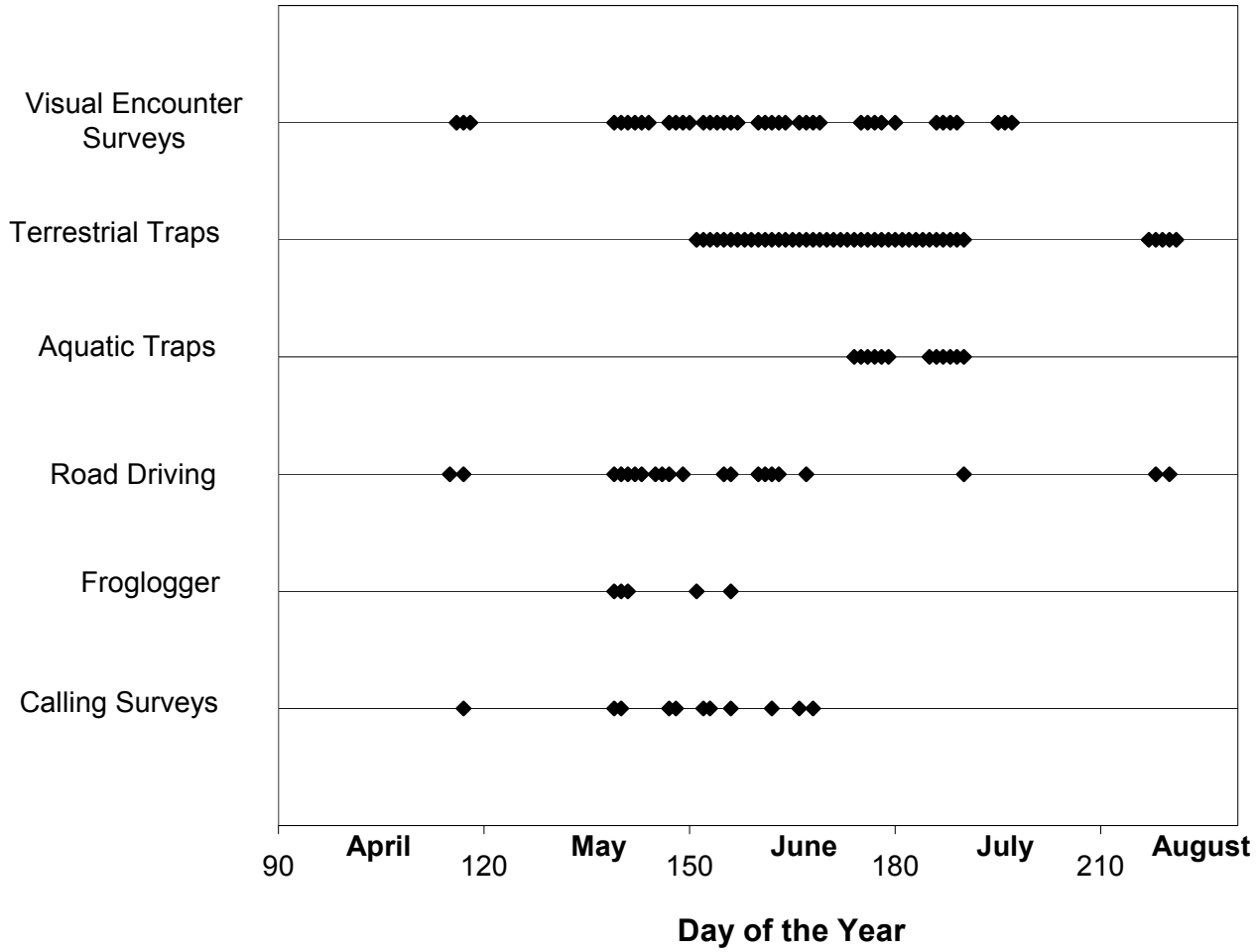


Figure 7a. The sampling techniques conducted during our 2001 and 2002 surveys according to the day of the year.

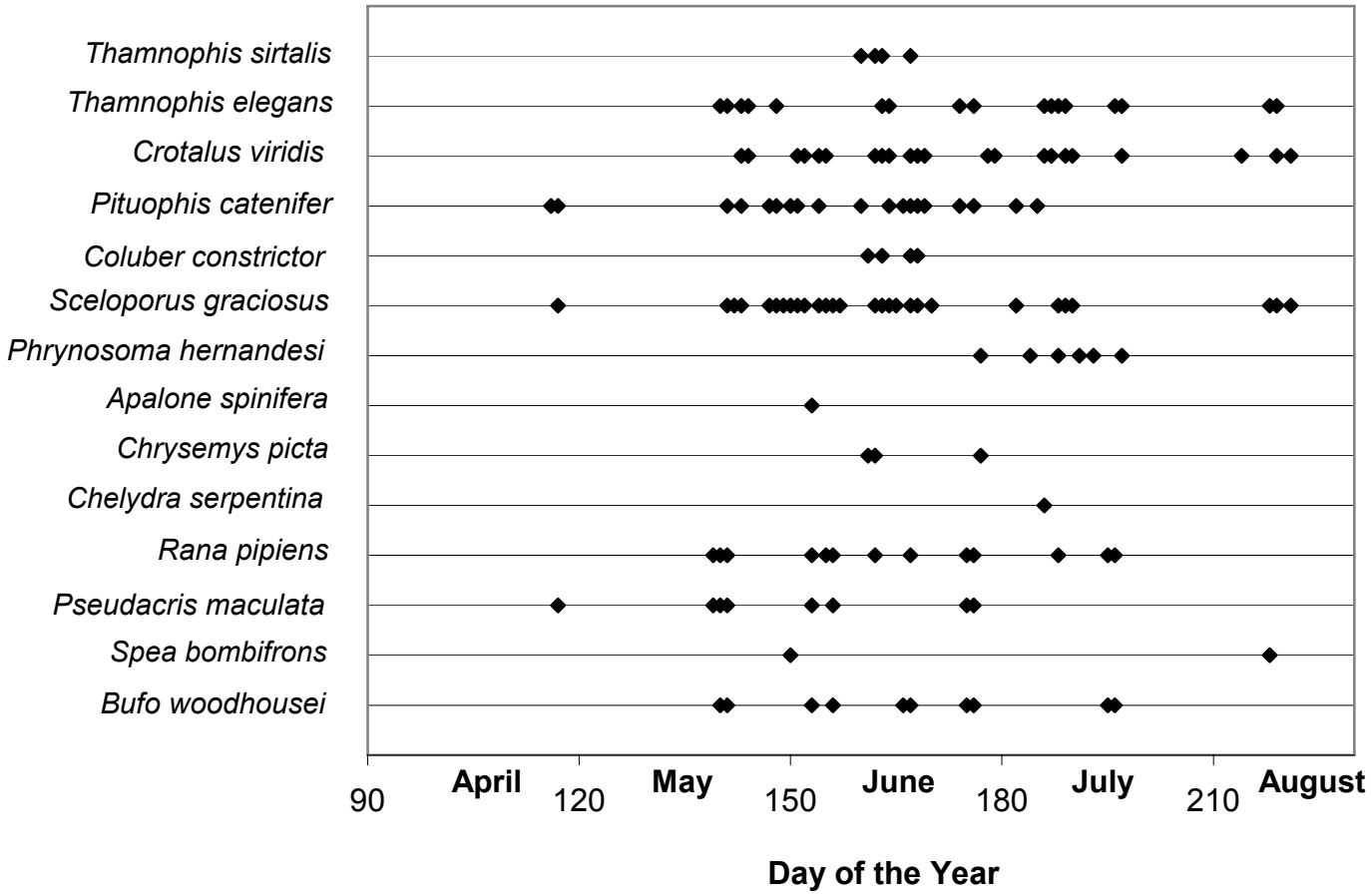
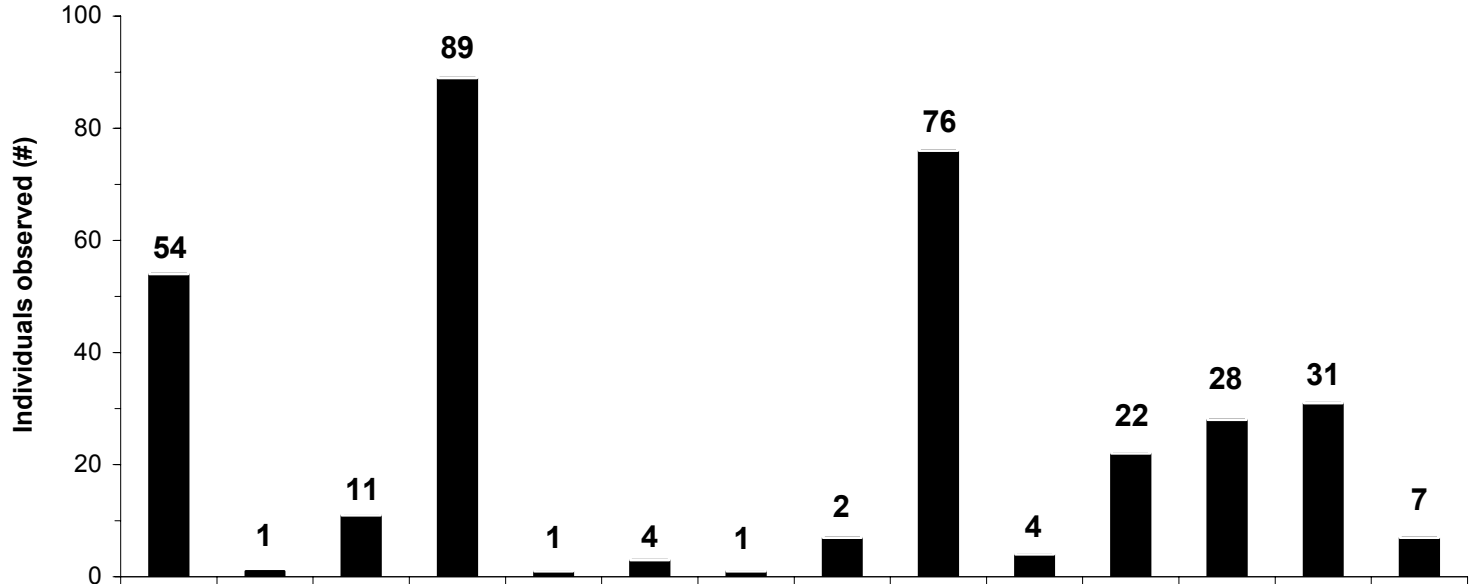


Figure 7b. Species observations recorded during our 2001 and 2002 surveys according to the day of the year.



	BUWO	SPBO	PSMA	RAPI	CHSE	CHPI	APSP	PHHE	SCGR	COCO	PICA	CRVI	THEL	THSI
Coniferous woodland	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Desert shrubland	0	0	0	0	0	0	0	2	12	0	3	8	0	0
Disturbed/Barren	0	1	0	0	0	0	0	0	17	1	10	7	6	1
Grassland	0	0	0	0	0	0	0	0	4	2	2	1	0	0
Juniper/Mtn. mahogany	0	0	0	0	0	0	0	1	33	0	0	5	0	0
Riparian	2	0	0	0	1	1	0	0	3	1	7	6	22	6
Sagebrush steppe	0	0	0	0	0	0	0	4	6	0	0	1	0	0
Wetland	52	0	11	89	0	2	1	0	1	0	0	0	3	0
Totals	54	1	11	89	1	3	1	7	76	4	22	28	31	7

Figure 8. The total number of species observed per habitat from all survey methods (except calling surveys) used in Bighorn Canyon National Recreation Area. Habitat types modified from Knight et al., 1987. (BUWO – *Bufo woodhousii*, SPBO – *Spea* bombifrons, PSMA – *Pseudacris maculata*, RAPI – *Rana pipiens*, CHSE – *Chelydra serpentina*, CHPI – *Chrysemys picta,* APSP – *Apolone spinifera*, PHHE – *Phrynosoma hernandesi*, SCGR – *Sceloporus graciosus*, COCO – *Coluber constrictor*, PICA – *Pituophis catenifer*, CRVI – *Crotalus viridis*, THEL – *Thamnophis elegans*, THSI – *Thamnophis sirtalis*).

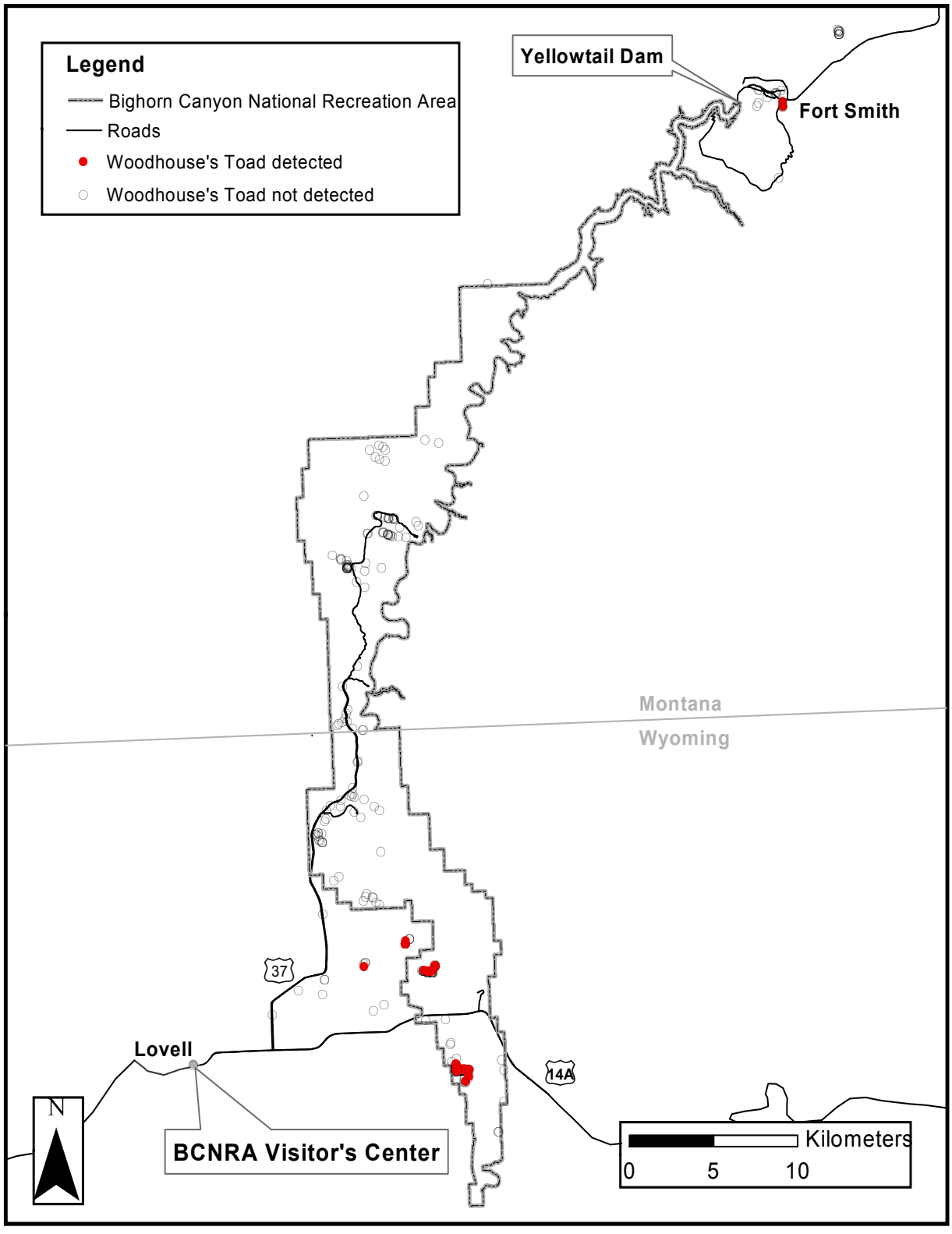


Figure 9. Woodhouse's Toad (*Bufo woodhousii*) dot distribution map of observations recorded during opportunistic encounters, road driving, trap captures, and visual encounter surveys.

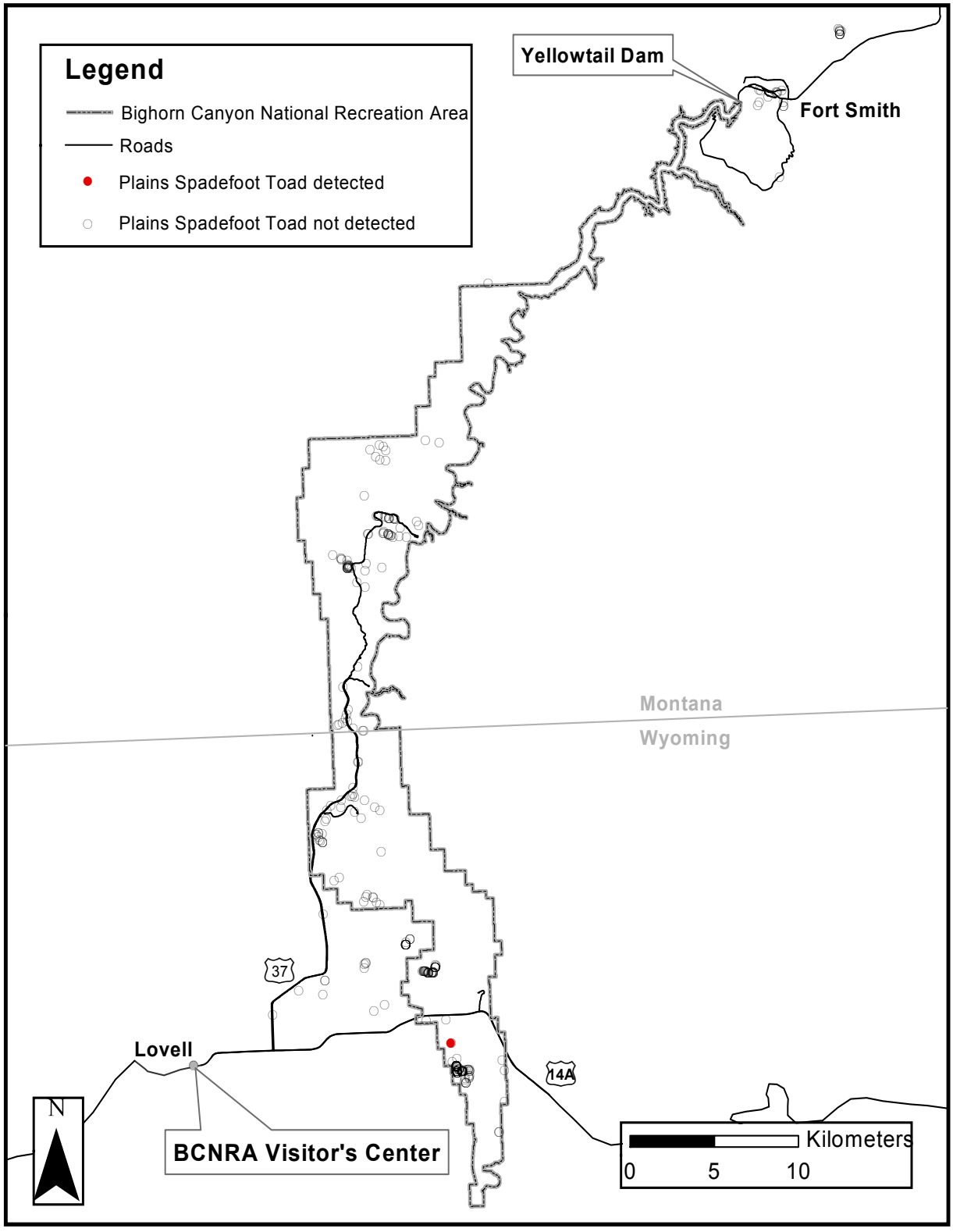


Figure 10. Plains Spadefoot (*Spea bombifrons*) dot distribution map of observations recorded during opportunistic encounters, road driving, trap captures, and visual encounter surveys.

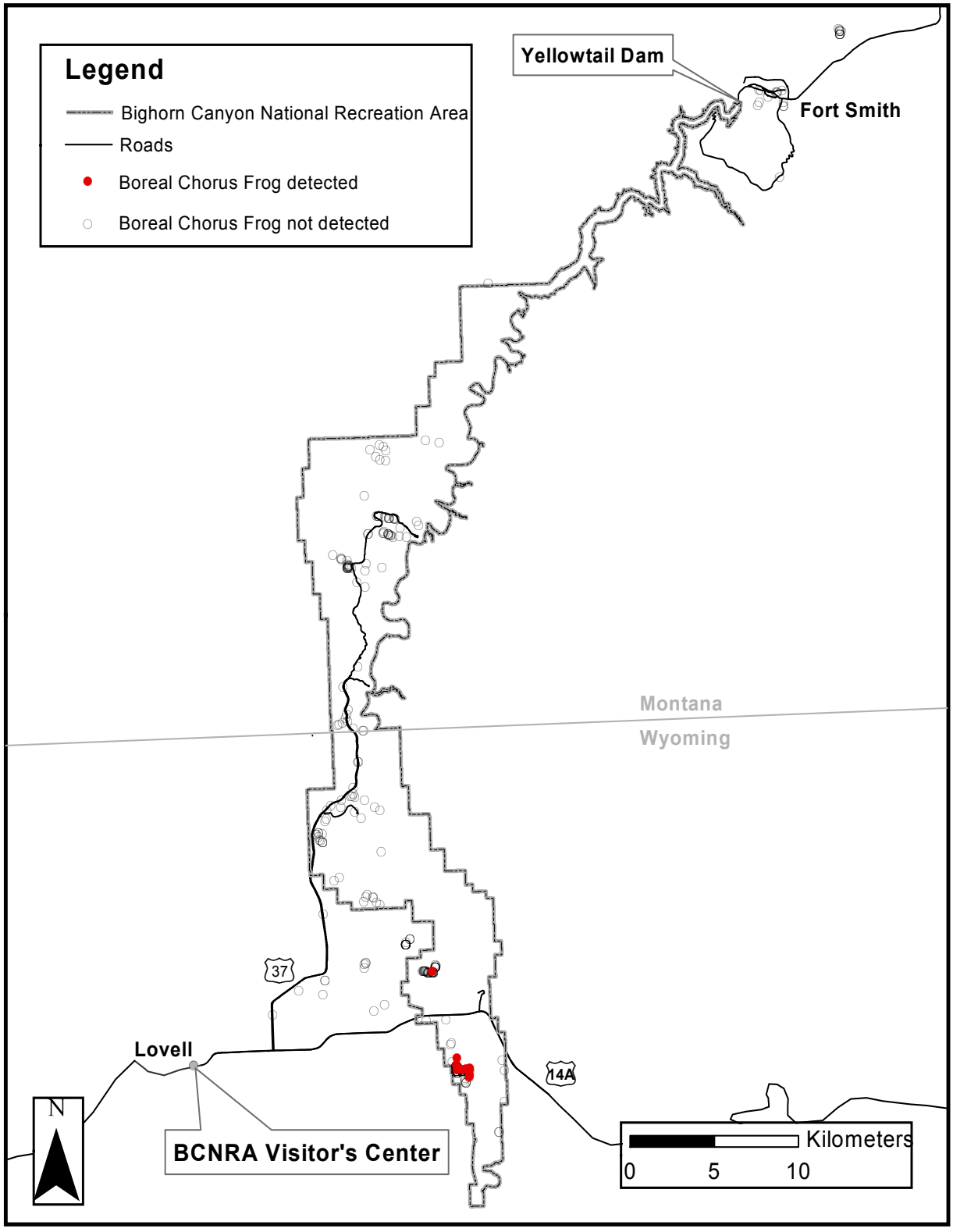


Figure 11. Boreal Chorus Frog (*Pseudacris maculata*) dot distribution map of observations recorded during opportunistic encounters, road driving, trap captures, and visual encounter surveys.

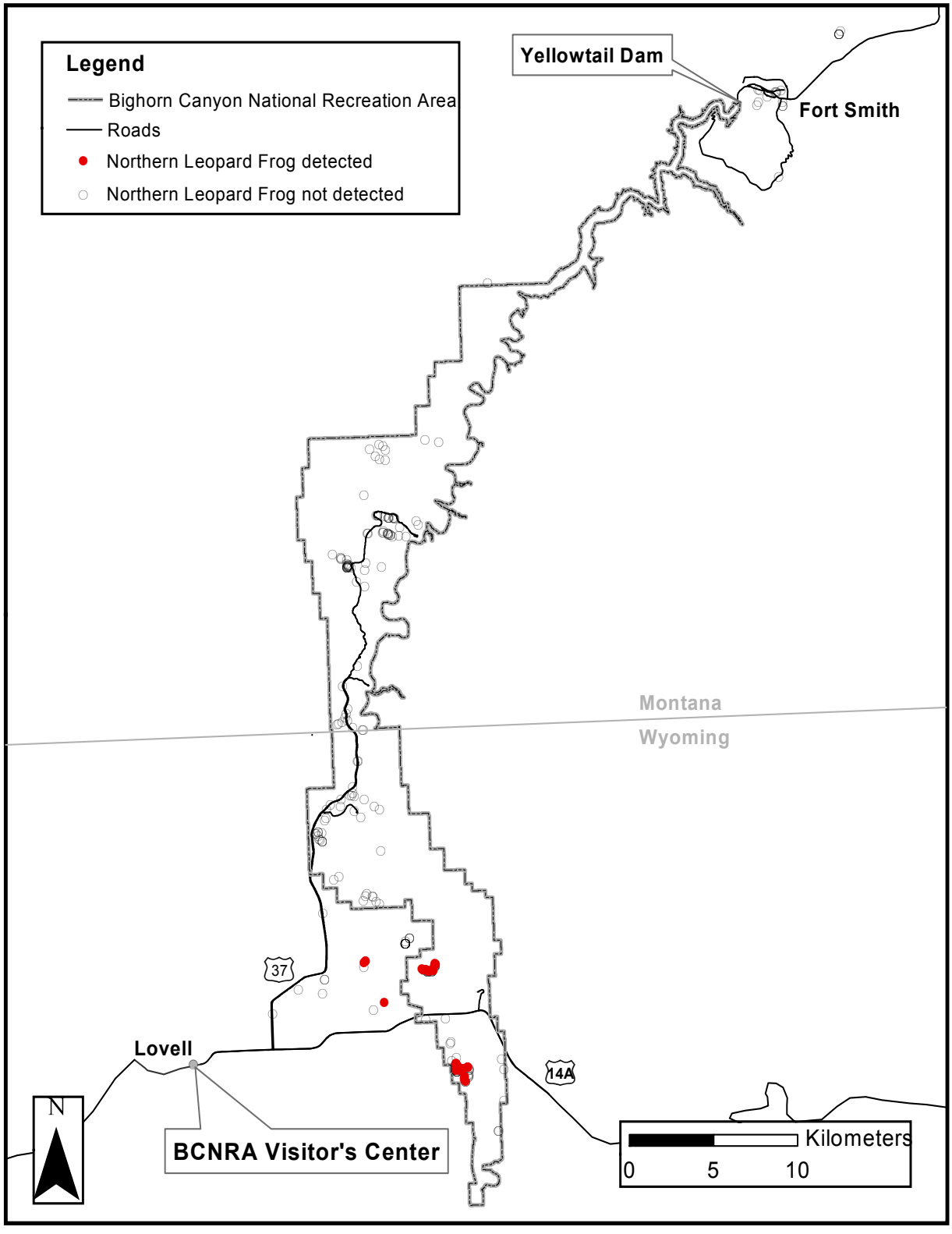


Figure 12. Northern Leopard Frog (*Rana pipiens*) dot distribution map of observations recorded during opportunistic encounters, road driving, trap captures, and visual encounter surveys.

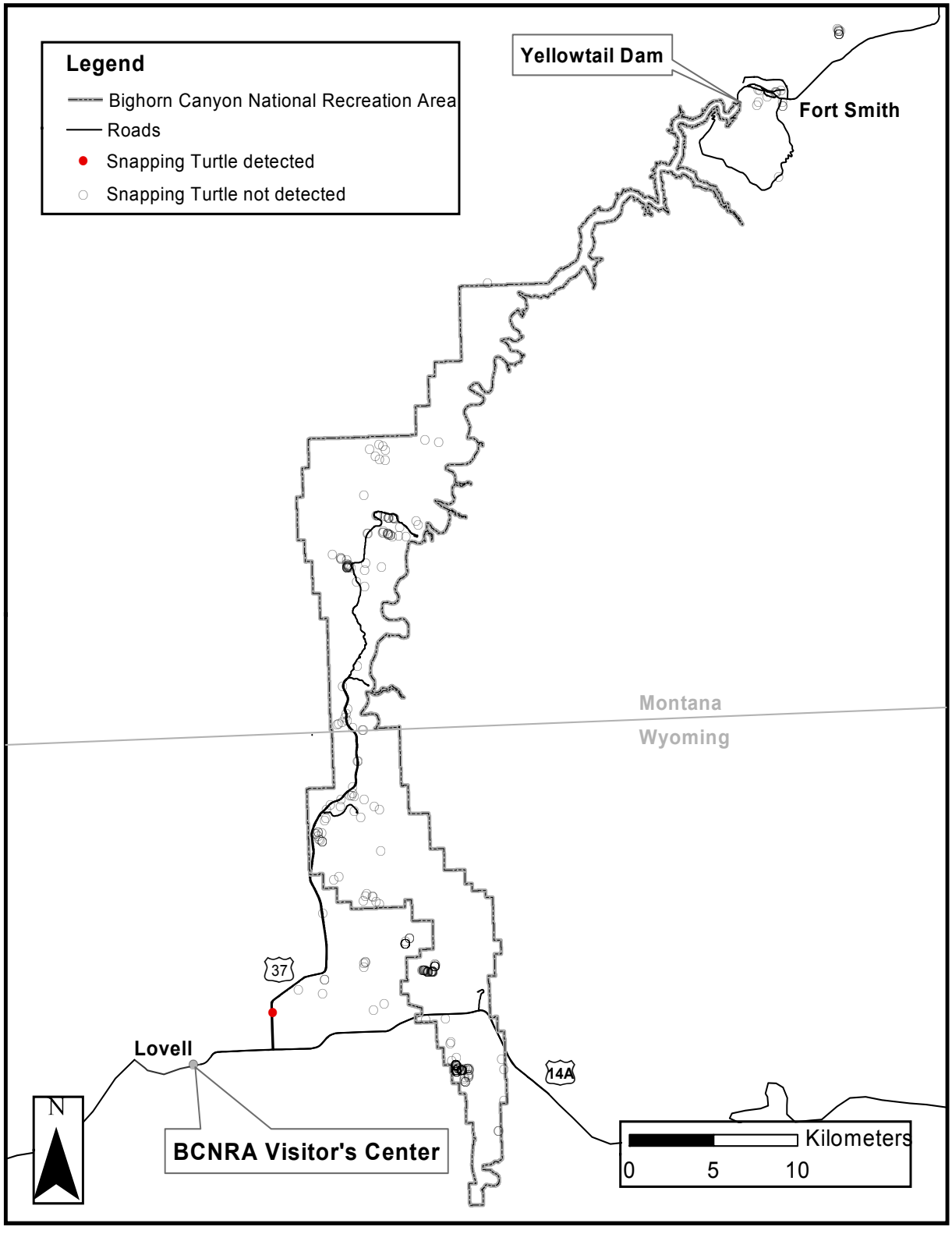


Figure 13. Snapping Turtle (*Chelydra serpentina*) dot distribution map of observations recorded during opportunistic encounters, road driving, trap captures, and visual encounter surveys.

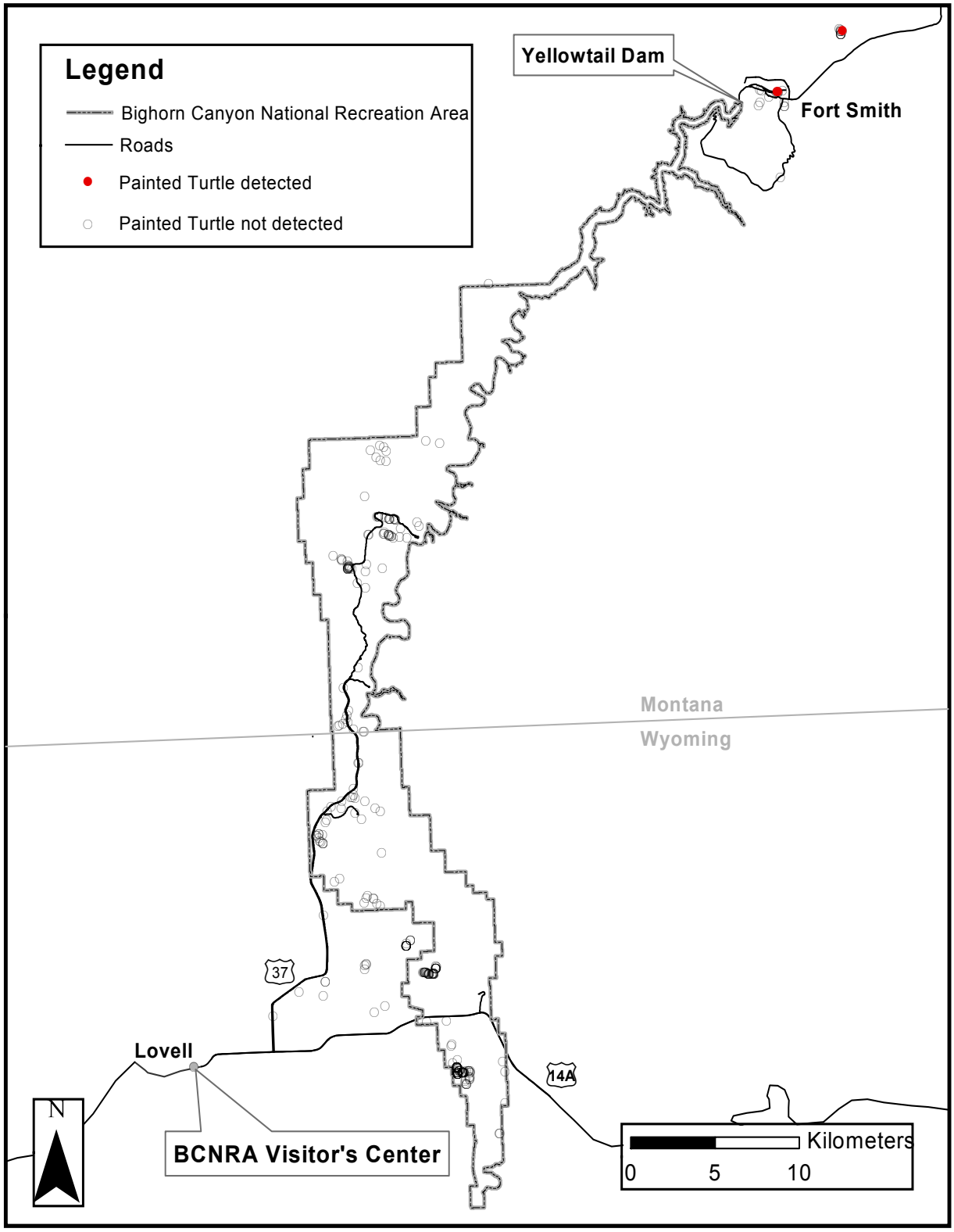


Figure 14. Painted Turtle (*Chrysemys picta*) dot distribution map of observations recorded during opportunistic encounters, road driving, trap captures, and visual encounter surveys.

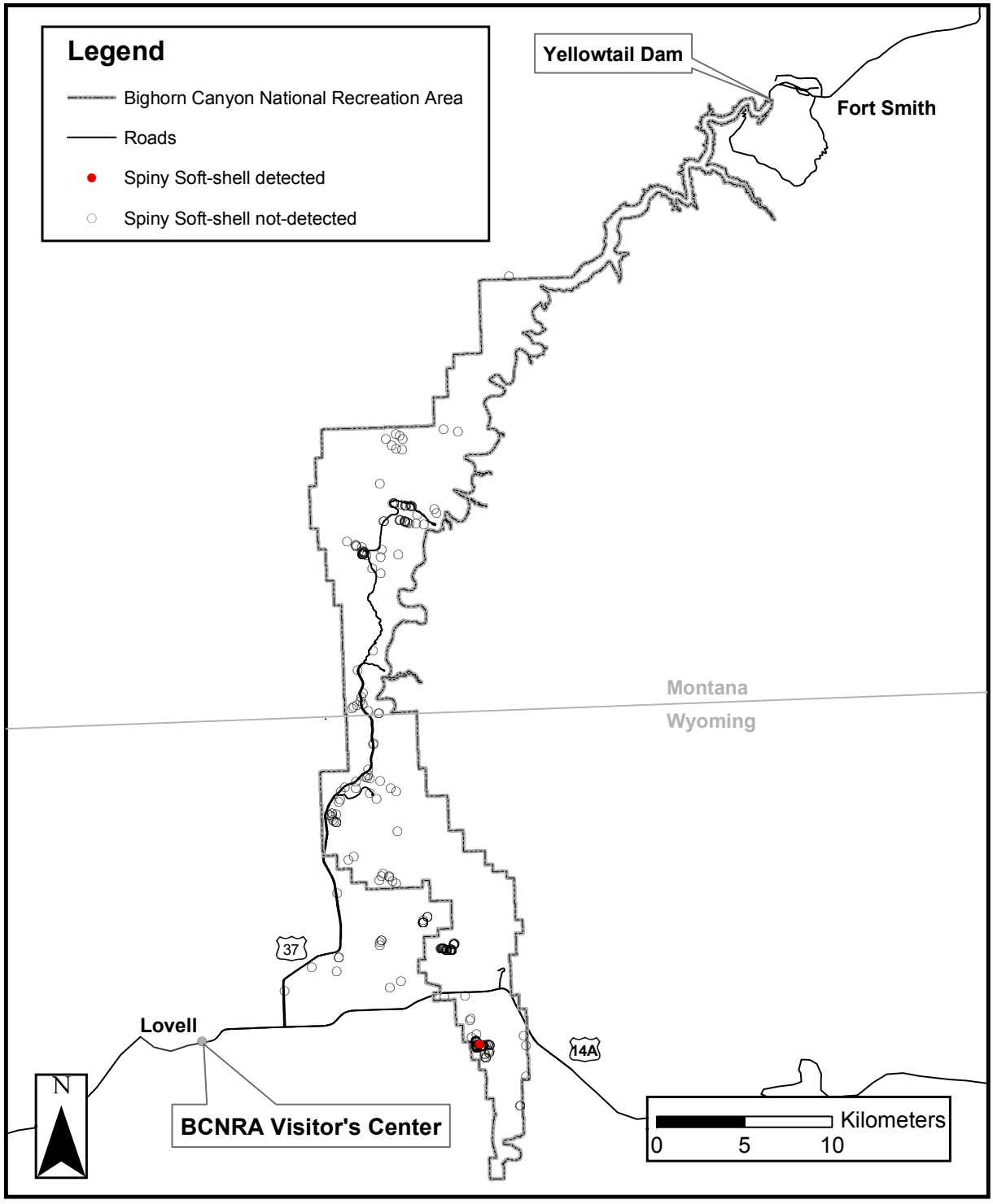


Figure 15. Spiny Softshell (*Apalone spinifera*) dot distribution map of observations recorded during opportunistic encounters, road driving, trap captures, and visual encounter surveys.

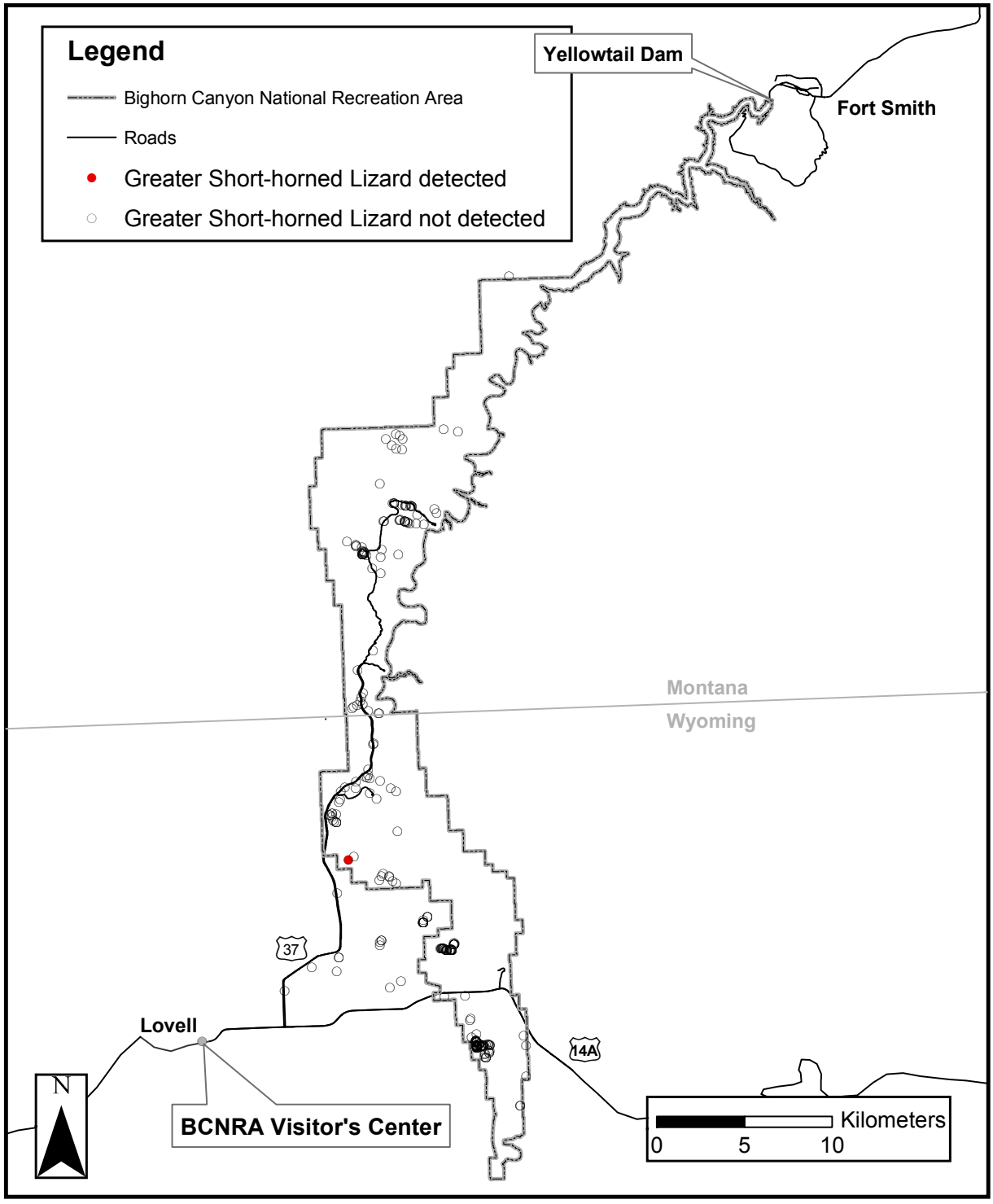


Figure 16. Greater Short-horned Lizard (*Phyrnosoma hernandesi)* dot distribution map of observations recorded during opportunistic encounters, road driving, trap captures, and visual encounter surveys.

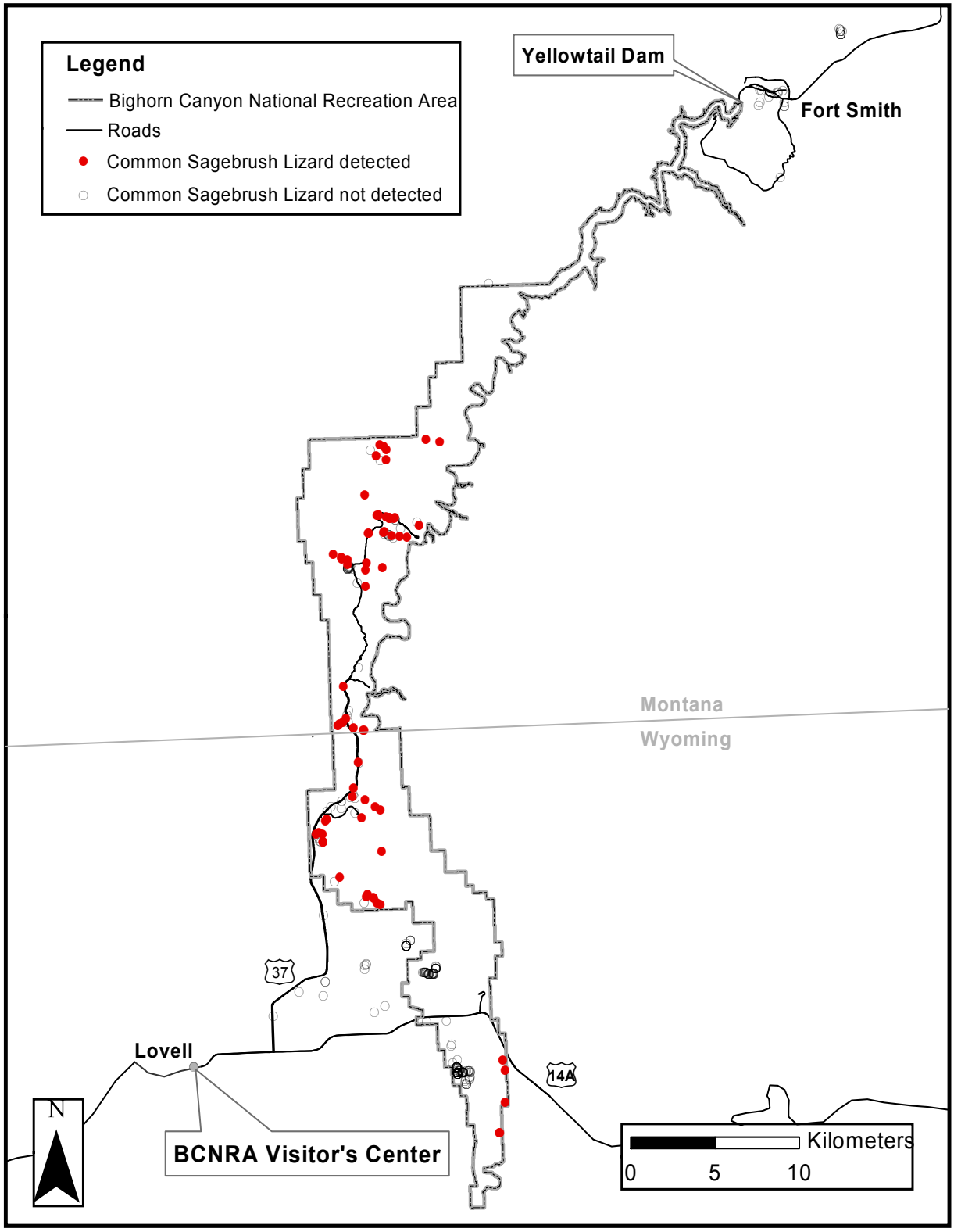


Figure 17. Common Sagebrush Lizard (*Sceloporus graciosus*) dot distribution map of observations recorded during opportunistic encounters, road driving, trap captures, and visual encounter surveys.

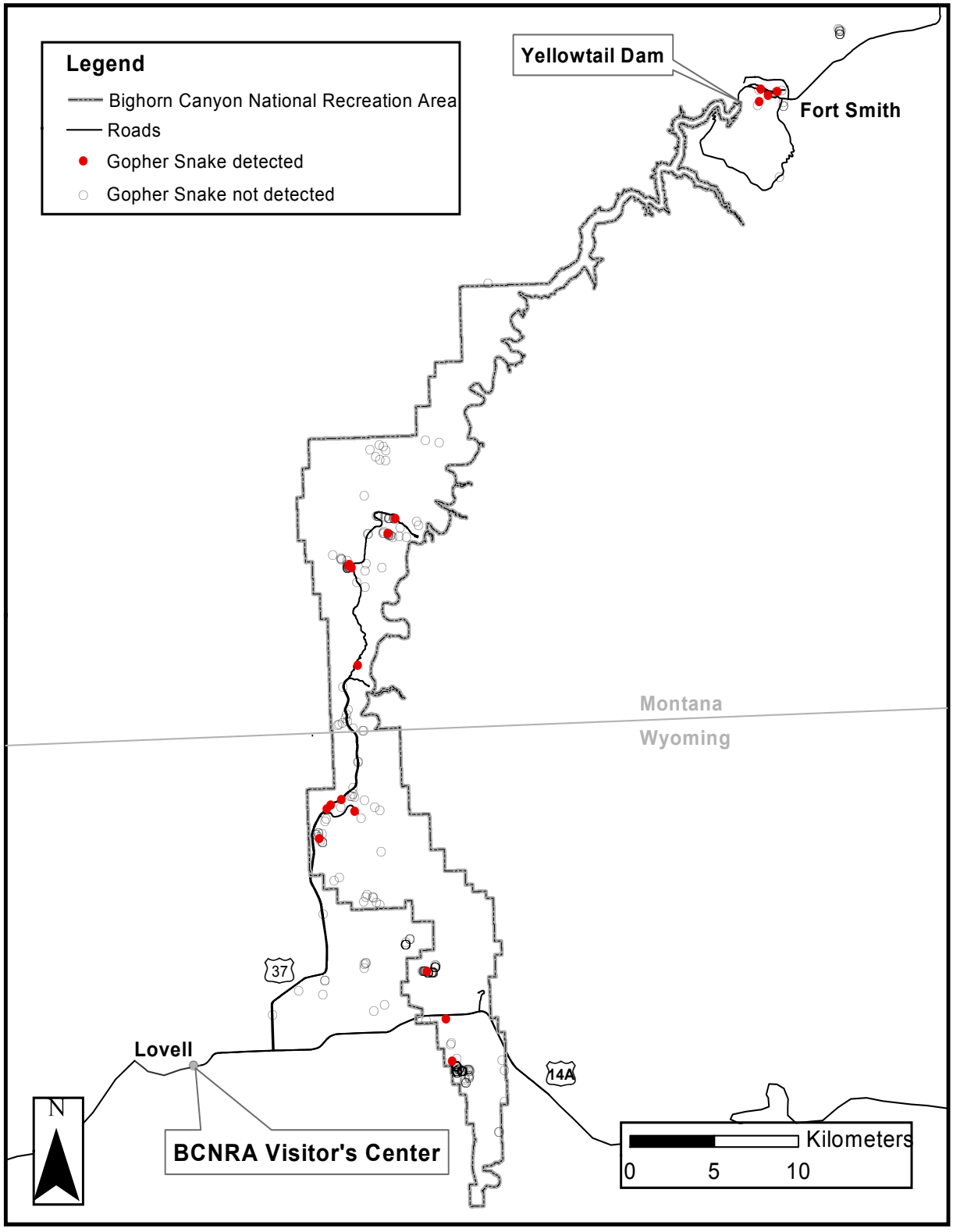


Figure 19. Gopher Snake (*Pituophis catenifer*) dot distribution map of observations recorded during opportunistic encounters, road driving, trap captures, and visual encounter surveys.

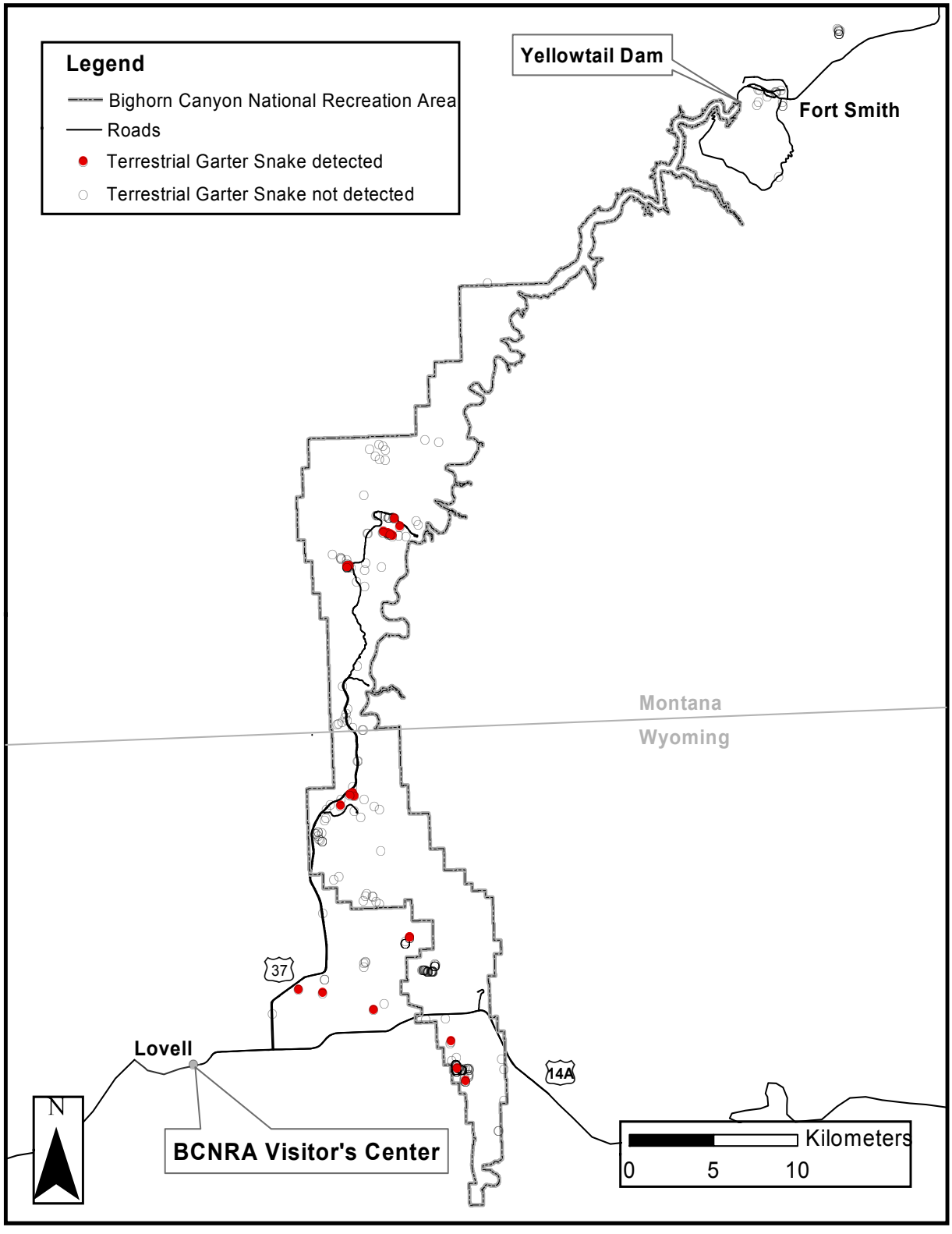


Figure 20. Terrestrial Garter Snake (*Thamnophis elegans*) dot distribution map of observations recorded during opportunistic encounters, road driving, trap captures, and visual encounter surveys.

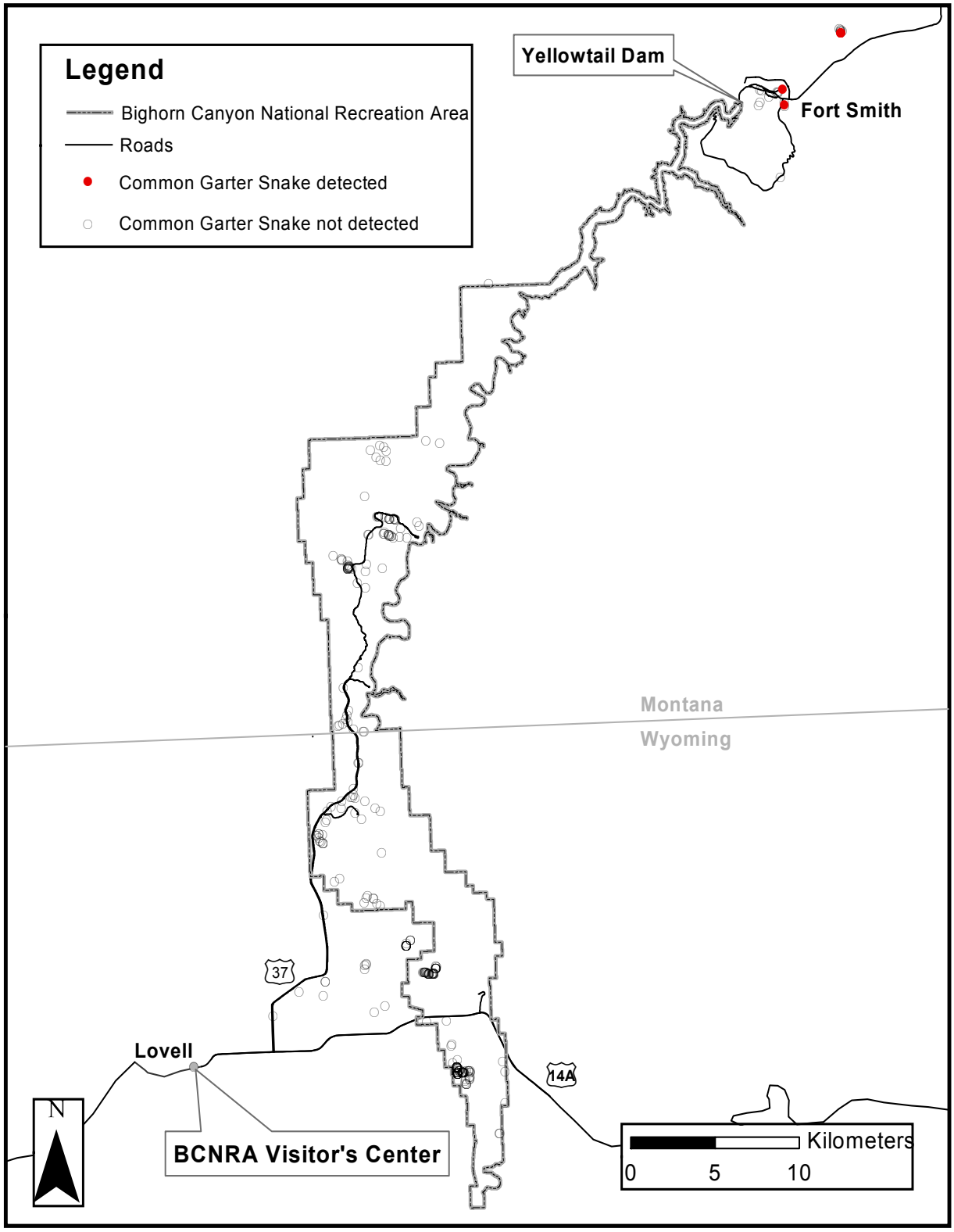


Figure 21. Common Garter Snake (*Thamnophis sirtalis*) dot distribution map of observations recorded during opportunistic encounters, road driving, trap captures, and visual encounter surveys.

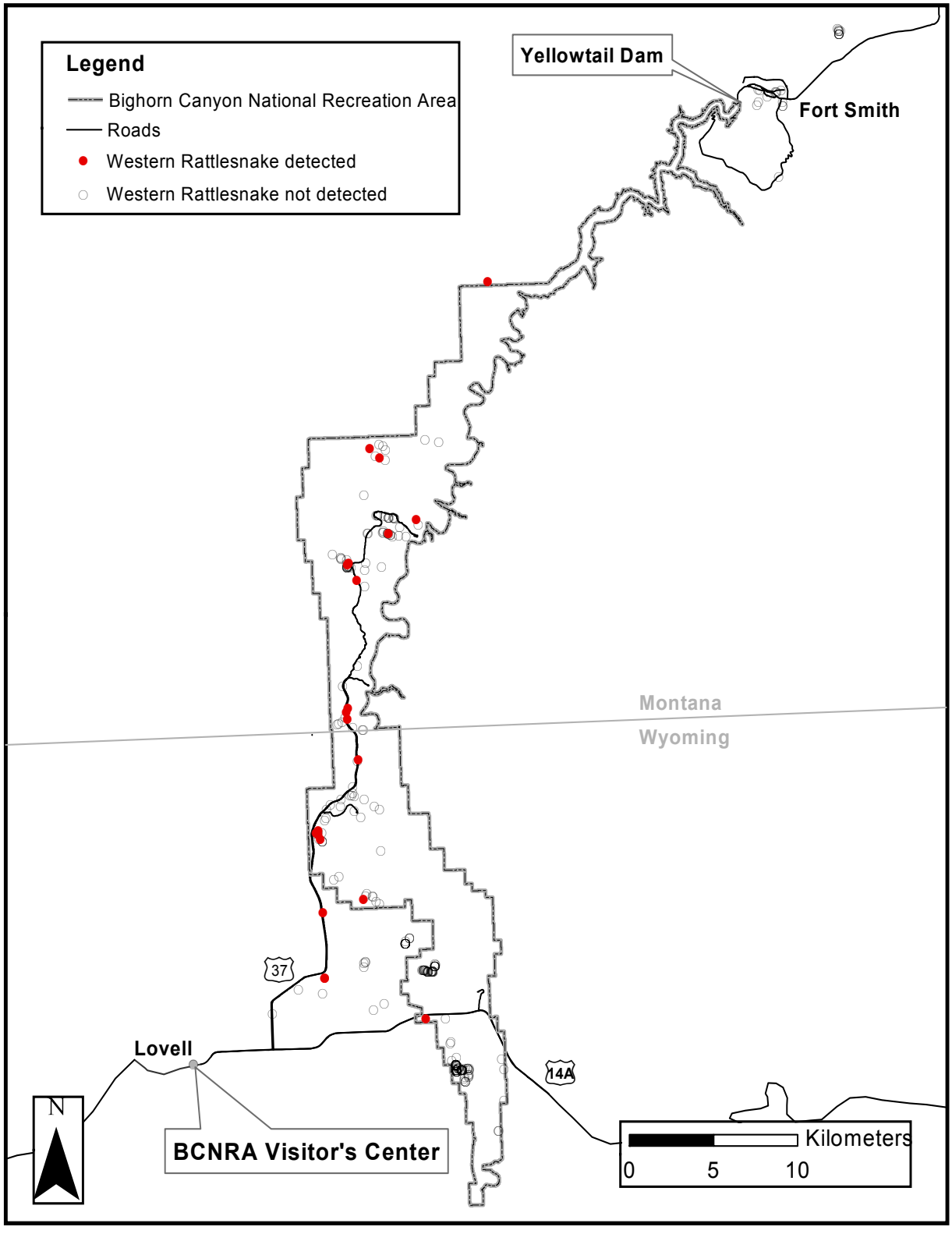


Figure 22. Western Rattlesnake (*Crotalus viridis*) dot distribution map of observations recorded during opportunistic encounters, road driving, trap captures, and visual encounter surveys.

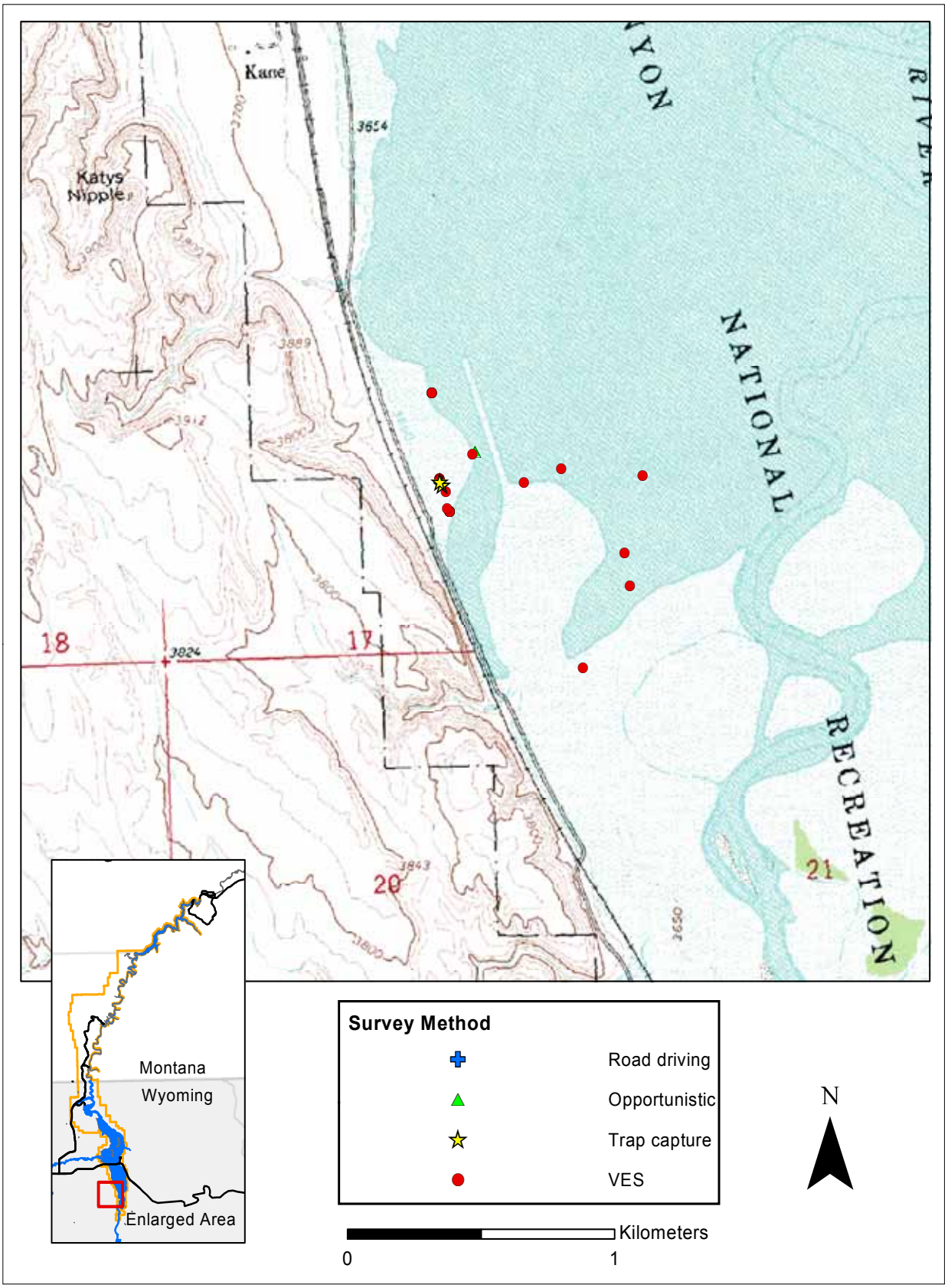


Figure 23a. Woodhouse's Toad distribution (Kane Quadrangle, Wyo. 24k series).

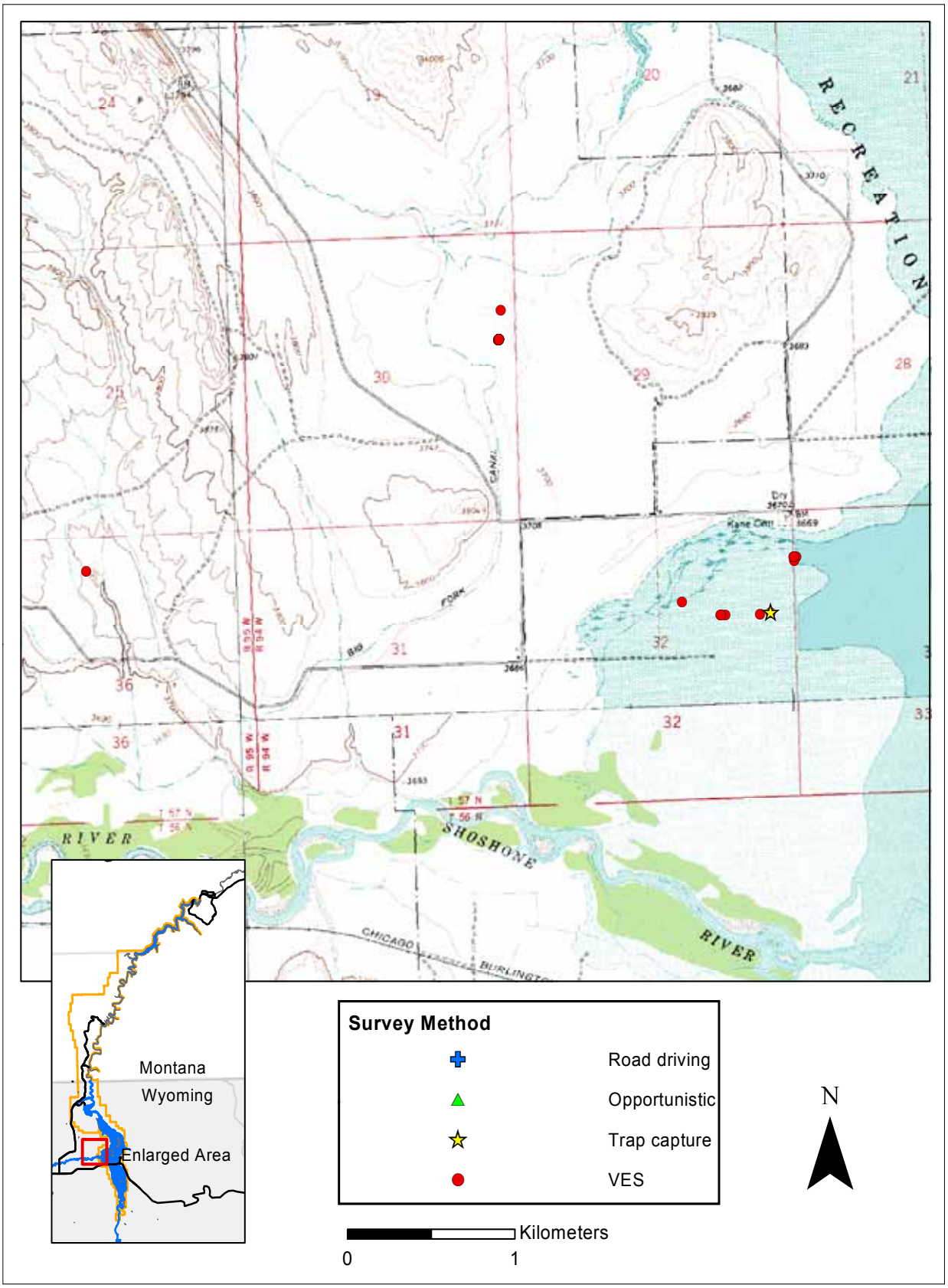


Figure 23b. Woodhouse's Toad distribution (Kane and Natural Trap Cave Quadrangles, Wyo. 24k series).

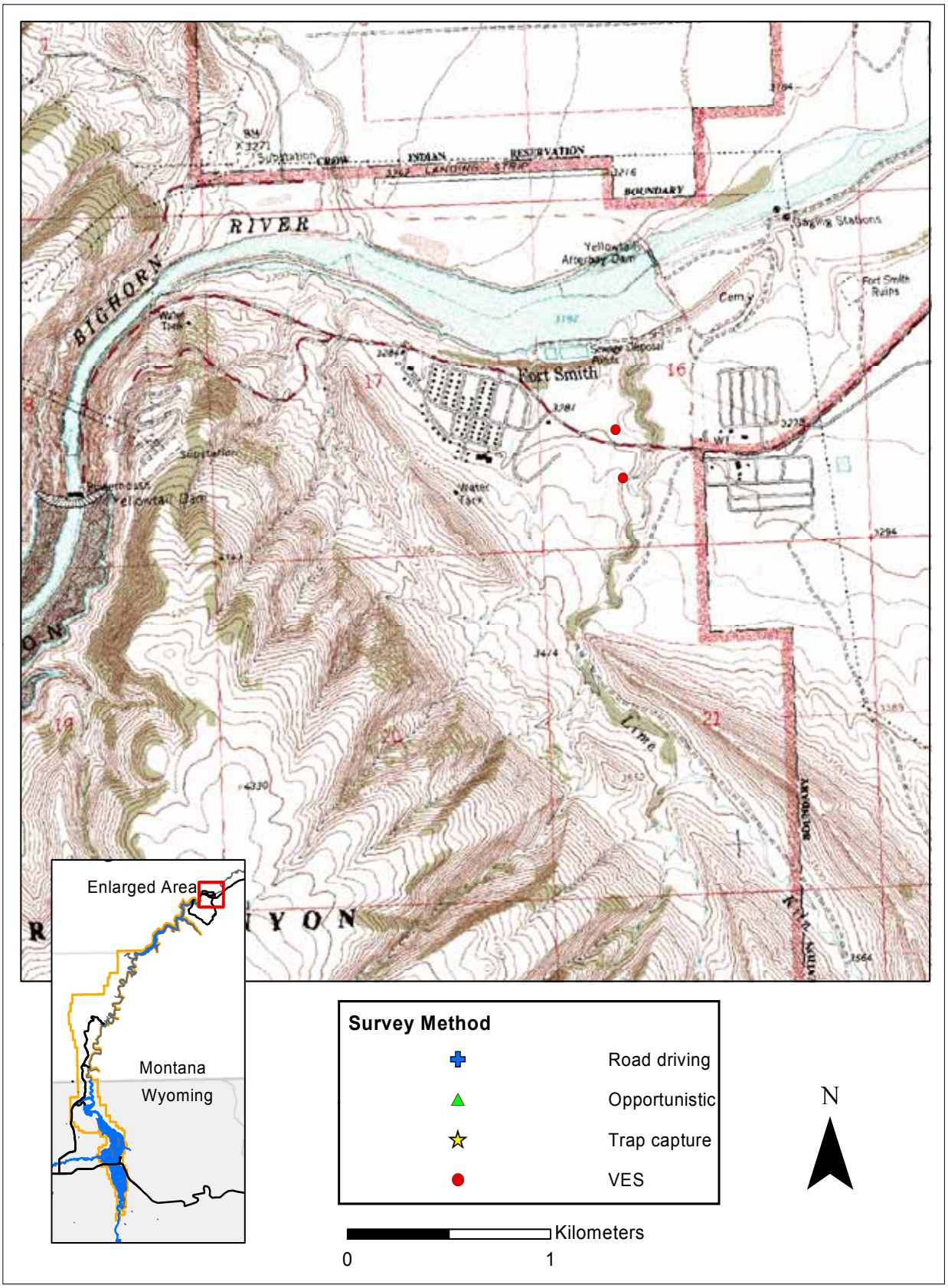


Figure 23c. Woodhouse's Toad distribution (Yellowtail Dam Quadrangle, Mont. 24k series).

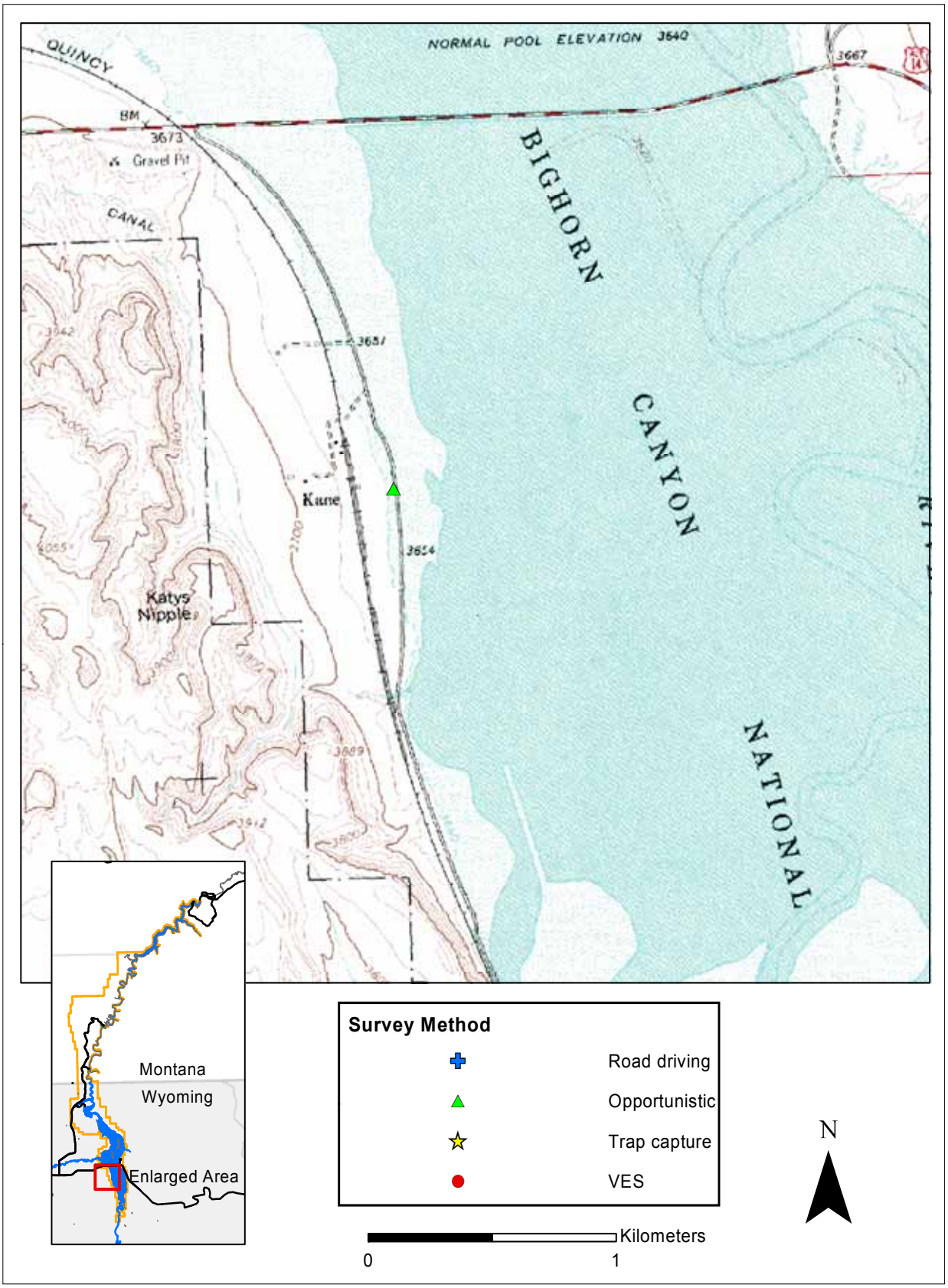


Figure 24. Plains Spadefoot distribution (Kane Quadrangle, Wyo. 24k series).

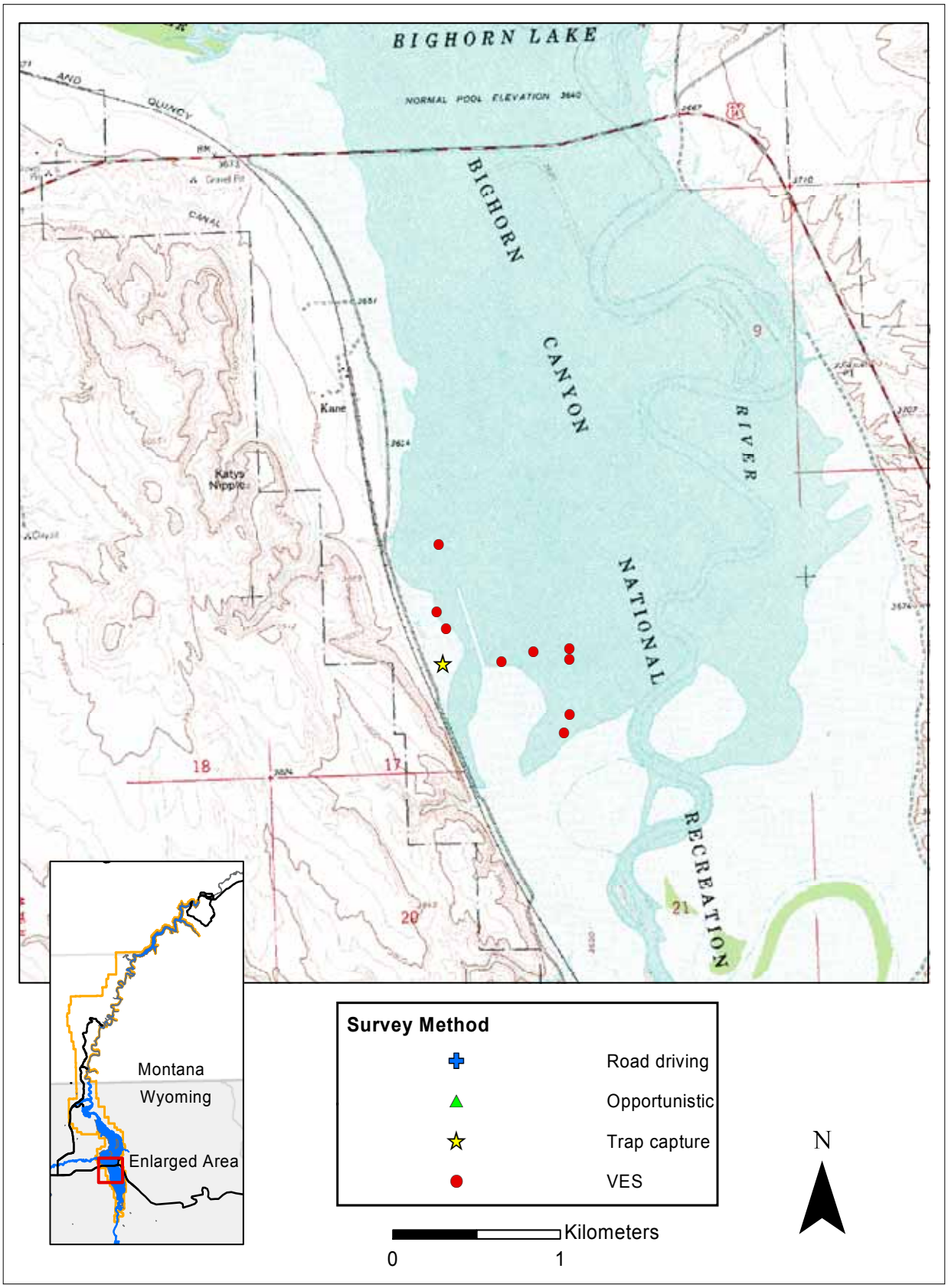


Figure 25a. Boreal Chorus Frog distribution (Kane Quadrangle, Wyo. 24k series).

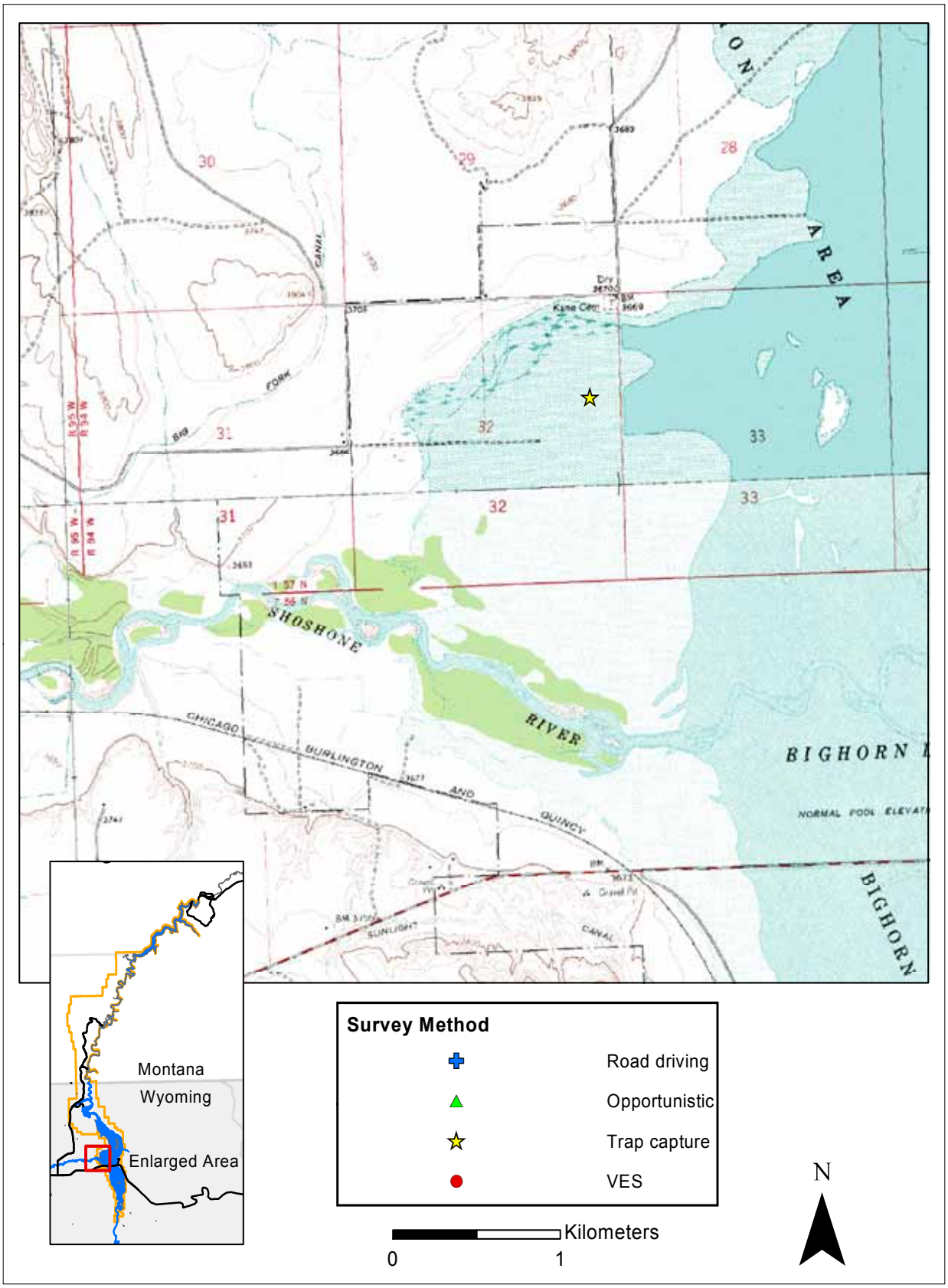


Figure 25b. Boreal Chorus Frog distribution (Kane and Natural Trap Cave Quadrangles, Wyo. 24k series).

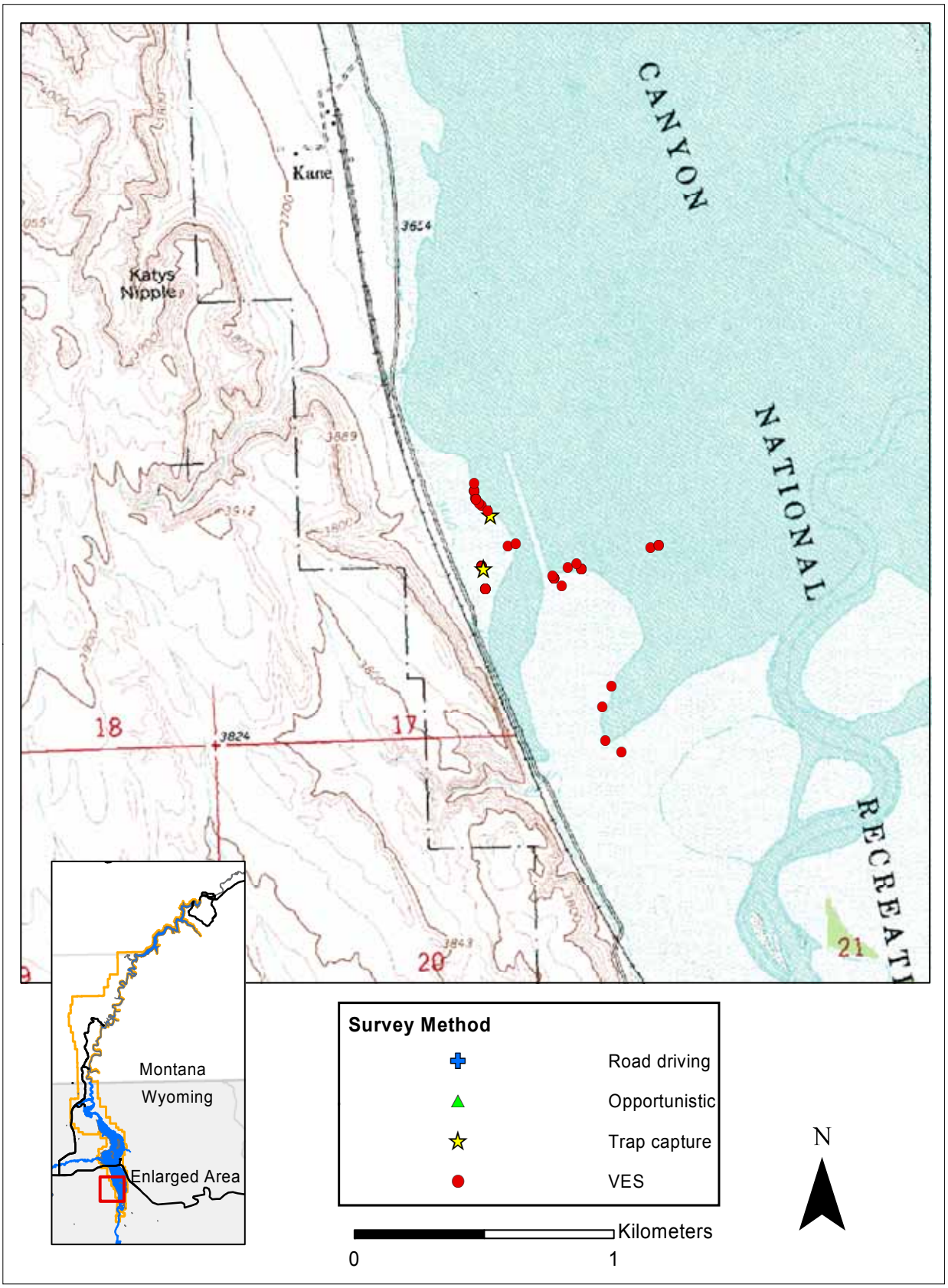


Figure 26a. Northern Leopard Frog distribution (Kane Quadrangle, Wyo. 24k series).

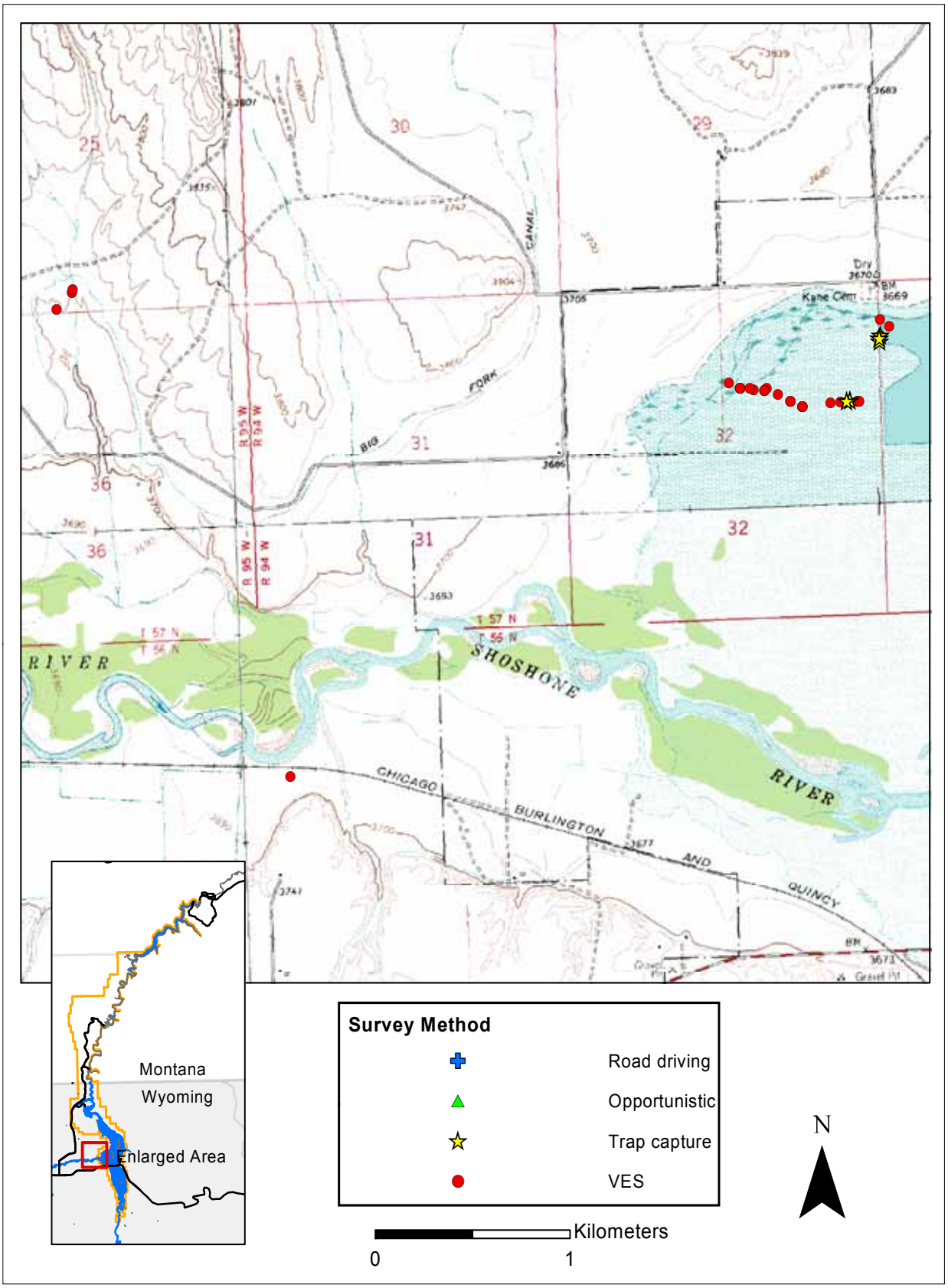


Figure 26b. Northern Leopard Frog distribution (Kane and Natural Trap Cave Quadrangles, Wyo. 24k series).

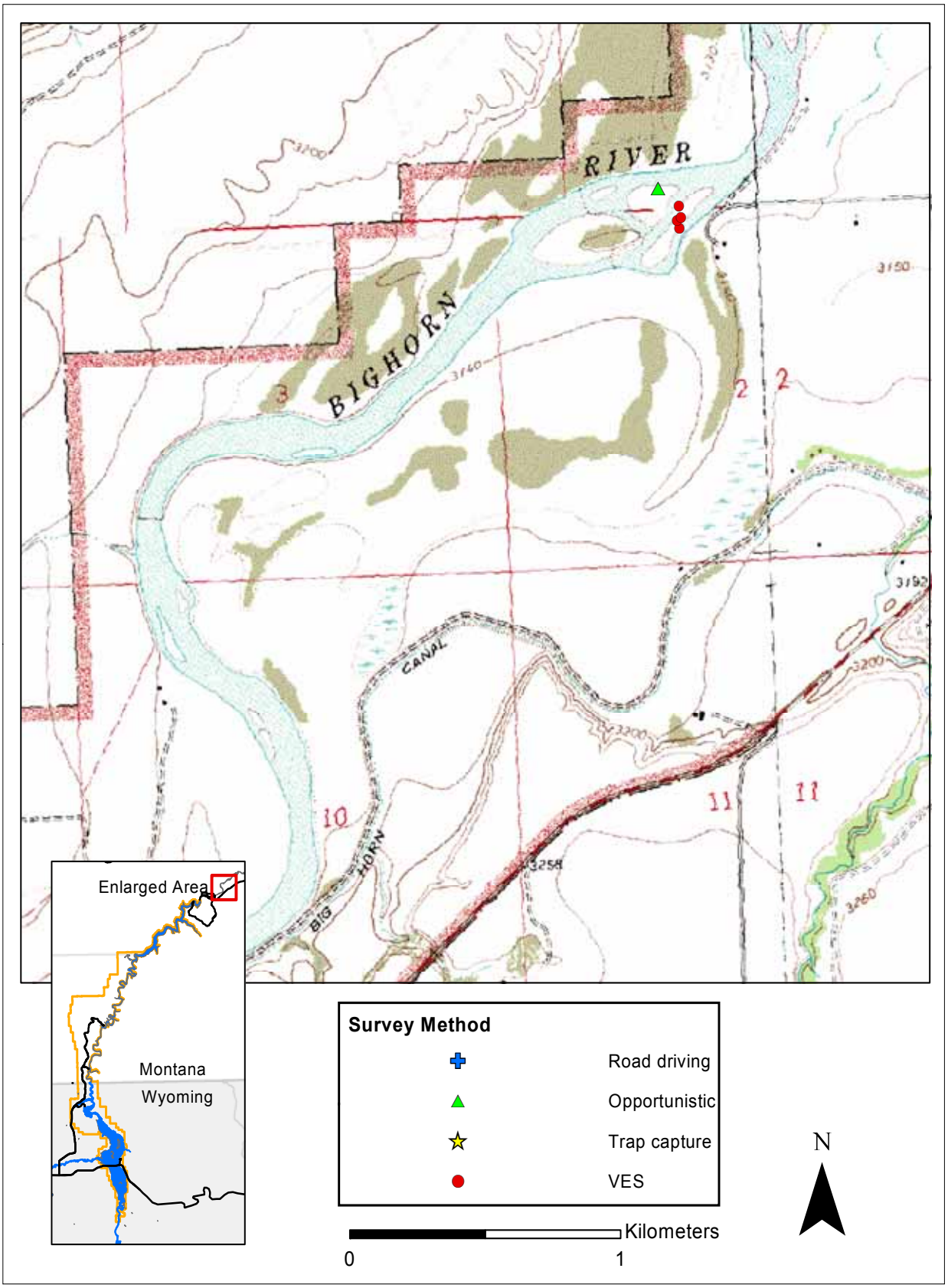


Figure 26c. Northern Leopard Frog distribution (Yellowtail Dam Quadrangle, Mont. 24k series).

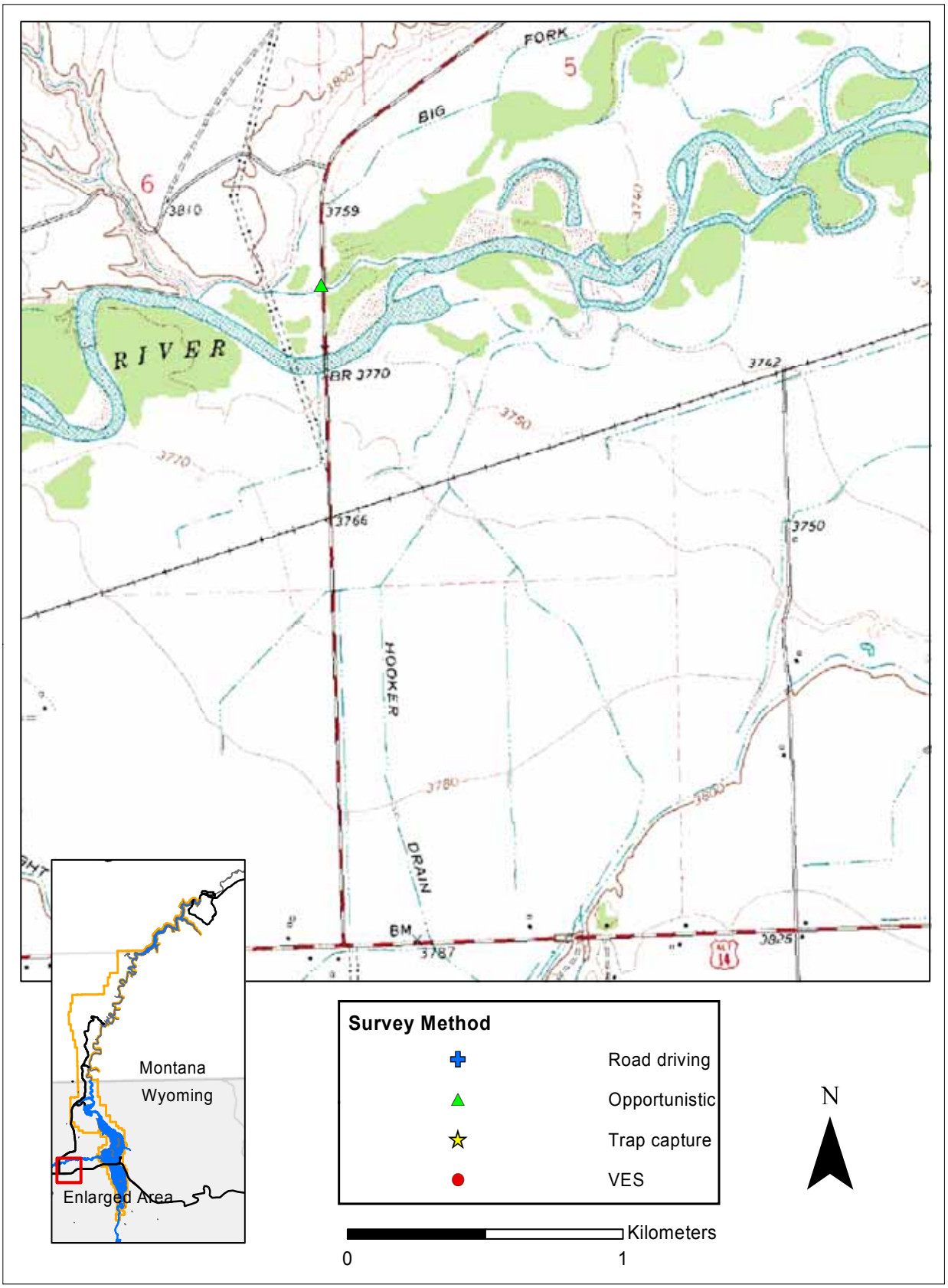


Figure 27. Snapping Turtle distribution (Lovell Lakes Quadrangle, Wyo. 24k series).

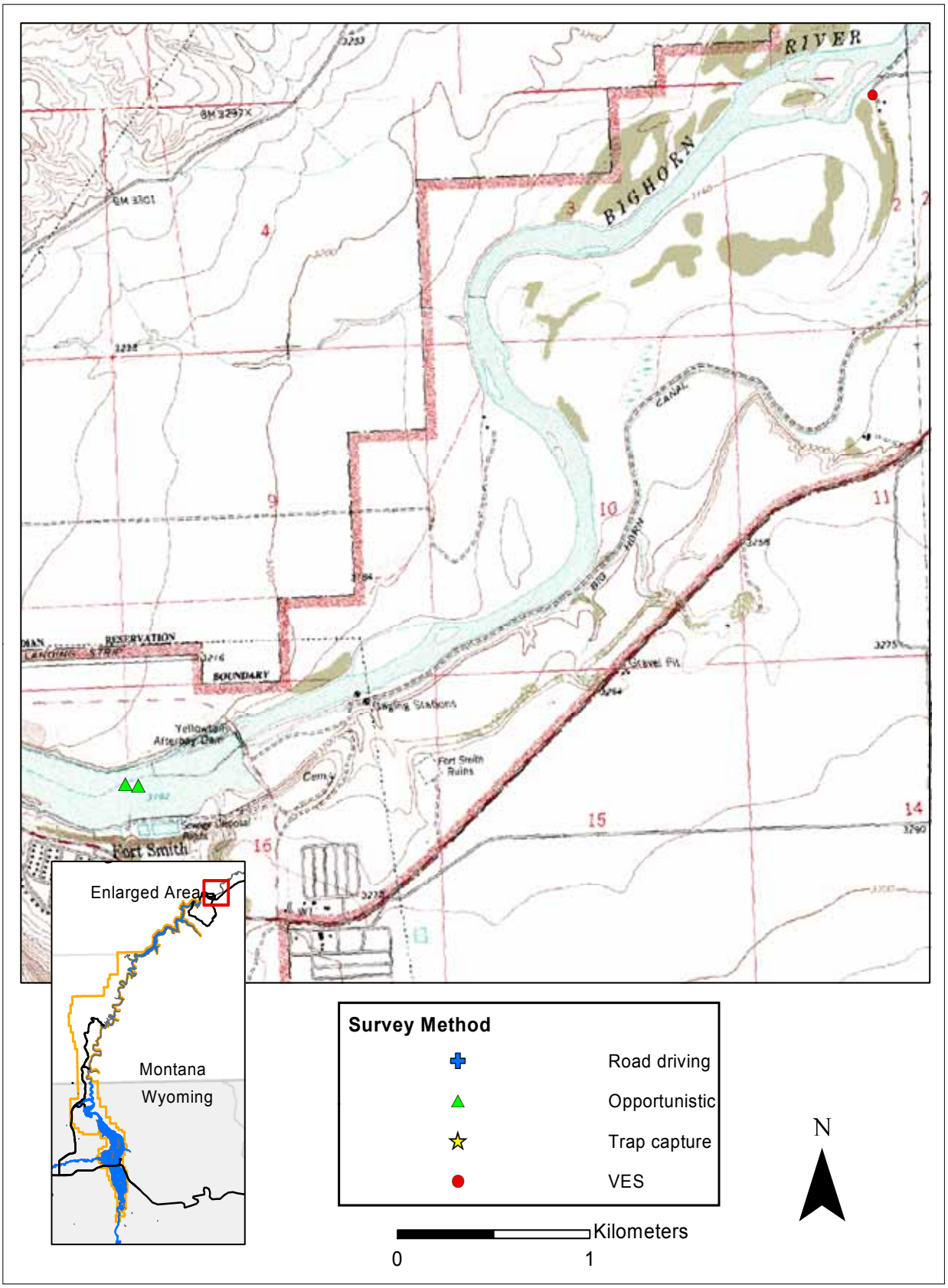


Figure 28. Painted Turtle distribution (Yellowtail Dam Quadrangle, Mont. 24k series).

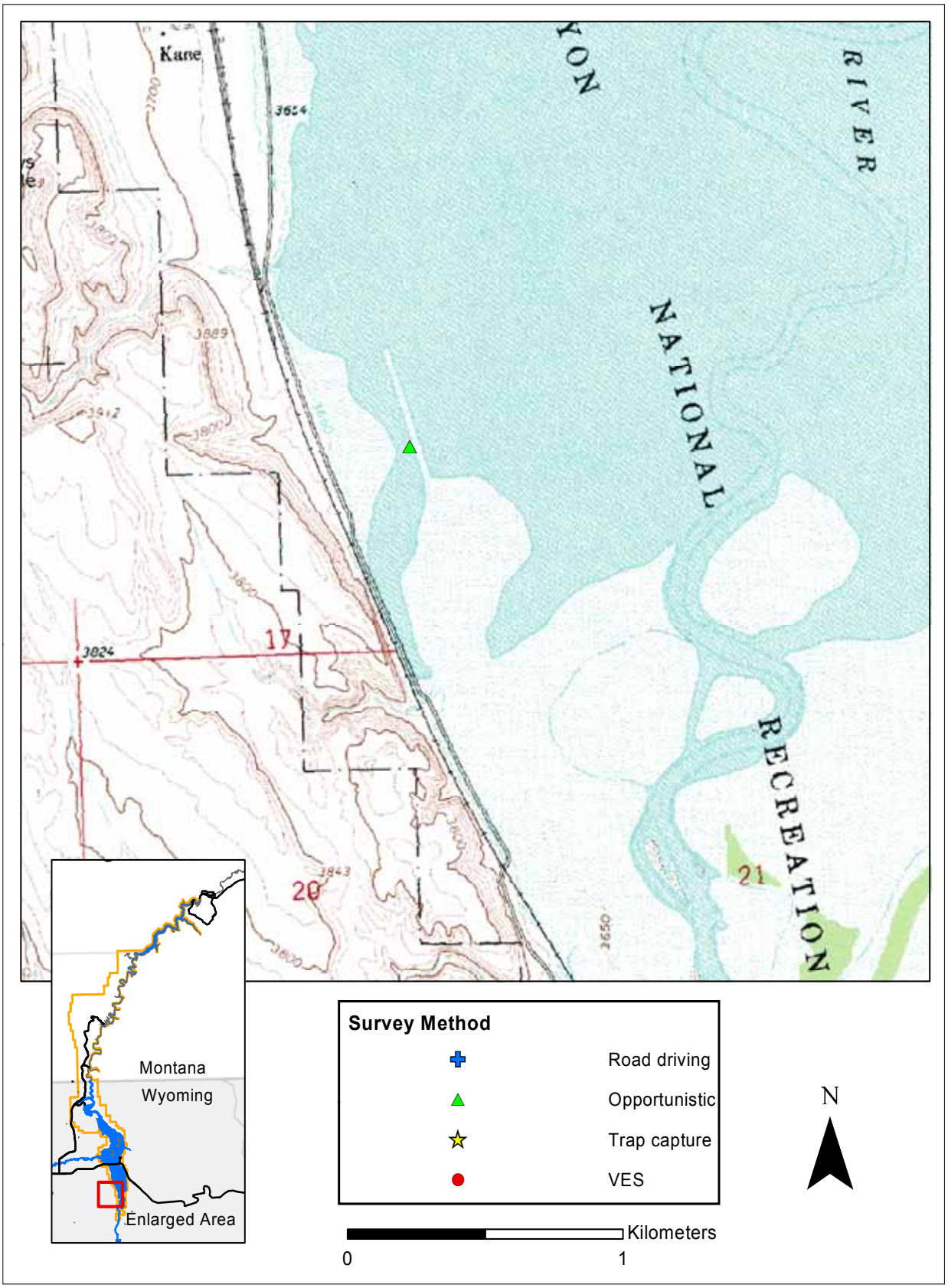


Figure 29. Spiny Softshell Turtle distribution (Kane Quadrangle, Wyo. 24k series).

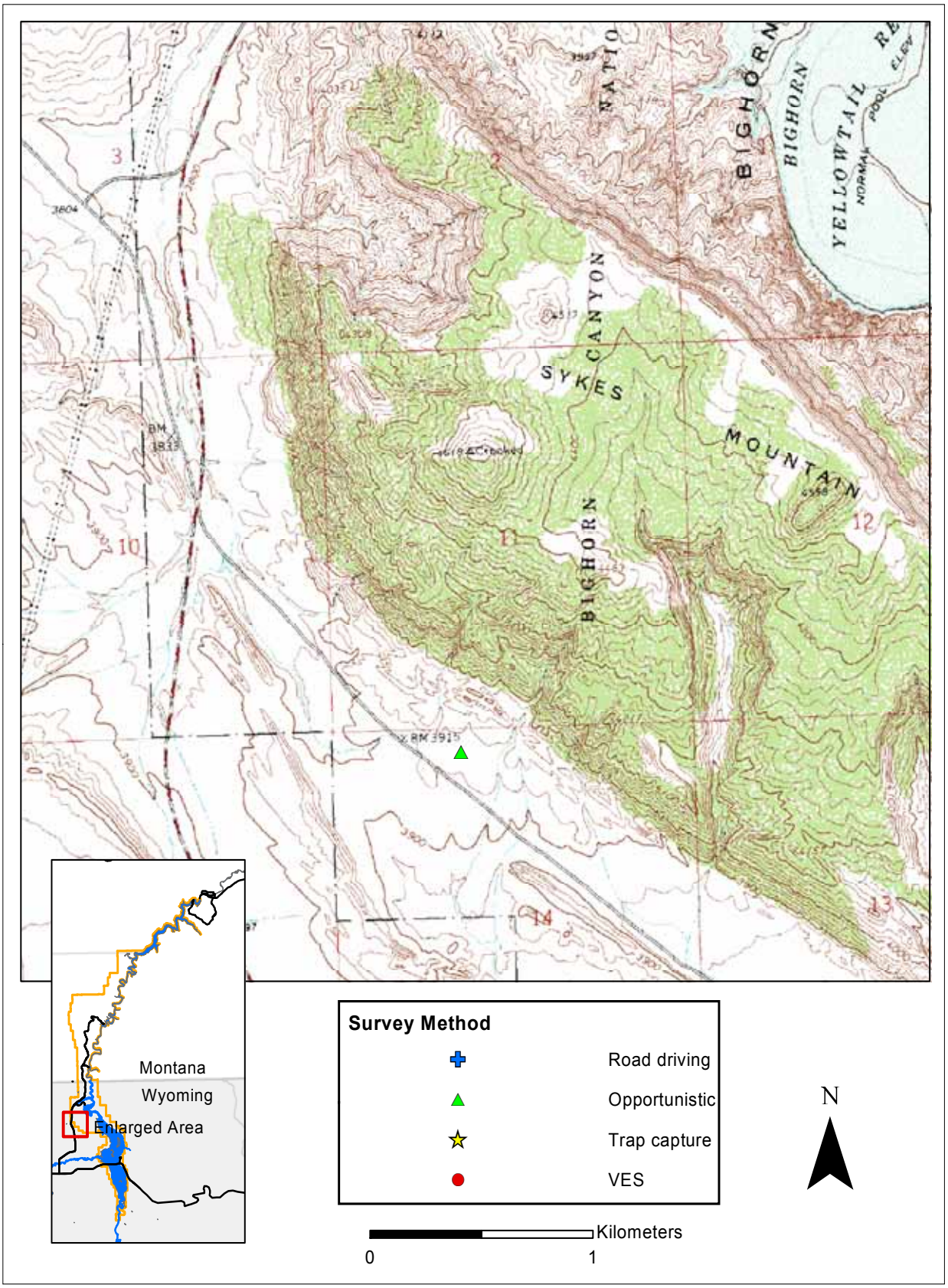


Figure 30. Greater Short-horned Lizard distribution (Sykes Springs Quadrangle, Wyo. 24k series).

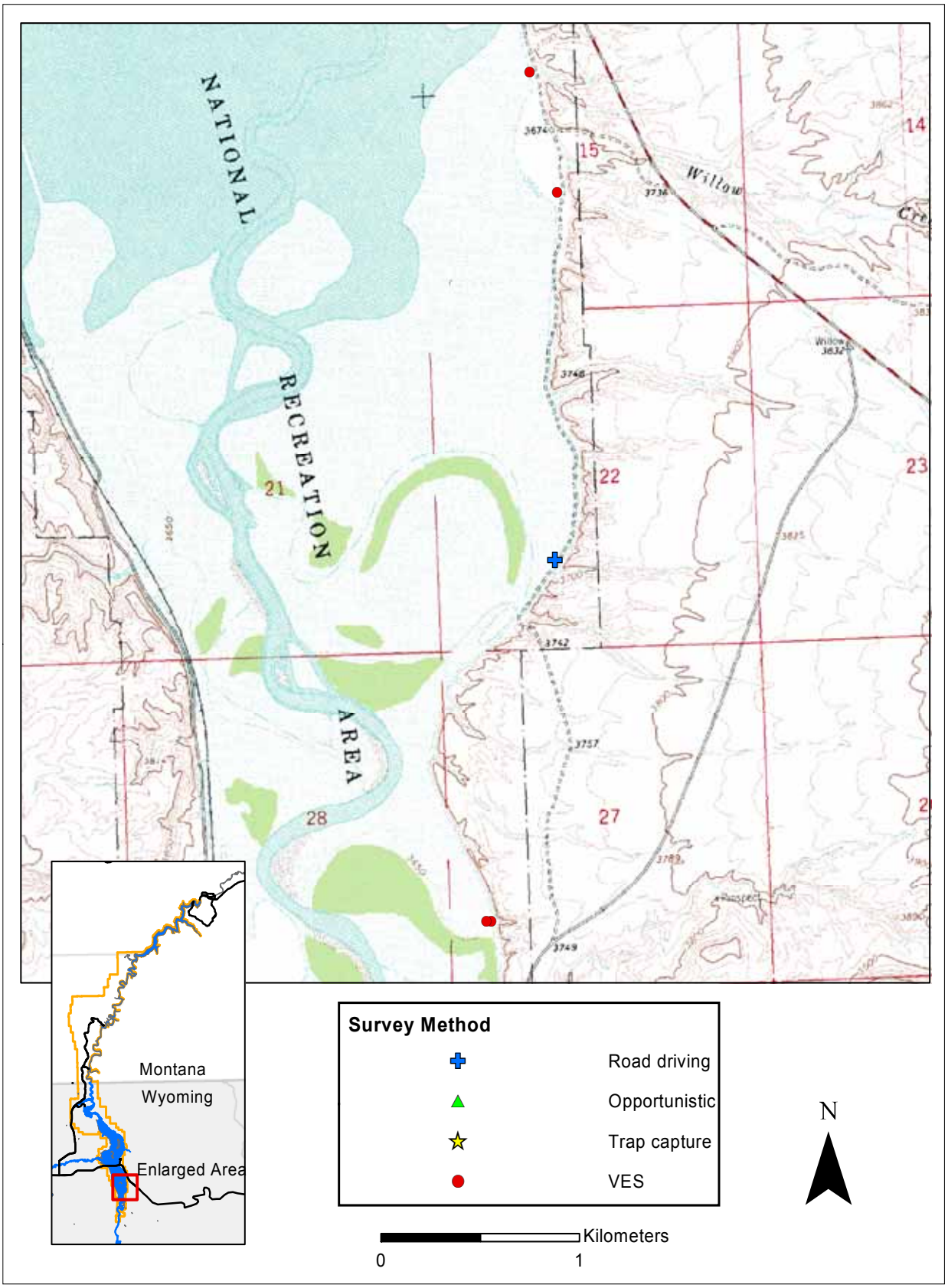


Figure 31a. Common Sagebrush Lizard distribution (Kane Quadrangle, Wyo. 24k series).

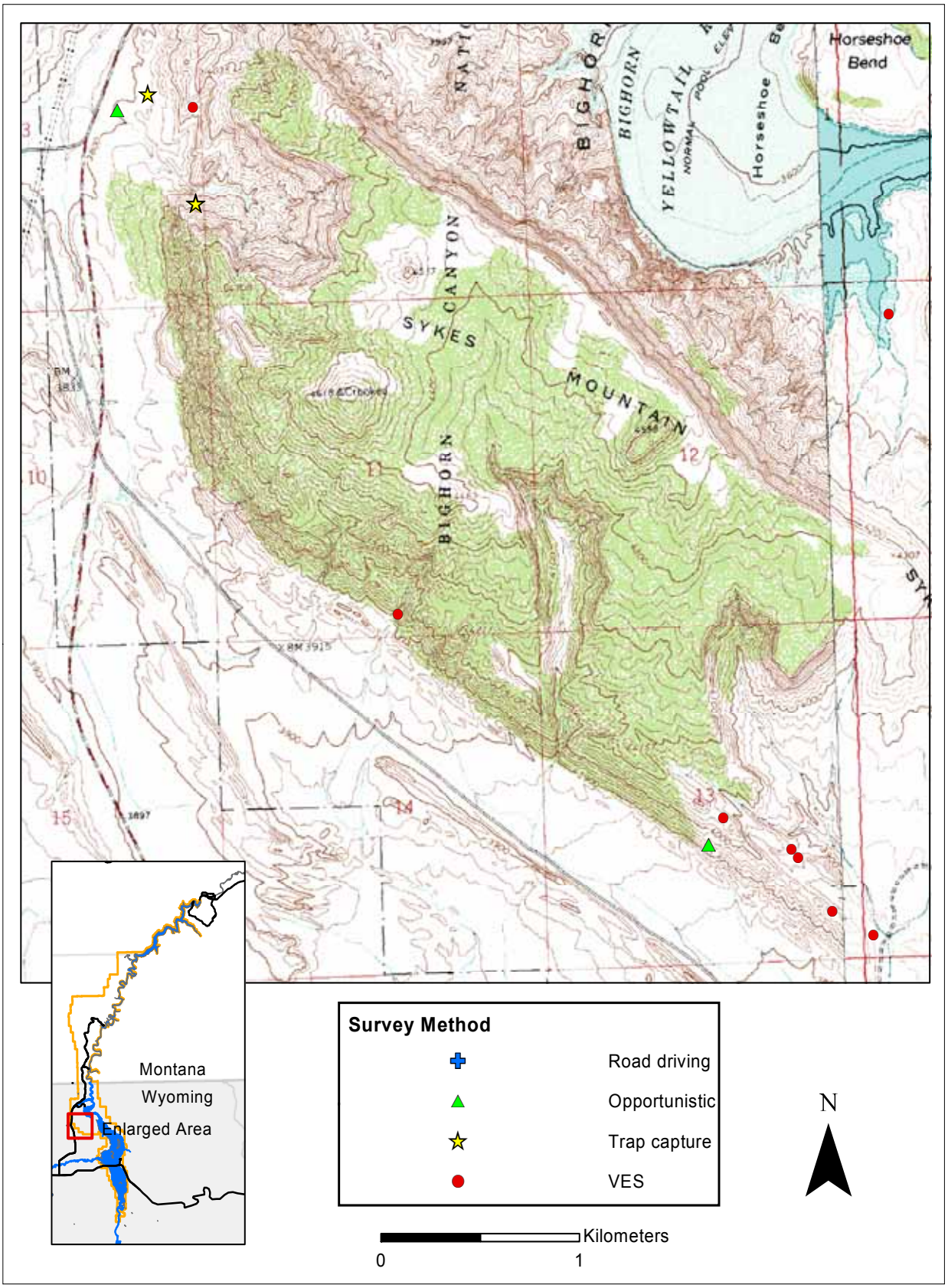


Figure 31b. Common Sagebrush Lizard distribution (Sykes Springs Quadrangle, Wyo. 24k series).

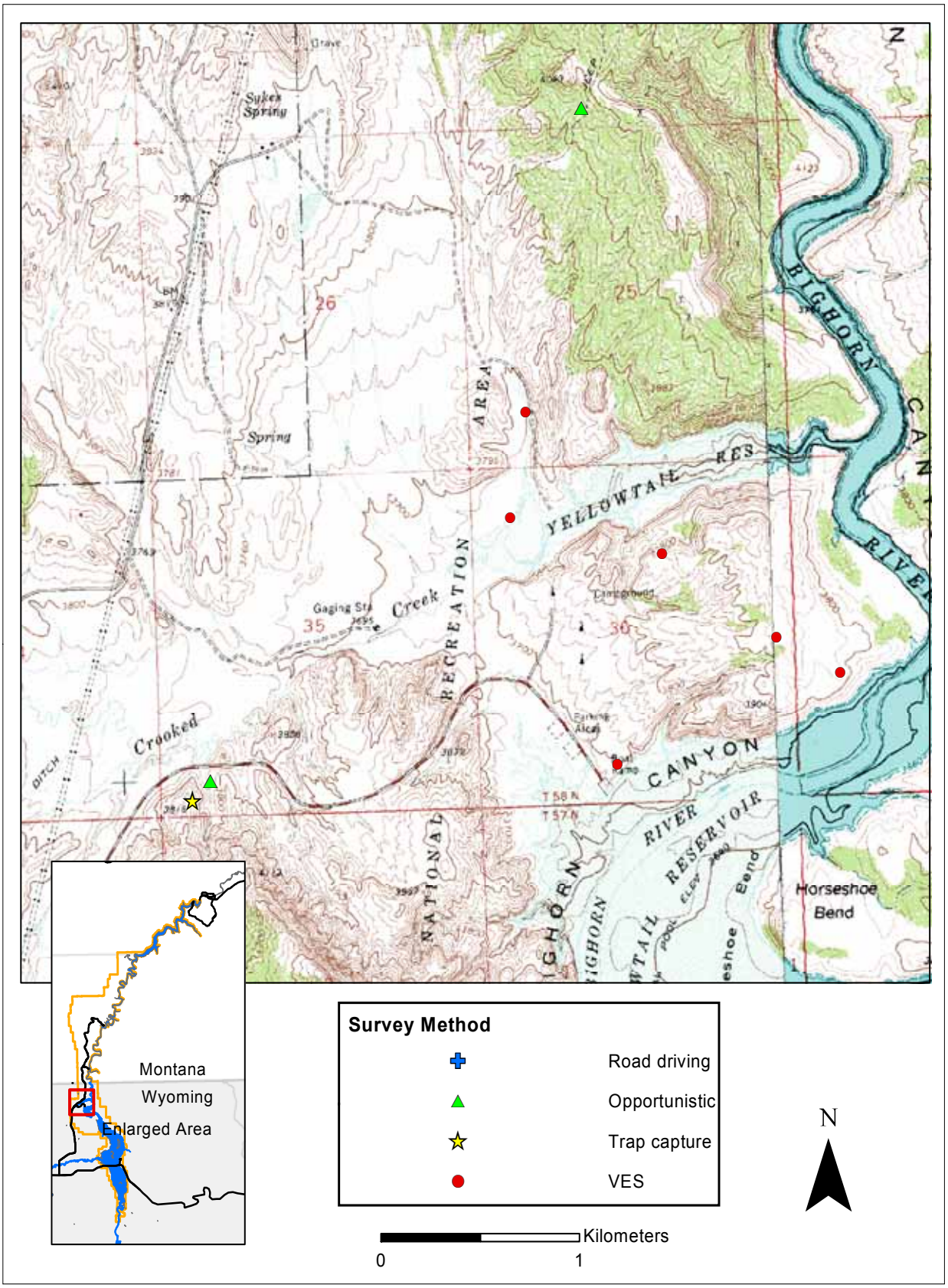


Figure 31c. Common Sagebrush Lizard distribution (Sykes Springs Quadrangle, Wyo. 24k series).

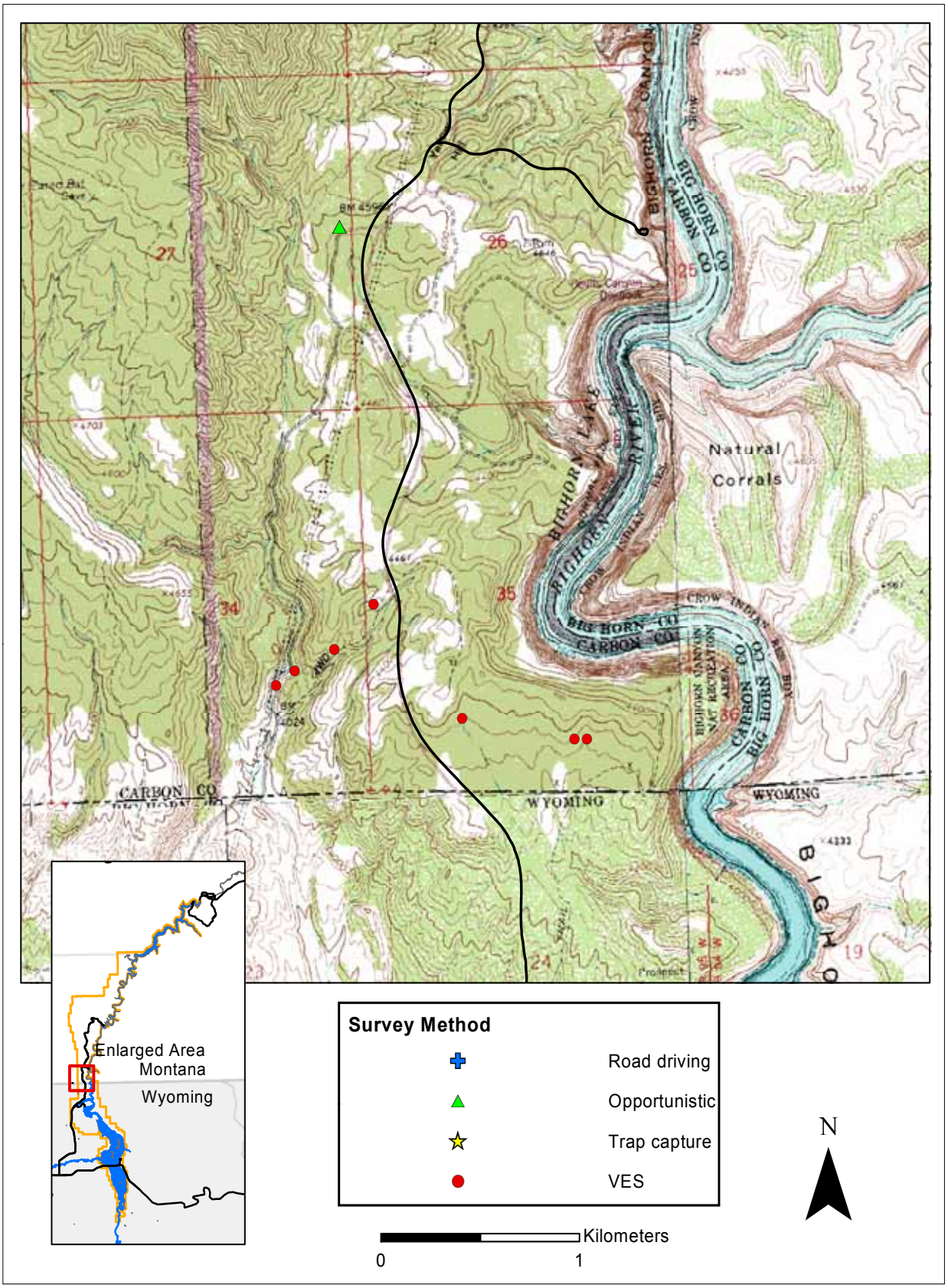


Figure 31d. Common Sagebrush Lizard distribution (Hillsboro, Mystery Cave, and Sykes Springs Quadrangles, Mont./Wyo. 24k series).

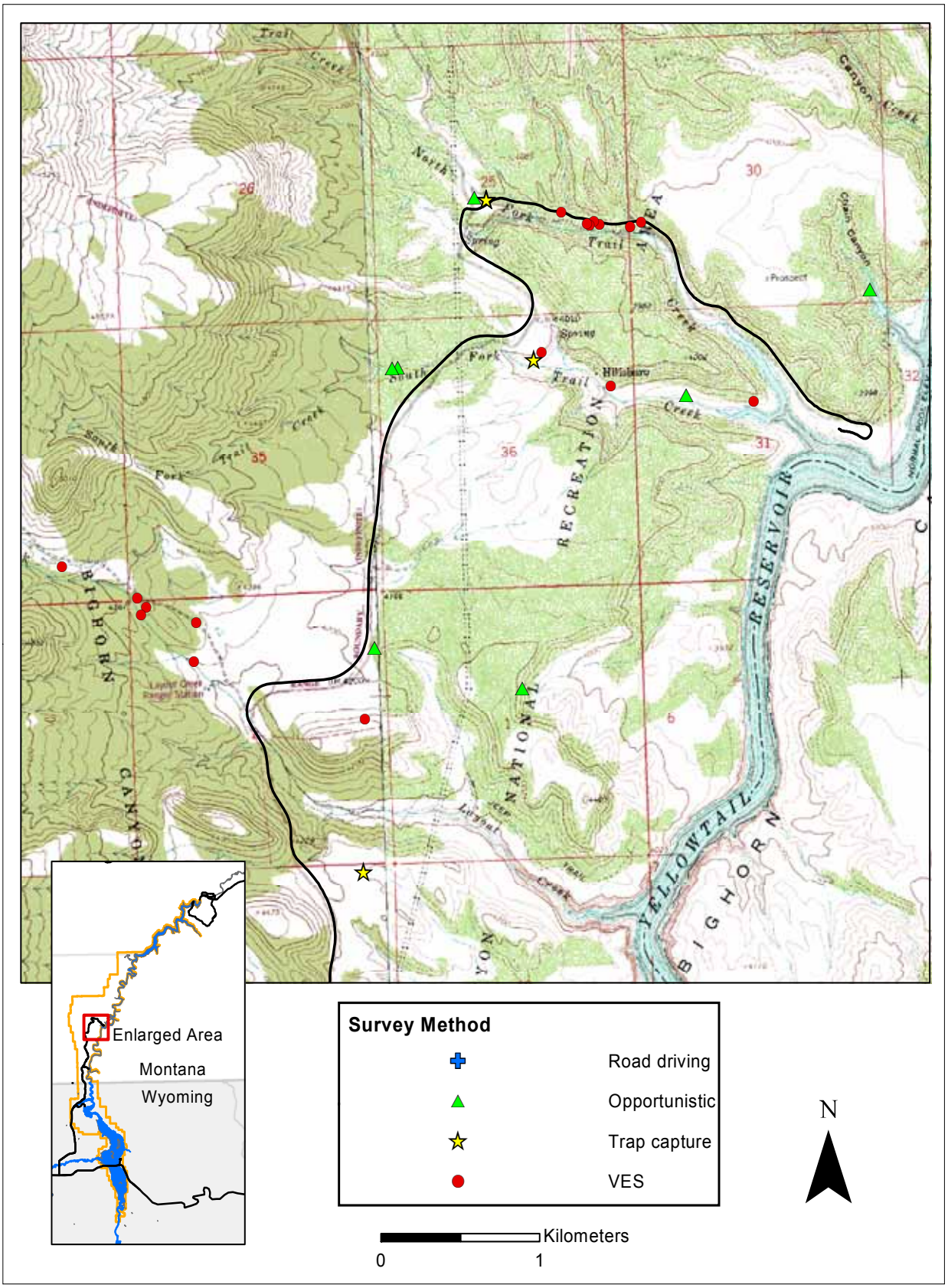


Figure 31e. Common Sagebrush Lizard distribution (Mystery Cave and Hillsboro Quadrangles, Mont. 24k series).

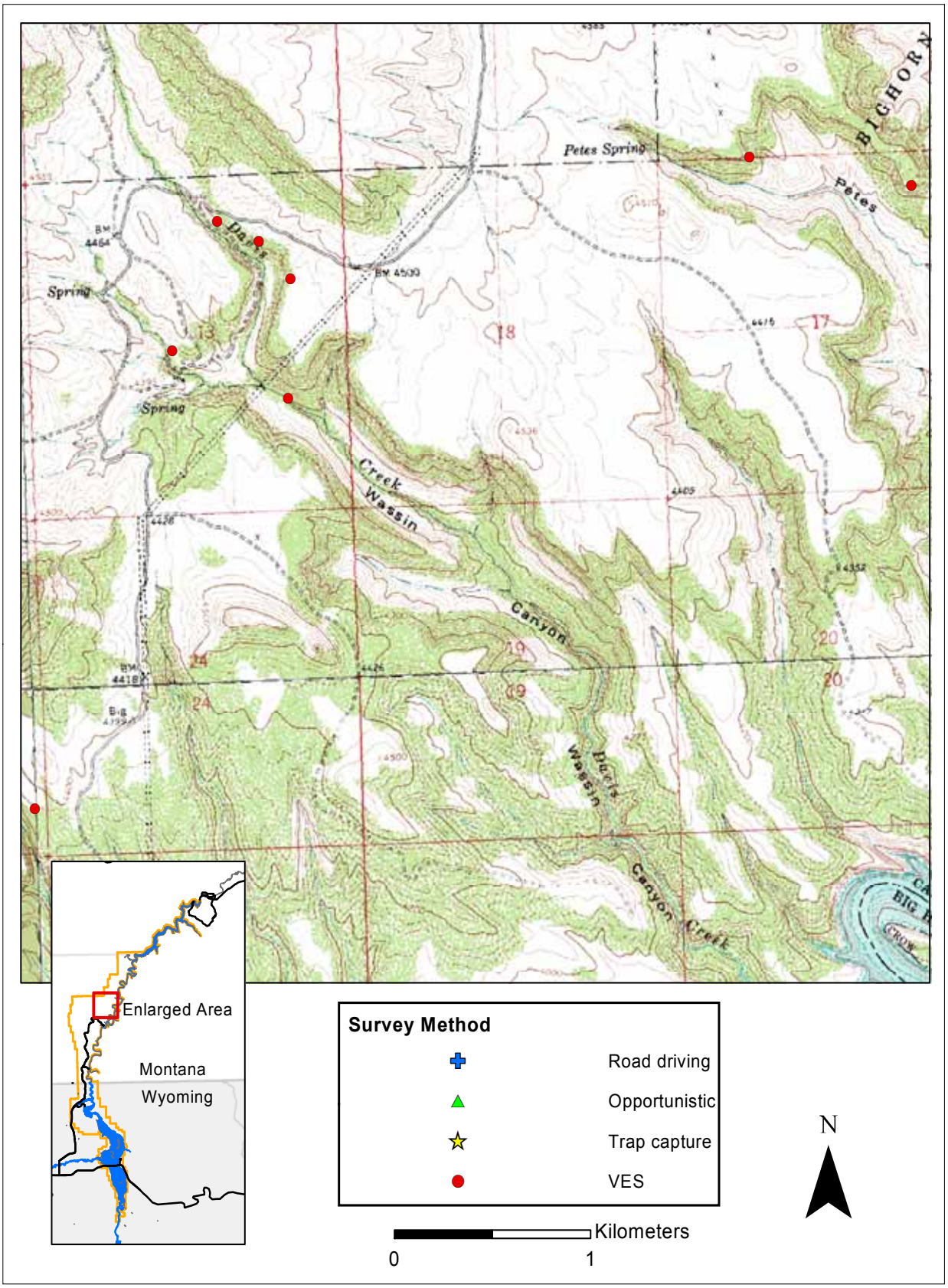


Figure 31f. Common Sagebrush Lizard distribution (Dead Indian Hill, Mystery Cave, and Hillsboro Quadrangles, Mont. 24k series).

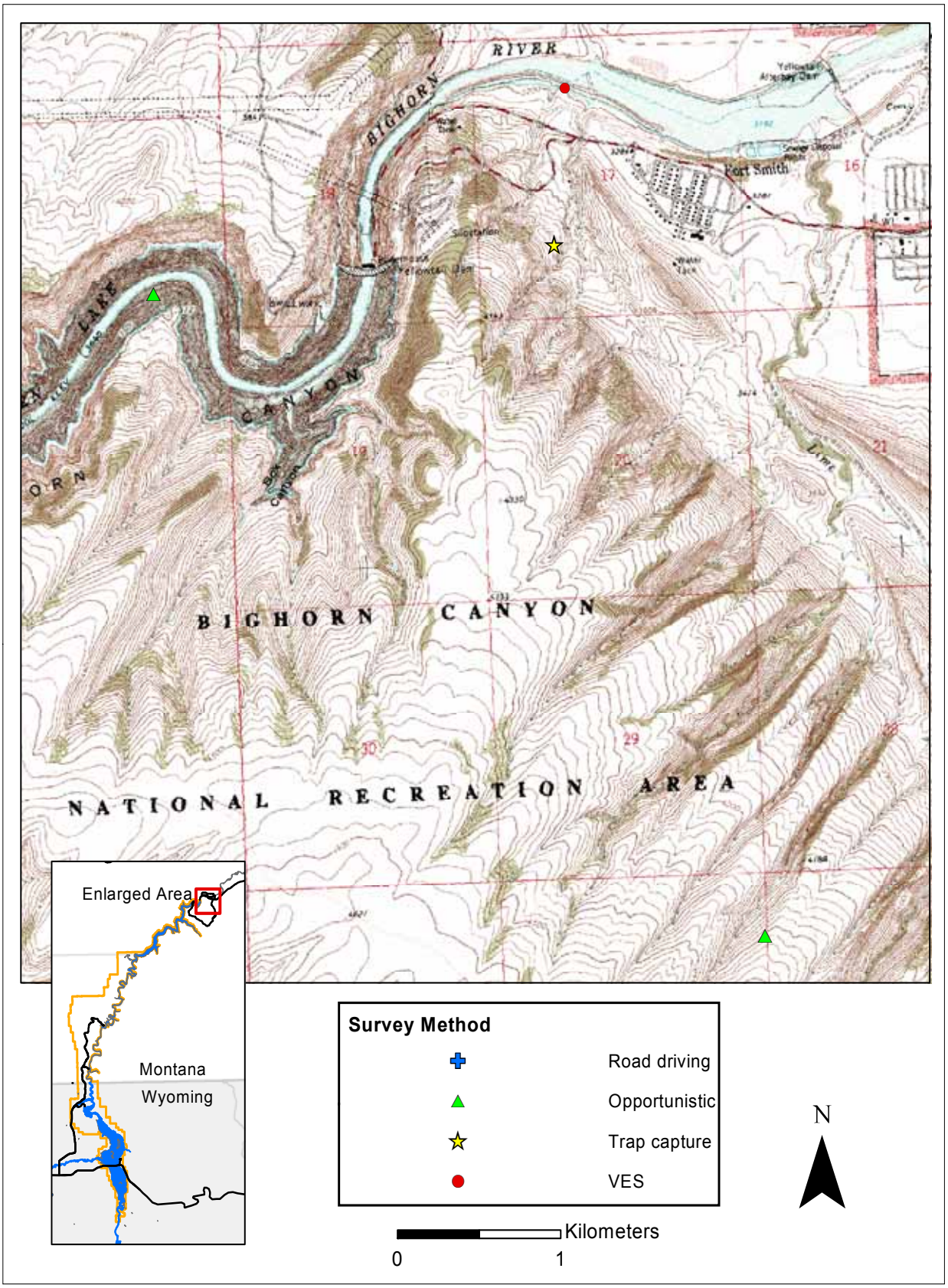


Figure 32. Eastern Racer distribution (Yellowtail Dam Quadrangle, Mont. 24k series).

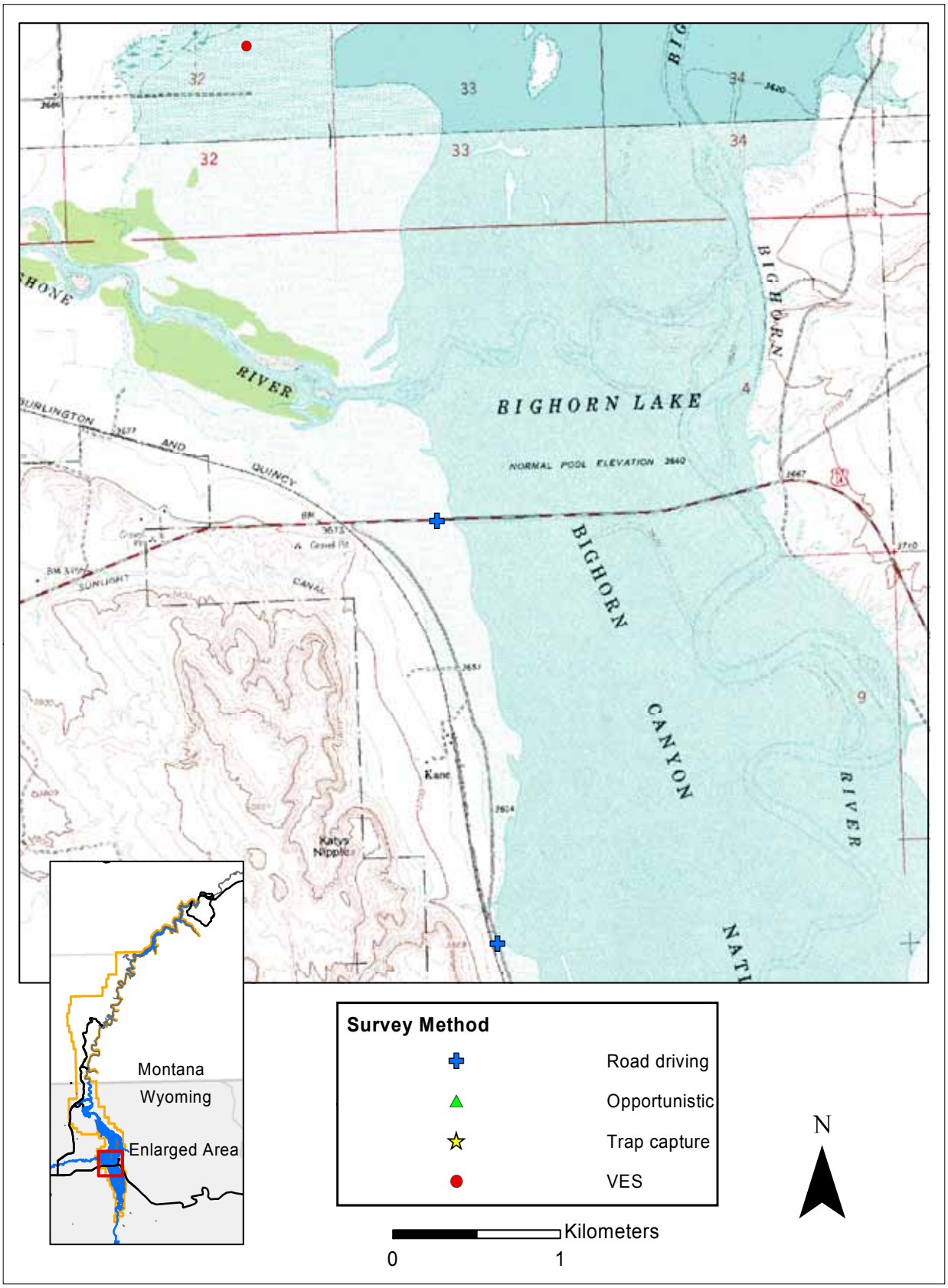


Figure 33a. Gopher Snake distribution (Kane Quadrangle, Wyo. 24k series).

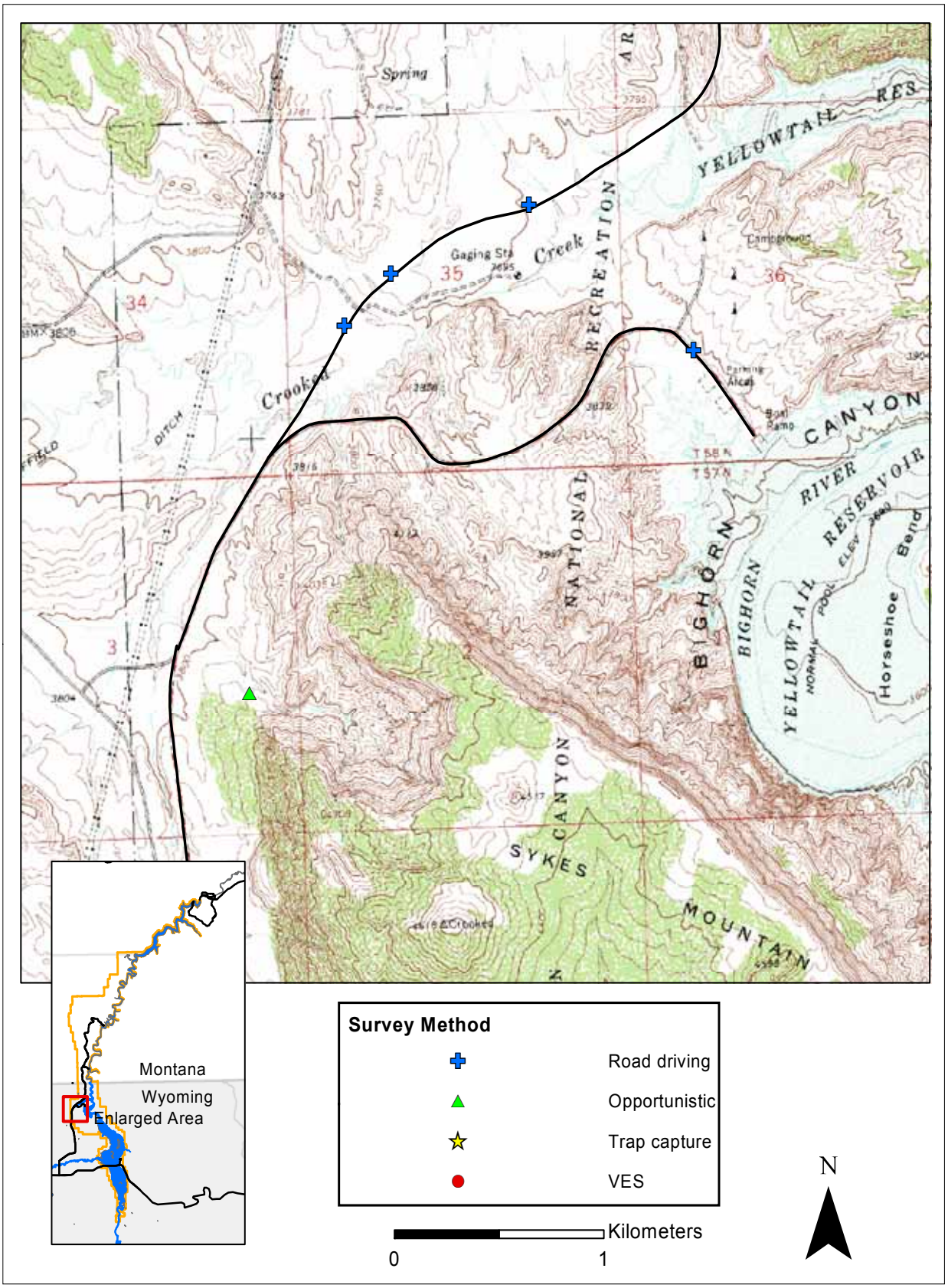


Figure 33b. Gopher Snake distribution (Sykes Springs Quadrangle, Wyo. 24k series).

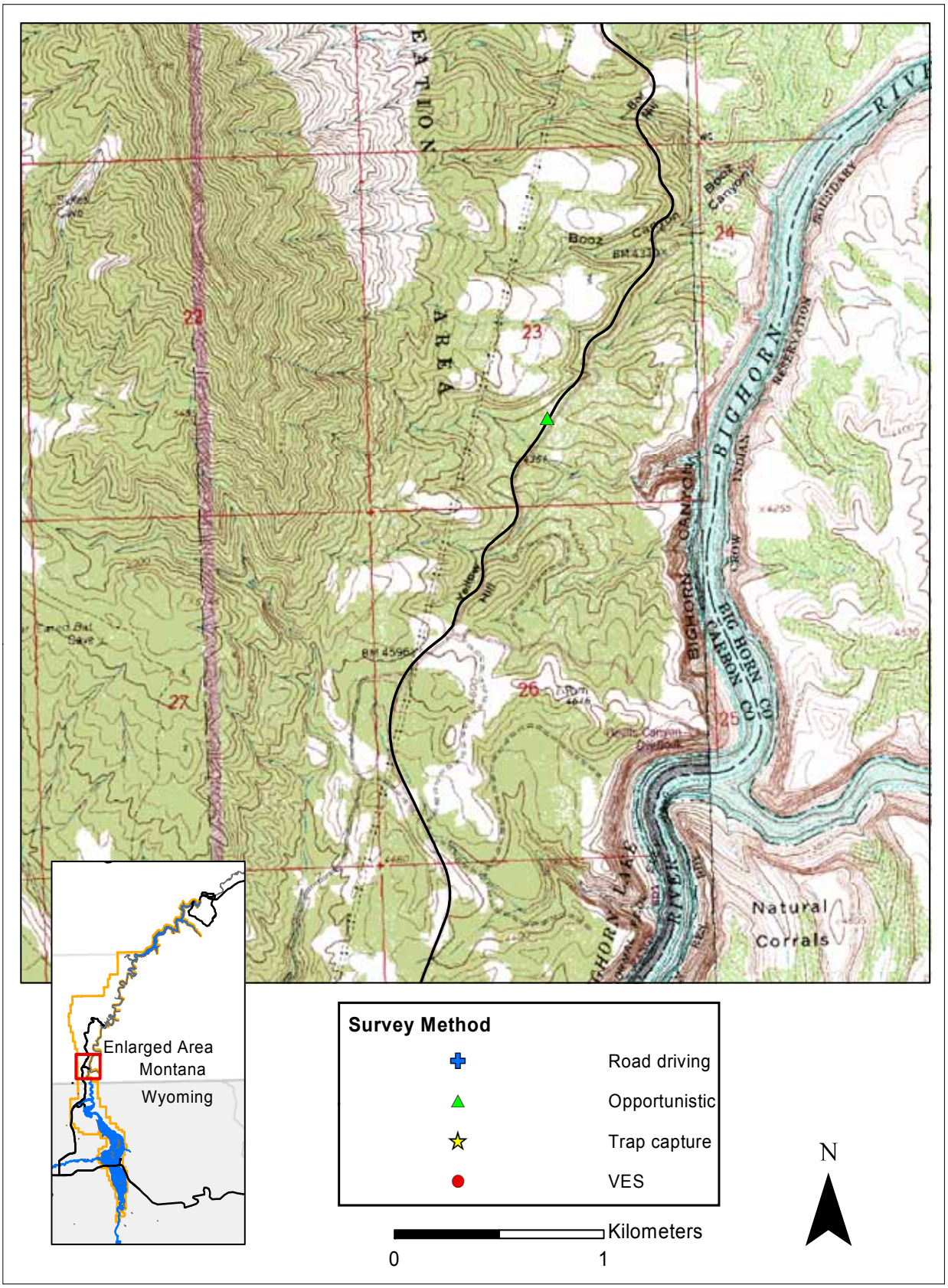


Figure 33c. Gopher Snake distribution (Hillsboro and Mystery Cave Quadrangles, Mont./Wyo. 24k series).

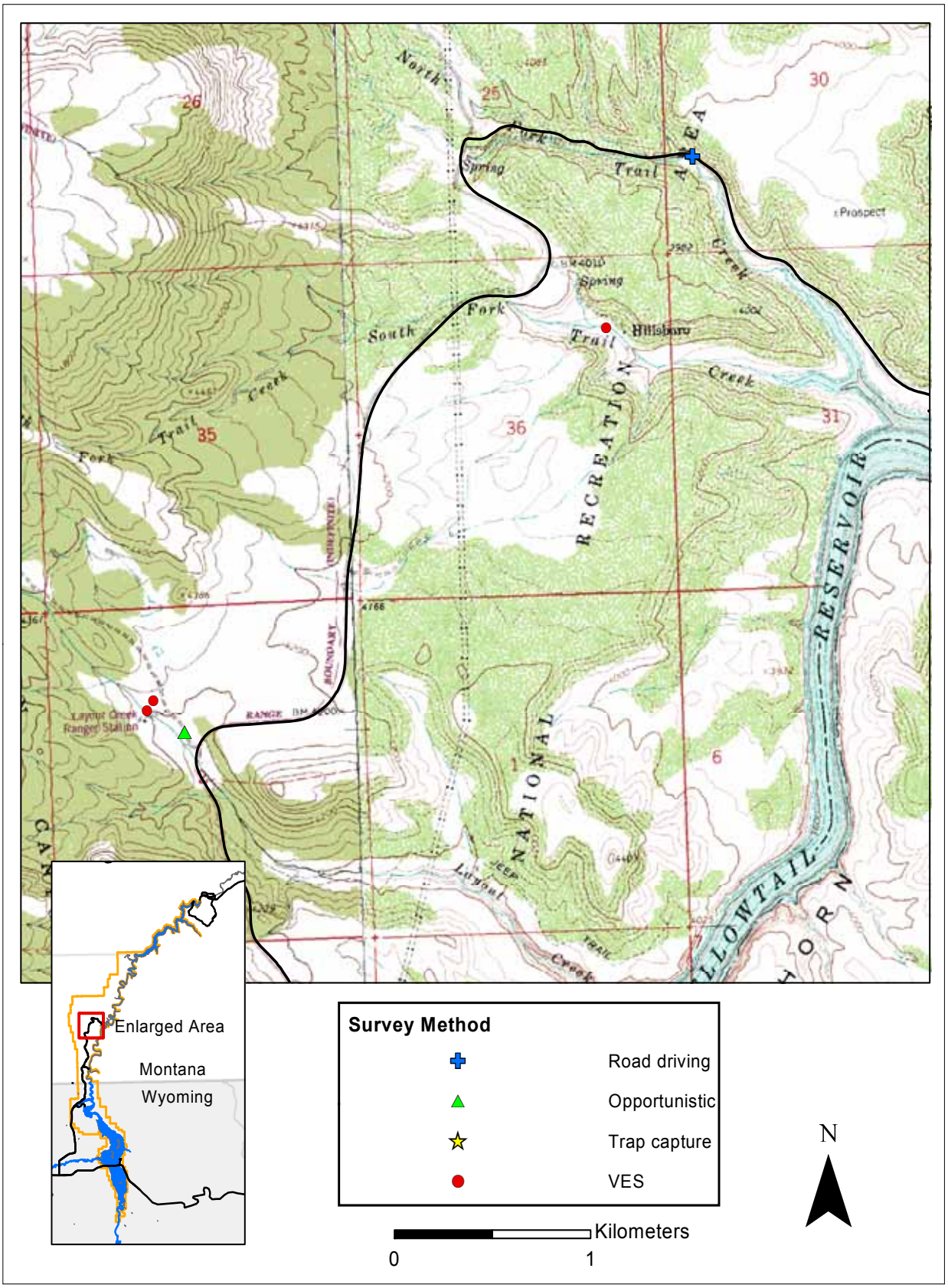


Figure 33d. Gopher Snake distribution (Hillsboro and Mystery Cave Quadrangles, Mont./Wyo. 24k series).

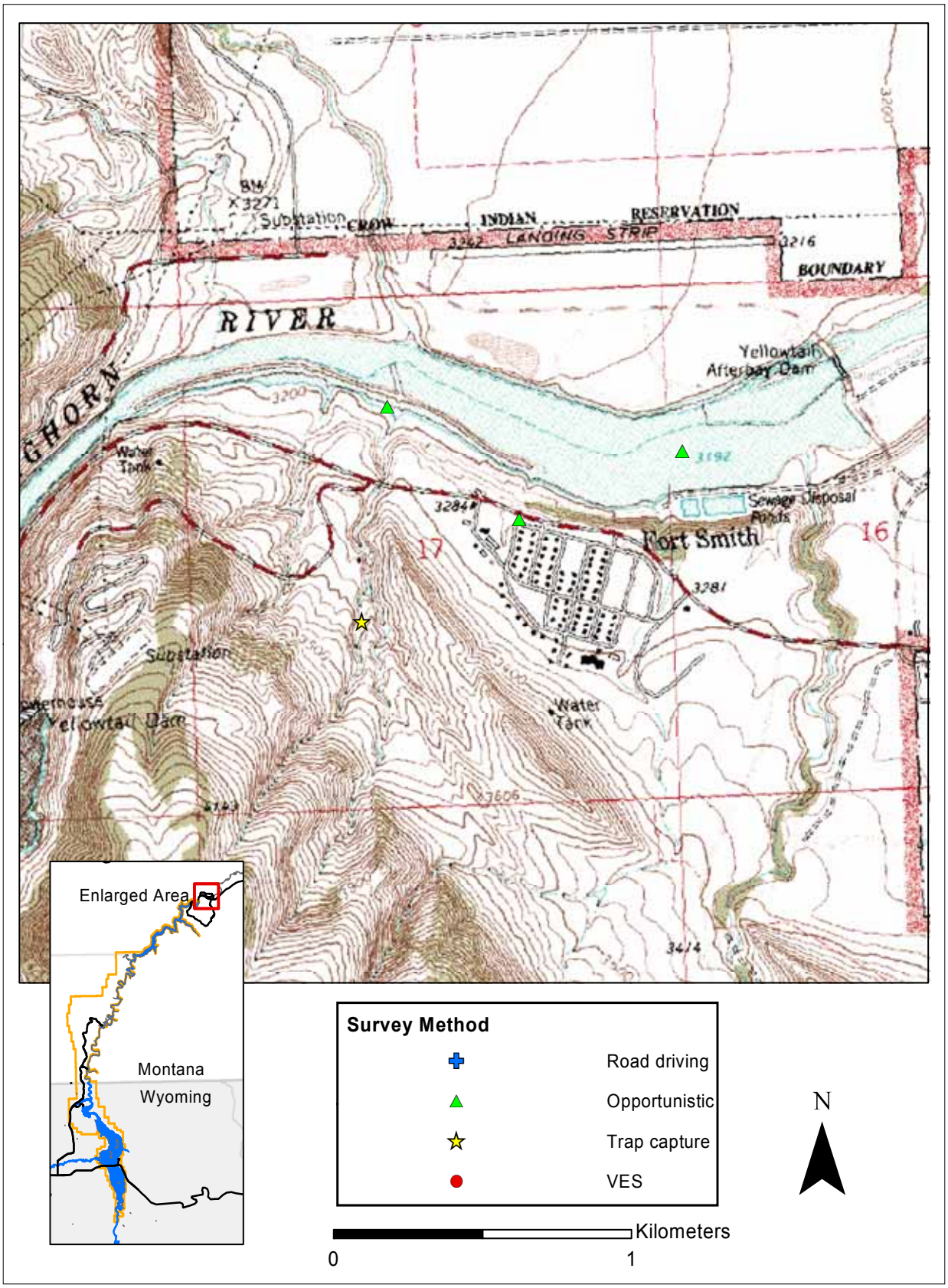


Figure 33e. Gopher Snake distribution (Yellowtail Dam Quadrangles, Mont. 24k series).

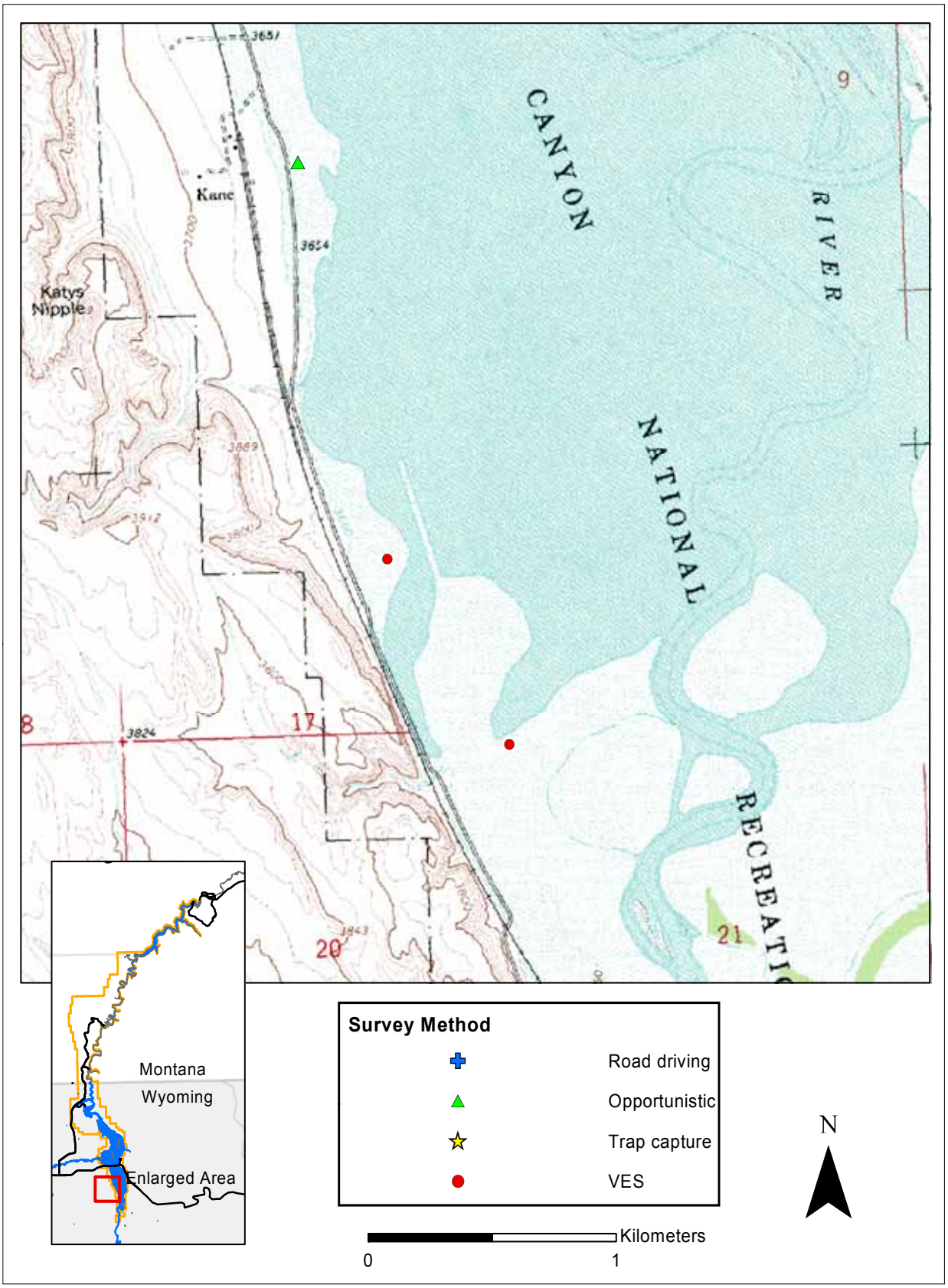


Figure 34a. Terrestrial Garter Snake distribution (Kane Quadrangle, Wyo. 24k series).

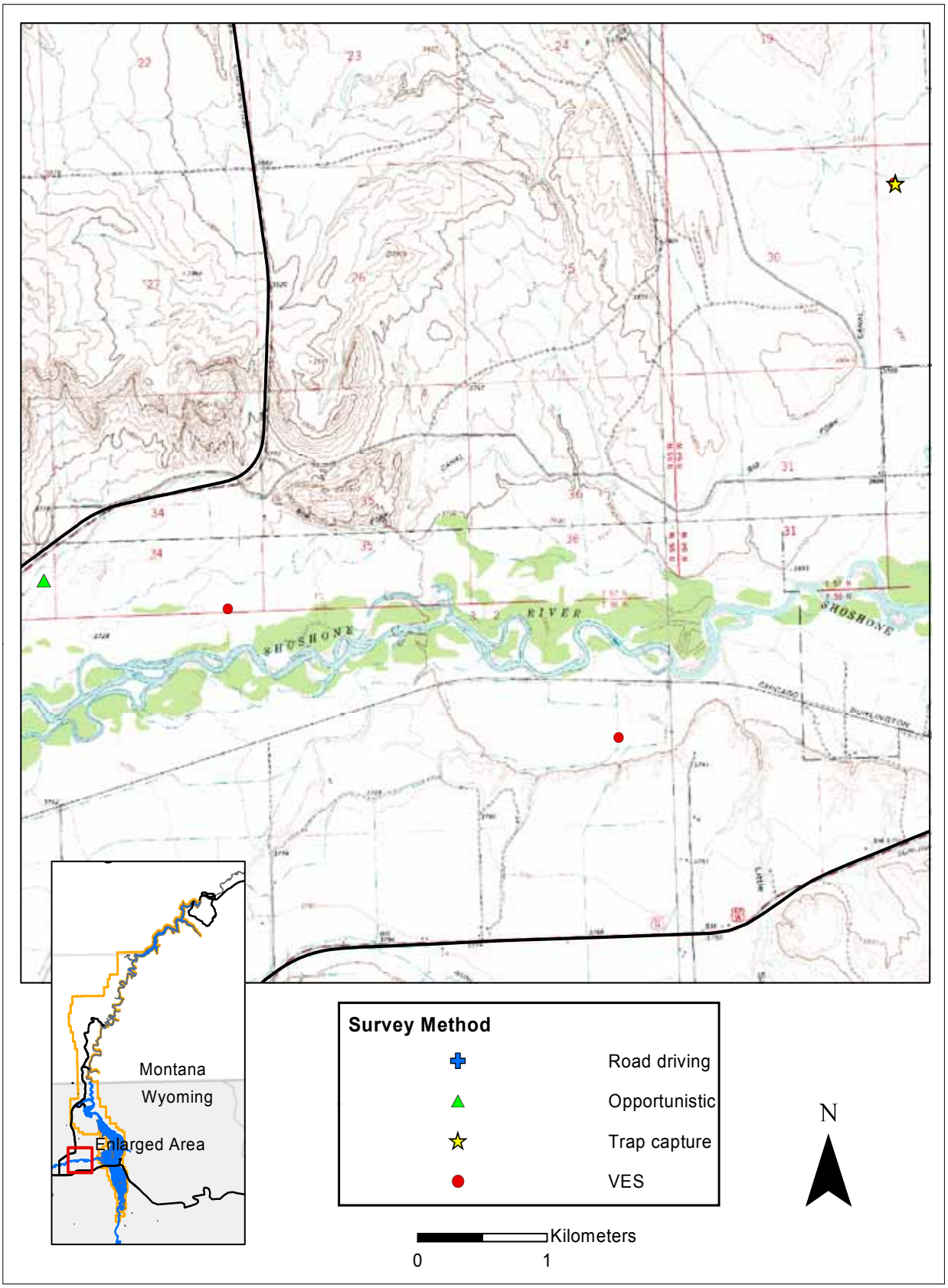


Figure 34b. Terrestrial Garter Snake distribution (Kane, Lovell Lakes, Natural Trap Cave, and Sykes Springs Quadrangles, Wyo. 24k series).

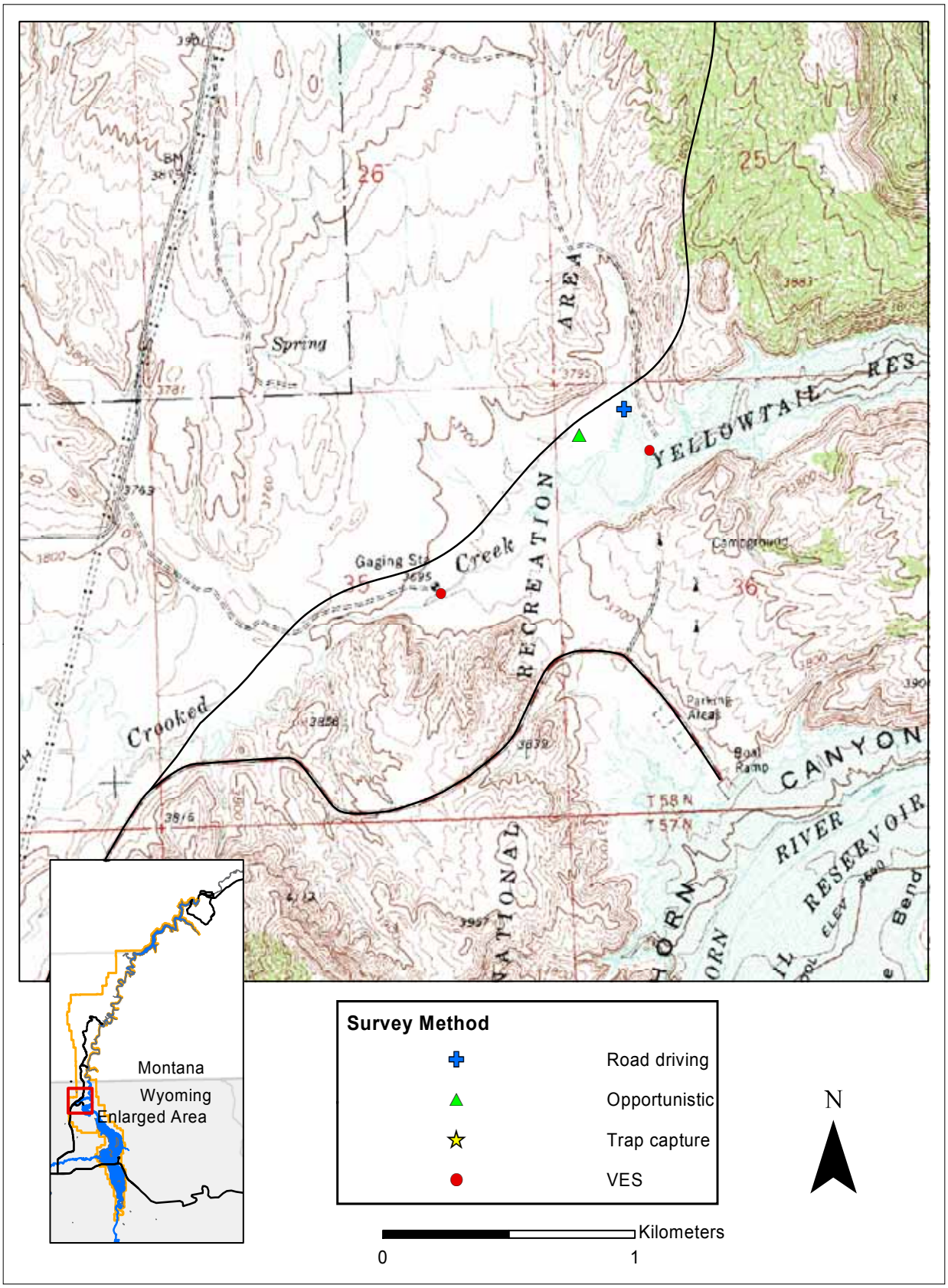


Figure 34c. Terrestrial Garter Snake distribution (Sykes Springs Quadrangle, Wyo. 24k series).

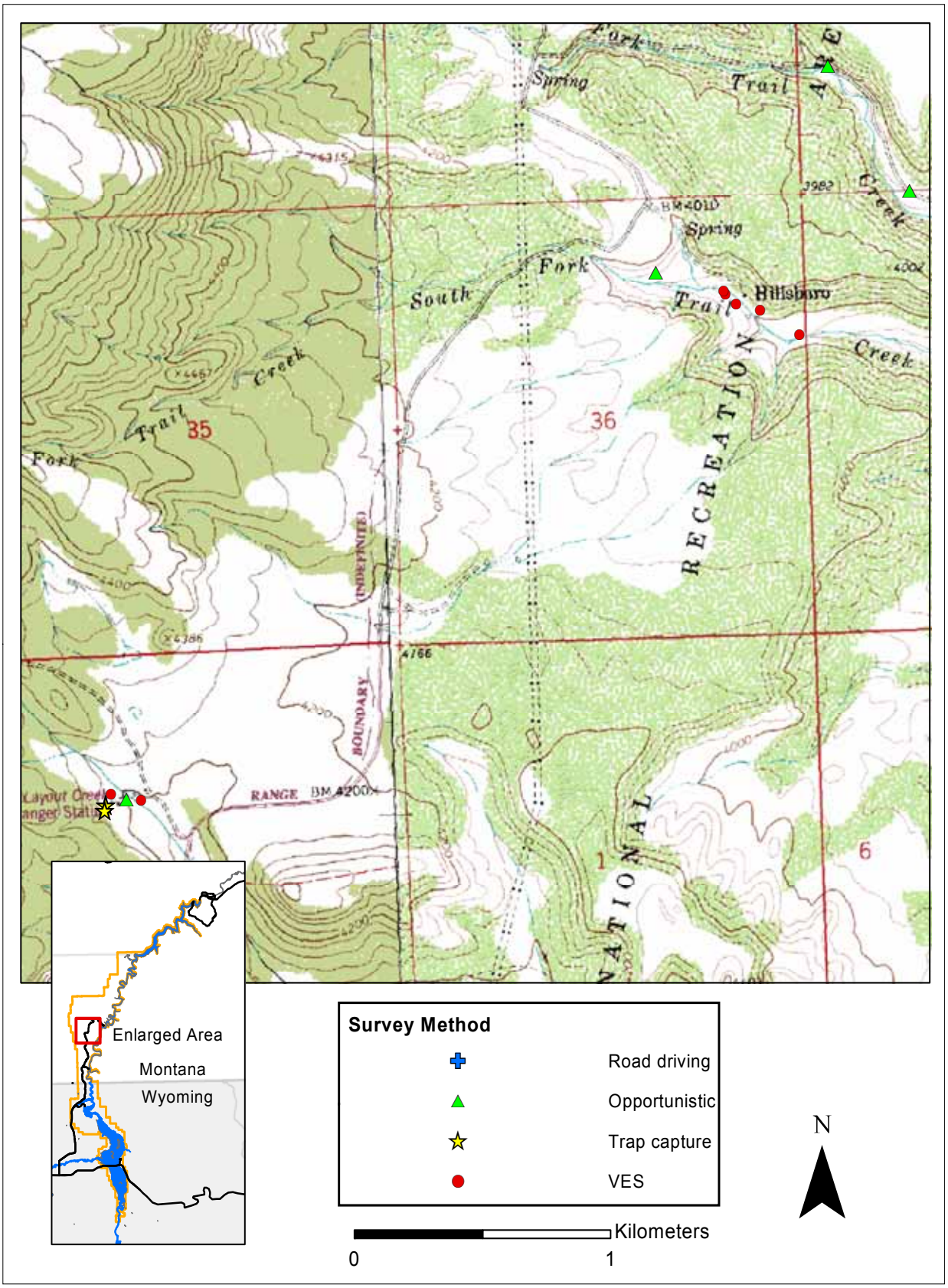


Figure 34d. Terrestrial Garter Snake distribution (Hillsboro and Mystery Cave Quadrangle, Mont./Wyo. 24k series).

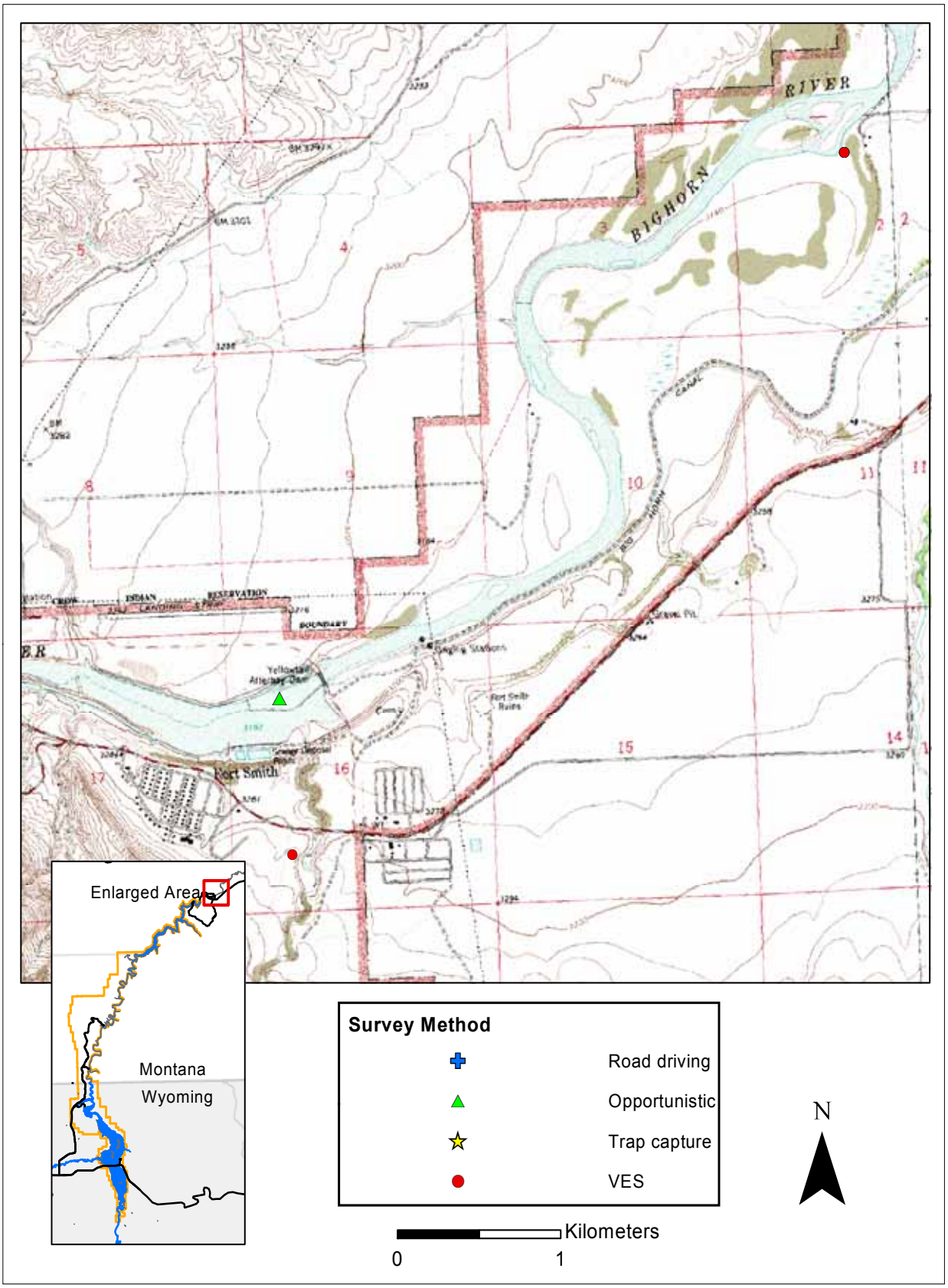


Figure 35. Common Garter Snake distribution (Yellowtail Dam Quadrangle, Mont. 24k series).

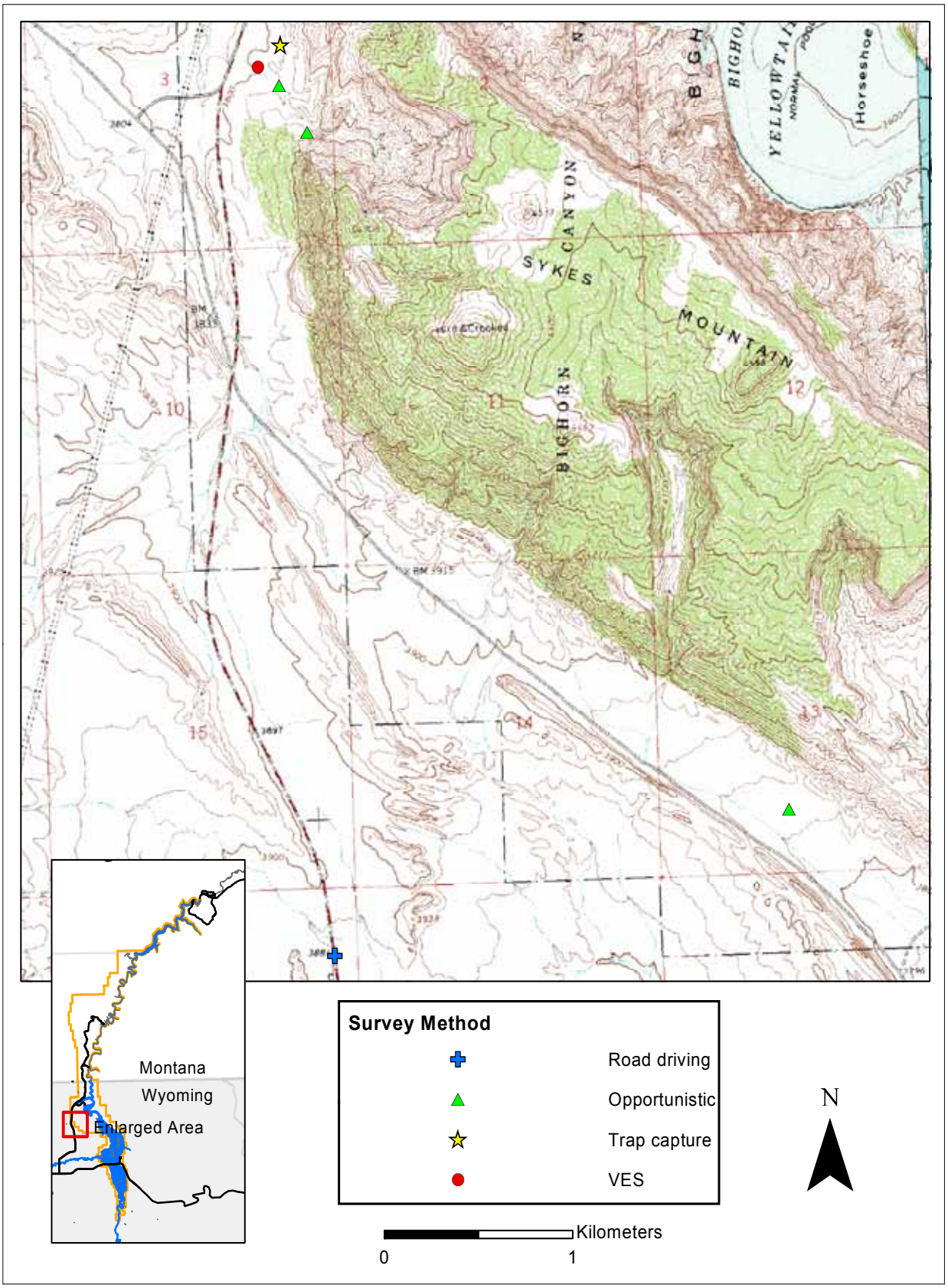


Figure 36a. Western Rattlesnake distribution (Sykes Springs Quadrangle, Wyo. 24k series).

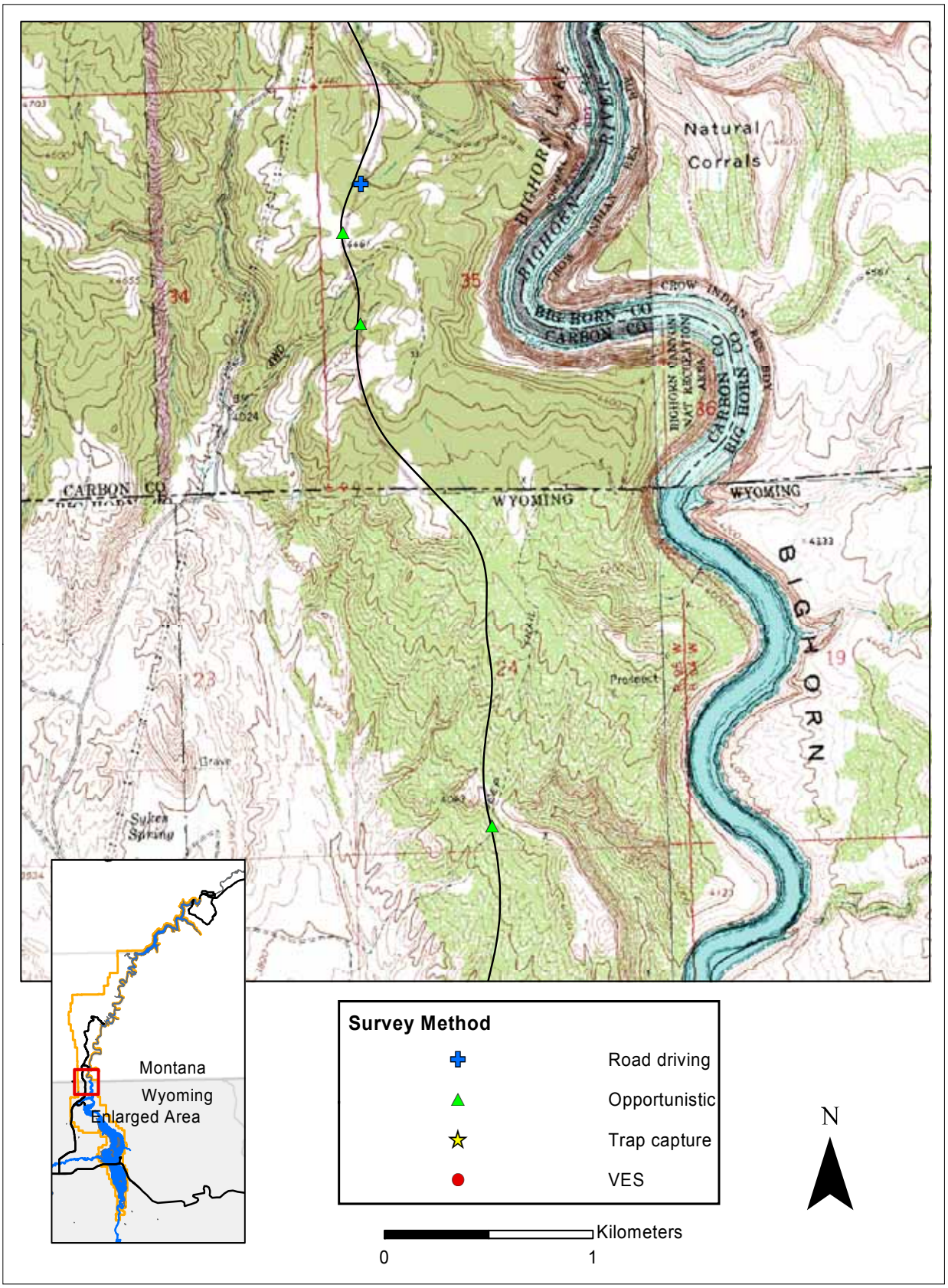


Figure 36b. Western Rattlesnake distribution (Hillsboro, Mystery Cave, Natural Trap Cave, and Sykes Springs Quadrangles, Mont./Wyo. 24k series).

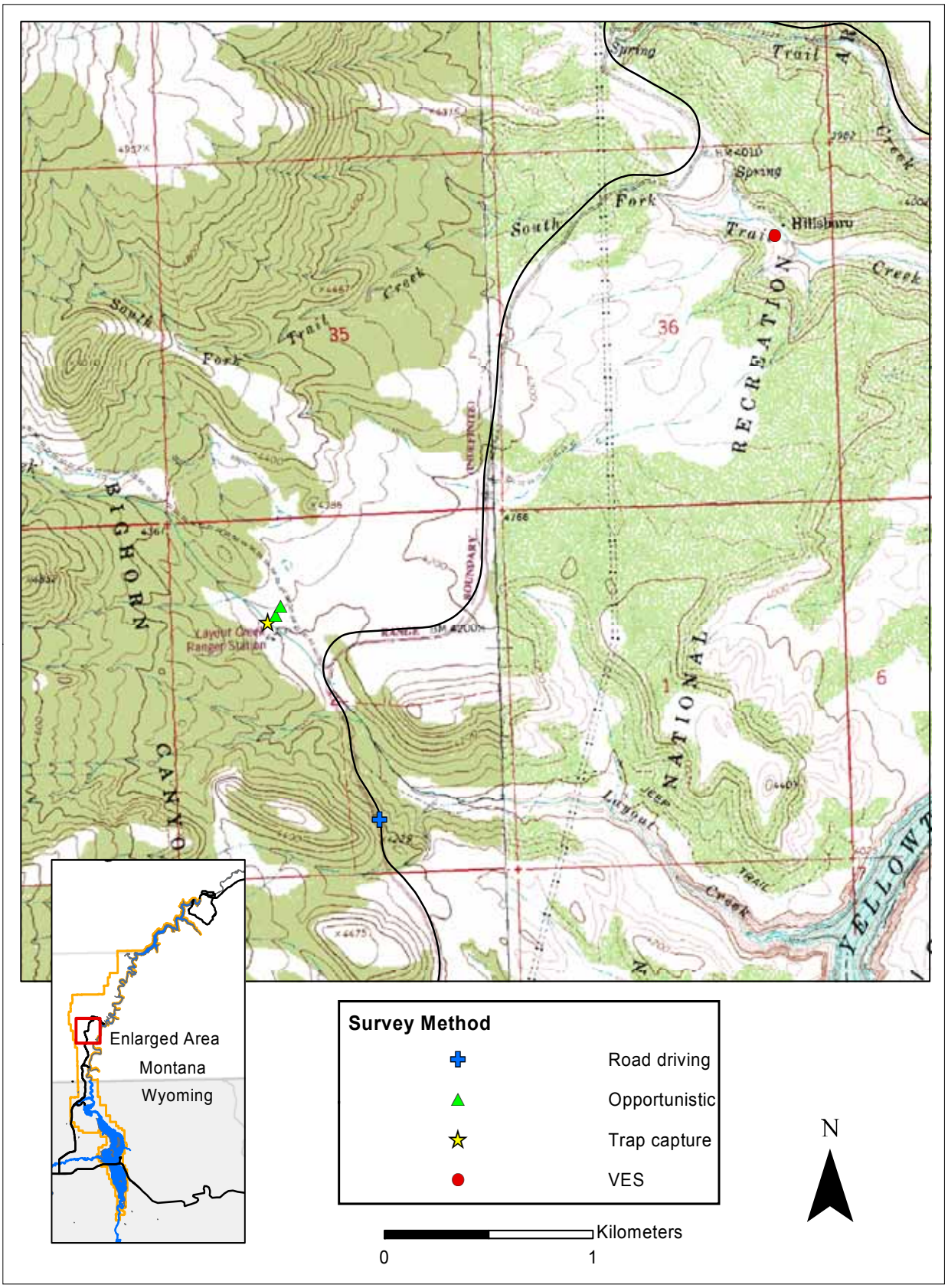


Figure 36c. Western Rattlesnake distribution (Hillsboro and Mystery Cave Quadrangles, Mont./Wyo. 24k series).

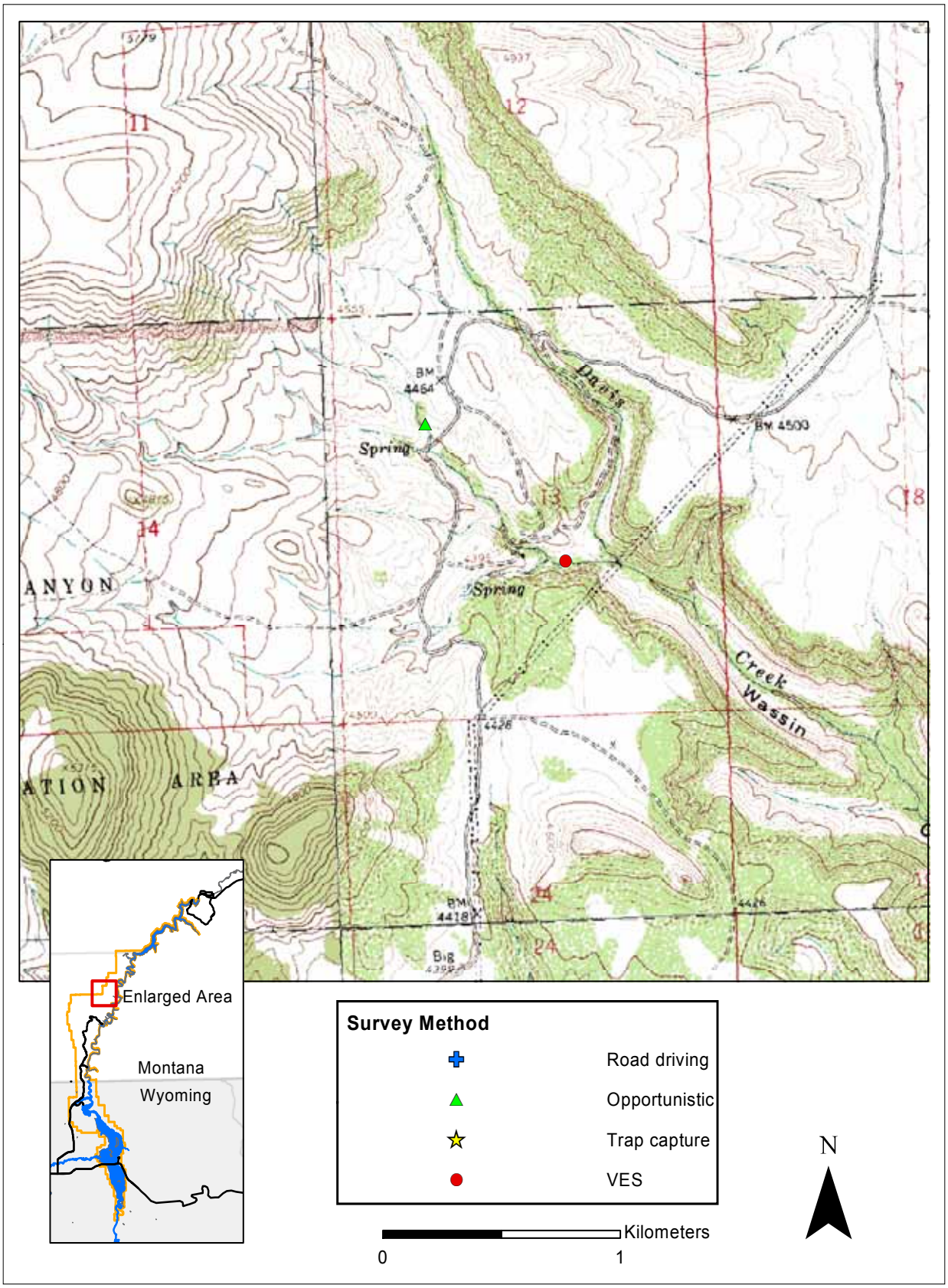


Figure 36d. Western Rattlesnake distribution (Dead Indian Hill Quadrangle, Mont. 24k series).

Appendices

Appendix A. Bighorn Canyon Habitat Classifications (Adapted from Knight et al., 1987).

1. Wetland

2. Riparian vegetation
    a. Floodplain meadow and mudflats
    b. Floodplain shrubland
    c. Floodplain woodland
    d. Creek woodland

3. Desert shrubland
    a. Saltbush
    b. Sagebrush
    c. Greasewood
    d. Mixed desert

4. Sagebrush steppe

5. Grassland
    a. Mixed-grass prairie
    b. Basin grassland
    c. Windswept plateau

6. Juniper/Mountain mahogany
    a. Juniper woodland
    b. Juniper/Mountain mahogany woodland
    c. Mountain mahogany woodland

7. Coniferous woodland or forest
    a. Limber pine
    b. Douglas fir
    c. Ponderosa pine
    d. Spruce-fir

8. Disturbed/Barren
    a. Rock
    b. Unvegetated

Appendix B. Wetland and Upland Sampling Site Photos.

Looking west over Kane Cemetery Pond from the southwest corner (Natural Trap Cave Quadrangle, Wyo. 7.5 minute series).

Looking east over pond located next to the south side of Kane Cemetery Pond (Natural Trap Cave Quadrangle, Wyo. 7.5 minute series).

View of Leck Mays pond looking west (Kane Quadrangle, Wyo. 7.5 minute series).

Photo taken of Railroad pond from the southeast end looking north (Kane Quadrangle, Wyo. 7.5 minute series).

Photo of pond 5 from the south end looking north (Sykes Spring Quadrangle, Wyo. 7.5 minute series).

Photo taken from the northeast end of Classroom pond looking south (Lovell Lakes Quadrangle, Wyo. 7.5 minute series).

View of Pond 6 from the southeast end looking northwest (Natural Trap Cave Quadrangle, Wyo. 7.5 minute series).

The north end of Pond 6 looking southwest (Natural Trap Cave Quadrangle, Wyo. 7.5 minute series).

Looking north over Pond 6.5 (Kane Quadrangle, Wyo. 7.5 minute series).

Pond 6.5 looking east (Kane Quadrangle, Wyo. 7.5 minute series).

Looking south over Pond 7 from the northwest end (Kane Quadrangle, Wyo. 7.5 minute series).

The west side of Pond 7 looking north (Kane Quadrangle, Wyo. 7.5 minute series).

Photo of Pond 8 looking east towards the Bighorn Mountains (Kane Quadrangle, Wyo. 7.5 minute series).

Looking west from the south side of Pond 8 (Kane Quadrangle, Wyo. 7.5 minute series).

Looking east over Pond 9 (Kane Quadrangle, Wyo. 7.5 minute series).

The northwest end of Pond 9 looking south (Kane Quadrangle, Wyo. 7.5 minute series).

This photo looking west over Pond 11 was taken on May 23, 2001. The pond was completely dry in early June (Kane Quadrangle, Wyo. 7.5 minute series).

Photo taken on May 29, 2001 of Ponds 1 and 2 looking north. These ponds were completely dry and not included in our surveys (Lovell Lakes Quadrangle, Wyo. 7.5 minute series).

The east side of Pond 4 looking west (Lovell Lakes Quadrangle, Wyo. 7.5 minute series).

Photo taken from the northeast end of Pond 3 looking south (Lovell Lakes Quadrangle, Wyo. 7.5 minute series).

Upland area near Horseshoe Bend campground consisting of basin grassland habitat. This photo was taken looking south toward Horseshoe Bend during a visual encounter survey (Sykes Spring Quadrangle, Wyo. 7.5 minute series).

Riparian habitat (creek woodland) at Hillsboro looking west toward the Pryor Mountains This area was searched using visual encounter surveys (Hillsboro Quadrangle, Mont. 7.5 minute series).

Creek woodland area searched using visual encounter surveys located south of Mason-Lovell Ranch (Kane Quadrangle, Wyo. 7.5 minute series).

Desert shrubland habitat searched near Sykes Mountain using visual encounter surveys (Sykes Spring Quadrangle, Wyo. 7.5 minute series).

Photo of desert shrubland habitat located southwest of Sykes Mountain (Sykes Spring Quadrangle, Wyo. 7.5 series).

Desert shrubland habitat located south of Sykes Mountain (Sykes Spring Quadrangle, Wyo. 7.5 minute series).

Photo of terrestrial funnel traps at trap site 1 (UTM 12N e0713572 n4980904) in desert shrubland habitat. This photo was taken looking east toward Sykes Mtn. (Sykes Springs Quadrangle, Wyo. 7.5 minute series).

Photo of riparian habitat at Crooked Creek that was searched using visual encounter surveys (Sykes Spring Quadrangle, Wyo. 7.5 minute series).

View of mixed desert shrubland habitat near Horseshoe Bend looking north (Sykes Spring Quadrangle, Wyo. 7.5 minute series).

View of juniper/mountain mahogany habitat north of Horseshoe Bend (Sykes Spring Quadrangle, Wyo. 7.5 minute series).

Photo of mountain mahogany habitat taken northeast of Horseshoe Bend (Mystery Cave Qudarangle, Mont.-Wyo. 7.5 minute series).

Photo of sagebrush steppe habitat located north of Layout Creek and the Ewing-Snell Ranch (Hillsboro Quadrangle, Mont.-Wyo. 7.5 minute series).

Photo of disturbed/barren habitat west of Crooked Creek Ranger Station (Sykes Spring Quadrangle 7.5 minute series, Wyoming).

Photo of juniper habitat (Natural Trap Cave Quadrangle 7.5 minute series, Wyoming).

Appendix C. Species Voucher Photos.

Woodhouse's Toad (*Bufo woodhousii*) observed June 7, 2002 (12:15 pm) at Kane Cemetery Pond, UTM 12N e0720526 n4973449.

Plains Spadefoot Toad (*Spea bombifrons*) observed June 1, 2002 (10:20 pm) on gravel road near Railroad Pond, UTM 12N e721445 n4969112.

Northern Leopard Frog (*Rana pipiens*) observed June26, 2002 (11:19 am) at Pond 8, UTM 12N e722487 n4967724.

Boreal Chorus Frog (*Pseudacris maculata*) observed 26 June, 2002 (10:47 am) at Pond 8, UTM 12N e722161 n4967654.

Snapping Turtle (*Chelydra serpentina*) observed.July 7, 2002 (6:15 pm) on Hwy 37 one mile north of Shoshone River brige, UTM 12N e710873 n4970759.

Gopher Snake (*Pituophis catenifer*) observed June 5, 2002 (12:50 pm) at Upper Layout Creek near Ewing-Snell Ranch, UTM 12N e715403 n4995812.

Western Rattlesnake (*Crotalus viridis*) observed July 7, 2002 (1:30 pm) one mile north of Crooked Creek, UTM 12N e715965 n4984890.

Appendix D. Explanations of NPSpecies Codes (Occurrence, Distribution, and Abundance).

PARK STATUS

- **Present:**
  Species occurrence in park is documented and assumed extant.
- **Historic:**
  Species historical occurrence in the park is documented, but recent investigations indicate that the species is now probably absent.
- **Probably Present:**
  Park is within species range and contains appropriate habitat. Documented occurrences of the species in the adjoining region of the park give reason to suspect that it probably occurs within the park. The degree of probability may vary within this category, including species that range from common to rare.
- **Encroaching:**
  The species is not documented in the park, but is documented as being adjacent to the park and has potential to occur in the park.
- **Unconfirmed:**
  Included for the park based on weak (unconfirmed) record or no evidence, giving minimal indication of the species occurrence in the park.
- **False Report:**
  Species previously reported to occur within the park, but current evidence indicates that the report was based on a misidentification, a taxonomic concept no longer accepted, or some other similar problem of interpretation.

SPECIES ABUNDANCE

- **Abundant:**
  May be seen daily, in suitable habitat and season, and counted in relatively large numbers.
- **Common:**
  May be seen daily, in suitable habitat and season, but not in large numbers.
- **Uncommon:**
  Likely to be seen monthly in appropriate season/habitat. May be locally common.
- **Rare:**
  Present, but usually seen only a few times each year.
- **Unknown:**
  Abundance unknown.

Appendix D. Continued.

RESIDENCY

- **Breeder:**
  Population reproduces in the park.
- **Resident:**
  A significant population is maintained in the park for more than two months each year, but it is not known to breed there.
- **Migratory:**
  Migratory species that occurs in park approximately two months or less each year and does not breed there.
- **Vagrant:**
  Park is outside of the species usual range.
- **Unknown:**
  Residency status in park is unknown.

SPECIES NATIVITY

- **Native:**
  The species is native to the park (either endemic or indigenous), or if the Park Status is Probably Present as defined above, the species would be native to the park if it were eventually confirmed in the park.
- **Non-Native (Exotic):**
  The species is not native to the park (neither endemic nor indigenous), or if the Park Status is Probably Present as defined above, the species would not be native to the park if it were eventually confirmed in the park.
- **Unknown:**
  Nativity classification in park is unknown.

Appendix E. Visual Encounter Survey (VES) Locations.

Date	Start time	End time	Easting	Northing	Zone	Observer(s)	Location
28-Apr-01	1430	16:30	715793.0	4983028.0	12	Baum, R.	Crooked Creek
28-Apr-01	1745	18:15	724229.4	4972210.2	12	Baum, R.	East side of Bighorn R. north of Cottonwd Cr.
28-Apr-01	1300	14:30	716040.0	4982599.0	12	Baum, R.	Horseshoe Bend Cmpgrnd
29-Apr-01	1415	14:45	718333.0	4978244.7	12	Baum, R., Bredow, W.	Abercrombie
29-Apr-01	1725	18:25	715555.7	4984730.0	12	Baum, R.	Spirited Horses pullout off of Hwy 37
30-Apr-01	1225	13:25	721615.4	4968431.8	12	Baum, R.	Railroad pond
30-Apr-01	1100	12:00	721277.6	4969280.2	12	Baum, R.	Railroad pond ditch
21-May-01	1658	18:00	720536.0	4973431.7	12	Baum, R.	East Kane Cemetery pond wetlands
22-May-01	1341	16:07	720429.7	4973513.3	12	Baum, R.	Kane Cemetery pond
22-May-01	1039	11:57	716465.8	4973126.9	12	Baum, R.	Pond 5
23-May-01	1009	10:50	724250.3	4964176.9	12	Baum, R.	Pond 11
23-May-01	1452	15:19	721813.4	4967905.2	12	Baum, R.	Pond 6 1/2
23-May-01	1326	14:10	721874.6	4967629.0	12	Baum, R.	Pond 7
23-May-01	1416	14:46	722127.3	4967681.2	12	Baum, R.	Pond 8
23-May-01	1607	16:47	722296.1	4967070.5	12	Baum, R.	Pond 9
24-May-01	1044	11:08	724597.0	4967865.0	12	Baum, R.	Mason-Lovell Ranch
24-May-01	1202	15:35	715029.0	4996359.0	12	Baum, R.	Upper Layout Cr.
25-May-01	1414	16:14	717504.2	4997671.5	12	Baum, R., Peterson, C., Redder, A.	Hillsboro
25-May-01	1106	13:19	716876.0	4982016.0	12	Baum, R., Peterson, C., Redder, A.	Horseshoe Bend Cmpgrnd
26-May-01	0955	11:35	714912.0	4982448.0	12	Baum, R., Peterson, C., Redder, A.	Crooked Creek
26-May-01	1600	16:54	720429.7	4973513.3	12	Baum, R., Peterson, C., Redder, A.	Kane Cemetery pond
26-May-01	1206	12:47	724438.0	4968207.0	12	Baum, R., Peterson, C., Redder, A.	Mason-Lovell Ranch & creek wdlnd to south
26-May-01	1447	15:15	721874.6	4967629.0	12	Baum, R., Redder, A.	Pond 7
29-May-01	1434	15:04	713462.2	4971959.7	12	Baum, R.	Pond 1
29-May-01	1513	16:23	714388.3	4972050.6	12	Baum, R.	Pond 4
30-May-01	1152	12:45	716612.9	4972164.6	12	Baum, R.	Classroom pond
30-May-01	1726	18:06	713794.4	4972058.5	12	Baum, R.	Pond 2
30-May-01	1646	17:26	714055.1	4972007.5	12	Baum, R.	Pond 3
30-May-01	1445	16:20	716465.8	4973126.9	12	Baum, R.	Pond 5

Appendix E. Continued.

Date	Start time	End time	Easting	Northing	Zone	Observer(s)	Location
30-May-01	0908	11:08	719314.7	4974643.8	12	Baum, R.	Pond 6
31-May-01	1405	15:40	717207.9	4971062.0	12	Baum, R.	Leck Mays pond
31-May-01	1610	17:14	721615.4	4968431.8	12	Baum, R.	Railroad pond
01-Jun-01	1645	17:45	715040.0	4996305.0	12	Baum, R.	Ewing-Snell Ranch
01-Jun-01	0927	11:42	716734.0	5001751.0	12	Baum, R.	Lockhart Ranch, Wassin Canyon
05-Jun-01	1337	15:03	717587.0	4998544.0	12	Baum, R.	North Fork Trail Creek, north side of BL road
05-Jun-01	0936	12:38	718509.0	5002787.0	12	Baum, R.	Pete's Canyon
06-Jun-01	1236	13:57	724317.0	4964163.0	12	Baum, R.	Creek Wdlnd south of Pond 11
06-Jun-01	1729	19:01	713823.0	4980843.0	12	Baum, R.	West side of Sykes mtn.
07-Jun-01	1050	11:50	717409.7	5002179.2	12	Baum, R.	Davis Cr. in north fork of Wassin Canyon
07-Jun-01	0857	10:11	720516.0	5007705.0	12	Baum, R.	Dry Head Creek area
07-Jun-01	1640	18:05	714137.0	4978356.0	12	Baum, R.	South/southwest side of Sykes mtn.
08-Jun-01	0940	11:20	716762.0	4976427.0	12	Baum, R.	Southeast side of Sykes mtn.
16-Jul-01	1455	15:25	716612.9	4972164.6	12	Baum, R.	Classroom pond
16-Jul-01	0925	11:50	720429.7	4973513.3	12	Baum, R.	Kane Cemetery pond
16-Jul-01	1330	14:35	719314.7	4974643.8	12	Baum, R.	Pond 6
17-Jul-01	1755	18:20	713794.4	4972058.5	12	Baum, R.	Pond 2
17-Jul-01	1726	17:55	714055.1	4972007.5	12	Baum, R	Pond 3
17-Jul-01	1655	17:25	714388.3	4972050.6	12	Baum, R.	Pond 4
17-Jul-01	1520	16:30	716465.8	4973126.9	12	Baum, R.	Pond 5
17-Jul-01	1025	11:00	721813.4	4967905.2	12	Baum, R.	Pond 6 1/2
17-Jul-01	1105	11:45	721874.6	4967629.0	12	Baum, R.	Pond 7
17-Jul-01	0920	10:20	722127.3	4967681.2	12	Baum, R.	Pond 8
17-Jul-01	1205	13:10	722296.1	4967070.5	12	Baum, R.	Pond 9
18-Jul-01	0755	8:37	717207.9	4971062.0	12	Baum, R.	Leck Mays pond
18-Jul-01	0855	9:34	721615.4	4968431.8	12	Baum, R.	Railroad Pond
30-May-02	1035	1135	714109.7	4981472.0	12	Baum, R.	VES site 3
30-May-02	1205	1235	716486.1	4982751.0	12	Baum, R.	VES site 18
30-May-02	1345	1415	716783.5	4984557.6	12	Baum, R.	VES site 24

Appendix E. Continued.

Date	Start time	End time	Easting	Northing	Zone	Observer(s)	Location
31-May-02	0930	1000	713109.9	4982056.5	12	Baum, R.	VES site 4
31-May-02	1130	1200	716460.5	4995498.6	12	Baum, R.	VES site 15
31-May-02	1245	1315	717715.9	4995698.3	12	Baum, R.	VES site 23
31-May-02	1025	1055	715141.9	4995986.6	12	Baum, R.	Layout Cr. east of Ewing-Snell Ranch
31-May-02	1440	1510	717624.5	4999048.4	12	Baum, R.	VES site 5
3-Jun-02	1110	1140	716457.2	4999628.3	12	Baum, R.; Kuttler, T.	VES site 6
3-Jun-02	1300	1330	713867.3	5000978.5	12	Baum, R.; Kuttler, T.	east Pryor Range
4-Jun-02	1500	1240	722296.1	4967070.5	12	Baum, R.; Kuttler, T.	Pond 9; YWHMA
4-Jun-02	1335	1435	721874.6	4967629.0	12	Baum, R.; Kuttler, T.	Pond 7; YWHMA
4-Jun-02	1135	1235	722127.3	4967681.2	12	Baum, R.; Kuttler, T.	Pond 8; YWHMA
4-Jun-02	1007	1107	721813.4	4967905.2	12	Baum, R.; Kuttler, T.	Pond 6.5; YWHMA
5-Jun-02	1245	1315	723816.4	4963858.2	12	Baum, R.; Kuttler, T.	Upper Layout Cr. at Ewing-Snell Ranch
6-Jun-02	0930	1030	721615.4	4968431.8	12	Baum, R.; Kuttler, T.	Railroad Pond; YWHMA
6-Jun-02	1307	1420	714388.3	4972050.6	12	Baum, R.; Kuttler, T.	Pond 4; YWHMA
6-Jun-02	1440	1540	716612.9	4972164.6	12	Baum, R.; Kuttler, T.	Classroom Pond; YWHMA
6-Jun-02	1050	1150	717207.9	4971062.0	12	Baum, R.; Kuttler, T.	Leck Mayes Pond; YWHMA
7-Jun-02	0815	0915	716465.8	4973126.9	12	Baum, R.; Kuttler, T.	Pond 5; YWHMA
7-Jun-02	1107	1245	720429.7	4973513.3	12	Baum, R.; Kuttler, T.	Kane Cemetery Pond; YWHMA
7-Jun-02	1000	1100	719314.7	4974643.8	12	Baum, R.; Kuttler, T.	Pond 6; YWHMA
11-Jun-02	1410	1440	274542.5	5024931.9	13	Baum, R.; Kuttler, T.	3 mile access near Bighorn R. (Ft. Smith)
11-Jun-02	1257	1327	270493.9	5021263.2	13	Baum, R.; Kuttler, T.	Picnic area east of Ft. Smith
12-Jun-02	0910	1000	266826.0	5020984.0	13	Kuttler, T.	Ok-A-Beh area
12-Jun-02	1100	1220	269827.0	5021553.0	13	Kuttler, T.	Ft. Smith hill
12-Jun-02	1240	1340	268972.0	5021616.0	13	Kuttler, T.	near Yellowtail Dam
12-Jun-02	1400	1430	270331.0	5021724.0	13	Kuttler, T.	Ft. Smith area
12-Jun-02	1440	1530	270459.0	5021830.0	13	Kuttler, T.	Ft. Smith sewage treatment ponds
13-Jun-02	1315	1415	27465.0	502516.0	13	Kuttler, T.	3 mile access area
13-Jun-02	0900	0930	270373.0	5021828.0	13	Kuttler, T.	Ft. Smith sewage treatment ponds
13-Jun-02	1030	1130	269772.0	5022396.0	13	Kuttler, T.	large pond north of Bighorn R. at Ft. Smith

Appendix E. Continued.

Date	Start time	End time	Easting	Northing	Zone	Observer(s)	Location
13-Jun-02	1200	1300	274419.0	5024988.0	13	Kuttler, T.	3 mile access wetland
14-Jun-02	1320	1350	718322.1	4997410.1	12	Baum, R.	S. Fork Trail Cr. east of Hillsboro Ranch
14-Jun-02	1225	1255	717788.8	4997565.5	12	Baum, R.	Hillsboro Ranch
14-Jun-02	1417	1447	717173.7	4998493.6	12	Baum, R.	N. Fork Trail Cr.
14-Jun-02	1025	1055	724373.0	4968382.3	12	Baum, R.	Creek woodland north of Mason-Lovel Ranch
14-Jun-02	0945	1015	724572.1	4967962.8	12	Baum, R.	Mason-Lovell Ranch
14-Jun-02	1430	1530	270884.0	5021913.0	13	Kuttler, T.	near Yellowtail Afterbay
14-Jun-02	1310	1410	269566.0	5022173.0	13	Kuttler, T.	Yellowtail Afterbay campground
15-Jun-02	1155	1305	714858.8	4996696.7	12	Baum, R.	Ewing-Snell Ranch
15-Jun-02	1330	1430	717728.5	5001612.7	12	Baum, R.	Lockhart Ranch
17-Jun-02	1120	1220	270824.0	5021076.0	13	Kuttler, T.	Ft. Smith firing range
17-Jun-02	1010	1110	270440.0	5021300.0	13	Kuttler, T.	Picnic area near Ft. Smith
17-Jun-02	1340	1440	269655.0	5021329.0	13	Kuttler, T.	Ft. Smith area
18-Jun-02	1347	1417	720148.7	4998383.4	12	Baum, R.	VES site 16
18-Jun-02	1420	1450	719312.4	4998513.5	12	Baum, R.	Chain Canyon drainage
18-Jun-02	0910	1010	270911.0	5021252.0	13	Kuttler, T.	Lime Kiln Cr near Ft. Smith firing range
18-Jun-02	1030	1130	270922.0	5021880.0	13	Kuttler, T.	Lime Kiln Cr. north of bridge
18-Jun-02	1430	1450	269490.0	5021985.0	13	Kuttler, T.	Ft. Smith Campground
18-Jun-02	1220	1320	274480.0	5025002.0	13	Kuttler, T.	3 mile access wetland
18-Jun-02	1325	1355	274485.0	5025012.0	13	Kuttler, T.	3 mile access area
19-Jun-02	1120	1220	714518.2	4995877.7	12	Baum, R.	Upper Layout Cr. west of Ewing-Snell Ranch
19-Jun-02	1312	1345	715468.1	4995879.0	12	Baum, R.	VES site 26; north of Ewing-Snell Ranch
19-Jun-02	1508	1538	716475.1	5002111.0	12	Baum, R.	VES site 28; west of Lockhart Ranch
19-Jun-02	1430	1500	716696.5	5002492.9	12	Baum, R.	VES site 27; NW of Lockhart Ranch
19-Jun-02	0935	1042	713999.0	4982505.8	12	Baum, R.	Crooked Cr.
19-Jun-02	1245	1345	269681.0	5022050.0	13	Kuttler, T.	near Ft. Smith sewage treatment plants
19-Jun-02	1030	1145	270545.0	5022179.0	13	Kuttler, T.	Yellowtail Afterbay area
20-Jun-02	1000	1200	718738.5	5000797.7	12	Baum, R.	Wassin Canyon
26-Jun-02	1140	1240	722296.1	4967070.5	12	Baum, R.; Kuttler, T.	Pond 9; YWHMA

Appendix E. Continued.

Date	Start time	End time	Easting	Northing	Zone	Observer(s)	Location
26-Jun-02	0823	0923	721874.6	4967629.0	12	Baum, R.; Kuttler, T.	Pond 7; YWHMA
26-Jun-02	1020	1120	722127.3	4967681.2	12	Baum, R.; Kuttler, T.	Pond 8; YWHMA
26-Jun-02	0925	1015	721813.4	4967905.2	12	Baum, R.; Kuttler, T.	Pond 6.5; YWHMA
26-Jun-02	1330	1430	721615.4	4968431.8	12	Baum, R.; Kuttler, T.	Railroad Pond; YWHMA
27-Jun-02	1100	1200	716465.8	4973126.9	12	Baum, R.; Kuttler, T.	Pond 5; YWHMA
27-Jun-02	0815	0930	720429.7	4973513.3	12	Baum, R.; Kuttler, T.	Kane Cemetery Pond; YWHMA
27-Jun-02	1002	1045	719314.7	4974643.8	12	Baum, R.; Kuttler, T.	Pond 6; YWHMA
27-Jun-02	1345	1415	714575.2	4989035.8	12	Baum, R.; Kuttler, T.	VES site 17
27-Jun-02	1417	1447	714188.7	4989231.0	12	Baum, R.; Kuttler, T.	VES site 25
28-Jun-02	0954	1024	714995.4	4978090.4	12	Baum, R.; Kuttler, T.	VES site 7
28-Jun-02	0915	0950	714471.3	4978111.7	12	Baum, R.; Kuttler, T.	VES site 1
29-Jun-02	1400	1430	729962.4	5010859.2	12	Baum, R.	Big Bull Cr.
29-Jun-02	1015	1120	723178.6	4999573.6	12	Baum, R.	Gyp Creek
29-Jun-02	1220	1240	723665.0	5011752.2	12	Baum, R.	Pitchfork Cr.
1-Jul-02	1135	1220	723770.2	4963733.9	12	Baum, R.	shore of Bighorn R. at south end of YWHMA
1-Jul-02	1235	1330	723235.1	4970387.9	12	Baum, R.	shore of Bighorn R. at south of 14A bridge
7-Jul-02	1210	1310	715420.0	4995579.8	12	Baum, R.	Ewing-Snell Ranch
8-Jul-02	1750	1820	715713.7	4995816.5	12	Baum, R.	VES site 20; north of Ewing-Snell Ranch
9-Jul-02	0912	0945	715989.9	4981812.4	12	Baum, R.	VES site 19; south of Horseshoe Bend campground
9-Jul-02	1005	1035	715571.7	4986505.8	12	Baum, R.	VES site 29; Wyoming/Montana stateline trail
9-Jul-02	1057	1127	716469.1	4990936.8	12	Baum, R.	VES site 30; Booz Canyon
10-Jul-02	1045	1115	715749.7	4986980.9	12	Baum, R.	VES site 31; Stateline trail
10-Jul-02	1455	1525	713833.4	4996557.0	12	Baum, R.	VES site 33; west Upper Layout Cr.
10-Jul-02	1200	1230	716982.3	5001917.8	12	Baum, R.	VES site 32; Lockhart Ranch area